



ENGINE

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STANDARD SERVICE PROCEDURES

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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. Bead size, continuity, and location are of great importance. Too thin a bead can result in leakage while too much can result in spillover which can break off and obstruct fluid feed lines. A continuous bead of the proper width is essential to obtain a leak-free joint.

Two types of form-in-place gasket materials are used in the engine area. Mopar Silicone Rubber Adhesive Sealant and anaerobic gasket materials, each have different properties and cannot be used interchangeably.

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 normally red in color. The material cures in the absence of air when squeezed between two metallic surfaces. It will not cure if left in the uncovered tube. It is normally red in color. 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 flat plate if required. Gasket surfaces must be free of oil and dirt. Make sure old gasket material is removed from blind attaching holes.

FORM-IN-PLACE GASKET APPLICATION

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

MOPAR Gasket Maker material should be applied sparingly 1mm(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 the material off location.

The MOPAR Silicone Rubber Adhesive Sealant gasket material or equivalent should be applied in a continuous bead approximately 3mm (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 towels. Compo-



nents 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 of material off 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° indicating 1, 2 or 3 (timing belt) teeth may have skipped, then, camshaft and accessory shaft timing with the crankshaft 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.

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

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

(c) 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.

(d) 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.

(e) Disconnect the coil connector for Direct Ignition System (DIS).

(f) Be sure throttle blade is fully open during the compression check.

(g) 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.

(h) Repeat Step G for all remaining cylinders.

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

(j) If one or more cylinders have abnormally low compression pressures, repeat steps 4b through 4h.

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

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

(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 pressure and vacuum. 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.

HONING CYLINDER BORES

Before honing, stuff plenty of clean shop towels under the bores, over the crankshaft to keep abrasive materials from entering crankcase area.

(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 (C-3501-3810) 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 available from major oil distributors. **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. 1).

(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.

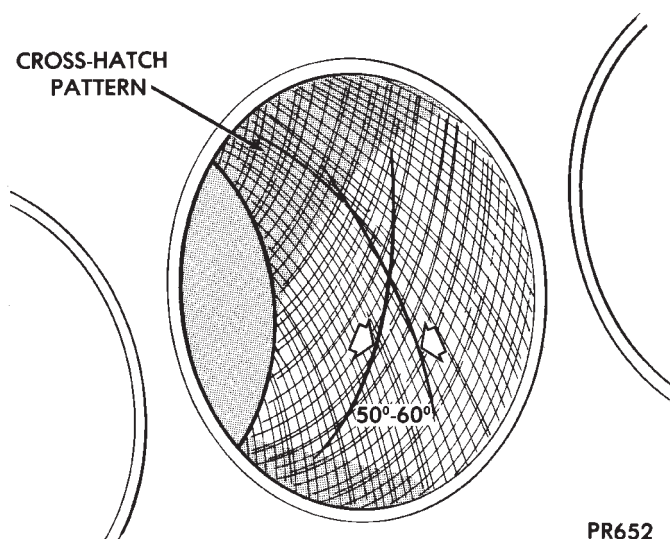


Fig. 1 Cylinder Bore Cross-Hatch Pattern

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

CAUTION: Be sure all abrasive 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.

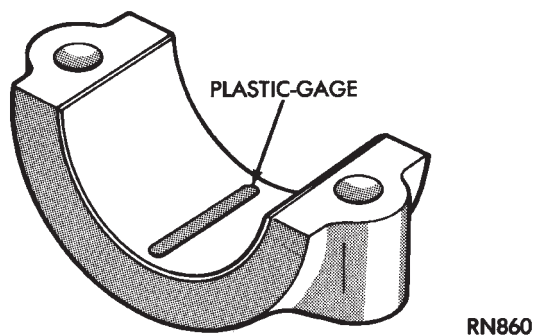


Fig. 2 Plastigage Placed in Lower Shell

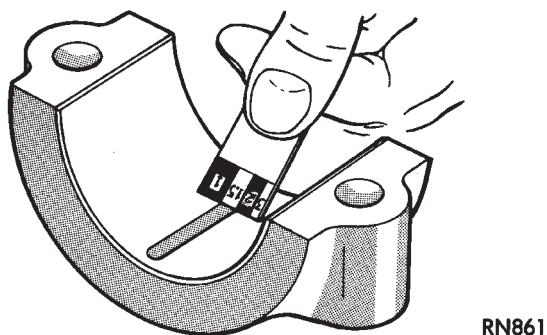


Fig. 3 Clearance Measurement

MEASURING MAIN BEARING CLEARANCE AND CONNECTING ROD BEARING CLEARANCE

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:

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

(2) 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 0.254mm (.010 inch) shim (e. g. cardboard, matchbook cover, etc.) between the bearing shell and the bearing cap on the adjacent bearings and tighten bolts to 14-20 N•m (10-15 ft.lb.)

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

REMOVE ALL SHIMS BEFORE REASSEMBLING ENGINE

ALTERNATIVE METHOD — With the weight of the crankshaft being supported by a jack under the counterweight adjacent to the bearing being checked.

(3) Place a piece of Plastigage across the entire width of the bearing shell in the cap approximately 6.35 mm (1/4 inch) off center and away from the oil holes (Fig. 2). (In addition, suspect areas can be checked by placing the Plastigage in the suspect area). Torque the bearing cap bolts of the bearing being checked to the proper specifications.

(4) Remove the bearing cap and compare the width of the flattened Plastigage (Fig. 3) 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. **Plastic-Gage generally is accompanied by two scales. One scale is in inches, the other is a metric scale.**

(5) Plastigage is available in a variety of clearance ranges. The 0.025-0.076mm (.001-.003 inch) is usually the most appropriate for checking engine bearing proper specifications.

CONNECTING ROD BEARING CLEARANCE

Engine crankshaft 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 inch.) off center and away from the oil hole (Fig. 2). In addition, suspect areas can be checked by placing plastigage in the suspect area.

(4) Before assembling the rod cap with Plastigage in place, the crankshaft must be rotated until the connecting being checked starts moving toward the top of the engine. Only then should the cap be assembled and torqued to specifications. **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. 3) 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.**

(6) Plastigage is available in a variety of clearance ranges. The 0.025-0.076mm (.001-.003 inch) is usually the most appropriate for checking engine bearing proper specifications.

HYDRAULIC 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.

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

(3) Low oil pressure.

(4) The oil restrictor pressed into the vertical oil passage to the cylinder head Balance Shaft Engines Only is plugged with debris.

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

(6) Worn valve guides.

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

(8) Faulty hydraulic lash adjuster.

(a) Check for sponginess while still installed in cylinder head. Depress part of rocker arm just over adjuster. Normal adjusters should feel very firm. Spongy adjusters can be depressed to the bottomed position easily.

(b) Remove suspected rocker arm/lash adjuster assembly and replace the assembly. **Do not disassemble the lash adjuster from the rocker arm.**

(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.

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 (or equivalent) Tap, and installing an insert into the tapped hole. This brings the hole back to its original thread size.

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

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

HYDROSTATIC LOCKED ENGINE

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

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

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

(2) Remove negative battery cable.

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

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

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

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

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

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

(8) Install new spark plugs.

(9) Drain engine oil and remove oil filter.

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

(11) Connect negative battery cable.

(12) Start engine and check for any leaks.



ENGINE DIAGNOSIS—PERFORMANCE

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT START	1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Moisture on ignition wires and distributor cap. 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 and cap 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 filter. 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. 6. EGR valve leaking.	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). 6. Test and replace, if necessary (refer to Group 25, Emissions Control 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 in throttle body. 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 injector. 4. Clean system and replace fuel filter.



ENGINE DIAGNOSIS—MECHANICAL

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Low oil pressure. 4. Dirt in tappets/lash adjusters. 5. Bent push rods. 6. Worn rocker arms. 7. Worn tappets/lash adjusters. 8. Worn valve guides. 9. Excessive runout of valve seats on valve faces.	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. Clean hydraulic tappets/hydraulic lash adjusters. 5. Install new push rods. 6. Inspect oil supply to rocker arms. 7. Install new hydraulic tappets/hydraulic lash adjusters. 8. Ream and install new valves with oversize stems. 9. Grind valve seats and valves.
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 No. 2 main 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 or cracked. 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, if necessary. 10. Install new oil pump.
OIL LEAKS	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part.	1. Replace the gasket. 2. Tighten, repair or replace the part.
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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GENERAL INFORMATION

ENGINE IDENTIFICATION NUMBER OR CODE

The engine identification number is located on the rear of the cylinder block just below the cylinder head (Fig. 2).

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.

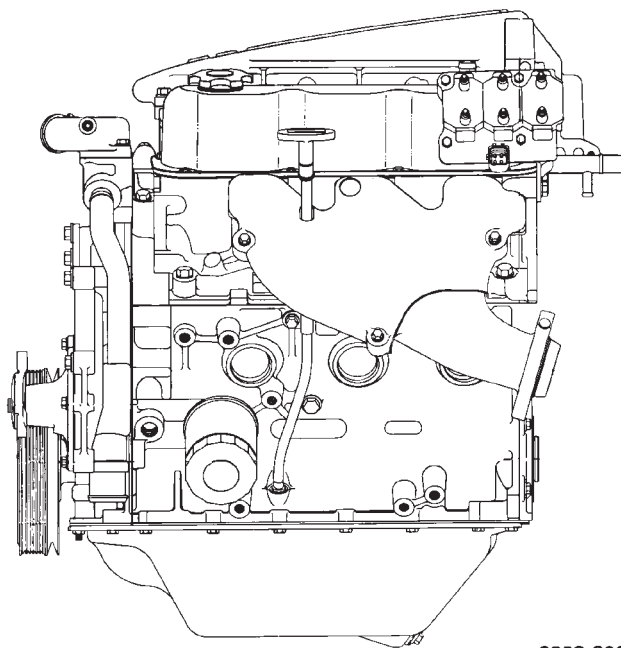
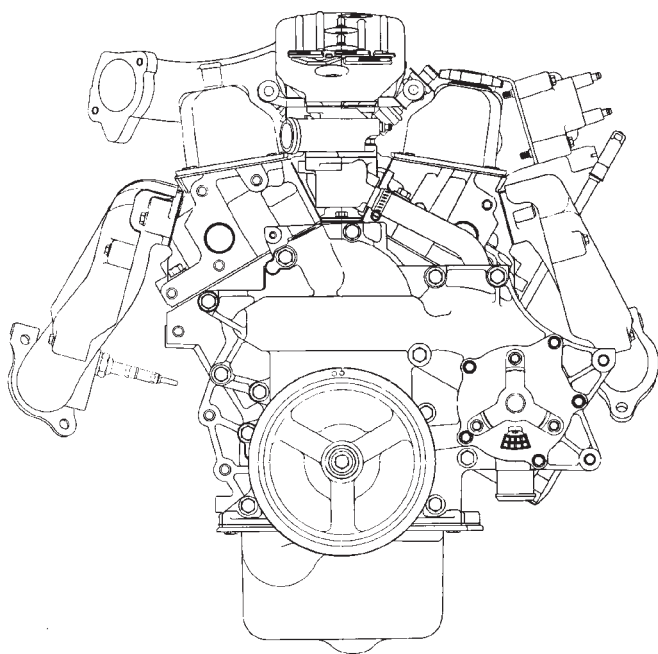
PISTONS: The pistons are cast aluminum alloy. Three rings are used. Piston pins, press fitted into place, join the pistons to forged steel connecting rods.

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, provides front oil pan closure, 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.

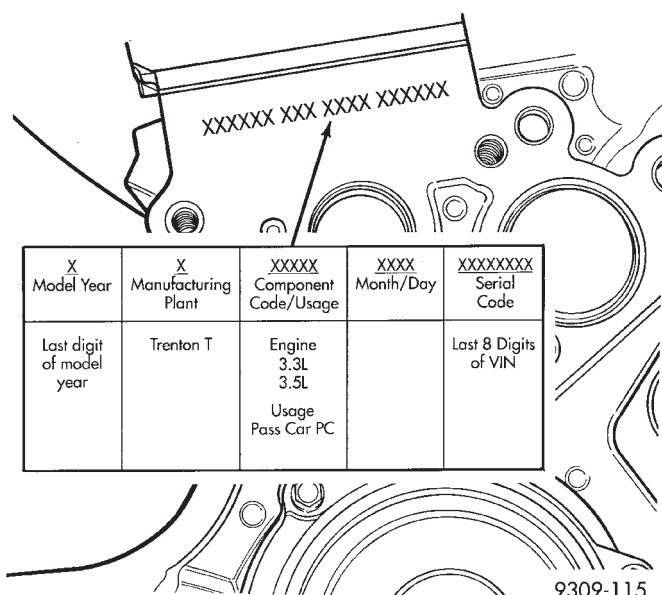
SPECIFICATIONS

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	153 @ 5300 RPM
Torque	177 Lb. Ft. @ 2800 RPM
Firing Order	1-2-3-4-5-6
Lubrication	Pressure Feed-Full Flow Filtration (Direct Crankshaft Driven Pump)
Engine Oil Capacity	4.7 Liters (5 Qts.) Including Oil Filter, 4.3 Liter (4.5 Qts.) Without Oil Filter
Cooling System	Liquid Cooled-Forced Circulation
Cylinder Block	Cast Iron
Crankshaft	Nodular Iron
Cylinder Head	Aluminum Alloy
Connecting Rods	Forged Steel
Pistons	Aluminum Alloy



9309-200

Fig. 1 3.3L V-6 Engine



9309-115

Fig. 2 Engine Identification

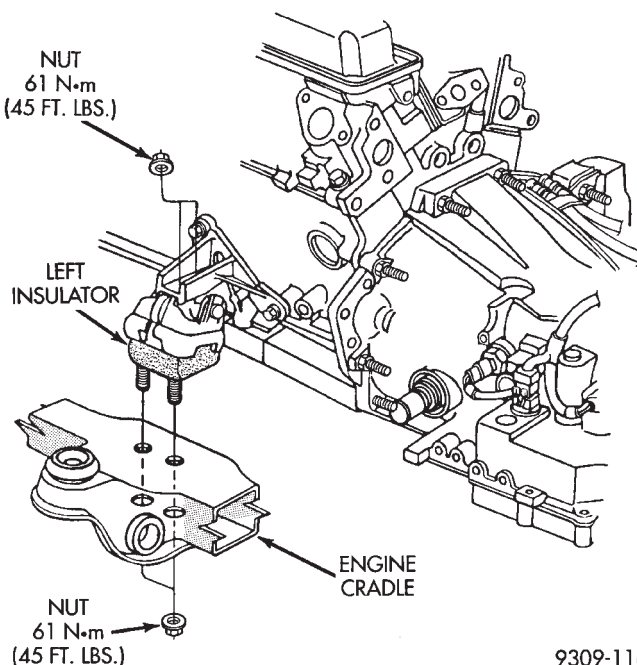
VALVE COVERS: The covers are sealed with steel reinforced silicon rubber gaskets.

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 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.



9309-116

Fig. 3 Engine Mounting — Typical



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. 2).
- (5) Raise engine carefully with jack enough to remove the insulator from its mount.

INSTALLATION

- (1) Install insulator onto the frame.
- (2) Lower the engine onto the insulator mount (Fig. 2). 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.).

REAR MOUNT

- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator thru bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount.
- (5) Reverse removal procedure for installation. Refer to for bolt tightening specifications.

ENGINE HYDRO-MOUNT INSULATORS

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

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

ENGINE ASSEMBLY

REMOVAL

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

- (11) Disconnect exhaust pipe at manifold.

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

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

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

- (15) Remove two lower transmission to block screws.

- (16) Remove starter.

- (17) Lower vehicles and disconnect vacuum lines and ground strap.

- (18) Support transmission with floor jack.

- (19) Attach engine lifting hoist and support engine.

- (20) Remove upper transmission case to block bolts.

- (21) See Engine Mounting in (Fig. 3). Remove insulator mounting nuts from mount.

- (22) Remove engine.

INSTALLATION

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

- (2) Align engine mounts and install all nuts. Tighten fasteners to specified torque (Fig. 3).

- (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 screws. 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 see Accessory Belt Drive in Cooling System Group 7.

- (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 Cooling System Group 7 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.



ROCKER ARMS AND SHAFT ASSEMBLY

REMOVAL

- (1) Remove upper intake manifold assembly. Refer to Intake and Exhaust Manifolds, Group 11.
- (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. 4) for rocker arm for positioning on the shaft.

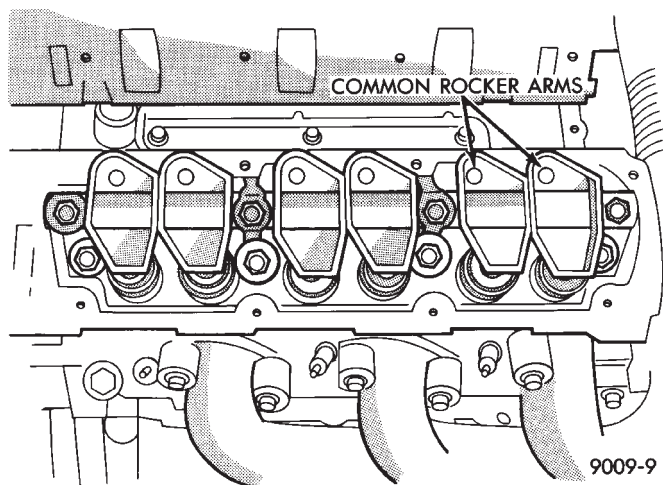


Fig. 4 Rocker Arm Location Left Bank

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. 4).

WARNING: 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 Exhaust Systems and Intake Manifolds Group 11.

CYLINDER HEADS

The alloy aluminum cylinder heads shown in (Fig. 5) are held in place by 9 bolts. The spark plugs are located in peak of the wedge between the valves.

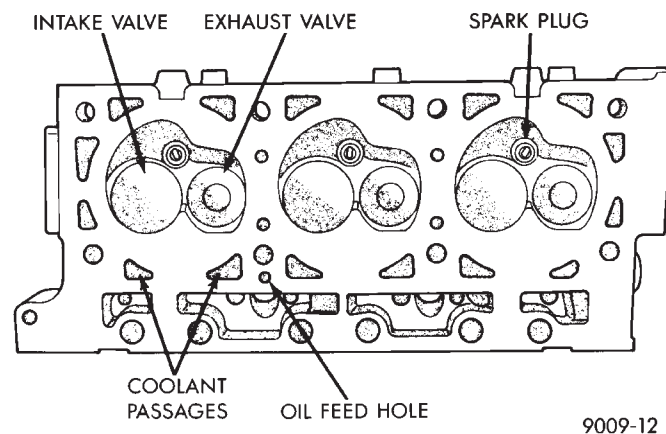


Fig. 5 Cylinder Head Assembly

REMOVAL

- (1) Drain cooling system refer to Cooling System Group 7 for procedure and disconnect negative battery cable.
- Remove intake manifold, and throttle body. Refer to Group 11 Exhaust System and Intake Manifold.
- (2) Disconnect coil wires, sending unit wire, heater hoses and by-pass hose.
- (3) Remove closed ventilation system, evaporation control system and cylinder head covers.
- (4) Remove exhaust manifolds.
- (5) Remove rocker arm and shaft assemblies. Remove push rods and **identify to insure installation in original locations.**
- (6) Remove the 9 head bolts from each cylinder head and remove cylinder heads (Fig. 6).

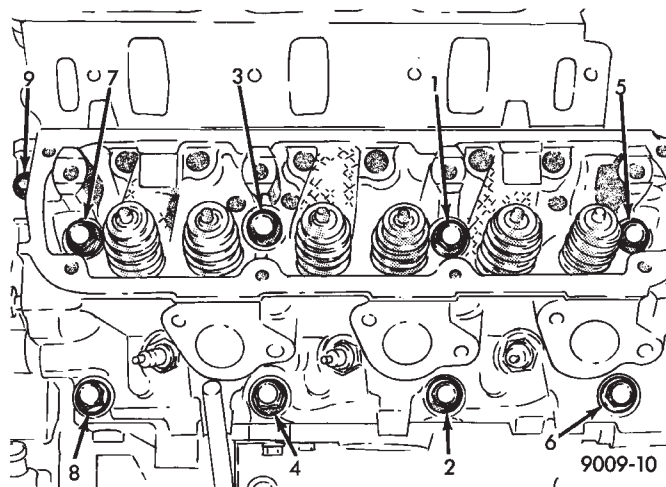


Fig. 6 Cylinder Head Bolts Location



INSPECTION

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

(2) Clean cylinder head and oil passages.

(3) Check cylinder head for flatness (Fig. 7).

(4) Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out of flatness exceeds .019mm (.00075 inch), 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 1mm (.004 inch) out of flat, allowable is $12 \times .019\text{mm}$ (.00075 inch) equals .22mm (.009 in.) This amount of out of flat is acceptable.

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

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

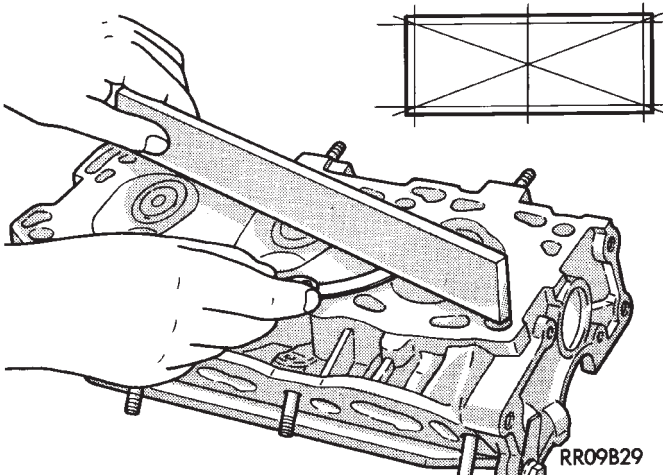


Fig. 7 Check Cylinder Head

INSTALLATION

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

(2) Install new gaskets on cylinder block (Fig. 8).

The Cylinder head bolts are torqued using the torque yield method, they should be examined BEFORE reuse. If the threads are necked down, the bolts should be replaced (Fig. 9).

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) Tighten the cylinder head bolts 1 thru 8 in the sequence shown in (Fig. 10). 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**

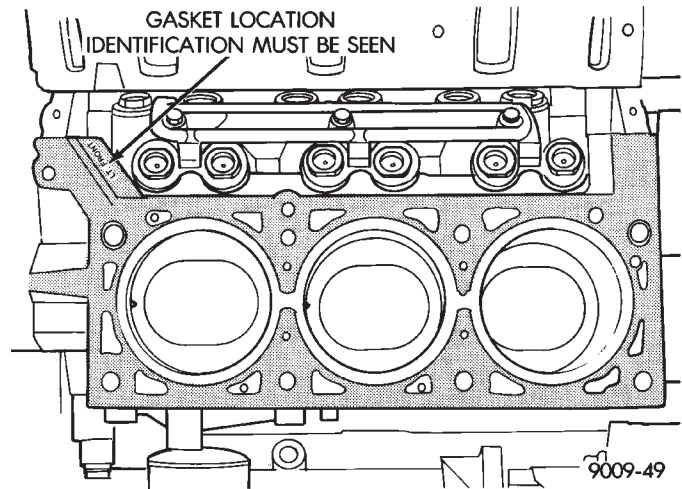


Fig. 8 Head Gasket Installation

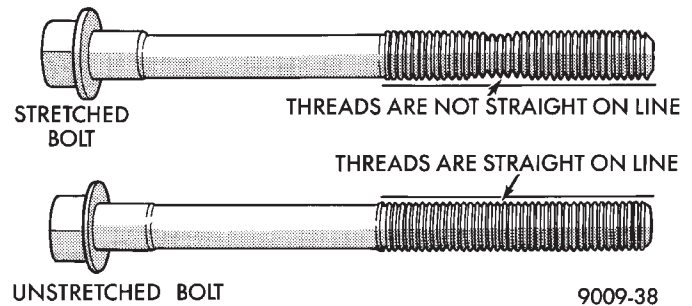


Fig. 9 Checking Bolts for Stretching (Necking)

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

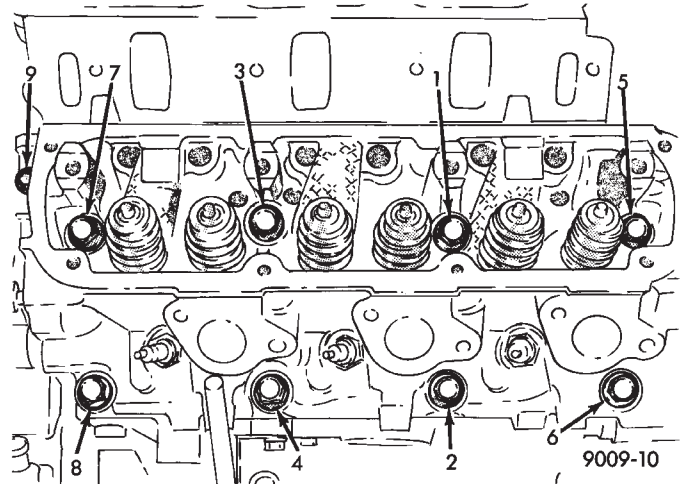


Fig. 10 Cylinder Head Tightening Sequence

(5) Tighten head bolt number 9 (Fig. 10) to 33 N•m (25 ft. lbs.) after head bolts 1 thru 8 have been tightened to specifications.

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



(7) 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. 11).

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

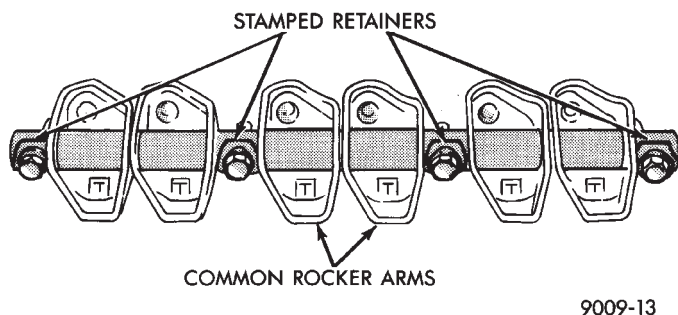


Fig. 11 Rocker Arm Shaft Retainers

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. 12).

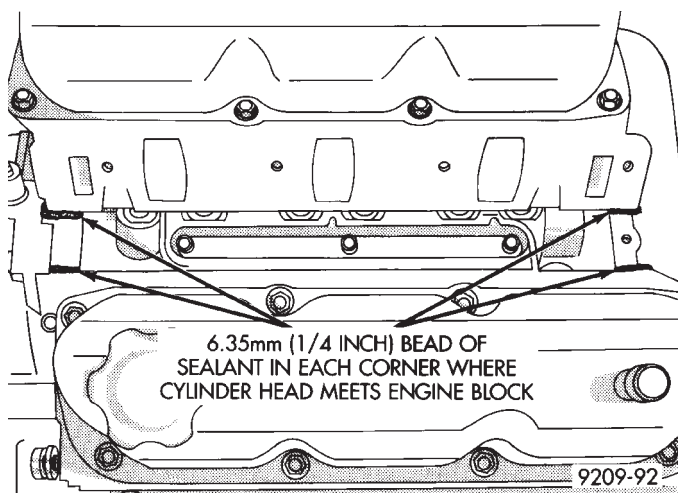


Fig. 12 Intake Manifold Gasket Sealing

(3) Carefully install the intake manifold gasket (Fig. 13). 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 torque bolts to 22 N•m (200 in. lbs.) in sequence shown in (Fig. 14). Then torque 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. lb.) and nuts to 20 N•m (15 ft. lbs.).

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

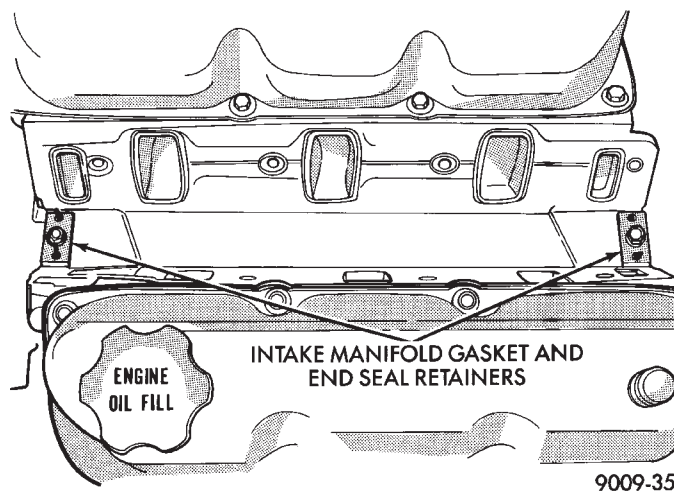


Fig. 13 Intake Manifold Gasket Retainers

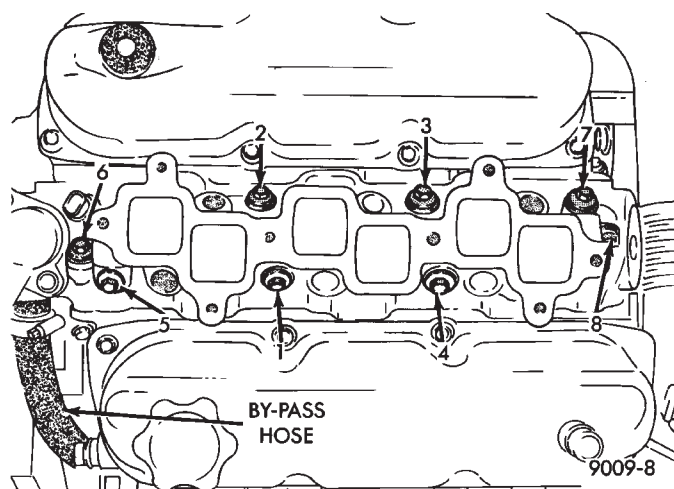


Fig. 14 Intake Manifold Removal and Installation
VALVE SERVICE

VALVES AND VALVE SPRINGS

The valves are arranged in line in the cylinder heads and inclined 18 degrees. The rocker shaft support are cast integral with the heads.

REMOVAL

(1) With cylinder head removed, compress valve springs using Valve Spring Compressor Tool C-3422-B with adapter 6412 as shown in (Fig. 15).

(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.

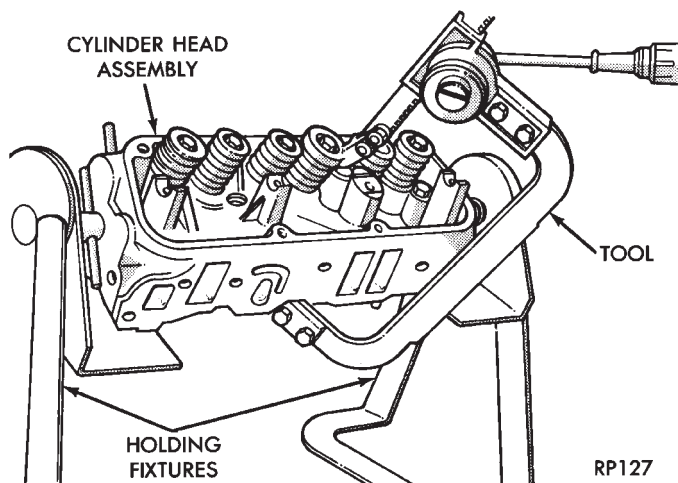


Fig. 15 Compress Valve Springs with Special Tool C-3422B with adapter 6412

VALVE INSPECTION

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

(2) Measure valve stems for wear. Refer to specifications (Fig. 18).

Valve stems are chrome plated and should not be polished.

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

(4) Measure valve stem guide clearance as follows:

(a) Install valve into cylinder head so it is 14mm (.551 inch) off the valve seat. A small piece of hose may be used to hold valve in place.

(b) Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 16).

(c) Move valve to and from the indicator. Refer to specifications (Fig. 18).

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

(5) Service valves with oversize stems and over size seals are available in 0.15mm (.005 inch), 0.40mm, (.015 inch) and 0.80mm (.030 inch) oversize.

Oversize seals must be used with oversize valves.

Reamers to accommodate the oversize valve stem are as follows:

(6) 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 0.80mm (.030 inch)** Use step procedure of 0.15mm (.005 inch), 0.40mm (.015 inch) and 0.80mm (.030 inch) so the valve guides may be reamed true in relation to the valve seat. Af-

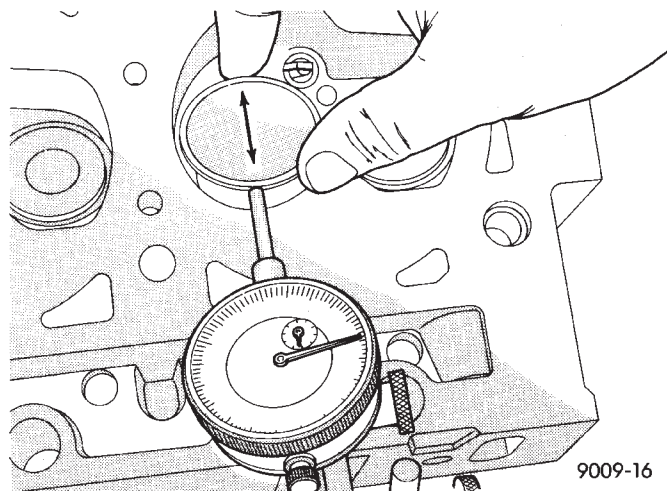


Fig. 16 Measuring Valve Guide Wear

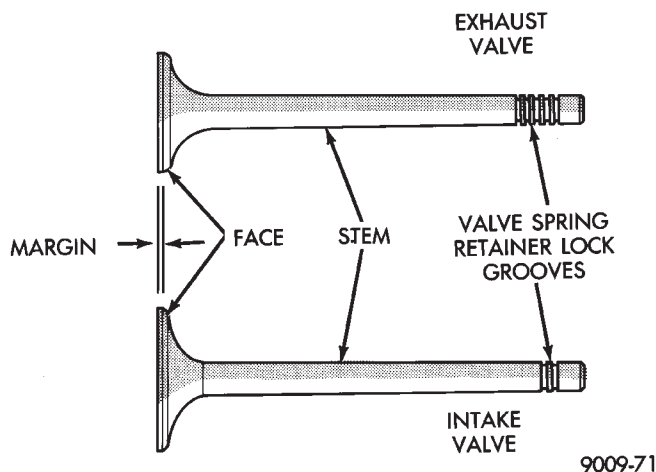


Fig. 17 Intake and Exhaust Valves

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-.3208 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.)	

9109-46

Fig. 18 Valve Guide Specifications

ter reaming guides, the seat runout should be measured and resurfaced if necessary. See Refacing Valves and Valve Seats.

VALVE GUIDES

Replace cylinder head if guide does not clean up with 0.80mm (.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:	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

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

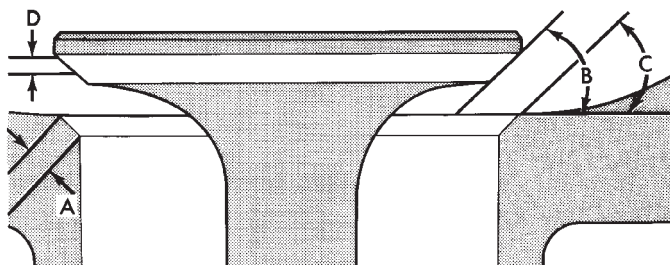
(1) Inspect the remaining margin after the valves are refaced Refer to specifications (Fig. 19).

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

(2) Measure the concentricity of valve seat using dial indicator. Total runout should not exceed .051mm (.002 inch) total indicator reading.

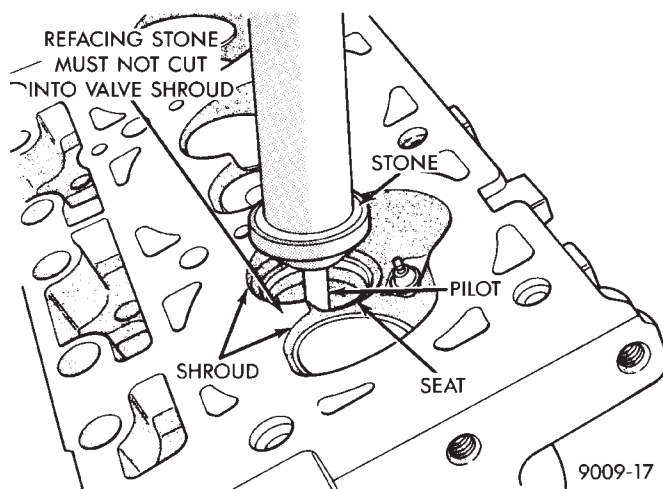


A- SEAT WIDTH (INTAKE 1.75 TO 2.25mm (.069 TO .088 IN.)
EXHAUST: 1.50 TO 2.00mm (.059 TO .078 IN.)
B- FACE ANGLE (INTAKE & EXHAUST: 44 1/2°)
C- SEAT ANGLE (INTAKE & EXHAUST: 45°-45 1/2°)
D- SEAT CONTACT AREA

9009-88

Fig. 20 Valve Seats

(3) Inspect the valve seat with Prussian blue to determine where the valve contacts the seat. To do



9009-17

Fig. 21 Refacing Valve Seats

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.

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 2.25mm (0.69 to .088 inch) The width of the exhaust seats should be 1.50 to 2.00mm (.059 to .078 inch) (Fig. 20)

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

TESTING VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 22). **As an example;** the compression length of the spring to be tested is 33.34mm (1-5/16 inches). Turn table of Tool C-647 until surface is in line with the 33.34mm (1-5/16 inch) mark on the threaded stud and the zero mark on the front. Place spring over stud on the table and lift compressing lever to set tone device. 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.

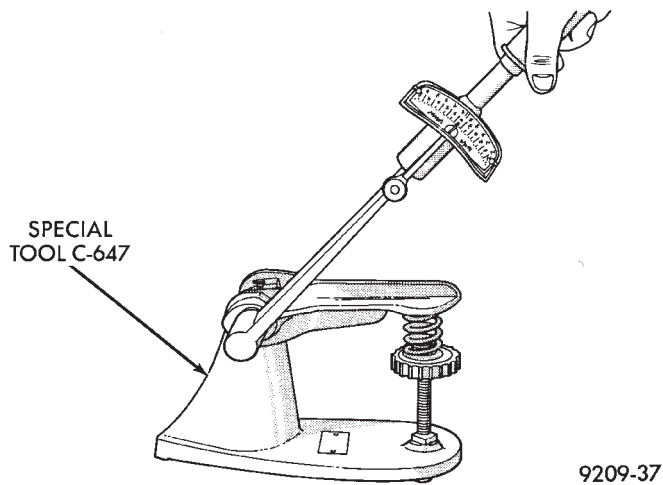


Fig. 22 Testing Valve Spring with Tool C-647

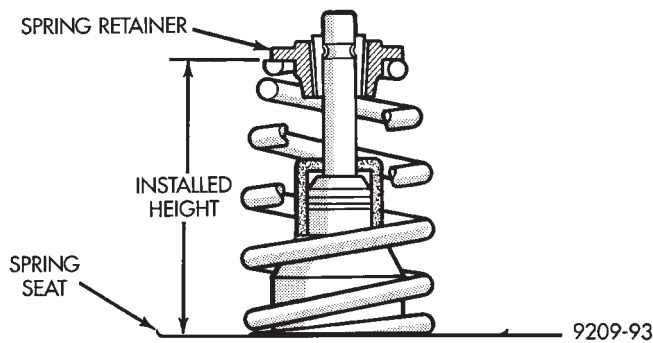


Fig. 23 Checking Valve Installed Height

VALVE INSTALLATION

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

(2) If valves or seats are reground, check installed valve spring height (Fig. 23).

(3) Install new cup seals on all valve stems and over valve guides (Fig. 23). Install valve springs and valve retainers.

(4) 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, 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, (40.6mm), install a 1/32 inch (.794mm) spacer in head counterbore to bring spring height back to normal 1-17/32 to 1-19/32 inch (39.1 to 40.6mm).**

REPLACE VALVE STEM SEALS OR VALVE SPRINGS, CYLINDER HEAD NOT REMOVED

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

(2) Disconnect negative battery cable.

(3) Remove Air Cleaner Cover and hose assembly.

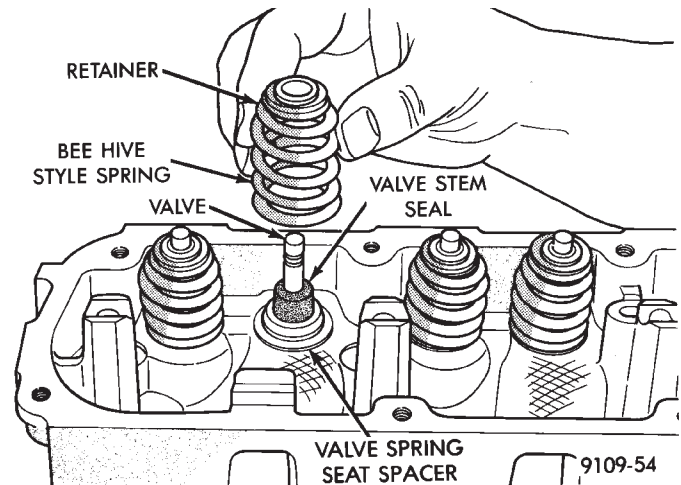


Fig. 24 Installing Valve, Cup Seal, Spring and Retainer

(4) Remove Intake Manifold; Refer to Intake/Exhaust Manifold 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 pulley retaining screw, 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 90 to 100 psi air pressure (620.5 to 689 kPa). This is to hold valves into place while servicing components.

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

(11) The intake valve stem seals 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 pinch seal between retainer and top of valve guide.

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

(13) Remove spark plug adapter tool.

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

(15) Install rocker arm covers tighten screws to 14 N•m (120 in. lbs.) and connector to ignition coils.



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

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 alignment yoke retainer (Fig. 25).

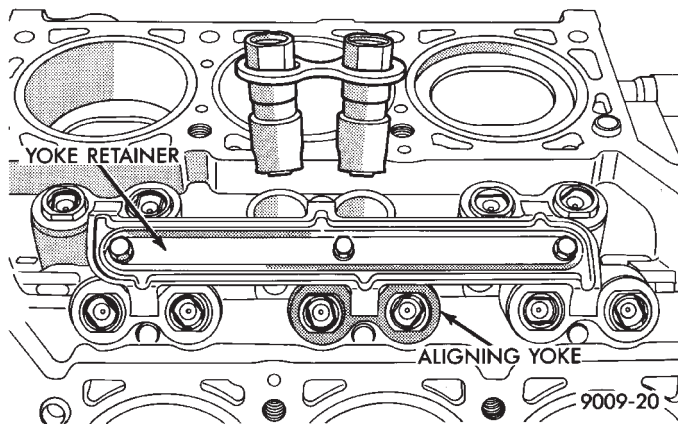


Fig. 25 Roller Tappets Aligning Yoke and Retainer

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.

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 leakdown 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.

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.

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.

DISASSEMBLY (FIG. 26)

(1) Pry out plunger retainer spring clip.



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TSB 26-08-95 October, 1995

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

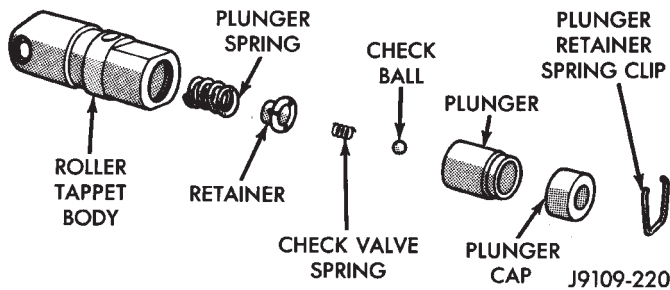


Fig. 26 Hydraulic Roller Tappet Assembly

CLEANING AND ASSEMBLY

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

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

(3) 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.

(4) Assemble tappets (Fig. 26).

INSTALLATION

(1) Lubricate tappets.

(2) Install tappets in their original positions.

(3) With roller tappets, install aligning yokes with (Fig. 26).

(4) Install yoke retainer and torque screws to 12 N•m (105 in. lbs.) (Fig. 25).

(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 TIMING

(1) Remove front valve 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 pulley.

(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 5.08mm (.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 .254mm (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.

TIMING CHAIN COVER, OIL SEAL AND CHAIN

COVER

REMOVAL

(1) Disconnect battery. Remove fan module.

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

(3) Raise vehicle on hoist. Drain engine oil.

(4) Disconnect the sway bar and place it to the rear of the vehicle to gain access to the oil pan.

(5) Remove the transmission supports brackets and inspection cover.

(6) Remove oil pan and oil pump pick-up.

(7) Remove drive belt. Refer to Cooling System Group 7 for procedure.

(8) Remove power steering pump and set aside.

(9) Remove crankshaft damper (Fig. 1).

(10) Remove tensioner pulley bracket.

(11) Remove cam sensor from chain case cover (Fig. 2).

(12) Remove chain case cover (Fig. 2).

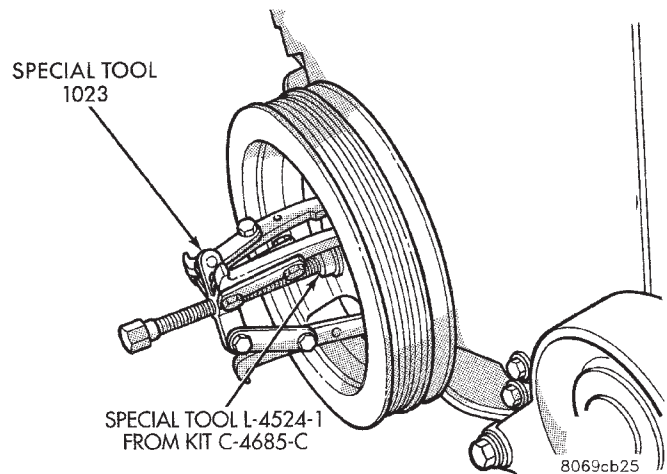


Fig. 1 Removing Crankshaft Damper

MEASURING TIMING CHAIN FOR 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. lb.) with cylinder head installed or 20 N•m (15 ft. lb.) 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 (Fig. 3), 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. 3).

(4) Install a new timing chain, if its movement exceeds 3.175mm (1/8 inch) (Fig. 3).

(5) If chain is not satisfactory, remove camshaft sprocket attaching bolt, and remove timing chain with camshaft sprocket.

(6) Using a suitable puller remove the crankshaft sprocket. Be careful not to damage the crankshaft surface.

(7) Position a new crankshaft sprocket on the shaft, install sprocket with suitable tool and mallet. Be sure sprocket is seated into position.

(8) Rotate crankshaft so the timing arrow is to the 12 O'clock position.

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

(10) 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.

(11) Using straight edge to check alignment of timing arrows (Fig. 4).

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

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

(14) Check camshaft endplay. With new thrust plate specification is .0127 to .304 mm (.005 to .012 inches.). Old thrust plate specification is .31 mm (.012 inch.) maximum. If not within these limits install new thrust plate.

(15) Install timing chain snubber. Tighten retaining screws to 12 N•m (105 in. lbs.).

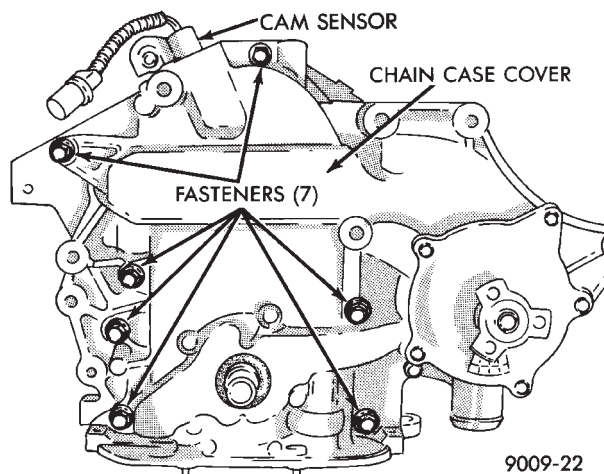


Fig. 2 Timing Chain Case Cover

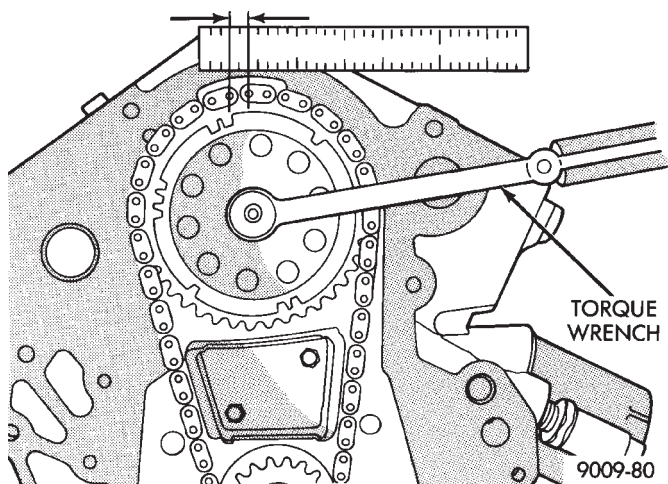


Fig. 3 Measuring Timing Chain Wear and Stretch

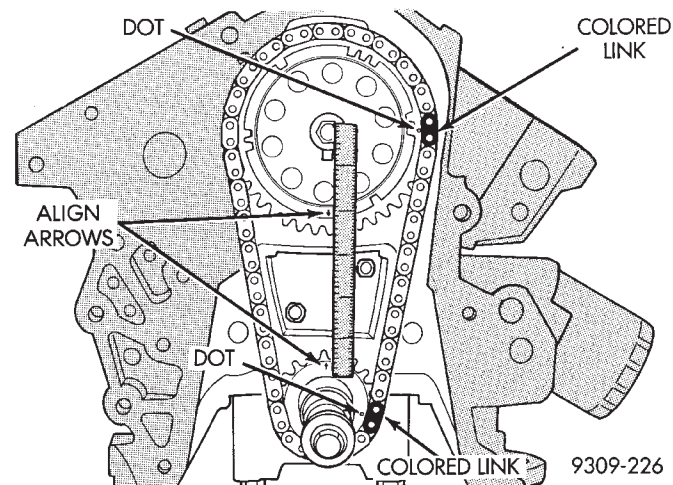


Fig. 4 Alignment of Timing Marks

INSTALLATION

(1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs. Crankshaft oil seal must be removed to insure correct oil pump engagement.

(2) Use a new cover gasket, O-rings. (Fig. 5).

(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. 5).

(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 screws (Fig. 3). 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. 6).

(8) Install crankshaft pulley (Fig. 7).

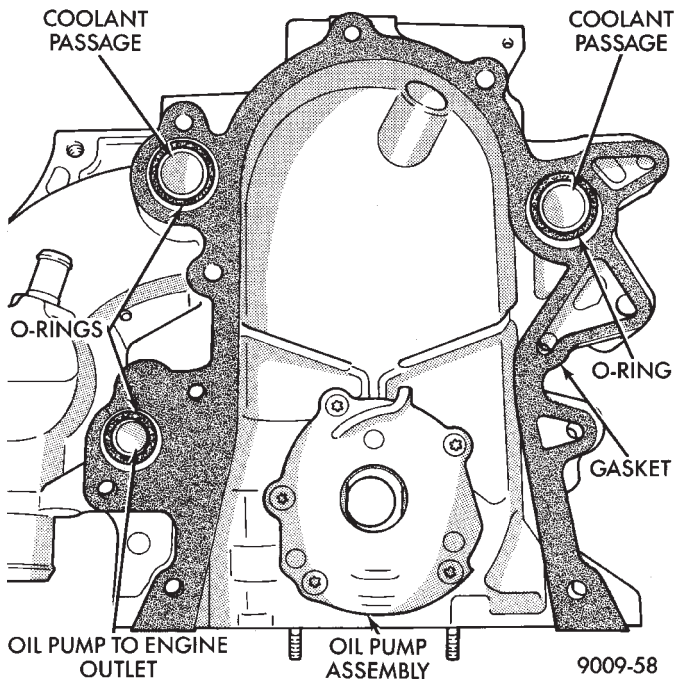


Fig. 5 Timing Chain Case Cover Gaskets and O-Rings

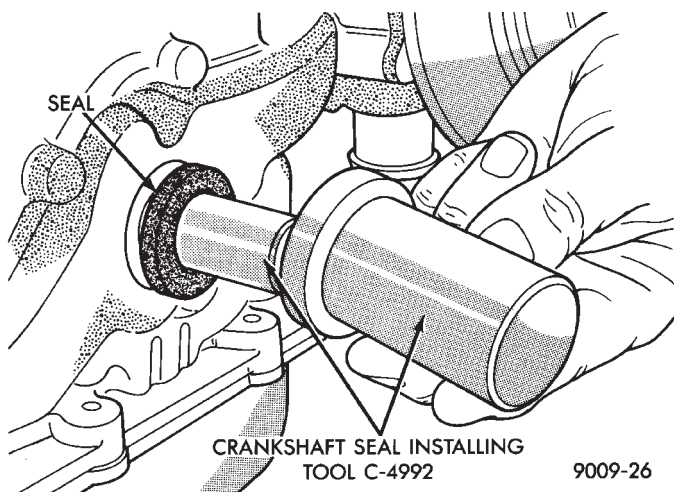


Fig. 6 Install Crankshaft Oil Seal

- (10) Install tensioner pulley bracket.
- (11) Install cam sensor. Refer to Ignition System Group 8D for installation procedure.
- (12) Install A/C compressor mounting bracket.
- (13) Install A/C compressor.
- (14) Install accessory drive belt. Refer to Cooling System Group 7 for installation procedure.

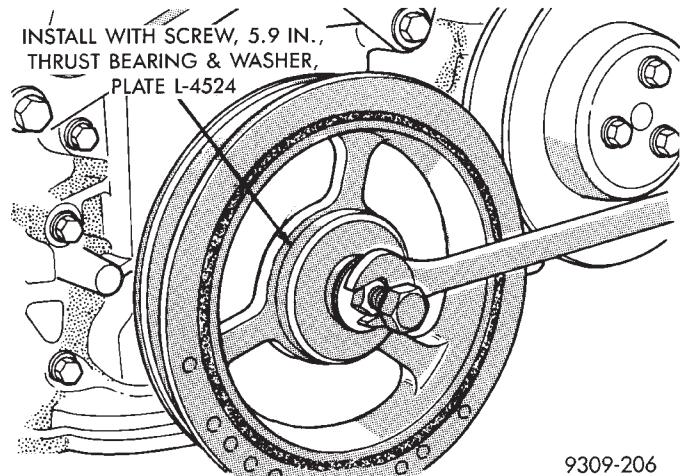


Fig. 7 Installing Crankshaft Pulley

- (15) Install oil pump pick-up and oil pan and transmission inspection cover if removed.
- (16) Install engine mount.
- (17) Fill crankcase with oil to proper level.
- (18) Fill cooling system. Refer to Cooling System Group 7 for procedure.
- (19) Connect battery.

TIMING CHAIN COVER EXTERNAL OIL SEAL

REMOVAL

- (1) Remove drive belt. (Refer to Cooling System Group 7) for procedure. Remove fan module.
- (2) Remove crankshaft pulley (Fig. 1).
- (3) Using Tool C-4991 to remove oil seal (Fig. 8). Be careful not to damage that crankshaft seal surface of cover.

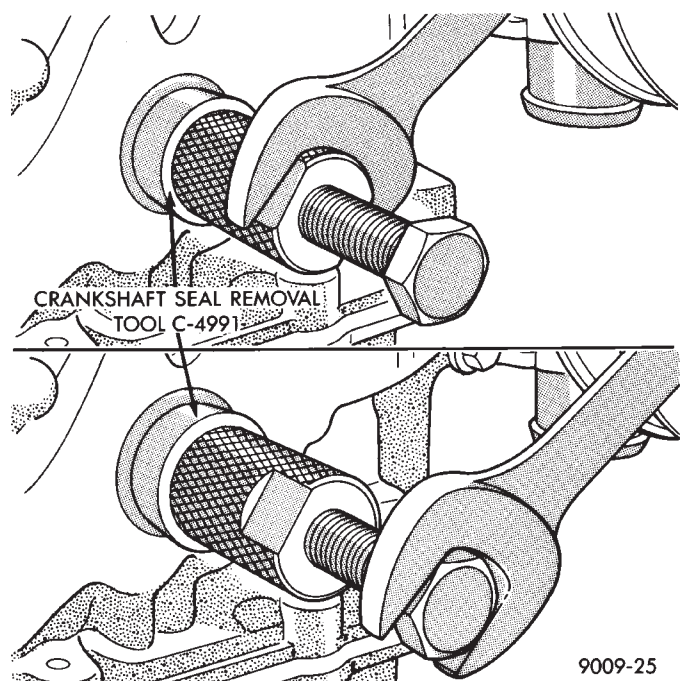


Fig. 8 Removing Crankshaft Oil Seal



INSTALLATION

- (1) Install new seal by using Tool C-4992 (Fig. 6).
- (2) Place seal into opening with seal spring towards the inside of engine. Install seal until flush with cover.
- (3) Install crankshaft pulley using plate L-4524. Thrust Bearing/washer and 5.9 inch screw (Fig. 7).
- (4) Install accessory drive belt. Refer to Cooling System Group 7 for installation procedure.

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. 9).
- (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.

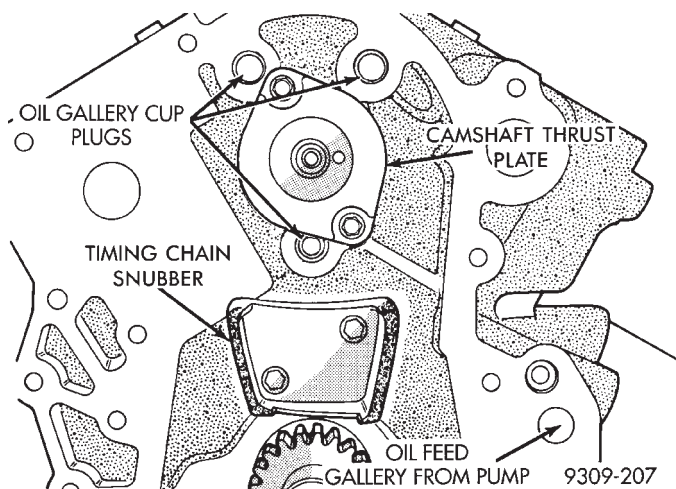


Fig. 9 Camshaft Thrust Plate

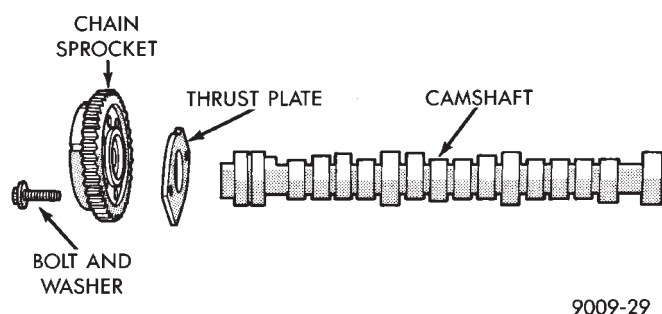


Fig. 10 Camshaft and Sprocket Assembly

INSTALLATION

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

Whenever an engine has been rebuilt or a new camshaft or tappets have been installed, add one pint of Chrysler Crankcase Conditioner or equivalent to engine oil to aid in break in. The oil mixture should be left in engine for a minimum of 805km (500 miles) and drained at the next normal oil change.

- (2) Install camshaft thrust plate with two screws as shown in (Fig. 10). 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. 12).

- (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) Measure camshaft end play. End Play should measure .0127 to .304 mm (.005 to .012 inches.) .310 mm (.012 inch. Max.). If not within limits install a 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.**

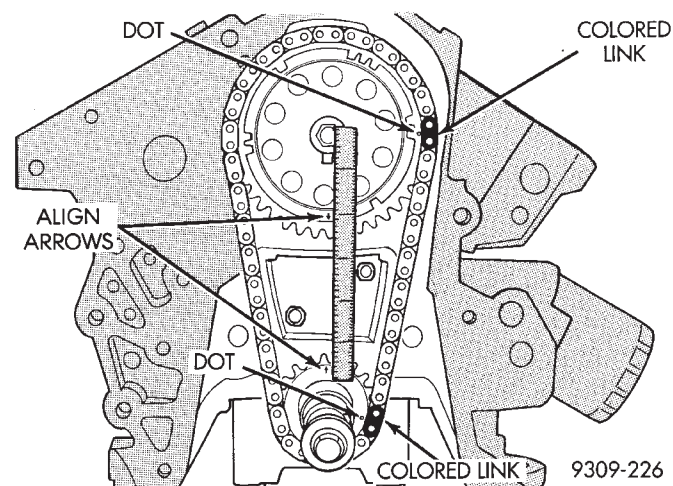


Fig. 11 Alignment of Timing Marks



CAMSHAFT BEARINGS—ENGINE REMOVED FROM VEHICLE

REMOVAL

(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. 12).

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

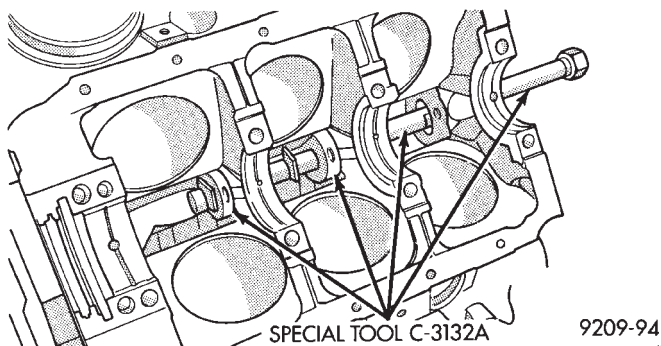


Fig. 12 Removed Installation of Camshaft Bearings with Tool C-3132A—Typical

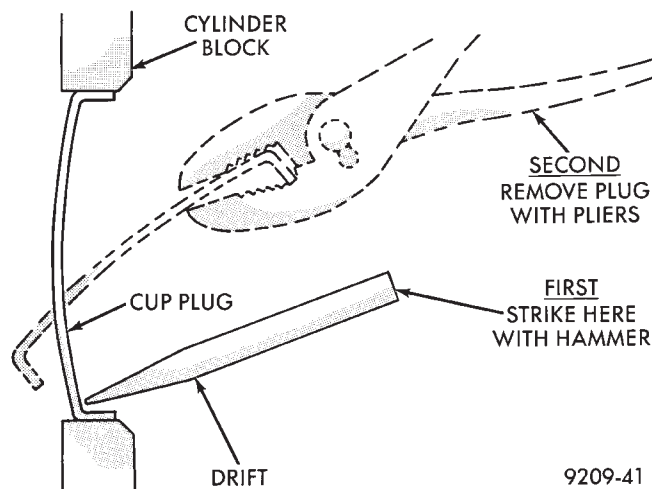


Fig. 13 Core Hole Plug Removal

ENGINE CORE, OIL AND CAM PLUGS

REMOVAL

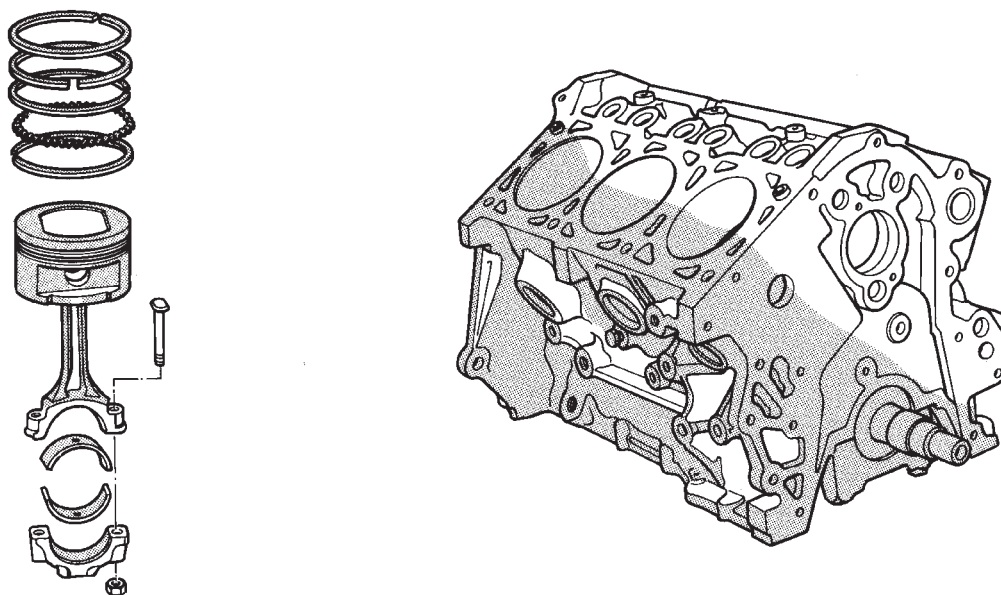
Using a blunt tool such as a drift and a hammer, strike the bottom edge of the cup plug. With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 13).

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 0.5mm (.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.



9009-73

Fig. 1 Cylinder Block, Piston and Connecting Rod Assembly

CYLINDER BLOCK, PISTON AND CONNECTING ROD ASSEMBLY SERVICE

CYLINDER BLOCK

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 (Fig. 1). 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. 2)

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

Be careful not to nick crankshaft journals.

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

CLEANING AND INSPECTION

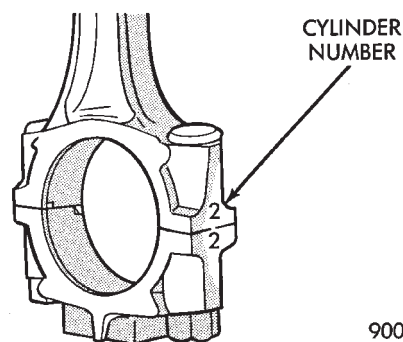
(1) Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.

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

(3) Examine block for cracks or fractures.

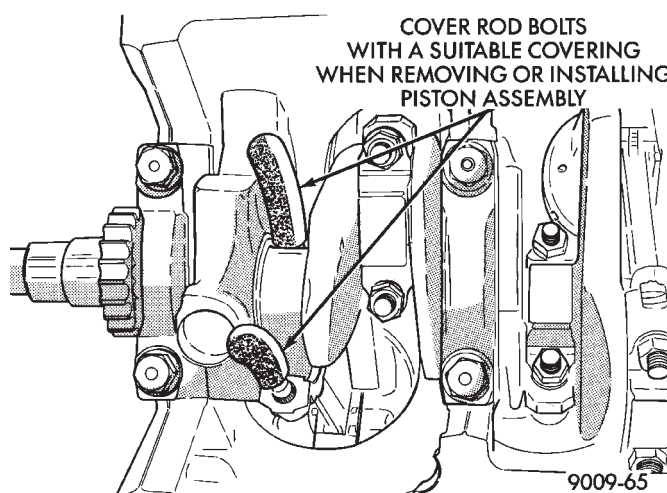
CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 4). If the cyl-



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Fig. 2 Identify Connecting Rod to Cylinder



9009-65

Fig. 3 Connecting Rod Protectors

inder 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

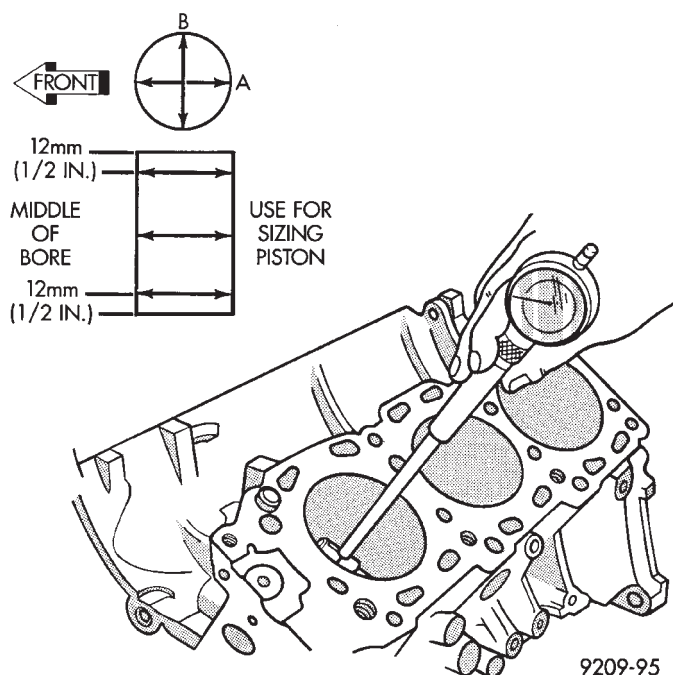


Fig. 4 Checking Cylinder Bore Size

closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained.

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

Measure the cylinder bore at three levels in directions A and B (Fig. 4). Top measurement should be 12mm (.50 inch) down and bottom measurement should be 12mm (.50 inch.) up from bottom of bore. Refer to (Fig. 5) for specifications.

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 (Fig. 4). 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 in the connecting rod. **The piston pin is not to be removed damage to the piston may 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

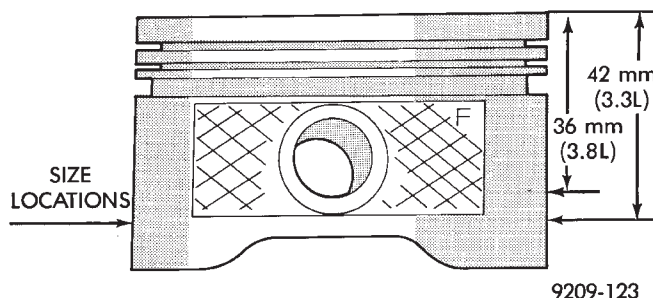


Fig. 6 Piston Measurements

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 12mm (.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).

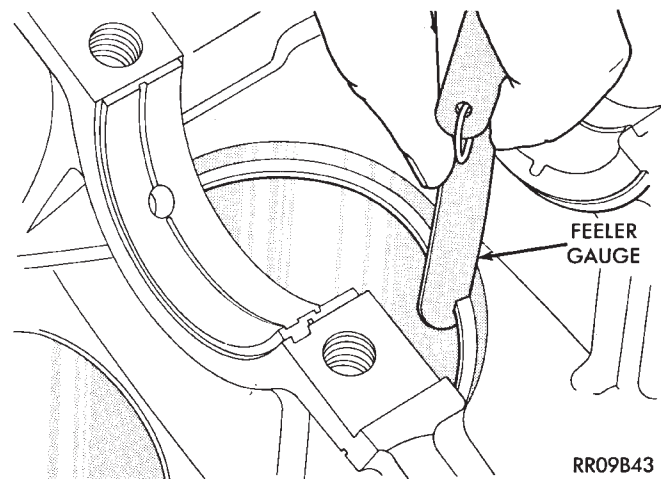


Fig. 7 Check Gap on Piston Rings

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. 10).

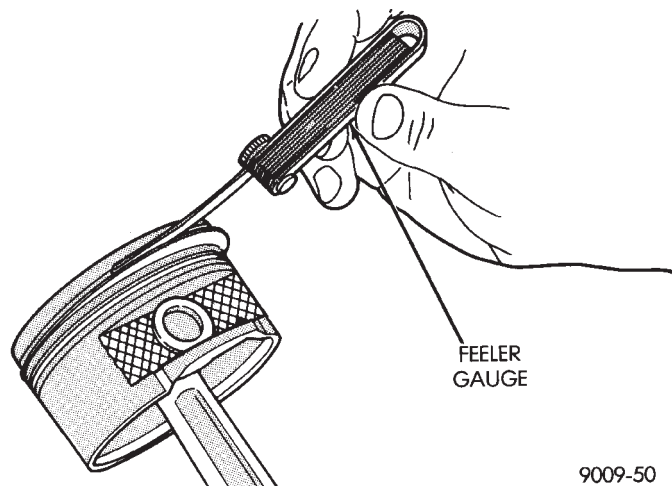


Ring Position	Ring Gap	Wear Limit
Upper Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .022 in.)	1.0 mm (.039 in.)
Oil Control Ring	0.25 to 0.100 mm (.010 to .039 in.)	1.88 mm (.074 in.)

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.)

9309-209

Fig. 8 Piston Ring Specifications



9009-50

Fig. 9 Measuring Piston Ring Side Clearance

CAUTION: Install piston rings in the following order:

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

(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. 11).

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

(4) Install No. 2 piston ring and then No. 1 piston ring (Fig. 12).

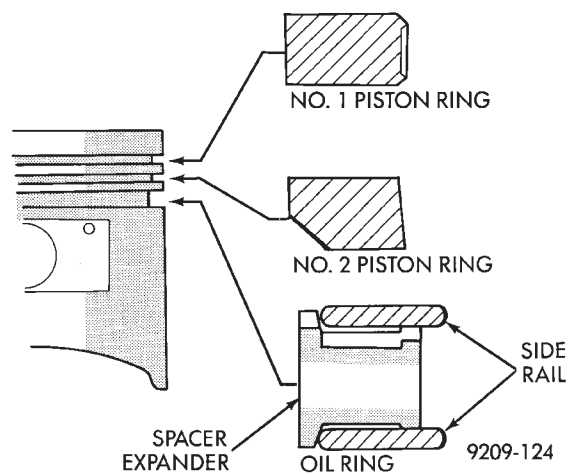


Fig. 10 Piston Ring Installation

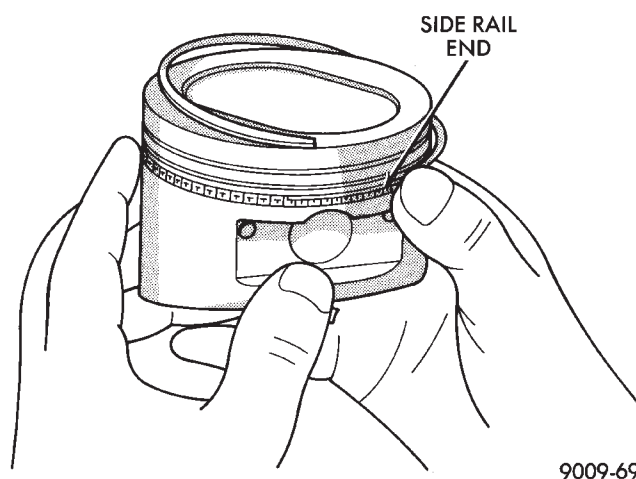


Fig. 11 Installing Side Rail

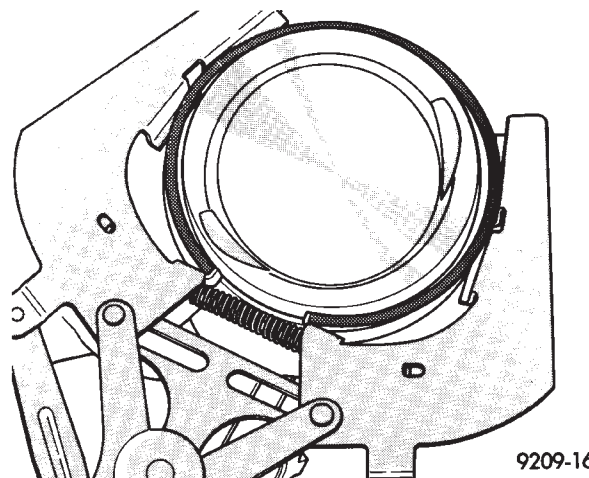


Fig. 12 Installing Upper and Intermediate Rings

(5) Position piston ring end gaps as shown in (Fig. 13).

(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.

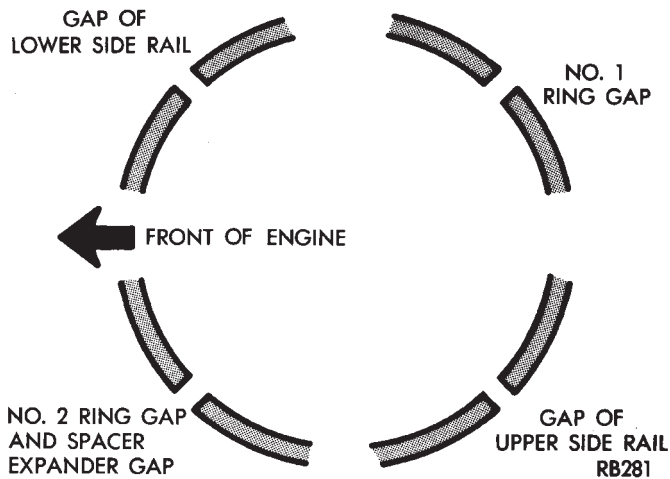


Fig. 13 Piston Ring End Gap Position

INSTALLING PISTON AND CONNECTING ROD ASSEMBLY

(1) Before installing pistons and connecting rod assemblies into the bore, be sure that compression ring gaps are staggered so that neither is in line with oil ring 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. 14).

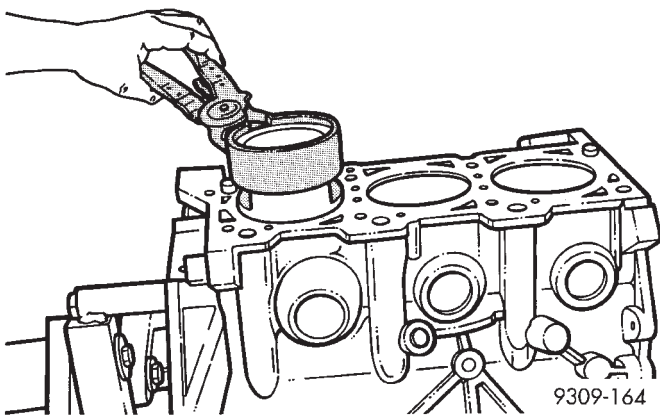


Fig. 14 Installing Piston

(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.**

(4) Install connecting rod bolt protectors on rod bolts. (Fig. 3)

(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.

(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.

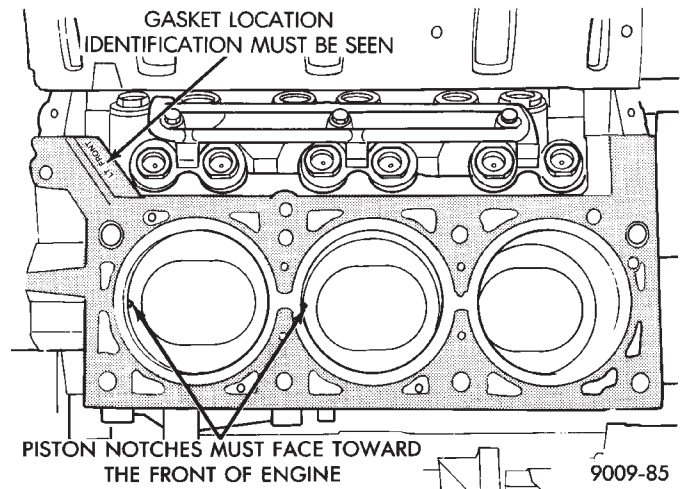


Fig. 15 Piston I.D. Notches

(7) The notch or groove on top of piston must be pointing toward front of engine (Fig. 15).

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

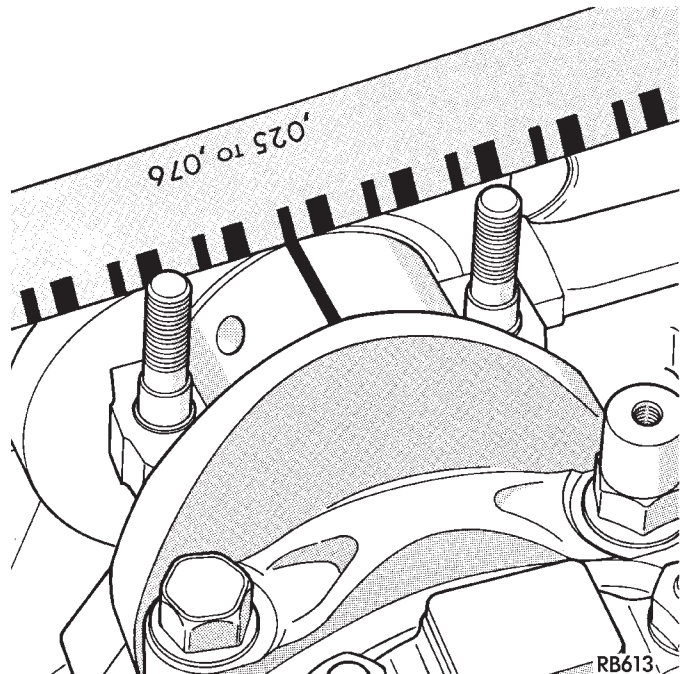


Fig. 16 Checking Connecting Rod Bearing Clearance

CONNECTING RODS

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 .025mm (.001 inch). Bearings are available in .025mm (.001 inch), .051mm (.002 inch), .076mm (.003 inch), .254mm (.010 inch) and .305mm (.012 inch) undersize. **Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.**

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

The rod bearing bolts should be examined before reuse. If the threads are necked down the bolts should be replaced (Fig. 19).

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. 17). Refer to (Fig. 18) for specifications.

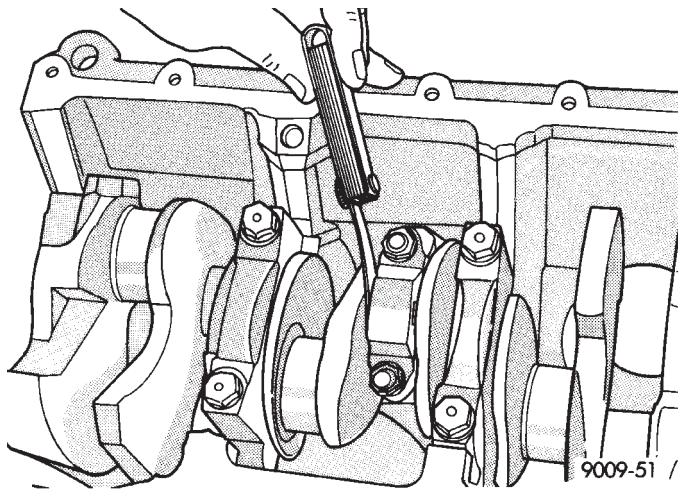


Fig. 17 Checking Connecting Rod Side Clearance

CRANKSHAFT SERVICE

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly. (Fig. 1) 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.

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. 18 Connecting Rod Specifications

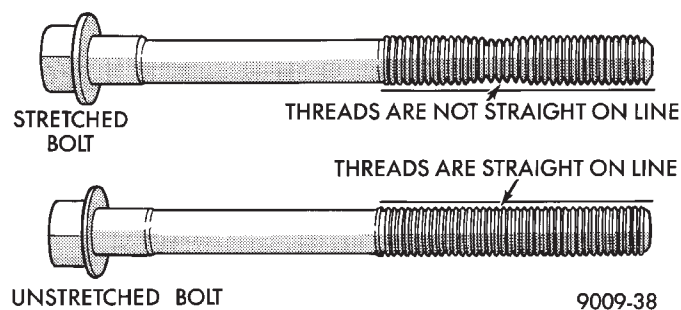


Fig. 19 Check for Stretched Bolts

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 .025mm (.001 inch). Journal grinding should not exceed .305mm (.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 the nodular cast iron crankshafts used it is important that the final paper or cloth polish after any journal regrind be in the same direction as normal rotation in the engine.

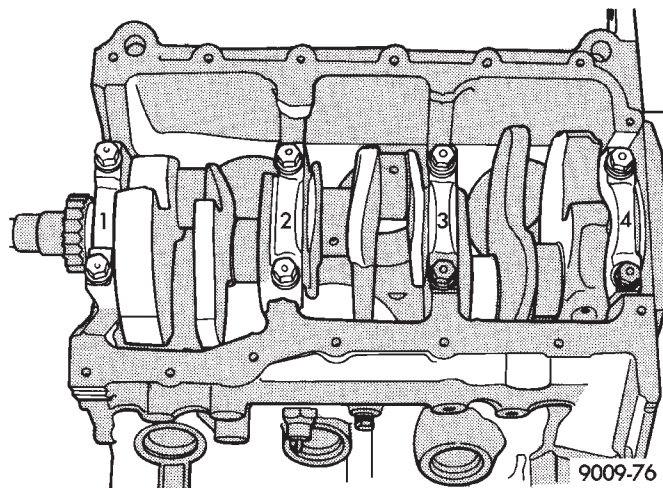


Fig. 1 Main Bearing Cap Identification



The upper Number 2 bearing is a three piece clinched design with a flanged upper half **ONLY** to carry the crankshaft thrust loads. It is **NOT** interchangeable with any other bearing halves in the engine (Fig. 2). 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 undersizes: 0.025mm (.001 inch), .051mm (.002 inch), .076mm (.003 inch), .254mm (.010 inch), and .305mm (.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

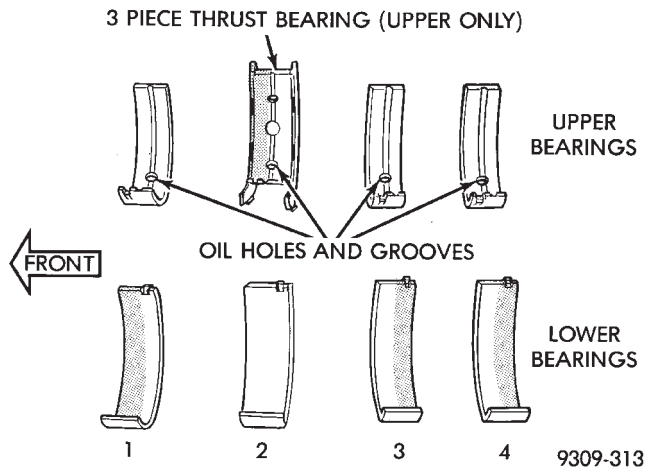


Fig. 2 Main Bearing Identification

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. 3) into the oil hole of crankshaft.
- (3) Slowly rotate crankshaft clockwise, forcing out upper half of bearing shell.

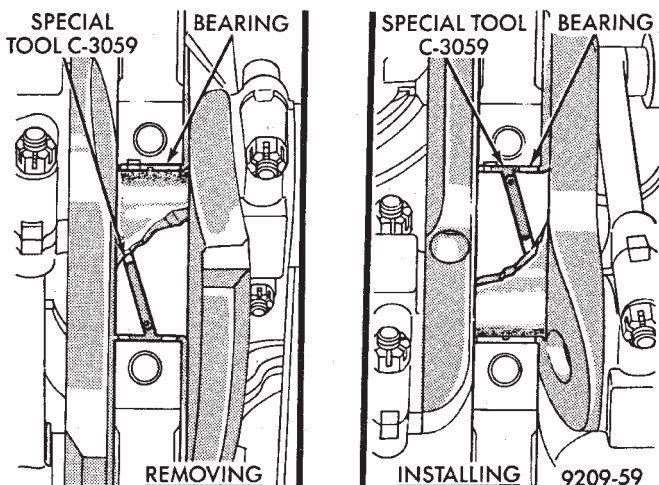


Fig. 3 Removing and Installing Upper Main Bearing With Special Tool C-3059

INSTALLATION

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. 3).
- (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).
- (5) Rotate the crankshaft until number 6 piston is at TDC.

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

- (a) Move crankshaft all the way to the rear of its travel.
- (b) Then, move crankshaft all the way to the front of its travel.
- (c) 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.
- (d) Tighten the #2 Thrust Bearing cap bolts to 41 N•m + 1/4 Turn (30 ft. lbs.+ 1/4 Turn). Remove the holding tool.

CHECKING CRANKSHAFT END PLAY

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 4).

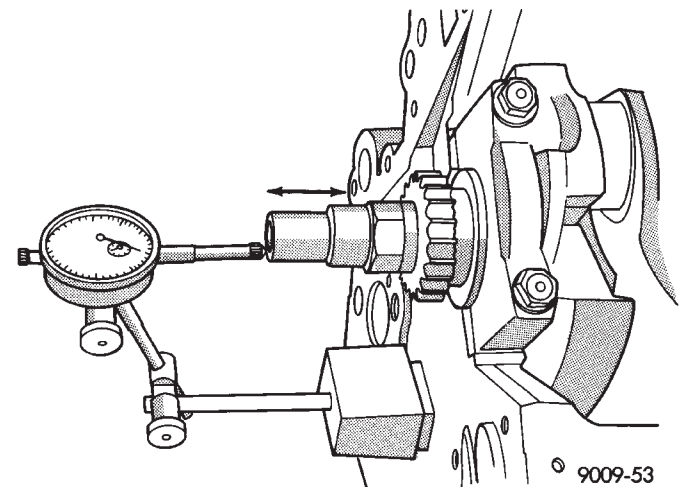


Fig. 4 Checking Crankshaft End Play

- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.



(4) Move crankshaft all the way to the front and read the dial indicator. Refer to (Fig. 5) for specification.

Crankshaft End-Play	
New Part: 0.10 to 0.30 mm (.004 to .012 in.)	
Wear Limit: 0.43 mm (.017 in.)	
Main and Connecting Rod Bearing Clearance	
New Part: .019 to .077 mm (.0007 to .0030 in.)	
Wear Limit: .102 mm (.004 in.)	
Crankshaft Journal Sizes	
Crankshaft Main Bearing Journal	
ALL	Diameter
Standard	64.00 $\pm$ 0.013 mm (2.519 $\pm$.0005 in.)
Crankshaft Connecting Rod Journal	
ALL	Diameter
Standard	58.00 $\pm$ 0.013 (2.283 $\pm$.0005 in.)

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Fig. 5 Crankshaft specification

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 (Fig. 5) for specification.

CRANKSHAFT OIL CLEARANCE

(1) Measure the journal outside diameter as shown in (Fig. 6). Refer to specification (Fig. 5).

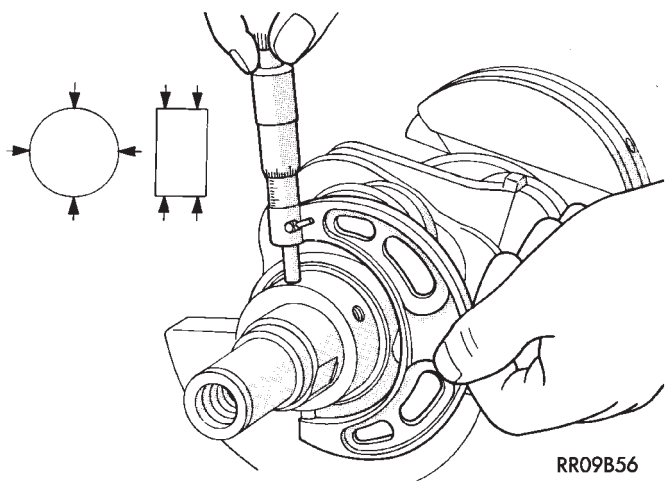


Fig. 6 Measure Crankshaft Journal O.D.

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. 7).

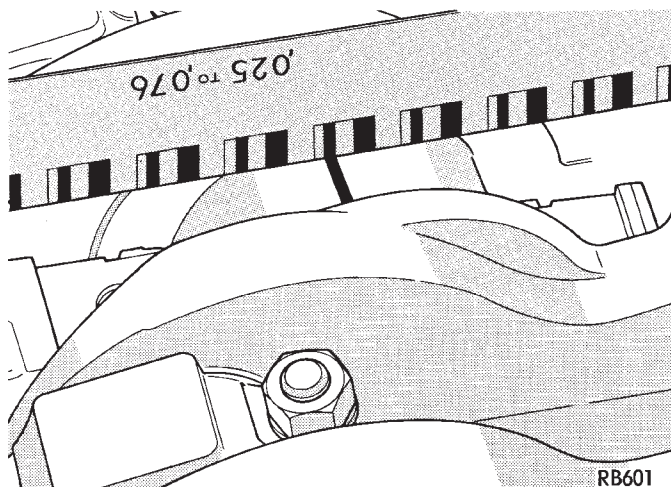


Fig. 7 Measuring Bearing Clearance with Plastigage

(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.

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

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

CRANKSHAFT OIL SEALS SERVICE

REMOVAL

Pry out rear seal with screwdriver. Be careful not to nick or damage crankshaft flange seal surface or retainer bore (Fig. 8).

INSTALLATION

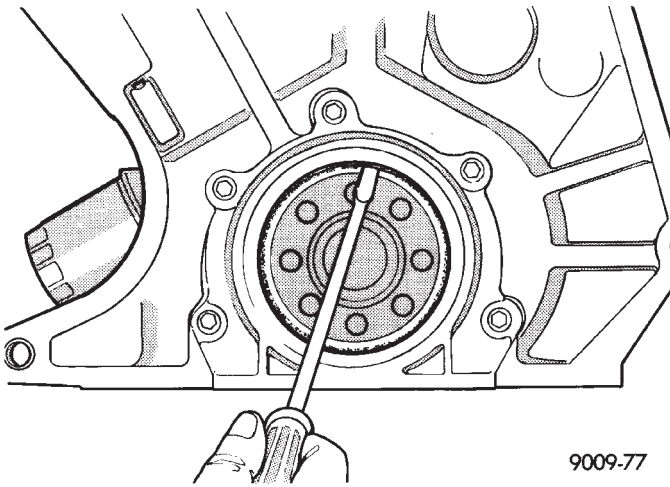
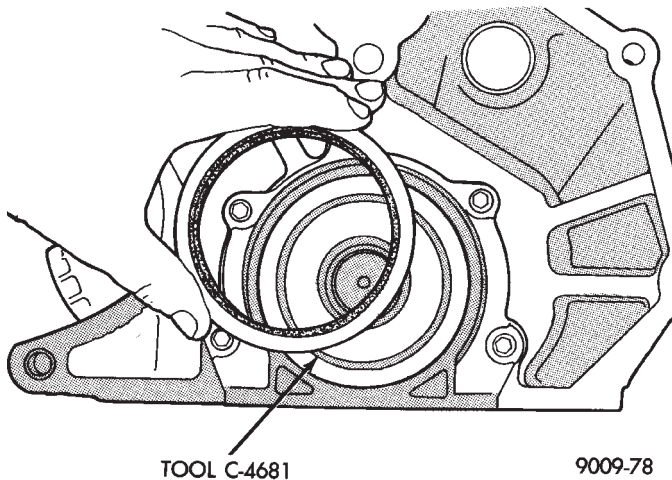
(1) Place Special Seal Pilot Tool C-4681 on crankshaft (Fig. 9).

(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 clean engine block and retainer of old gasket.

**Fig. 8 Removing Rear Crankshaft Oil Seal****Fig. 9 Installing Rear Crankshaft Oil Seal**

Make sure surfaces are clean and free of oil. Install new gasket and tighten screws to 12 N•m (105 in. lbs.).

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 galley. 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. 1).

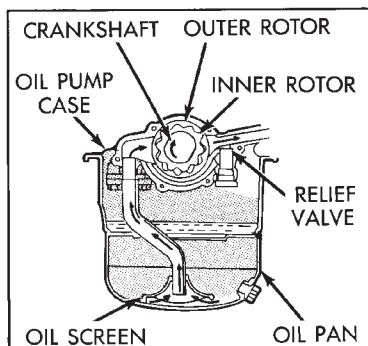
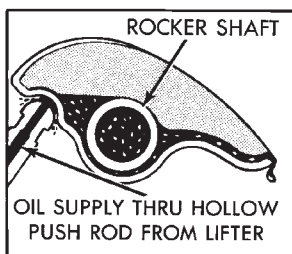
OIL PAN SERVICE

REMOVAL

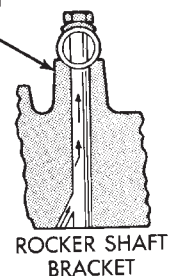
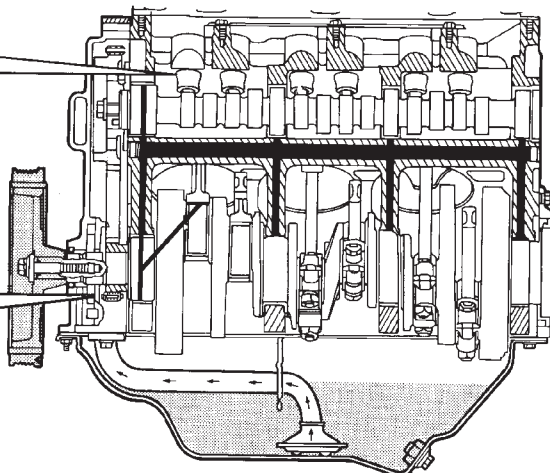
- (1) Disconnect negative battery cable, remove engine oil dipstick.
- (2) Raise vehicle. Drain engine oil.
- (3) Remove oil pan screws and remove oil pan.

CLEANING AND INSPECTION

- (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. Install a new drain plug gasket. Tighten to 27 N•m (20 ft. lb.).
- (3) Inspect oil pan mounting flange for bends or distortion. Straighten flange if necessary.



OIL FLOWS TO ONLY ONE BRACKET ON EACH HEAD. BRACKET IS SECOND FROM REAR ON RIGHT HEAD. BRACKET IS SECOND FROM FRONT ON LEFT HEAD



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Fig. 1 Engine Oiling System



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

INSTALLATION

(1) Put a new o-ring on the oil pick-up tube and install into Chain Case Cover tighten screw to 28 N•m (250 in. lbs.) (Fig. 2).

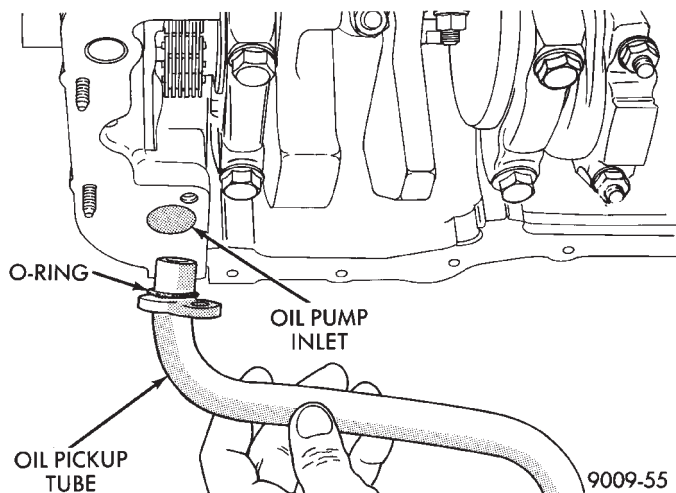


Fig. 2 Oil Pump Pick-up Tube Service

(2) 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. 3).

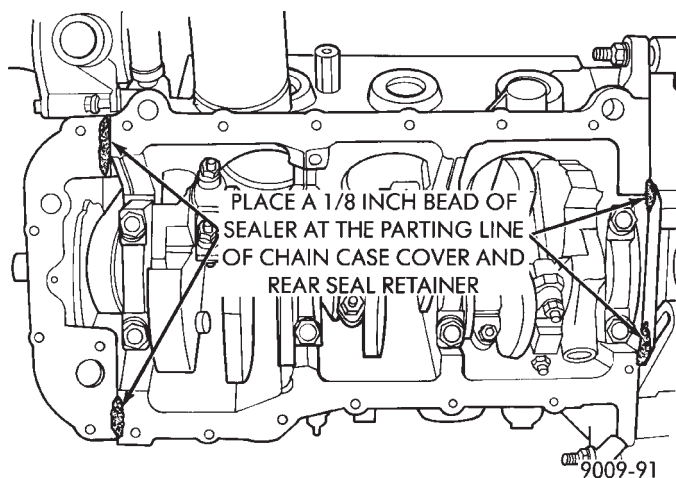


Fig. 3 Oil Pan Sealing

- (3) Use a new pan gasket (Fig. 4).
- (4) Install pan and tighten screws to 23 N•m (200 in. lb.).
- (5) Lower vehicle and install oil dipstick.
- (6) Connect negative battery cable.
- (7) Fill crankcase with oil to proper level.

OIL PUMP SERVICE

It is necessary to remove the oil pan, oil pickup and chain case cover (CCC) to service the oil pump rotors. The oil pump pressure relief valve can be serviced by removing the oil pan and oil pickup tube.

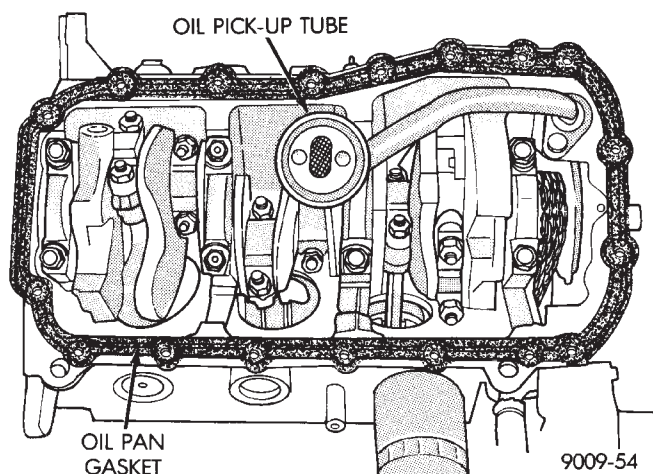


Fig. 4 Oil Pan Gasket Installation

Refer to Timing Chain Cover Removal and Installation of this section for procedures.

DISASSEMBLY

- (1) To remove the relief valve, proceed as follows:
 - (a) Drill a 3.175mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.
 - (b) 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. 5).

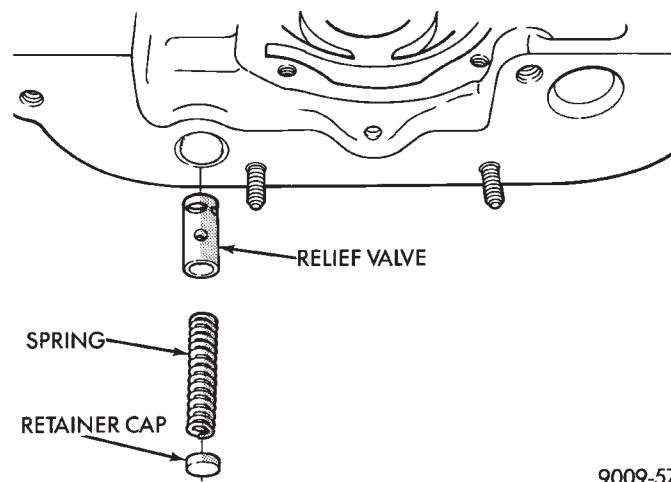
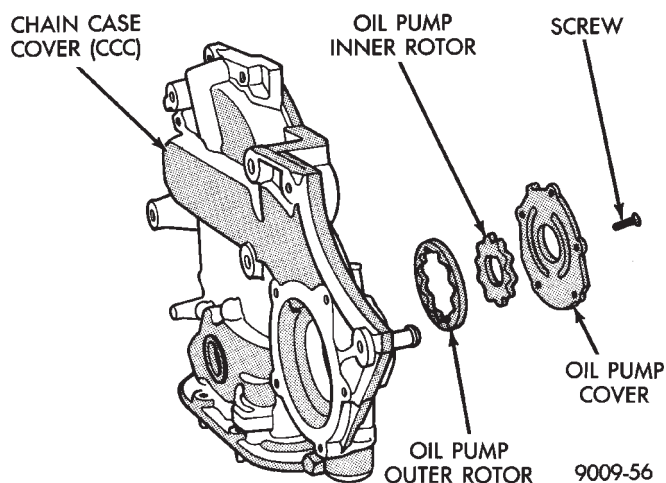


Fig. 5 Oil Pressure Relief Valve

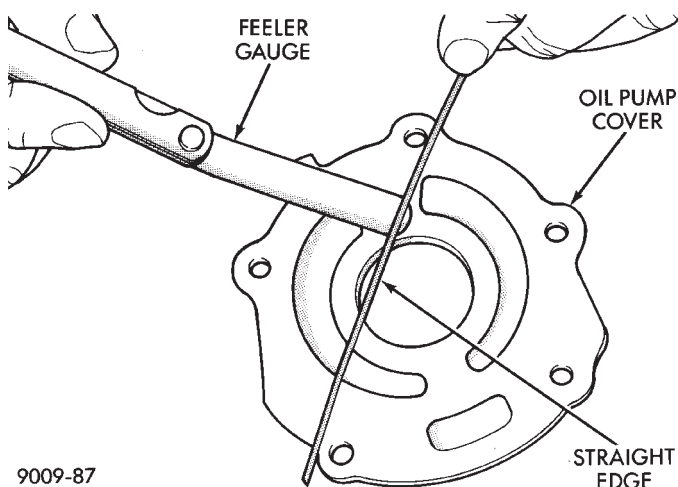
- (2) Remove oil pump cover screws, and lift off cover.
- (3) Remove pump rotors.
- (4) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 6).

INSPECTION AND REPAIR

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

**Fig. 6 Oil Pump**

(2) Lay a straightedge across the pump cover surface (Fig. 7). If a .076mm (.003 inch) feeler gauge can be inserted between cover and straight edge, cover should be replaced.

**Fig. 7 Checking Oil Pump Cover Flatness**

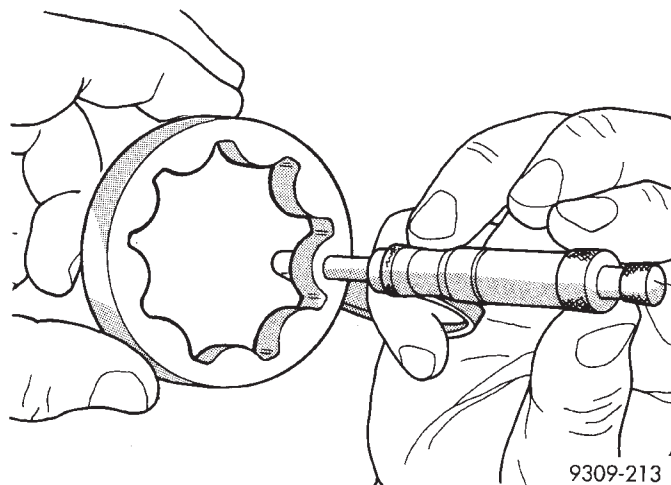
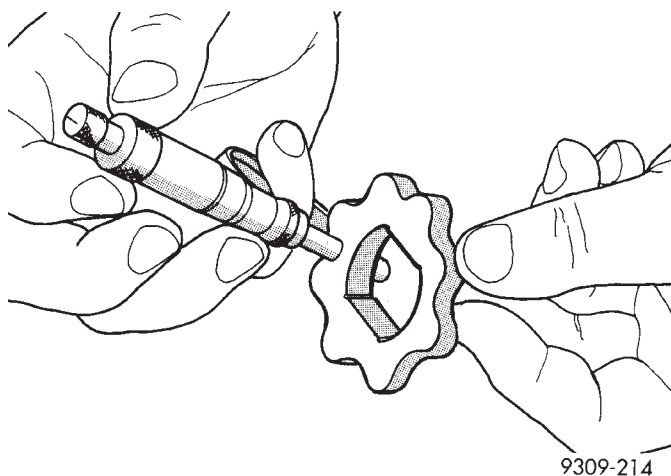
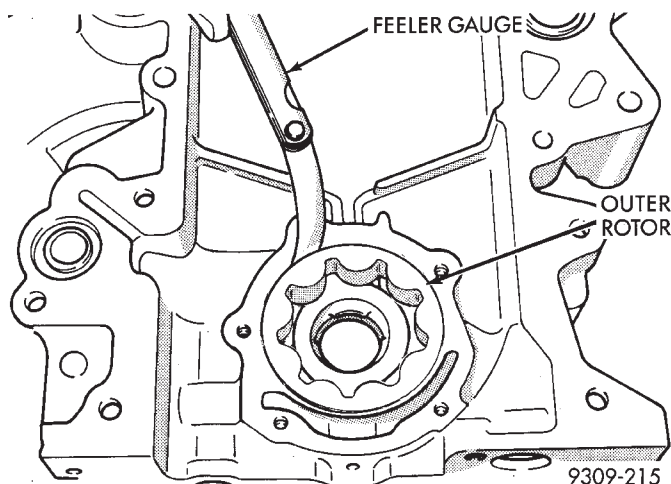
(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 7.64mm (0.301 inch.) or less (Fig. 8), or if the diameter is 79.95mm (3.148 inches.) or less, replace outer rotor.

(4) If inner rotor measures 7.64mm (.301 inch) or less replace inner rotor (Fig. 9).

(5) Slide outer rotor into CCC, press to one side with fingers and measure clearance between rotor and CCC (Fig. 10). If measurement is .39mm (.015 inch) or more, replace CCC only if outer rotor is in specification.

(6) Install inner rotor into CCC. If clearance between inner and outer rotors (Fig. 11) is .203mm (.008 inch) or more, replace both rotors.

(7) Place a straightedge across the face of the CCC, between bolt holes. If a feeler gauge of .102mm (.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 12). **ONLY** if rotors are in specs.

**Fig. 8 Measuring Outer Rotor Thickness****Fig. 9 Measuring Inner Rotor Thickness****Fig. 10 Measuring Outer Rotor Clearance in Housing**

(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.

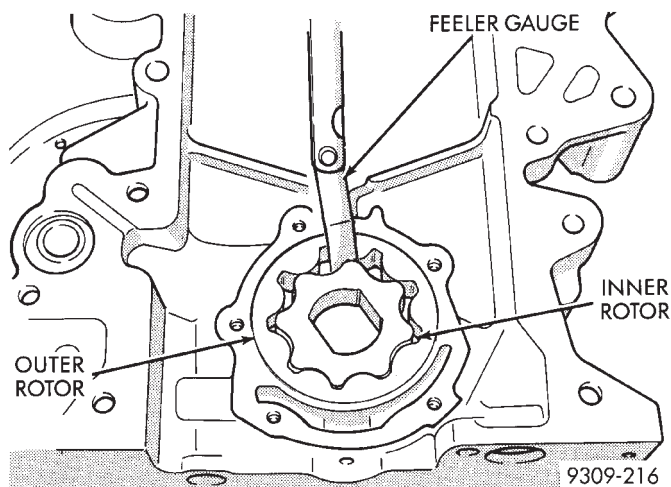


Fig. 11 Measuring Clearance Between Rotors

(9) The relief valve spring has a free length of approximately 49.5mm (1.95 inches) it should test between 19.5 and 20.5 pounds when compressed to 34mm (1-11/32 inches). Replace spring that fails to meet specifications (Fig. 5).

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

OIL PUMP ASSEMBLY AND INSTALLATION

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

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

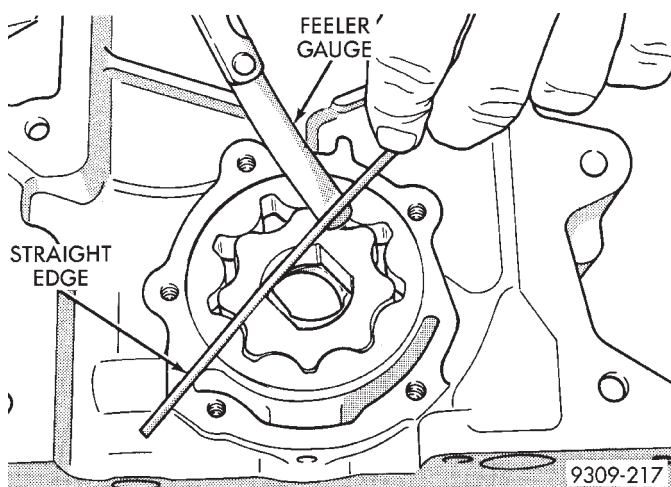


Fig. 12 Measuring Clearance Over Rotors

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. 13).

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

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

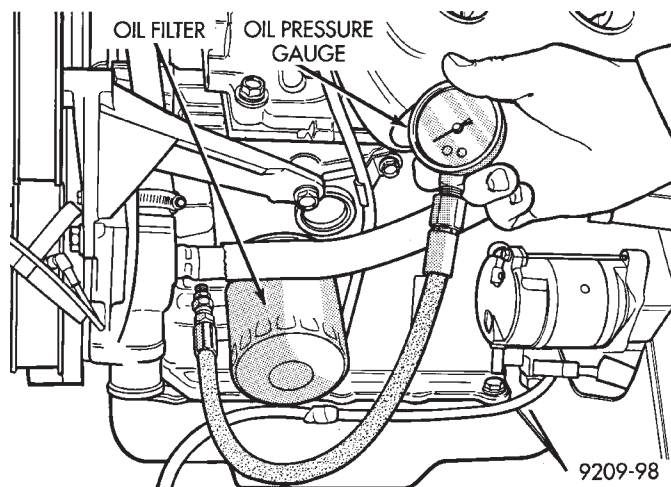


Fig. 13 Checking Oil Pump Pressure

OIL FILTER

When servicing oil filter avoid deforming the filter can by installing the remove/install tool band strap against the can to base lockseam. The lockseam joining the can to the base is reinforced by the base plate.

- (1) Using Tool C-4065, unscrew filter from base and discard (Fig. 14).
- (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.

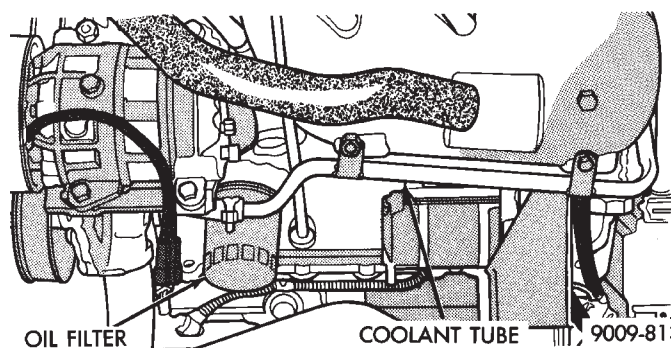


Fig. 14 Oil Filter



ENGINE SPECIFICATIONS

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	153hp @ 5300 RPM
Torque	177 lbs.-ft. @ 2800 RPM
Firing Order	1-2-3-4-5-6
Minimum Compression Pressure, see "Engine Performance" in Standard Service Procedures	690 kPa (100 psi)
Maximum Variation 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	0.9051 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)
Oil–Steel Rails	1.46–1.5 mm (0.0575–0.0591 inch)
	0.510 mm (0.0201 inch)
Ring Gap	
Compression	0.300–0.550 mm (0.0118–0.0217 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)
	0.014–0.226 mm (0.0005–0.0089 inch)
Service Rings	
Ring Gap	
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)

ENGINE SPECIFICATIONS (CONT.)

CONNECTING RODS

Side Clearance 0.127–0.381mm (0.005–0.015 inch)

CONNECTING ROD BEARINGS

Type	Aluminum Lead (Bi-Metal)
Clearance Desired	0.019–0.076mm (0.00075–0.003 inch.)
Maximum Allowable	0.076mm (0.003 inch.)
Bearings for Service	Std., 0.025mm (0.001), 0.051mm (0.002) 0.076mm (0.003), 0.254mm (0.010), 0.305 mm (0.012 inches.)

CRANKSHAFT

Type	Cast Nodular Iron
Bearings	Aluminum Lead (Bi-Metal)
Thrust Taken By	No. 2 Main Bearing
End Play	0.10–0.30 mm (0.004–0.012 inch.)
Maximum Allowable	0.43 mm (0.017 inch.)
Diametral Clearance Desired #1, 2, 3 and 4	0.019–0.050mm (0.0007–0.0022 inch.)
Maximum Diametral Clearance #1, 2, 3 and 4	0.055mm (0.0022 inch.)

MAIN BEARING JOURNALS

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

CONNECTING ROD JOURNALS

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

CAMSHAFT

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

CAMSHAFT JOURNALS

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

**ENGINE SPECIFICATIONS (CONT.)****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)	0°
Intake Closes (ABC)	60°
Exhaust Opens (BBC)	48°
Exhaust Closes (ATC)	12°
Valve Overlap	12°
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 (0.030 inches)

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	7.795–8.000 mm (0.313–0.3149 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.)



ENGINE SPECIFICATIONS (CONT.)

VALVES (EXHAUST)

Head Diameter	37.5mm (1.476 inch.)
Length Overall (New)	126.095–126.645mm (4.964–4.986 inch.)
Stem Diameter (Standard)	7.906–7.924mm (0.3112–0.3119 inch.)
Stem to Guide Clearance	0.051–0.175mm (0.002–0.006 inch.)
Maximum Allowable by Rocking Method	0.414mm (0.016 inch.)
Face Angle	44-1/2°
Valves for Service (Oversize Stem Diameter)	Std., 0.015mm (0.005), 0.40mm (0.015), 0.80mm (0.030 inches.)
Lift (Zero Lash)	10.16mm (0.400 inch.)
Minimum Valve Length After Grinding Tip	125.512mm (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.)	48.5mm (1.909 inch.)
Wire Diameter	4.75mm (0.187 inch.)
Number of coils	6.8
Load When Compressed to — Valve Closed	58–63 lbs. @ 1.570 inch.
— Valve Open	136–145 lbs. @ 1.14 inch.
Valve Spring Installed Height (Spring Seat to Retainer)	39.1–40.6mm (1-17/32–1-19/32 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	0.076mm (0.003 inch or more)
Outer Rotor Thickness	7.63mm (0.3005 inch or less)
Outer Rotor Diameter	79.78 (3.141 inch or less)
Inner Rotor Thickness	7.64mm (0.301 inch or less)
Clearance Over Rotors — Outer	0.10mm (0.004 inch or more)
— Inner	0.10mm (0.004 inch or more)
Outer Rotor Clearance	0.56mm (0.022 inch or more)
Tip Clearance Between Rotors	0.20mm (0.008 inch or more)



TORQUE

	Thread Size	Newton Meters	Foot Pounds	Inch Pounds
A/C Compressor to Bracket Bolt	7/16"—14	68	50	
A/C Compressor Support Bolts	3/8"—16	41	30	
Alternator Adjusting Strap Bolt	5/16"—18	23		200
Alternator Adjusting Strap Mounting Bolt	3/8"—16	41	30	
Alternator Bracket Bolt	3/8"—16	41	30	
Alternator Mounting Pivot Nut	3/8"—16	41	30	
Camshaft Sprocket Lockbolt	M10x1.5	54	40	
Camshaft Thrust Plate	M6x1	12		105
Chain Case Cover Bolt	M8x1.25	47	20	
	M10x1.5	54	40	
Connecting Rod Nut	3/8"—24	54 + 1/4 turn	40 + 1/4 turn	
Crankshaft Pulley Screw to Crankshaft	M10x1.5	54	40	
Cylinder Head Bolt	M8x1.25	33	25	
Cylinder Head Bolt	M11x1.5		45,65, 65 + 1/4 turn	
Cylinder Head Covers—Bolt	M6x1.0	12		105
Exhaust Manifold Screw	M8x1.25	23		200
Exhaust Crossover Pipe Flange Nut/Bolt	M10x1.5	33	25	
Intake Manifold Bolt	M8x1.25	23		200
Intake Manifold Gasket Retaining Screws	M6x1	12		105
Intake Manifold Plenum Bolt	M8x1.75	28		250
Main Bearing Cap Bolt	M11x1.5	41 + 1/4 turn	30 + 1/4 turn	
Oil Filter Attaching Nipple	3/4"—16	41	30	
Oil Level Sensor Plug	3/4x16	27	20	
Oil Pan Drain Plug	1/2"—20	27	20	
Oil Pan Screw	M6x1.0	12		105
Oil Pressure Gauge Sending Unit	1/8"NPTF	7		60
Oil Pump Cover Bolt T-30	M6x1.00x18	12		105
Oil Pump Pick-up Tube Screw	M8x1.75	28		250
PCV Valve	3/8-16 NPTF	7		60
Rocker Shaft Bracket Bolt	5/16"—18	28		250
Spark Plug	14 mm	27	20	
Starter Mounting Bolt	7/16"—14	68	50	
Strut Intake Manifold to Cylinder Head Bolt	M10x1.5	54	40	
Tappet Retainer Yoke Screw	M6x1	12		105
Temperature Gauge Sending Unit	1/8"—NPTF	7		60
Timing Chain Snubber Screw	M6x1	12		105
Water Pump to (Chain Case Cover) Bolt	M6x1.0	12		105

All Fasteners Should Be Clean and Lightly Oiled.



3.5L ENGINE

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GENERAL INFORMATION

ENGINE IDENTIFICATION NUMBER OR CODE

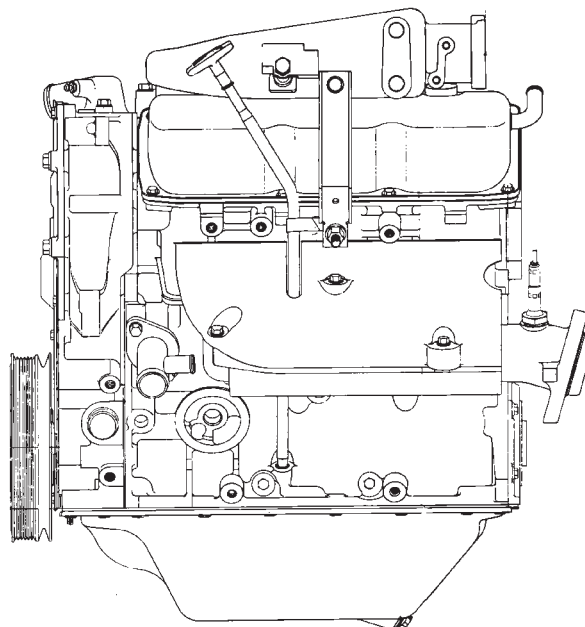
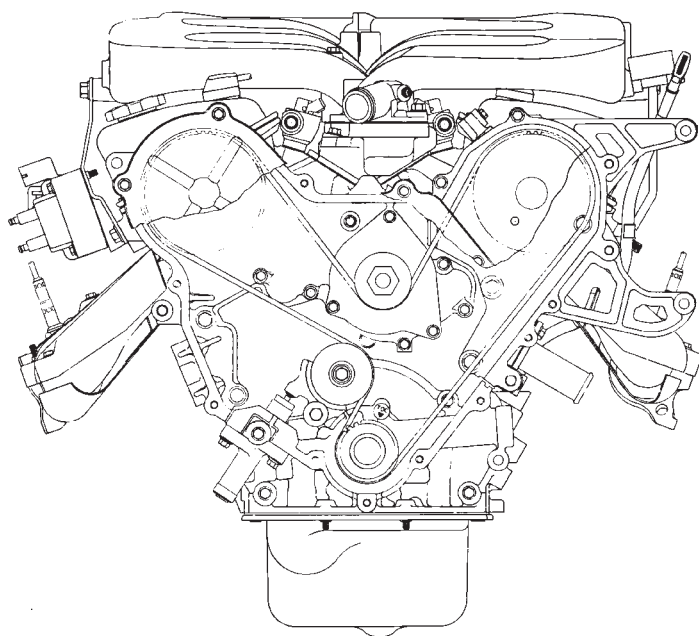
The engine identification number is located on the rear of the cylinder block just below the cylinder head (Fig. 1).

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 rigid-

ity 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 pins reduce torque fluctuations while a torsional vibration damper is used to control torsion caused vibration of the crankshaft.

3.5L ENGINE





SPECIFICATIONS

Type	60° V-6 Engine
Bore	96 mm (3.780 Inch)
Stroke	81 mm (3.189 Inch)
Compression Ratio	10.45:1
Displacement	3.5 Liters (215 Cubic Inch)
Brake Horsepower	214 @5800 RPM
Torque	221 Lb. Ft. @2800 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)

9309-114

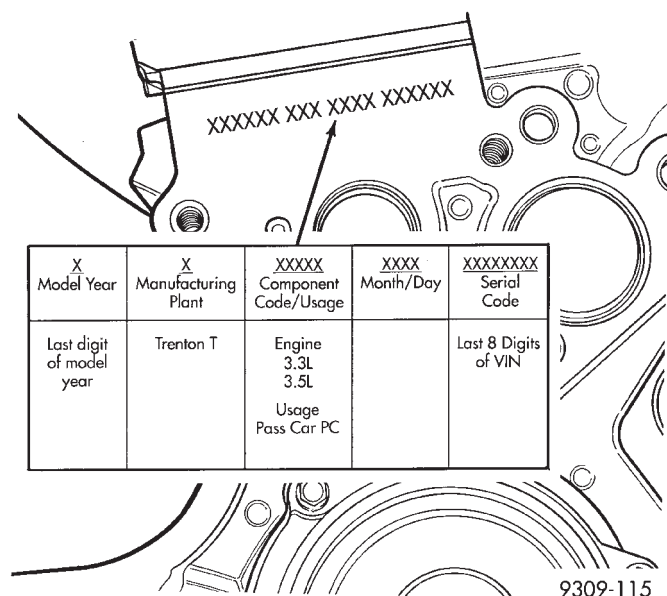


Fig. 1 Engine Identification

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 re-

tention 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 inserts are powdered metal. Valves of heat resistance 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: Two overhead camshafts provide 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 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.

ROCKER ARM SHAFTS: The shafts are retained by the aluminum alloy pedestals. Four shafts are used, one for each intake and exhaust rocker arm assembly on each cylinder head. The hollow shafts provide a duct for lubricating oil flow from the cylinder head to the valve mechanisms.

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

VALVES: Are made of heat resistant steel and are further treated to resist heat.

VALVE SPRINGS: Are especially designed right and left wound valve spring wire. Valve spring retainers, locks and valve spring seat are integral with the valve seal which includes a garter spring on it.

INTAKE MANIFOLD: The aluminum alloy manifold is a cross type with long runners to improve inertia. The air plenum chamber absorbs air pulsations created during the suction phase of each cylinder.

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.



ENGINE MOUNTS

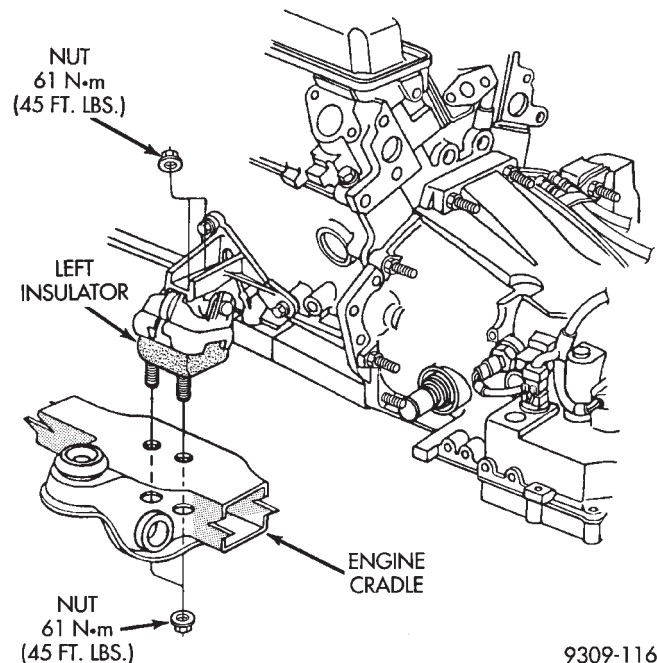


Fig. 2 Engine Mounting — Typical

REMOVAL

- (1) Remove the isolator 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 isolator to the frame (Fig. 2).
- (5) Raise engine carefully with jack enough to remove the isolator from its mount.

INSTALLATION

- (1) Install mount onto the frame.
- (2) Lower the engine onto the isolator mount (Fig. 2). Remove jack from vehicle.
- (3) Tighten the isolator 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.).

REAR MOUNT

- (1) Raise vehicle on hoist.
- (2) Support the transmission with a transmission jack.
- (3) Remove the insulator thru bolt from the mount.
- (4) Remove the transmission mount fasteners and remove mount.
- (5) Reverse removal procedure for installation.

ENGINE HYDRO-MOUNT INSULATORS

Engine hydro-mounts may show cracks this will not effect its performance and should not be replaced. Only replace the engine hydro-mounts when it's leaking fluid.

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

ENGINE ASSEMBLY

REMOVAL

- (1) Disconnect battery.
- (2) Mark hood position at hinges and remove hood.
- (3) Drain cooling system. Refer to Cooling System Group 7 for draining procedure.
- (4) Disconnect all electrical connections.
- (5) Remove coolant hoses from radiator and engine.
- (6) Remove radiator and fan assembly. Refer to Cooling System Group 7 for procedure.
- (7) See Fuel System Group 14, For procedures to release fuel pressure, disconnect fuel lines and accelerator cable.
- (8) Remove air cleaner assembly.
- (9) Hoist vehicle and drain engine oil.
- (10) Remove air conditioning compressor mounting bolts and set compressor aside.
- (11) Disconnect exhaust pipes at manifolds.
- (12) Remove transmission inspection cover and mark flex plate to torque converter position.
- (13) Remove screws holding torque converter to flex plate and attach C-clamp on bottom of converter housing to prevent torque converter from coming out.
- (14) Remove power steering pump mounting bolts and set pump aside.
- (15) Remove two lower transmission to block screws.
- (16) Remove starter.
- (17) Lower vehicle and disconnect vacuum lines and ground strap.
- (18) Install transmission holding fixture.
- (19) Attach engine lifting hoist and support engine (Fig. 3).
- (20) Remove upper transmission case to block bolts.
- (21) Remove engine.

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. 2).
- (3) Install transmission case to cylinder block, tighten bolts to 102 N•m (75 ft. lbs.) torque.



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TIMING SYSTEM AND SEALS SERVICE

TIMING BELT COVERS SERVICE

REMOVAL

(1) Drain cooling system and remove upper radiator hose for access to timing belt covers. Refer to Cooling System Group 7 for draining procedure. Remove fan module.

(2) Remove the accessory drive belts. Refer to Accessory Drive System in Group 7 for service procedure. Remove crankshaft pulley (Fig. 2).

(3) Remove the stamped steel cover (Fig. 1). Do not remove the sealer on the cover, it is reusable. If some sealer is missing use Mopar Silicone Rubber Adhesive Sealant or equivalent to replace the missing sealer.

(4) Remove the cast cover (Fig. 1).

(5) Remove the lower belt cover located behind the crankshaft pulley.

(6) To install reverse previous procedures.

RIGHT SIDE COVER
(STAMPED)

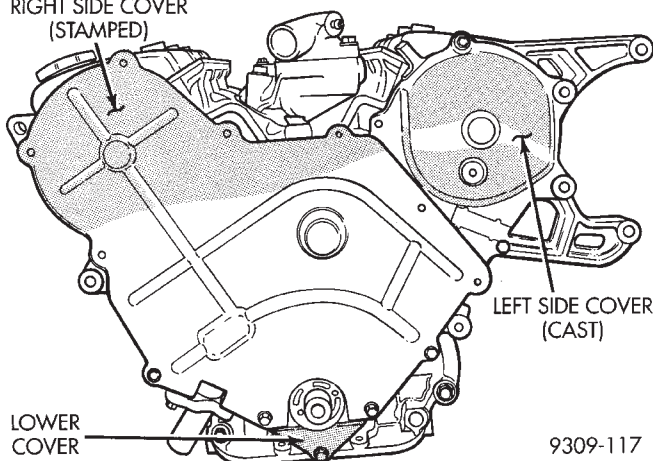


Fig. 1 Timing Belt Covers

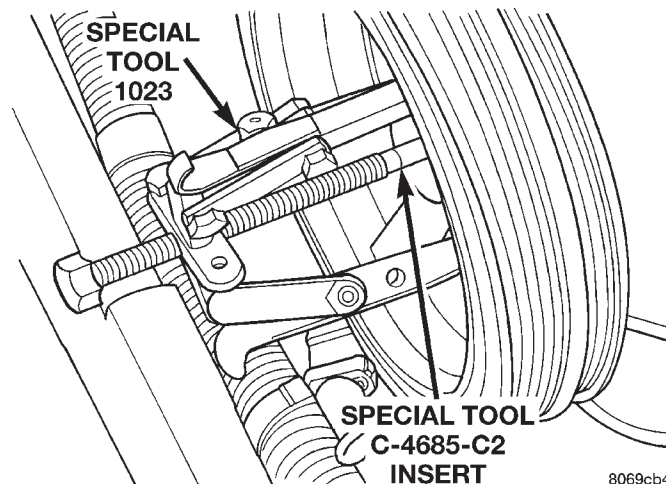


Fig. 2 Crankshaft Pulley — Removal

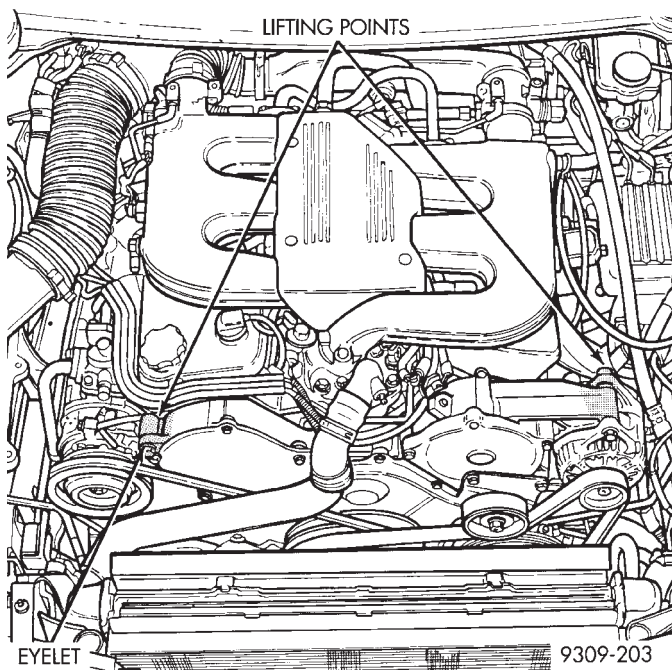


Fig. 3 Engine Lifting Points

(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 screws. 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 Accessory Belt Drive in Cooling System Group 7.

(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 Cooling System Group 7 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.



TIMING BELT INSPECTION—IN VEHICLE

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

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

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

(4) 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. 3).

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

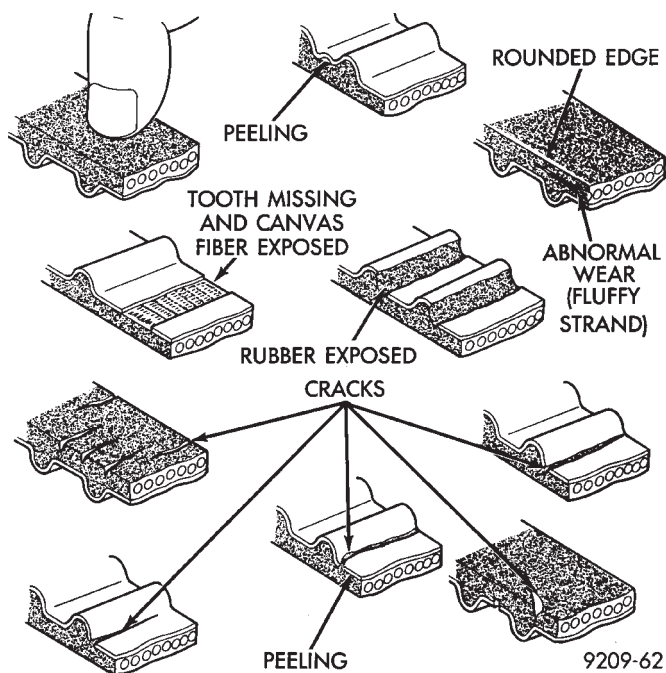


Fig. 3 Timing Belt Inspection

TIMING BELT SERVICE

REMOVAL

- (1) Mark belt running direction for installation.
- (2) Align the camshaft sprockets with marks on rear covers before timing belt is removed (Fig. 6).
- (3) Remove the timing belt tensioner (Fig. 4) and remove timing belt.

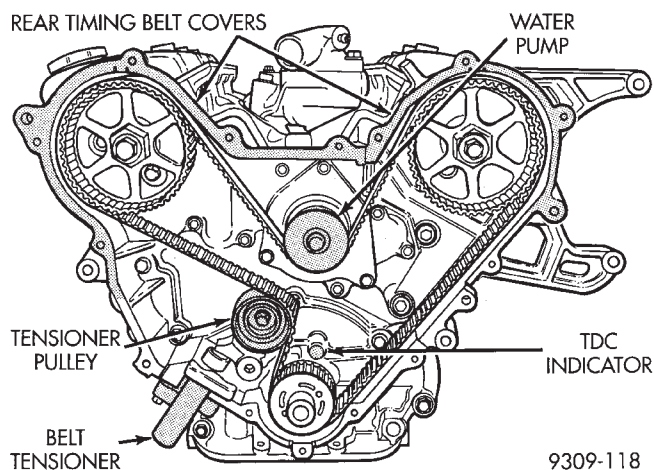


Fig. 4 Timing Belt System

TIMING BELT TENSIONER

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

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

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

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

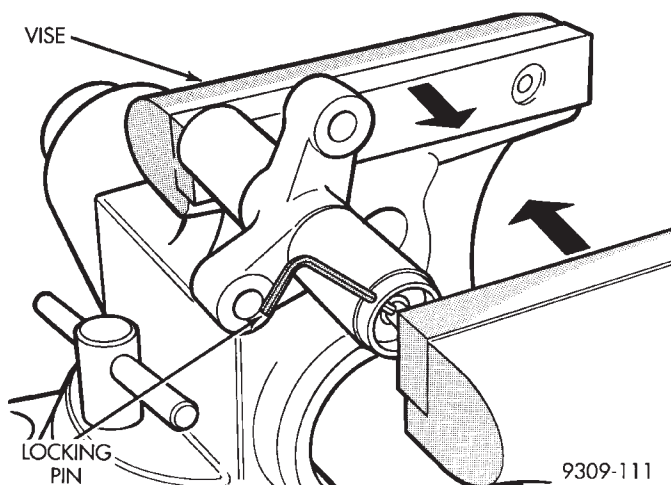


Fig. 5 Compressing Timing Belt Tensioner

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. 6).



(2) Align the camshaft sprockets between the marks on the covers (Fig. 6).

(3) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 6). After the belt is installed on the right sprocket keep tension on the belt until it is past 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.).

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

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

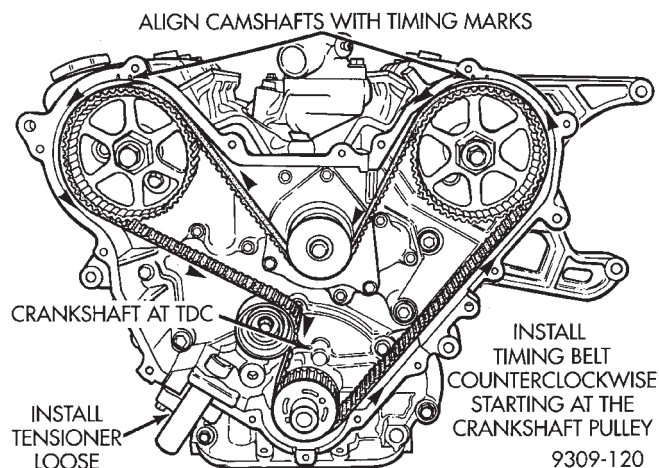


Fig. 6 Timing Belt Installation

SERVICING FRONT CRANKSHAFT OIL SEALS

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

(2) Remove crankshaft sprocket using Special Tool L-4407-A, (Fig. 7).

(3) Tap the dowel pin out of the crankshaft (Fig. 8).

(4) Remove crankshaft seal using Special Tool 6341 (Fig. 9).

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

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

(6) Install crankshaft seals using Special Tool 6342 (Fig. 10).

(7) Install the dowel pin into the crankshaft to 1.2 mm (0.047 inch.) (Fig. 8).

(8) Install crankshaft sprocket using special tool shown in (Fig. 11).

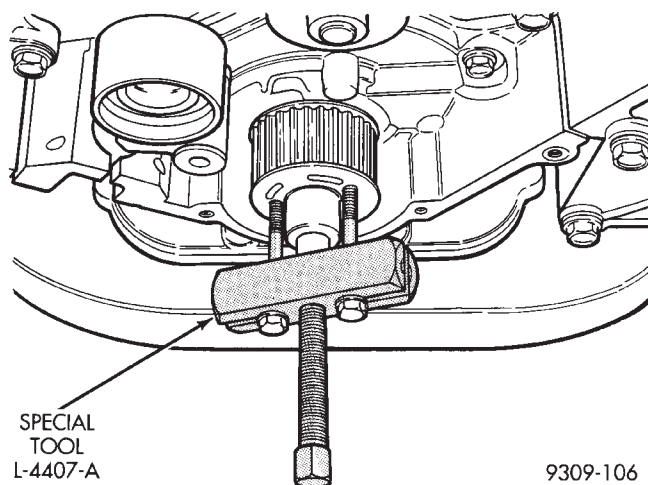


Fig. 7 Crankshaft Sprocket — Removal

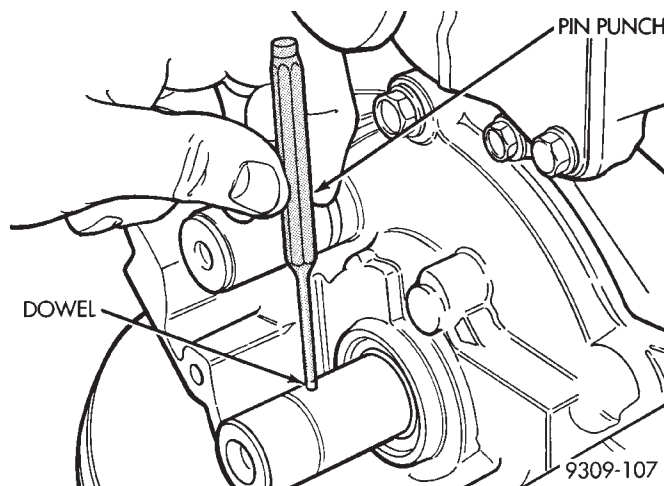


Fig. 8 Removing/Installing Crankshaft Sprocket Dowel Pin

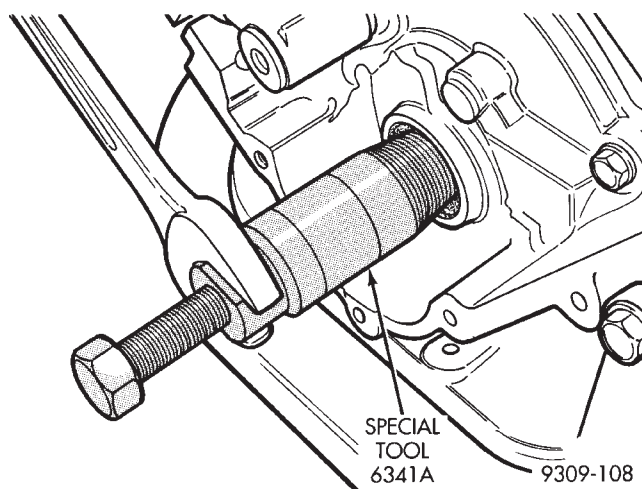


Fig. 9 Removing Crankshaft Oil Seal with Special Tool 6341A

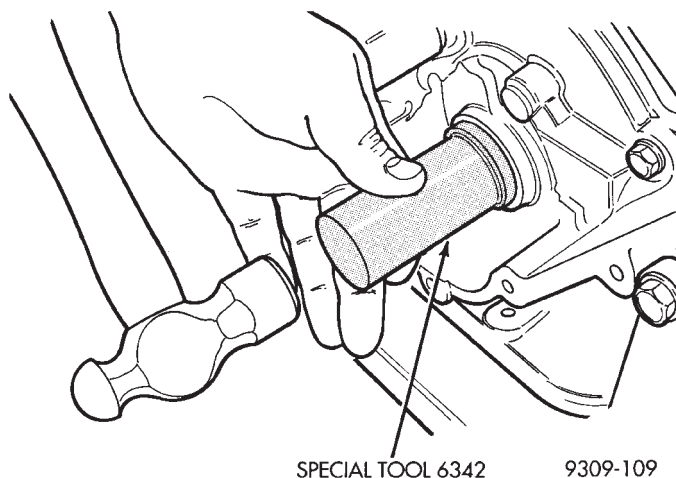


Fig. 10 Installing Crankshaft Oil Seal with Special Tool 6342

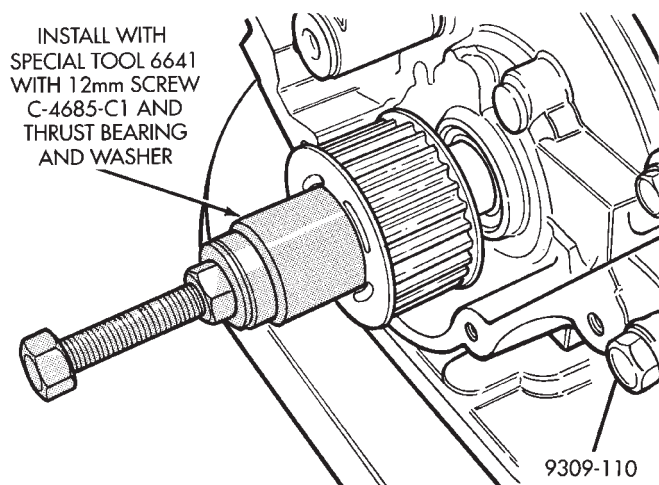


Fig. 11 Crankshaft Sprocket — Installation
CAMSHAFT SPROCKETS

REMOVAL

CAUTION: When cam sprockets are loosened or removed, the camshafts must be timed to the engine. Refer to camshaft timing and timing belt installation procedure outlined in this section. **THE CAMSHAFT SPROCKETS ARE NOT INTERCHANGABLE**

(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.

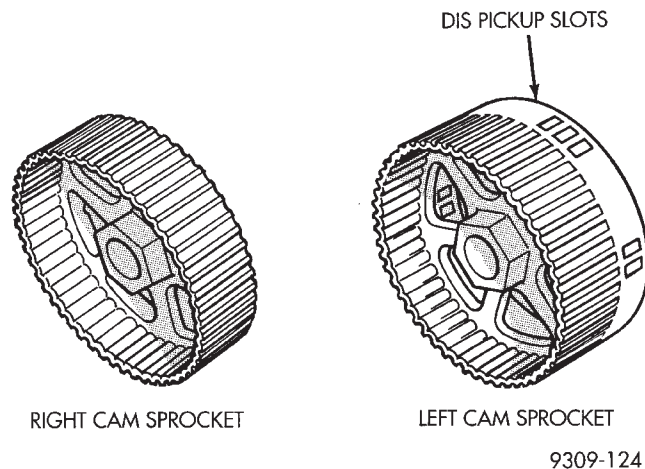


Fig. 12 Camshaft Sprocket Identification

CAMSHAFT AND TIMING BELT—INSTALLATION AND TIMING PROCEDURE

CAUTION: The camshaft sprockets are not interchangeable from side to side (Fig. 12).

(1) Place crankshaft sprocket to the TDC mark on the oil pump housing (Fig. 6).

(2) Set the left camshaft pilot hole and the right camshaft pilot hole as shown in (Fig. 13). Install the camshaft alignment Special Tools 6642-A to the rear of the cylinder heads.

(3) Preload the tensioner with a vise and install locking pin (Fig. 5).

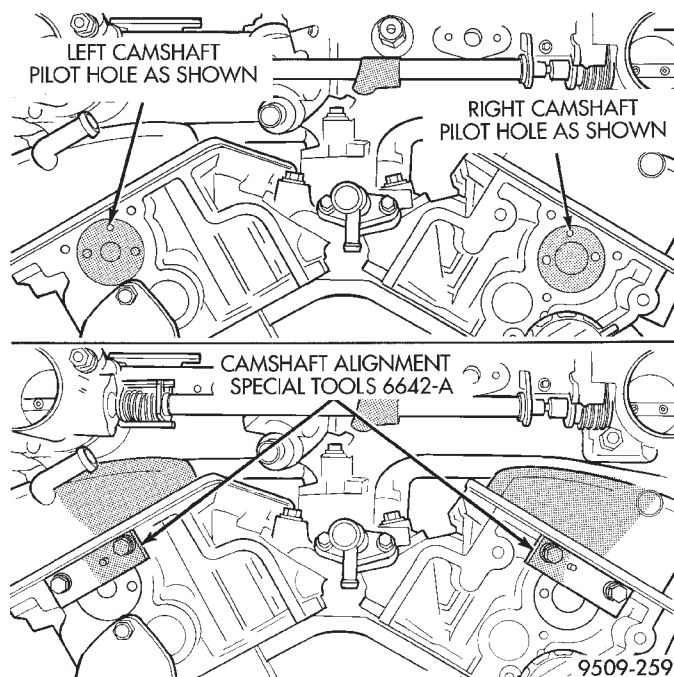


Fig. 13 Camshaft Alignment Special Tools 6642-A

(4) Install camshaft sprockets onto the camshafts. Apply sealer loctite 277 or equivalent to the ends of the bolts. 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 between the marks on the cover (Fig. 6).

(5) Install the timing belt starting at the crankshaft sprocket going in a counterclockwise direction (Fig. 6). After the belt is installed around the last sprocket keep tension on the belt until it is past the tensioner pulley.

(6) Holding the tensioner pulley against the belt, Install the tensioner into the housing and tighten to 28 N•m (250 in. lbs.).

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

(8) Install a dial indicator in number 1 cylinder to check TDC of the piston (Fig. 14). Rotate the crankshaft until the piston is at exactly TDC. This is important for engine performance.

(9) With number 1 piston at TDC, hold the camshaft sprocket hex with a 36 mm (1 7/16 in.) wrench and tighten the camshaft bolt to 127 N•m (95 ft. lbs.). Repeat step on other camshaft.

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

(11) Remove camshaft alignment special tools 6642-A 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 Service outlined in this section.

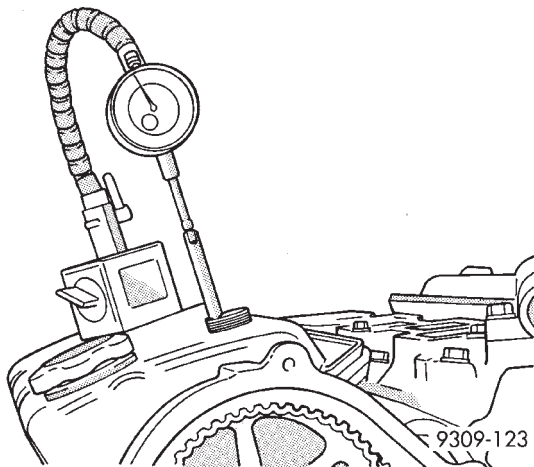


Fig. 14 Dial Indicator Locating TDC of Piston

CYLINDER HEAD AND CAMSHAFT SERVICE

CYLINDER HEAD COVER

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

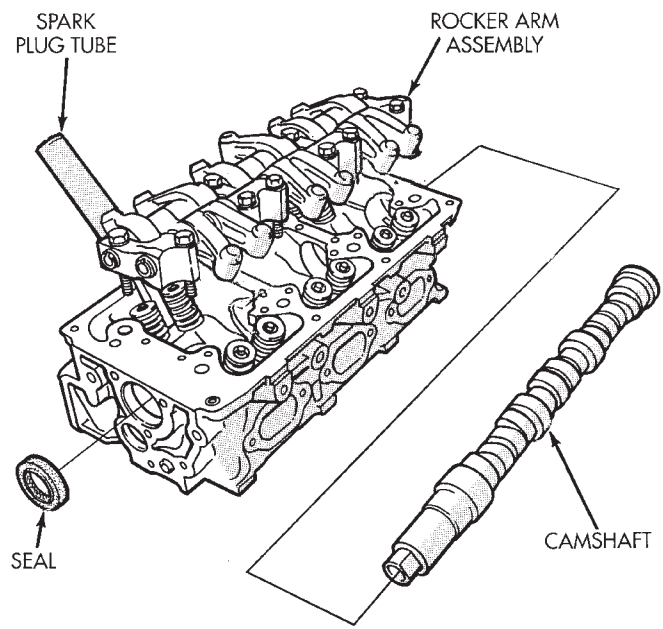


Fig. 1 Cylinder Head-Camshaft-Valves

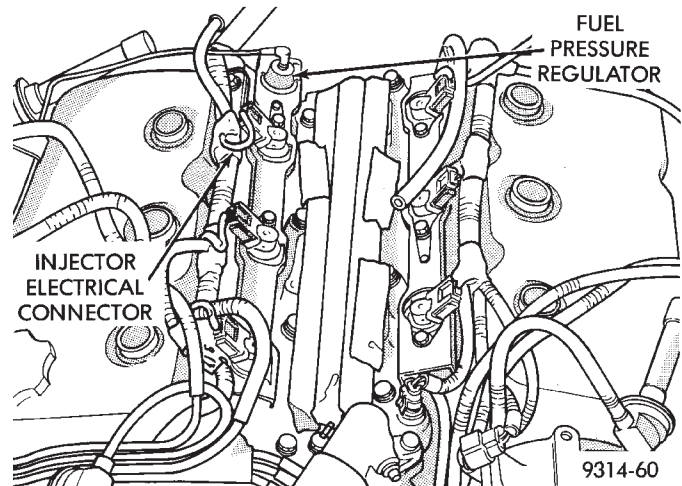


Fig. 2 Cover Lower Intake Manifold With Suitable Cover

REMOVAL

(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. 2).

(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. 3).

(6) Remove rocker cover screws and remove cover (Fig. 4).

INSTALLATION

(1) Clean cylinder head and cover mating surfaces. Install new gasket.



(2) Install cover and tighten cover bolt washer and gasket assembly to 12 N•m (105 in. lbs.) (Fig. 4).

(3) Install spark plug tube nut and o-ring (Fig. 3). Tighten nut to 7 N•m (60 in. lbs.).

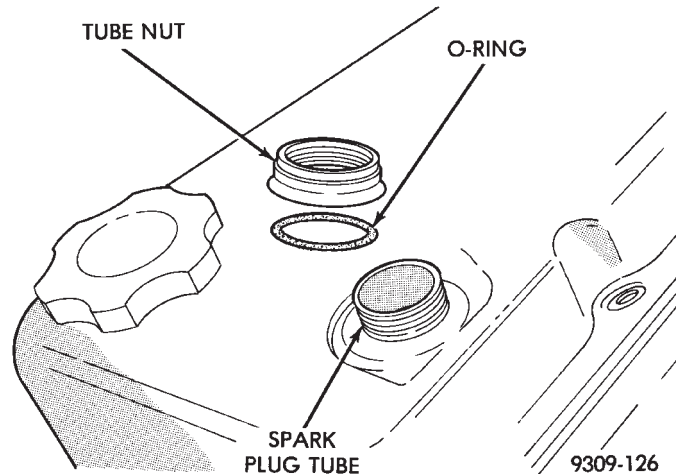


Fig. 3 Spark Plug Tube Nut and O-Ring

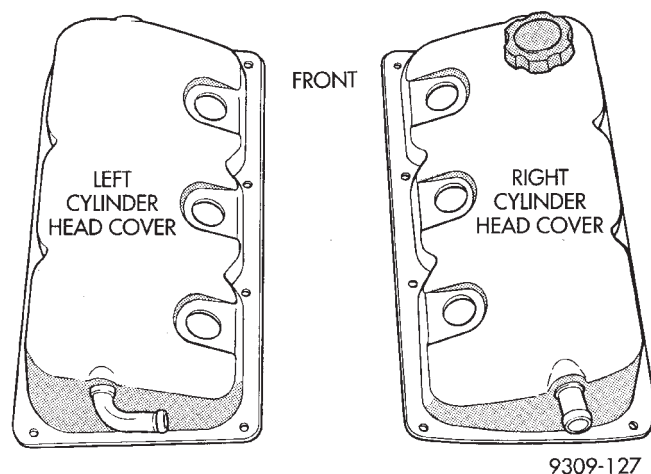


Fig. 4 Rocker Cover Assemblies

SPARK PLUG TUBE SERVICE

(1) Remove valve cover. Refer to procedure outlined in this section for procedure.

(2) Using locking pliers remove the tube from the cylinder head (Fig. 5). Discard old tube.

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

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

(5) Install **New Tube** with using the spark plug tube nut and a 32 mm socket **Immediately** tighten to 41 N•m (30 ft. lbs.).

(6) Install valve cover. Refer to procedure outlined in this section for procedure.

ROCKER ARM ASSEMBLY SERVICE

The rocker arm shafts are hollow and are used as a lubrication oil duct. The rocker arm shaft assembly

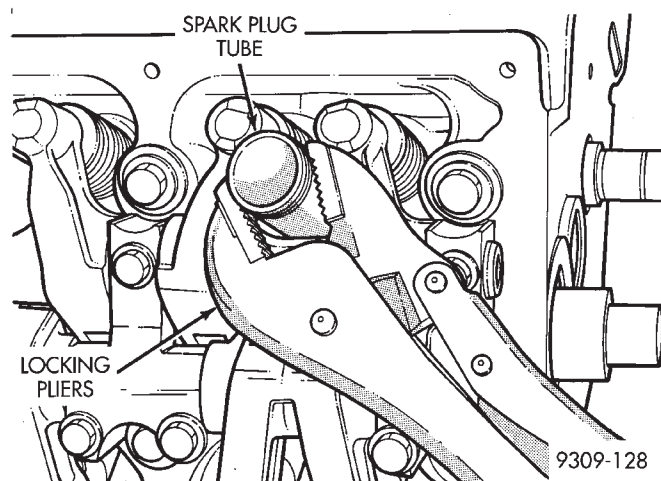


Fig. 5 Servicing Spark Plug Tubes

on the **right** side of the engine has an oil passage hole from the cylinder head located at the third rocker shaft support (Fig. 10). The rocker arm 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 (Fig. 11).

REMOVAL

(1) Remove valve covers. Refer to procedure outlined in this section.

(2) Identify the rocker arm assembly and rocker arms before disassembly (Fig. 6).

(3) Remove rocker arm assembly bolts.

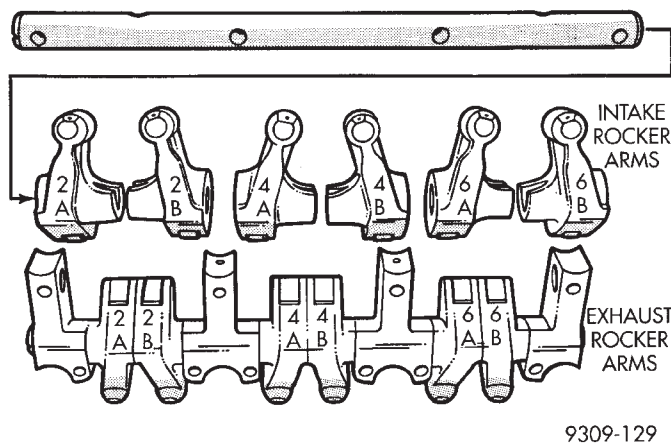


Fig. 6 Rocker Arms and Shaft Identification

ROCKER ARMS

The intake and exhaust rocker arms are different. They should be identified before disassembling the assembly (Fig. 6).

(1) Check rocker arms for wear or damage (Fig. 7):

- Roller scuffing or wear
- 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
- (2) Replace assembly as necessary if any rocker arms shows signs of wear.

CAUTION: Do Not remove lash adjuster from rocker arm assembly

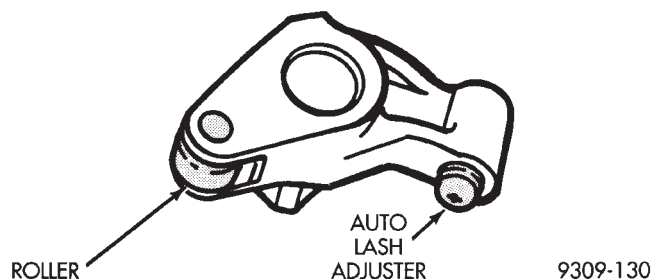


Fig. 7 Inspect Rocker Arms

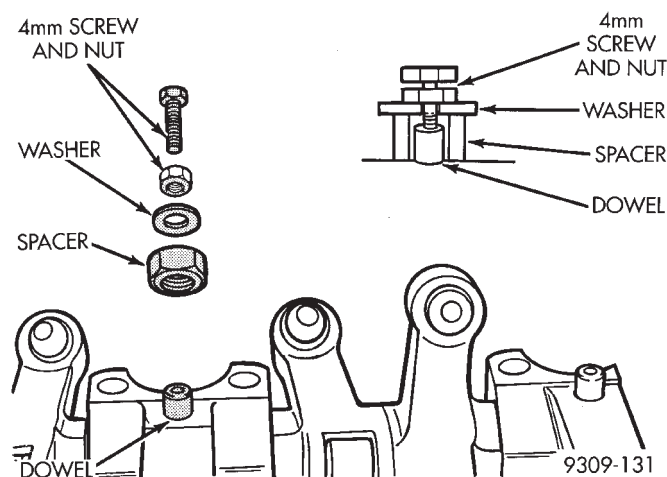


Fig. 8 Rocker Arms and Shaft — Disassembly

ROCKER ARM AND SHAFT ASSEMBLY —DISASSEMBLY

(1) Remove dowel pin using a 4 mm screw, nut, spacer, and washer installed into the pin (Fig. 8). Tighten the screw into the pin, then loosen the nut on the screw. This will pull the dowel out of the shaft support. Remove the rocker arms and pedestals in order.

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

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

ROCKER ARM ASSEMBLY

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

(2) Install dowel pins in their proper locations (Fig. 9). Dowel pins pass through the pedestal into the rocker shafts. Dowel pins should be press in until they bottom out in the pedestal.

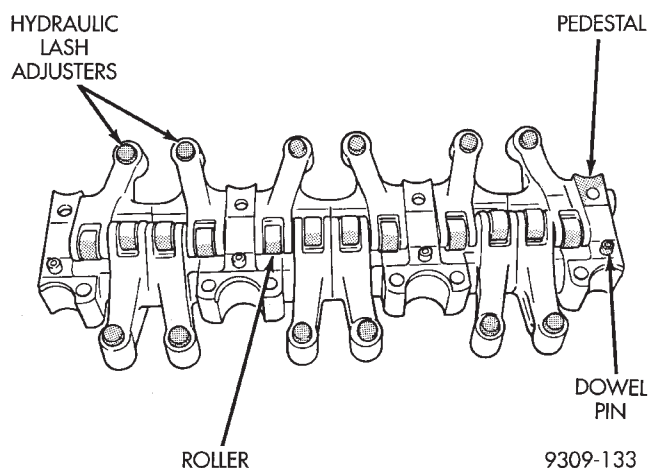


Fig. 9 Assemble Rocker Arm and Shafts—Assembly

ROCKER ARM SHAFT ASSEMBLY —INSTALLATION

(1) Rotate camshafts to the position shown in (Fig. ____). With the camshafts in these positions the lobes are in a neutral position (no load to the valve). This will allow the rocker arm shaft assembly to be tightened into position without any or no load on it.

(2) Install the rocker arm shaft assembly making sure that the identification marks face toward the front of engine .

(3) Install oil feed bolt in the into correct location on the rocker shaft retainer (Figs. 9 and 10). Tighten bolts in sequence to 31 N

31m (23 ft. lbs.).

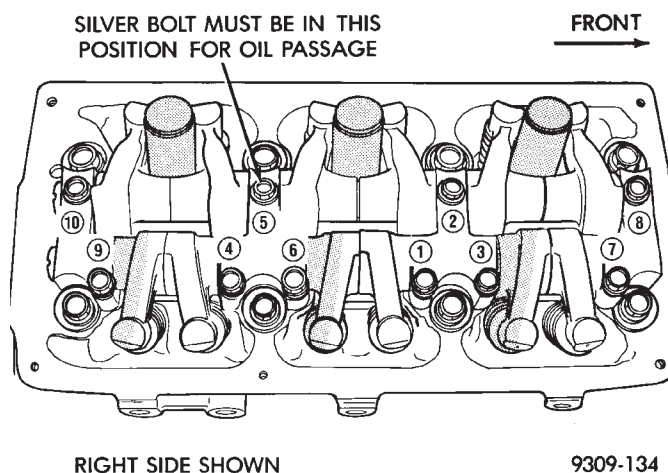
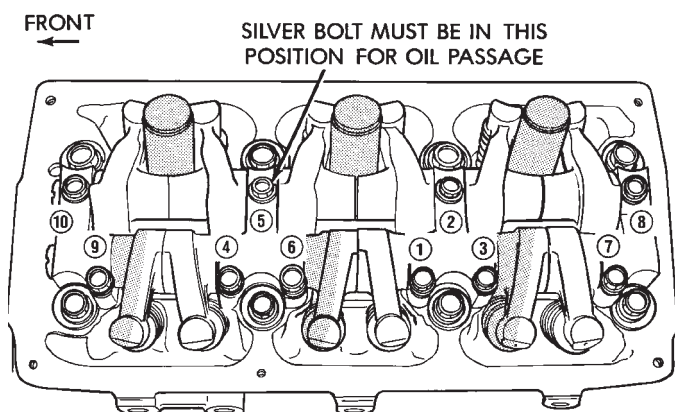


Fig. 10 Rocker Arm Shaft Assembly Torque Sequence —Right Side

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**



LEFT SIDE SHOWN

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Fig. 11 Rocker Arm Shaft Assembly Torque Sequence —Left Side

hydraulic lash adjuster from the rocker arm assembly (Fig. 7). Damage to the adjuster or rocker arm will occur.

CAMSHAFT SERVICE

CAMSHAFT— REMOVAL

Camshafts are serviced from the rear of the cylinder head. The cylinder head must be removed. Refer to cylinder head removal for procedure.

(1) Mark the rocker arm assembly before disassembly. Remove the rocker arm and shaft assembly from the head.

(2) Remove the rear camshaft cover and o-ring from head.

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

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

CAMSHAFT INSPECTION

(1) Inspect camshaft bearing journals for damage and binding (Fig. 12). If journals are binding, also check the cylinder head for damage. Also check cylinder head oil holes for clogging.

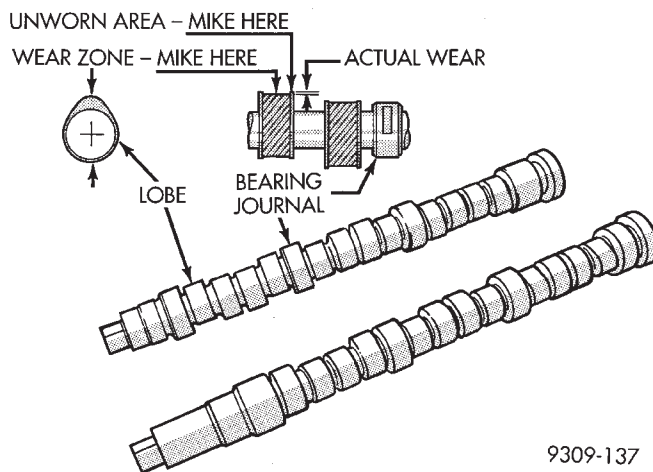
(2) Check the cam surface for abnormal wear and damage and replace if defective. Also measure the cam height (Fig. 12) and replace if out of limit, standard value is 0.0254 mm (.001 inch.), wear **limit** is 0.254 mm (0.010 inch.).

CAMSHAFT— INSTALLATION

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

(2) Install the camshaft cover and o-ring to the head and tighten to 28 N•m (250 in. lbs.).

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



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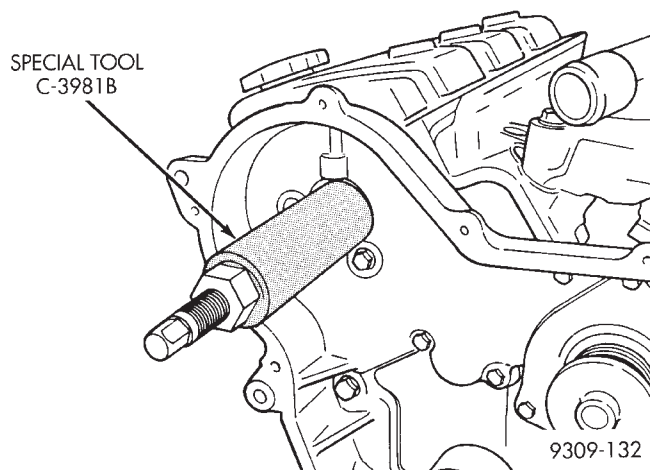
Fig. 12 Check Camshafts

CAMSHAFT OIL SEAL SERVICE

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. 13).



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Fig. 13 Remove Camshaft Oil Seal

INSTALLATION

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

(2) Install the oil seal using Special Tool 6052 (Fig. 14).

CYLINDER HEAD

REMOVAL

(1) Refer to Timing System Service in this group for disassembly and remove camshaft sprockets.

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

(3) Remove timing belt cover to cylinder head fasteners (Fig. 15).

(4) If the right side timing belt cover is removed

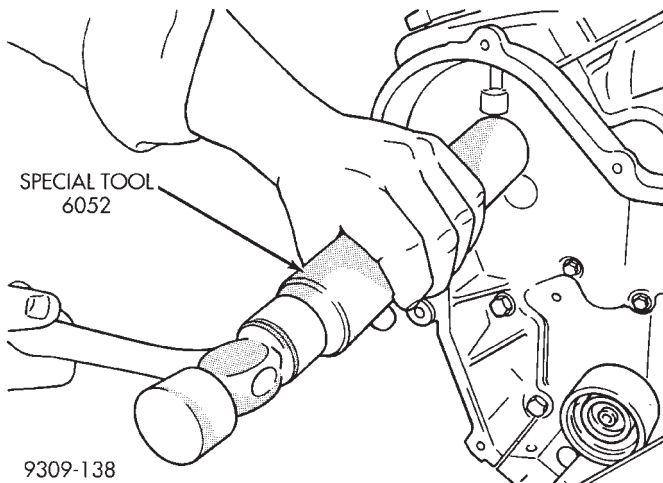


Fig. 14 Install Camshaft Oil Seal

there are o-rings located behind it for water pump passages (Fig. 16).

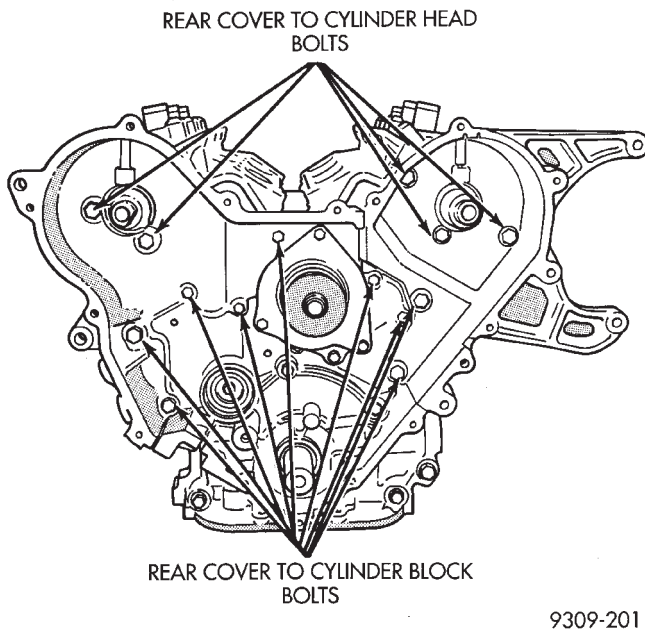


Fig. 15 Rear Timing Belt Cover Attaching Bolts

(5) Remove cylinder head bolts and remove 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 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 hole.

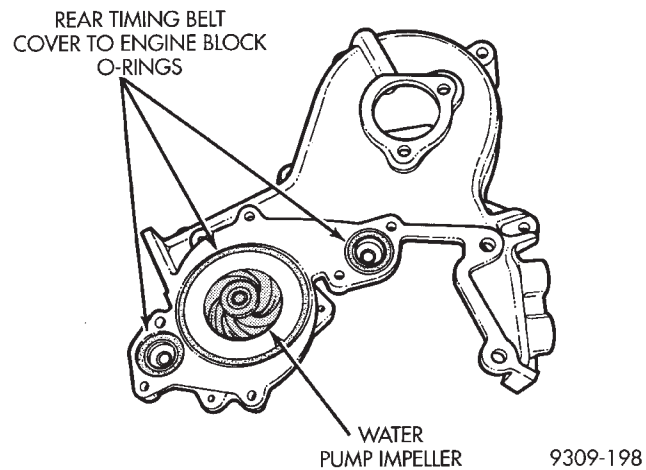


Fig. 16 Right Side Timing Belt Cover Water Pump O-Rings

INSPECTION

- (1) Before cleaning, check for leaks, damage and cracks.
- (2) Clean cylinder head and oil passages.
- (3) Check cylinder head for flatness (Fig. 17).

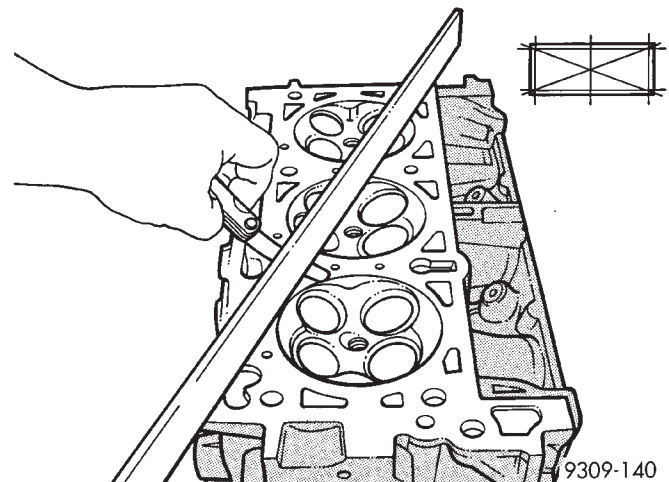


Fig. 17 Checking Cylinder Head Flatness

- (4) Cylinder head must be flat within:
- Standard dimension = less than 0.05mm (.002 inch)
 - Service Limit = 0.2mm (.008 inch)
 - Grinding Limit = Maximum of 0.2 mm (.008 inch) is permitted.

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

INSTALLATION

The cylinder head bolts are tighten using a torque to yield procedure. They should be examined **BEFORE** reuse. If the threads are necked down the bolts should be replaced (Fig. 19).

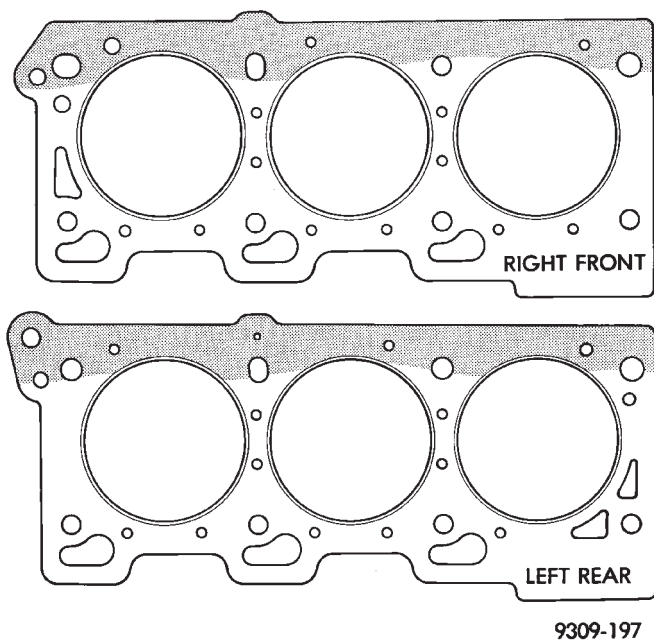


Fig. 18 Cylinder Head Gasket Identification

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.

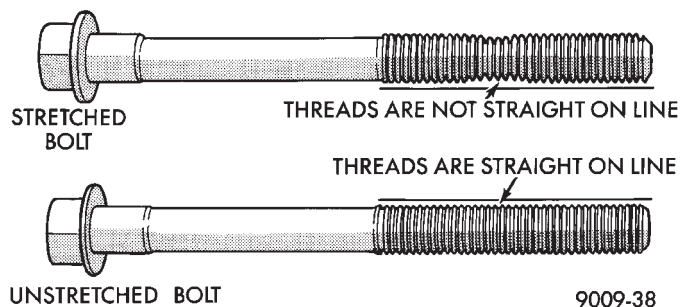


Fig. 19 Checking Bolts for Stretching (Necking)

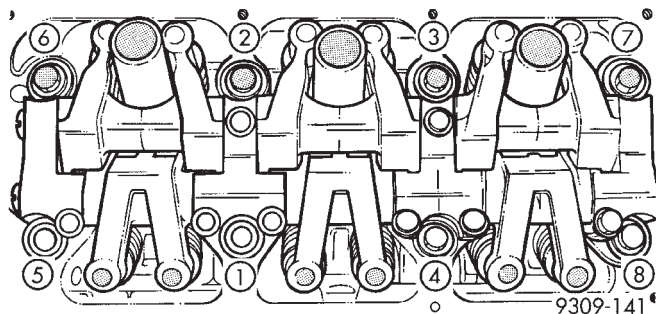


Fig. 20 Cylinder Head Bolt Tightening Sequence

- (1) Before installing the bolts the threads should be oiled with engine oil.
- (2) Install head gasket over locating dowels be sure the gasket is installed on the correct side (Fig. 18).
- (3) Install cylinder head over dowels.

(4) Tighten the cylinder head bolts in the sequence shown in (Fig. 20). 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.**

Bolt torque after 1/4 turn should be over 90 ft. lbs. If not, replace the bolt.

VALVE SERVICE

VALVE AND VALVE SPRINGS

REMOVAL

(1) With cylinder head removed, compress valve springs using the Valve Spring Compressors shown in (Fig. 21).

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

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

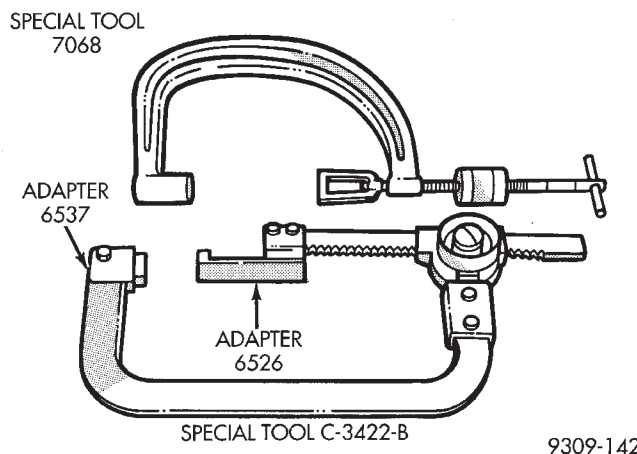


Fig. 21 Valve Spring Compressors

VALVE INSPECTION

- (1) Clean valves thoroughly and discard burned, warped and cracked valves.
- (2) Measure valve stems for wear. Refer to specifications (Fig. 24).

Valve stems are chrome plated and should not be polished.

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

(4) Measure valve stem guide clearance as follows:

- (a) Install valve into cylinder head so it is 15mm (.590 inch) off the valve seat. A small piece of hose may be used to hold valve in place.



(b) Attach dial indicator Tool C-3339 to cylinder head and set it at right angle of valve stem being measured (Fig. 22).

(c) Move valve to and from the indicator. Refer to specifications (Fig. 24).

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

(5) Service valves with oversize stems and over size seals are available in 0.15mm (.0059 inch.), 0.40mm (.0157 inch.) and 0.80mm (.0315 inch.) oversize.

Oversize seals must be used with oversize valves.

Reamers to accommodate the oversize valve stem are as follows:

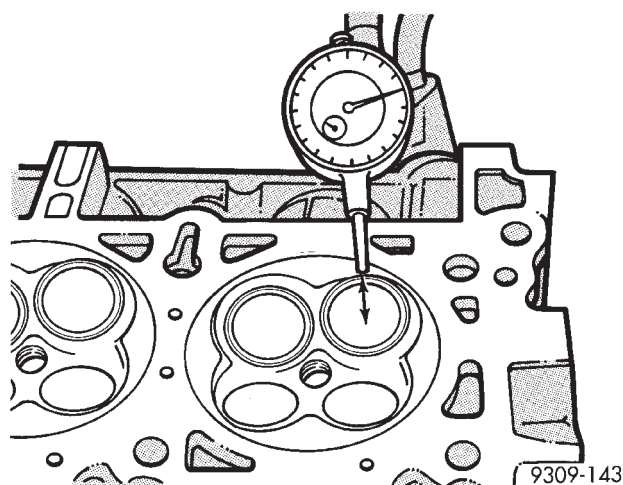


Fig. 22 Measuring Valve Guide Wear

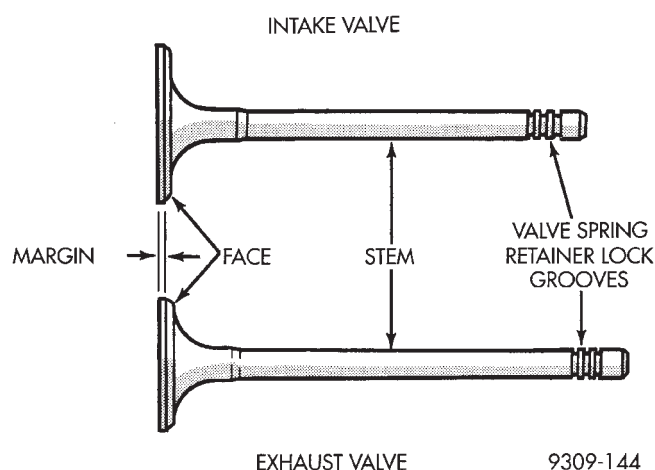


Fig. 23 Intake and Exhaust Valves

(6) 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 0.80mm (.0315 inch.)** Use step procedure of 0.15mm (.0059 inch.), 0.40mm (.0157 inch.) and 0.80mm (.030 inch) so the valve guides may be reamed true in relation to the valve seat. After reaming guides, the seat runout should be

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.)	

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Fig. 24 Valve Guide Specifications

measured and resurfaced if necessary. See Refacing Valves and Valve Seats.

VALVE GUIDES

Replace cylinder head if guide does not clean up with 0.80mm (.0315 inch) oversize reamer, or if guide is loose in cylinder head.

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. 25 Valve Specifications

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. 25).

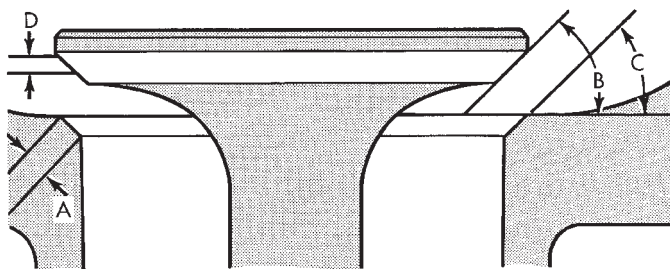
VALVES

(1) Inspect the remaining margin after the valves are refaced Refer to specifications (Fig. 25).

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 .051mm (.002 inch) total indicator reading.



A – SEAT WIDTH (INTAKE AND EXHAUST 1.25 TO 1.75 mm
(.049 TO .069 IN.))

B – FACE ANGLE (INTAKE & EXHAUST: 44½°-45°)

C – SEAT ANGLE (INTAKE & EXHAUST: 45°-45½°)

D – SEAT CONTACT AREA

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Fig. 26 Valve Seats

(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.

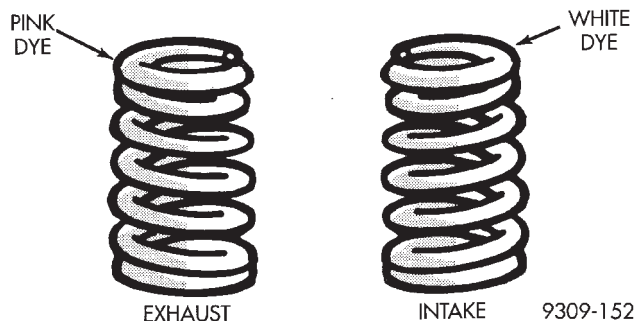
Valve seats which are worn or burned can be reworked, provided that correct angle and seat width are maintained. Otherwise cylinder head must be replaced.

(4) When seat is properly positioned the width of the intake and exhaust seats should be 1.25 to 1.75mm (0.492 to .0689 inch.)(Fig. 26).

(5) Check the valve spring installed height after refacing the valve and seat (Fig. 29).

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. 27).

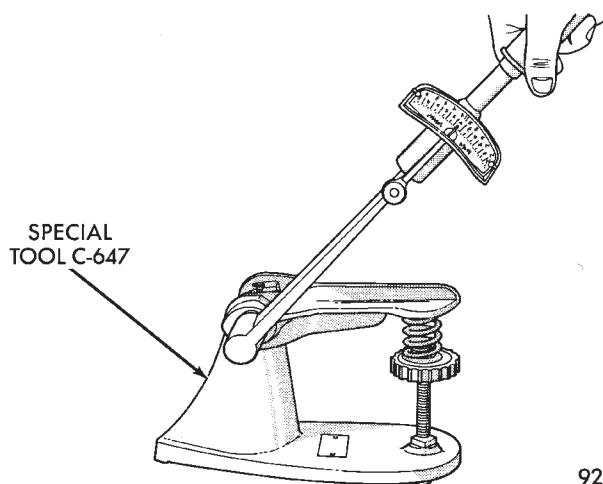


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Fig. 27 Valve Spring Identification

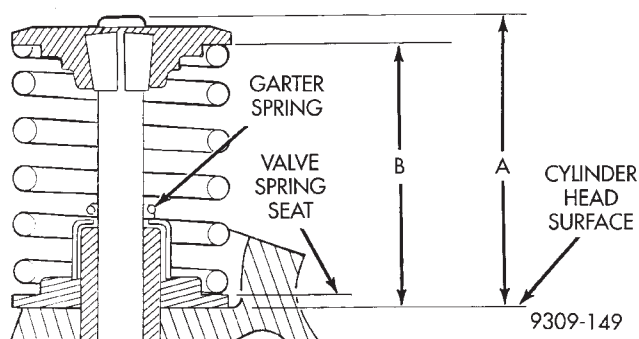
TESTING VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested (Fig. 28). **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 to obtain specified height and allowable tensions. Discard the springs that do not meet specifications.



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Fig. 28 Testing Valve Spring with Tool C-647



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Fig. 29 Checking Valve Tip Height and Valve Installed Height

VALVE INSTALLATION

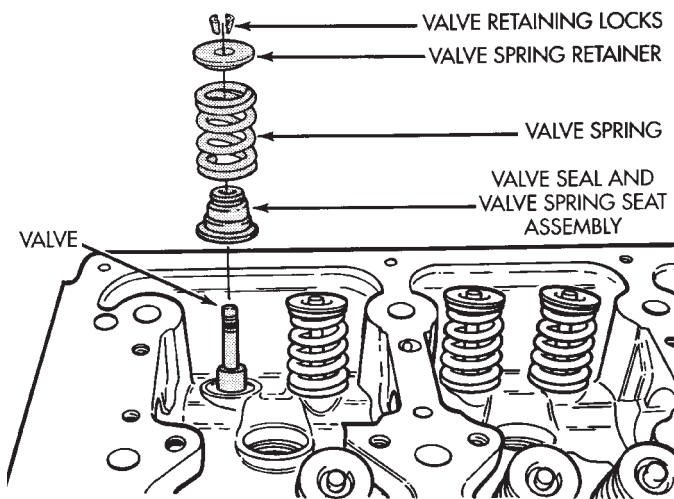
(1) Coat valve stems with clean engine oil and insert them in cylinder head.

(2) If valves or seats have been reground, check valve tip height (A) (Fig. 29). 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 measurements is taken from cylinder head surface to the top of valve stem.



(3) Install valve seal/spring seat assembly over valve guides on all valve stems (Fig. 30). 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. 29), make sure measurements are taken from top of spring seat to the bottom surface of spring retainer.** If height is greater than 38.75 mm (1.5256 inches.), install a .762 mm (0.030 inch) spacer in head counterbore under the valve spring seat to bring spring height back within specification.



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Fig. 30 Installing Valve, Seal/Spring Seat Assembly, Spring, Retainer and Locks

REPLACE VALVE STEM SEALS OR VALVE SPRINGS, CYLINDER HEAD NOT REMOVED

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

(2) Disconnect negative battery cable.

(3) Remove Air Cleaner Cover and hose assembly.

(4) Remove Intake Manifold; Refer to Intake/Exhaust Manifold 3.5L Engine Group 11 Exhaust System and Intake Manifold of this manual 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 arms assembly. Refer to this section for procedure.

(8) Rotate the crankshaft by the pulley retaining screw, till 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 90 to 100 psi air pressure (620.5 to 689 kPa). 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 retainer valve locks and valve spring.

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

CAUTION:Do not remove garter spring around the seal at the top of the valve stem seal (Fig. 29).

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

(13) Remove spark plug adapter tool .

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

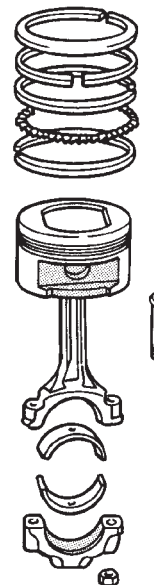
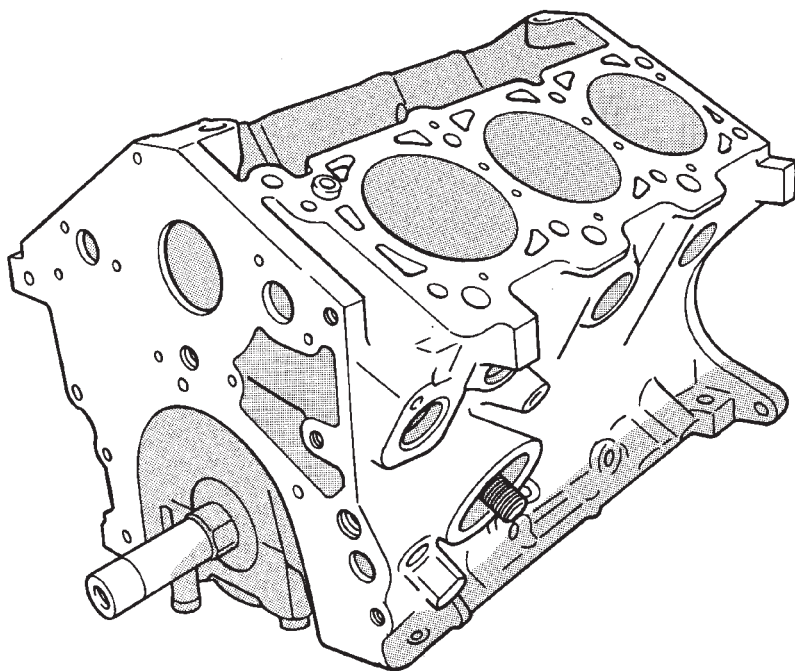
(15) Install rocker arm covers. Refer to procedure outline in this section.

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

(17) Install Intake Manifold; Refer to Intake Manifold Installation 3.5L Engine, Group 11 Exhaust System and Intake Manifold.



CYLINDER BLOCK, CRANKSHAFT, PISTON AND CONNECTING ROD ASSEMBLY SERVICE



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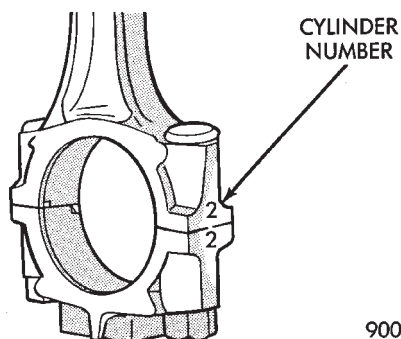
Fig. 1 Cylinder Block, Piston and Connecting Rod Assembly

CYLINDER BLOCK

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. 2)



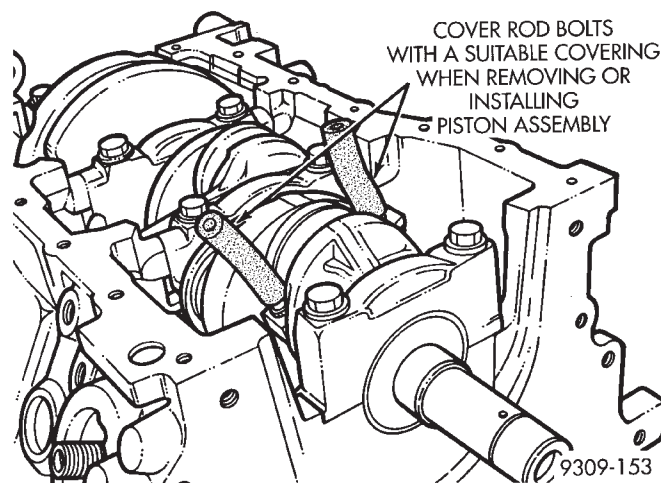
9009-74

Fig. 2 Identify Connecting Rod to Cylinder

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

Be careful not to nick crankshaft journals.

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



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Fig. 3 Connecting Rod Protectors

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.

CYLINDER BORE INSPECTION

The cylinder walls should be checked for out-of-round and taper with Tool C-119 (Fig. 4). If the cyl-

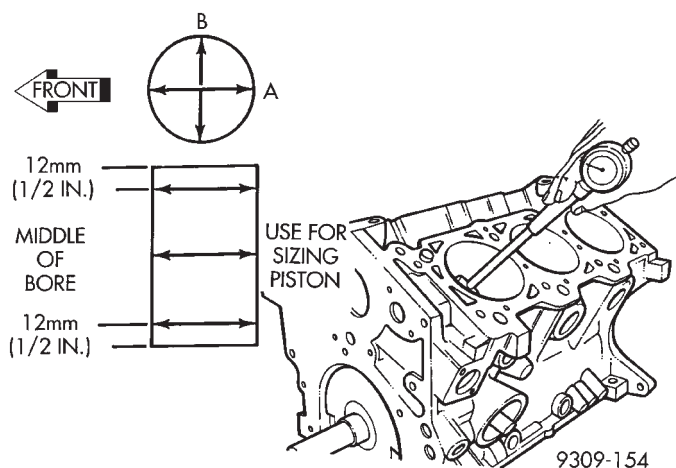


Fig. 4 Checking Cylinder Bore Size

inder walls are badly scuffed or scored, the cylinder block should be rebored and honed, and new pistons and rings fitted. Whatever type of boring equipment is used, boring and honing operation should be closely coordinated with the fitting of pistons and rings in order that specified clearances may be maintained.

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

Measure the cylinder bore at three levels in directions A and B (Fig. 4). Top measurement should be 12mm (.50 inch) down and bottom measurement should be 12mm (.50 inch.) up from bottom of bore. Refer to (Fig. 5) for specifications.

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. 6). Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line shown in (Fig. 4). 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 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.

Engine	Standard Bore	Maximum Out-of-Round	Maximum Taper
3.5 L	96.0 mm (3.780 inch.)	.076 mm (.003 inch.)	0.051 mm (.002 inch.)
Standard Piston Size			
3.5 L	95.974 - 95.956 mm (3.780 - 3.7778 inch.)		
Piston to Bore Clearance: 0.019 -0.051 mm (.0007 to .0020 inches.) Measurements taken at Piston Size location.			

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Fig. 5 Cylinder Bore and Piston Specifications

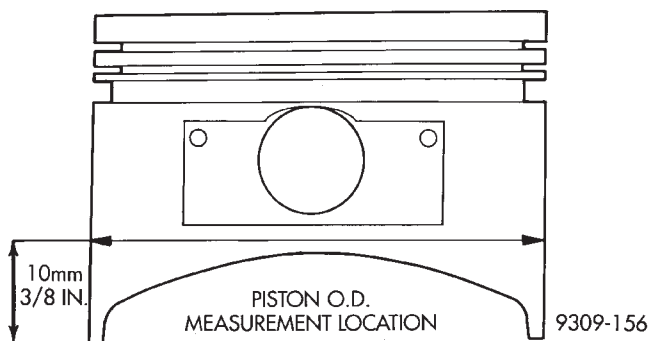


Fig. 6 Piston Measurements

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 12mm (.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).

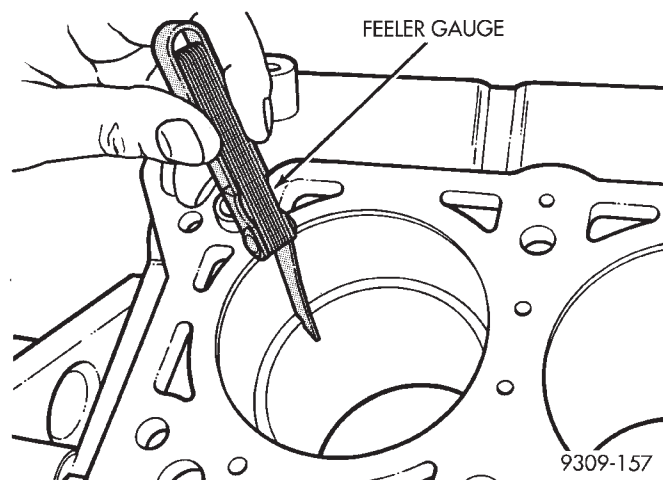


Fig. 7 Check Gap on Piston Rings

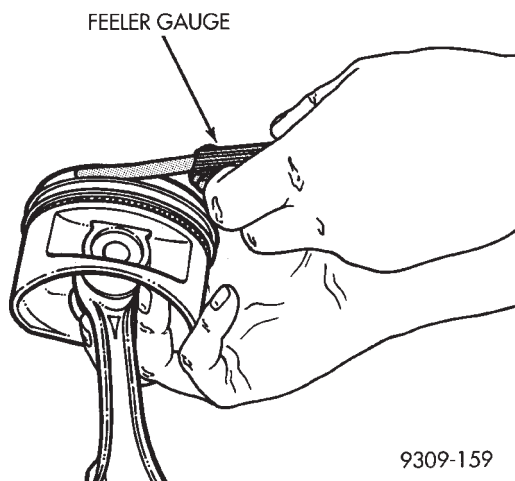


Ring Position	Ring Gap	Wear Limit
Upper Ring	0.30 to 0.46 mm (.012 to .018 in.)	0.8 mm (.031 in.)
Intermediate Ring	0.30 to 0.55 mm (.012 to .021 in.)	0.8 mm (.031 in.)
Oil Control Ring	0.25 to 0.76 mm (.010 to .030 in.)	1.0 mm (.039 in.)

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

9309-158

Fig. 8 Piston Ring Specifications

9309-159

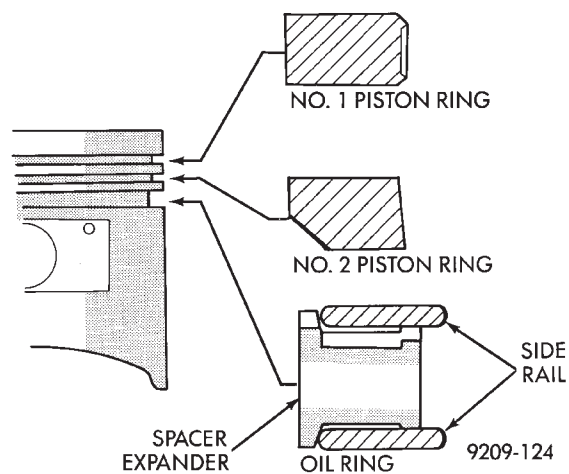
Fig. 9 Measuring Piston Ring Side Clearance**PISTON RINGS—INSTALLATION**

(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. 10).

CAUTION: Install piston rings in the following order:

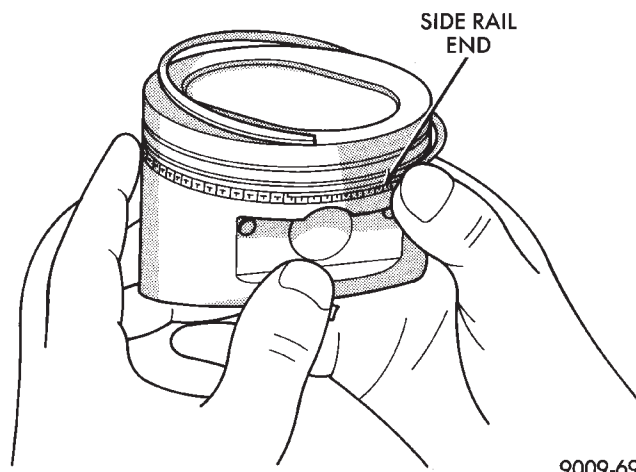
- Oil ring expander.
- Upper oil ring side rail.
- Lower oil ring side rail.
- No. 2 Intermediate piston ring.
- No. 1 Upper piston ring.

(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. 11).

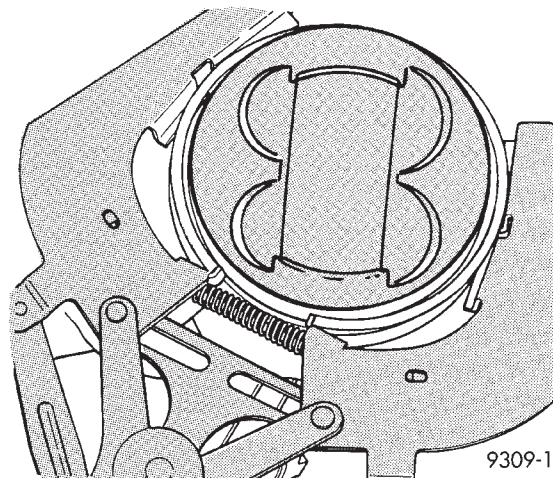
**Fig. 10 Piston Ring Installation**

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

(4) Install No. 2 piston ring and then No. 1 piston ring (Fig. 12).



9009-69

Fig. 11 Installing Side Rail

9309-162

Fig. 12 Installing Upper and Intermediate Rings



(5) Position piston ring end gaps as shown in (Fig. 13).

(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.

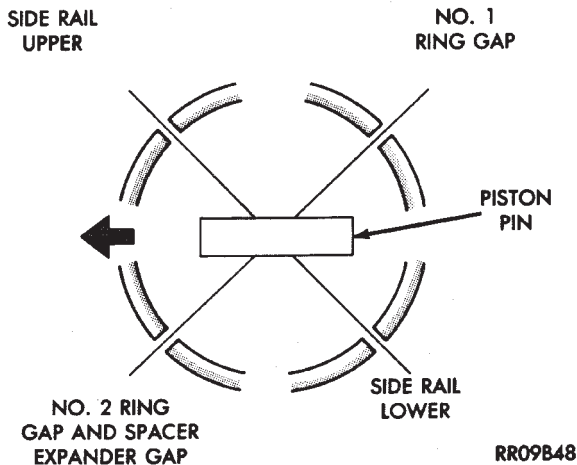


Fig. 13 Piston Ring End Gap Position

INSTALLING PISTON AND CONNECTING ROD ASSEMBLY

(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 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. 14).

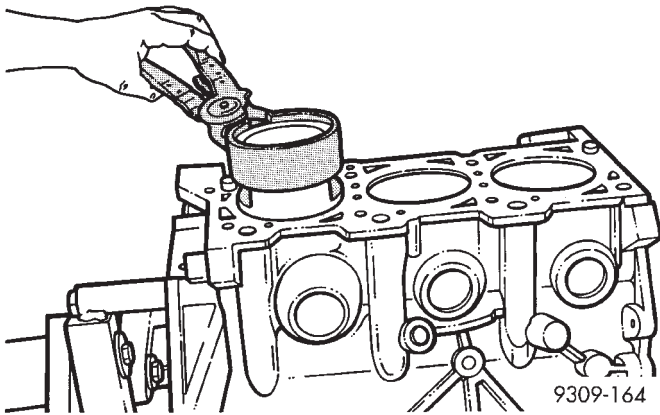


Fig. 14 Installing Piston

(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.**

(4) Install connecting rod bolt protectors on rod bolts. (Fig. 3)

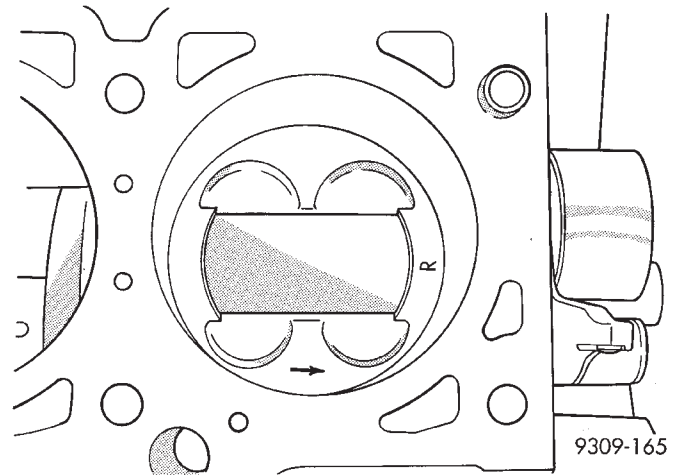


Fig. 15 Piston I.D. Marks

(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.

CAUTION: Piston Assemblies are not to be interchanged from bank to bank.

(6) The arrow on top of piston must be pointing toward front of engine (Fig. 15).

(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. lb.) Plus 1/4 turn.

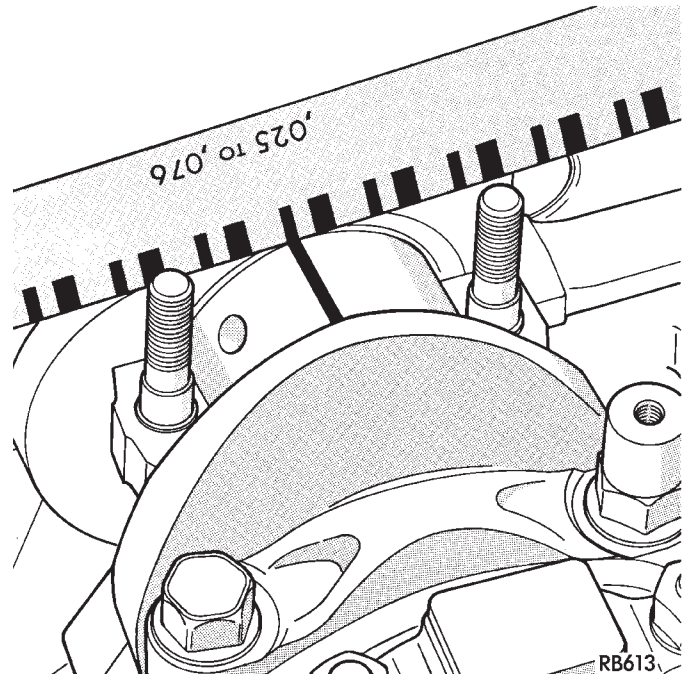


Fig. 16 Checking Connecting Rod Bearing Clearance—Typical



CONNECTING RODS

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 .025mm (.001 inch). Bearings are available in .025mm (.001 inch), .051mm (.002 inch), .076mm (.003 inch), .254mm (.010 inch) and .305mm (.012 inch) undersize. **Install the bearings in pairs. Do not use a new bearing half with an old bearing half. Do not file the rods or bearing caps.**

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

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

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. 18). Refer to (Fig. 19) for specifications.

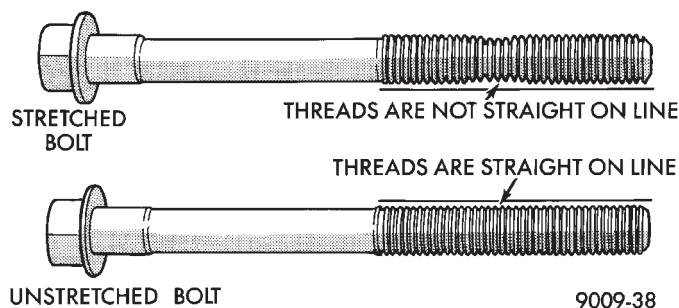


Fig. 17 Check for Stretched Bolts

CRANKSHAFT SERVICE

CRANKSHAFT MAIN BEARINGS

Bearing caps are not interchangeable and should be marked at removal to insure correct assembly. (Fig. 1) Upper and lower bearing halves are NOT in-

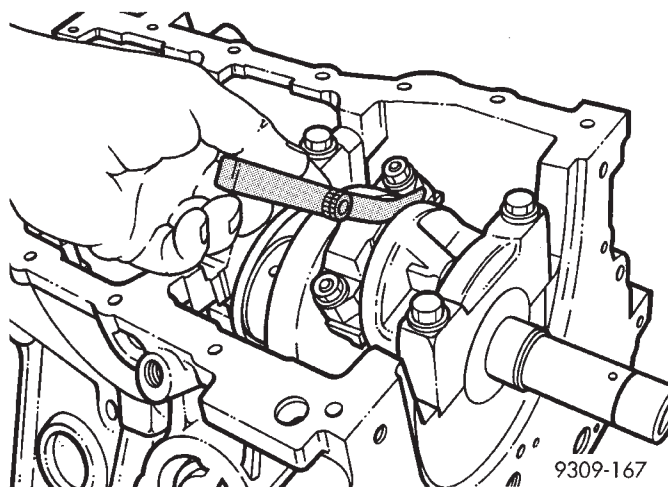


Fig. 18 Checking Connecting Rod Side Clearance

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.)

9309-168

Fig. 19 Connecting Rod Specifications

terchangeable. Lower main bearing halves of 1, 3 and 4 are interchangeable. Upper main bearing halves of 1, 3 and 4 are interchangeable.

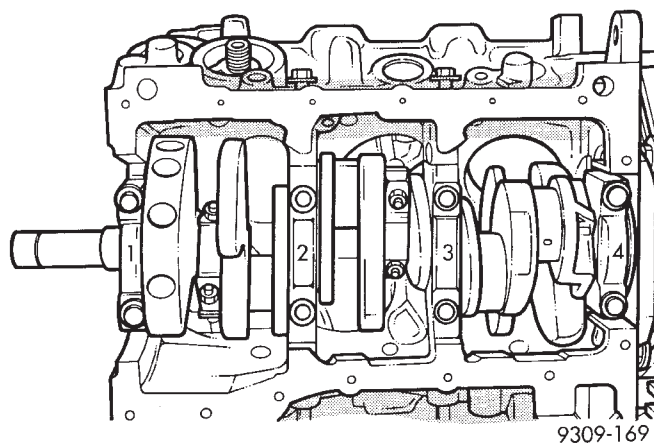


Fig. 1 Main Bearing Cap Identification

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 .025mm (.001 inch). Journal grinding should not exceed .305mm (.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.

Upper and lower Number 2 bearing is a three piece clinched design with flanged halves to carry the crankshaft thrust loads and are NOT interchangeable with any other bearing halves in the engine (Fig. 2). 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 undersizes: 0.025mm (.001 inch), .051mm (.002 inch), .076mm (.003 inch), .254mm (.010 inch), and .305mm (.012 inch). Never install an undersize bearing that will reduce clearance below specifications.

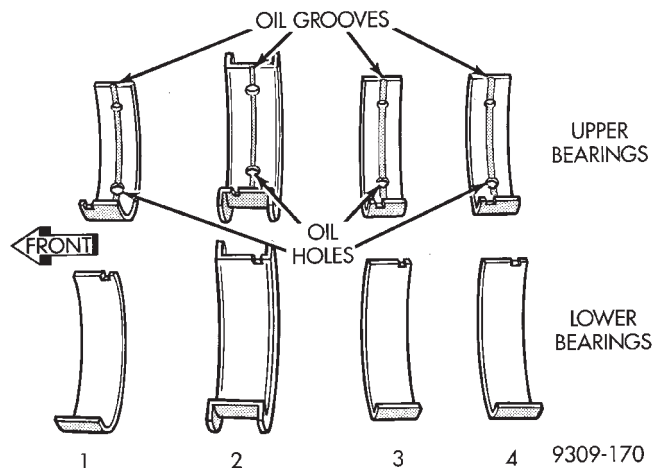


Fig. 2 Main Bearing Identification

REMOVAL

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

(2) Remove bearing caps one at a time. Remove upper half of bearing by inserting Special Main Bearing Tool C-3059. (Fig. 3) into the oil hole of crankshaft.

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

INSTALLATION

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. 3).

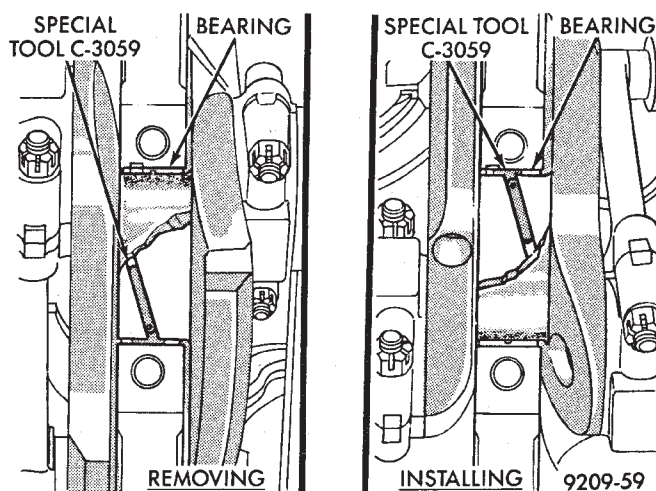


Fig. 3 Removing and Installing Upper Main Bearing With Special Tool C-3059

(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. 1). Then tighten the #3 tie bolts to 54 N•m (40 ft. lbs.) (Fig. 4).

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

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

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

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

(c) 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.

(d) 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.) (Fig. 4). Remove the holding tool.

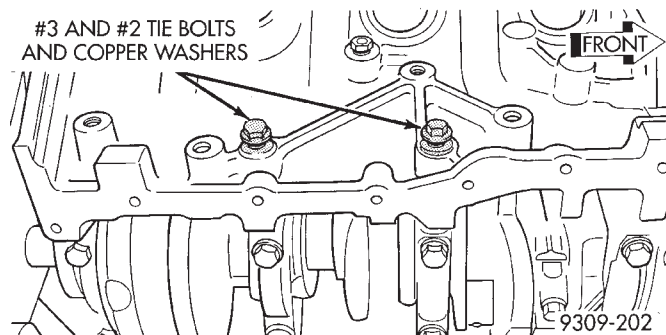
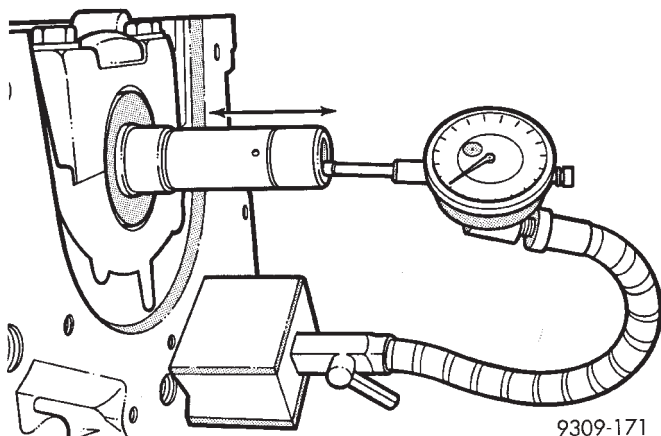


Fig. 4 Crankshaft Main Cap Tie Bolts



CHECKING CRANKSHAFT END PLAY

- (1) Mount a dial indicator to front of engine, locating probe on nose of crankshaft (Fig. 5).
- (2) Move crankshaft all the way to the rear of its travel.
- (3) Zero the dial indicator.
- (4) Move crankshaft all the way to the front and read the dial indicator. Refer to (Fig. 6) for specification.



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Fig. 5 Checking Crankshaft End Play

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 (Fig. 6) for specification.

CRANKSHAFT OIL CLEARANCE

- (1) Measure the journal outside diameter as shown in (Fig. 7). Refer to specification (Fig. 6).

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. 8).
- (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.

- (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. 8). Refer to specification (Fig. 6) for proper clearances. If the clearance exceeds the specified limits. Replace the

Crankshaft End-Play	
New Part:	0.10 - 0.30 mm (.004 - .0012 in.)
Wear Limit:	0.43 mm (.017 in.)

Main Bearing Clearance	
New Part:	.011 - .077 mm (.0004 - .003 in.)
Wear Limit:	.087 mm (.0034 in.)

Connecting Rod Bearing Clearance	
New Part:	.019 - .087 mm (.00075 - .0034 in.)
Wear Limit:	.095 mm (.0037 in.)

Crankshaft Journal Sizes

Crankshaft Main Bearing Journal Diameter

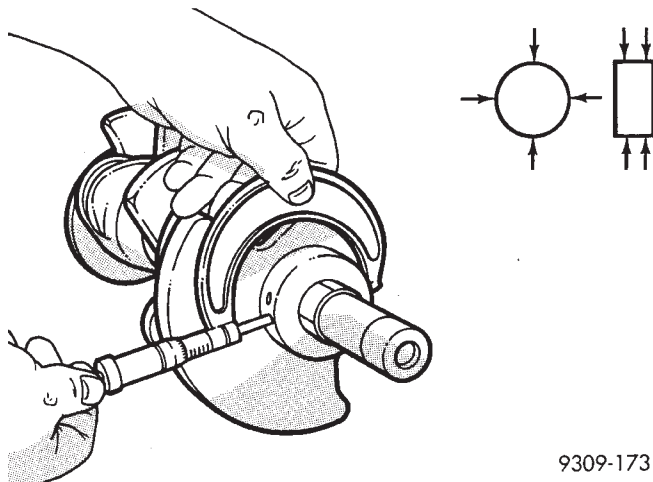
Standard	63.987 - 64.013 mm (2.519 - 2.520 in.)
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Crankshaft Connecting Rod Journal

Standard	57.979 - 58.005 mm (2.282 - 2.283 in.)
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Fig. 6 Crankshaft specification



9309-173

Fig. 7 Measure Crankshaft Journal O.D.

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.

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

CRANKSHAFT OIL SEALS SERVICE

REMOVAL

Pry out rear seal with screwdriver. Be careful not to nick or damage crankshaft flange seal surface or retainer bore (Fig. 9).

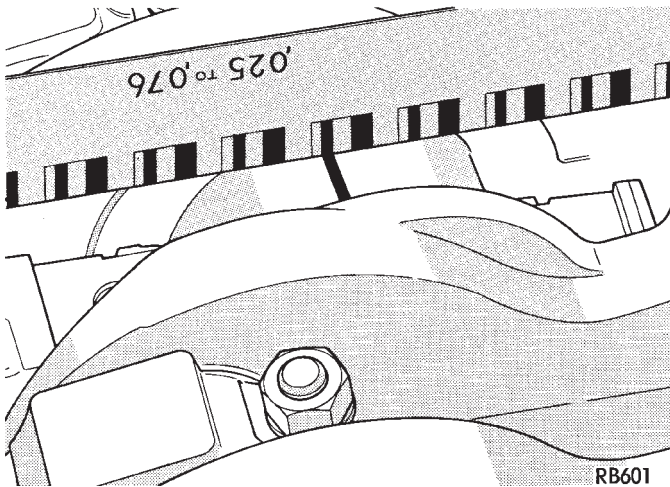


Fig. 8 Measuring Bearing Clearance with Plastigage—Typical

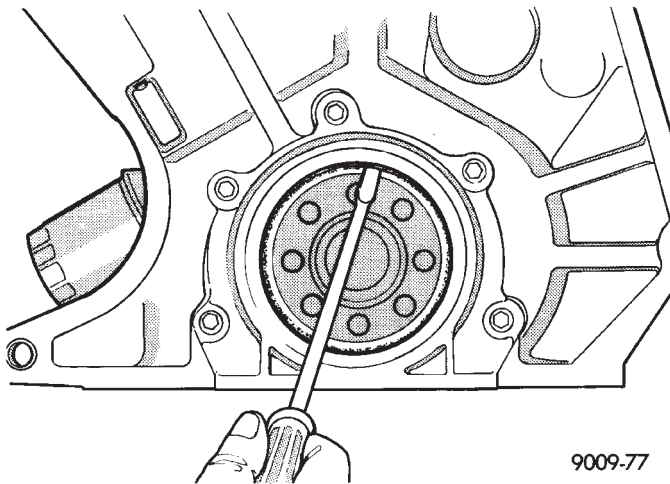


Fig. 9 Removing Rear Crankshaft Oil Seal

INSTALLATION

- (1) Place Special Seal Pilot Tool C-4681 on crankshaft (Fig. 10).
- (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 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.).

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

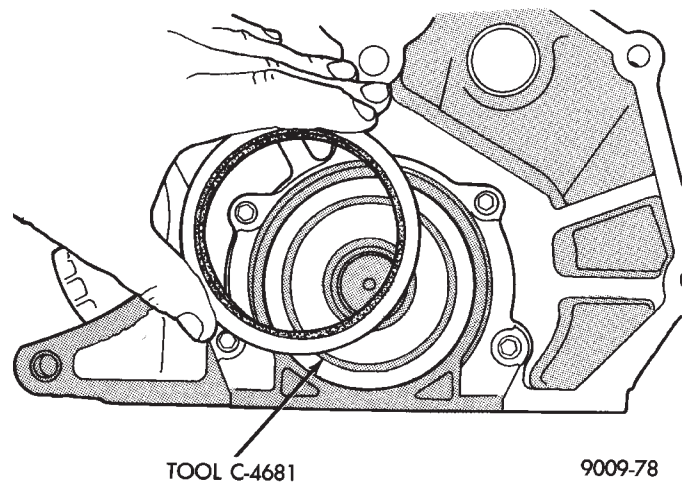


Fig. 10 Installing Rear Crankshaft Oil Seal

plug (Fig. 11). With the cup plug rotated, grasp firmly with pliers or other suitable tool and remove plug (Fig. 11).

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

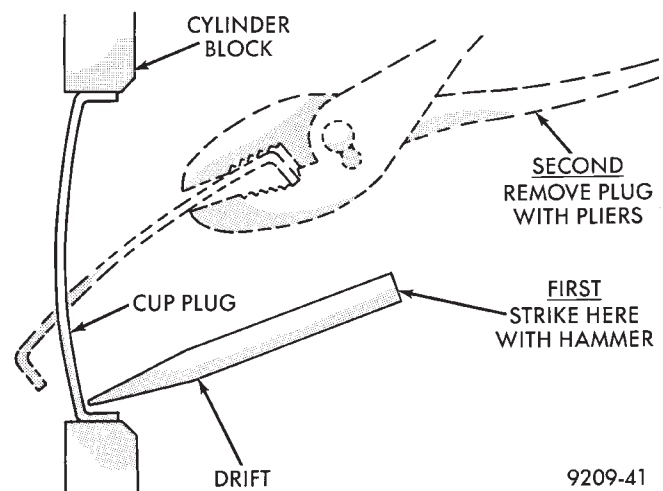


Fig. 11 Core Hole Plug Removal

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 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 0.5mm (.020 inch) inside the lead-in chamfer (Fig. 11).

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 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. 1).

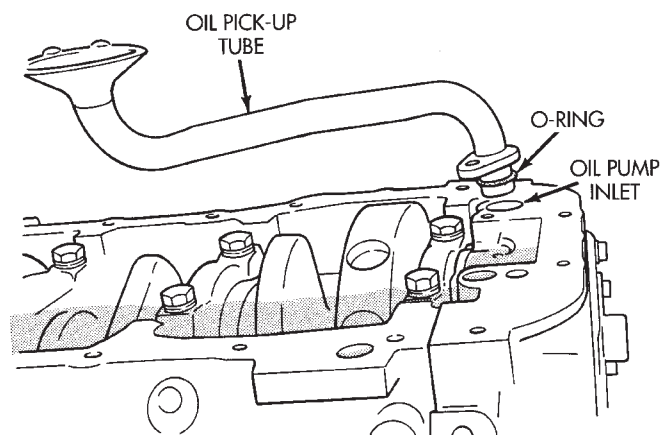
OIL PAN SERVICE

REMOVAL

- (1) Disconnect negative battery cable, remove engine oil dipstick.
- (2) Raise vehicle. Drain engine oil.
- (3) Remove oil pan screws and remove oil pan.
- (4) Remove oil pick-up tube from oil pump body (Fig. 2).
- (5) Remove the windage tray/oil pan gasket (Fig. 4).

CLEANING AND INSPECTION

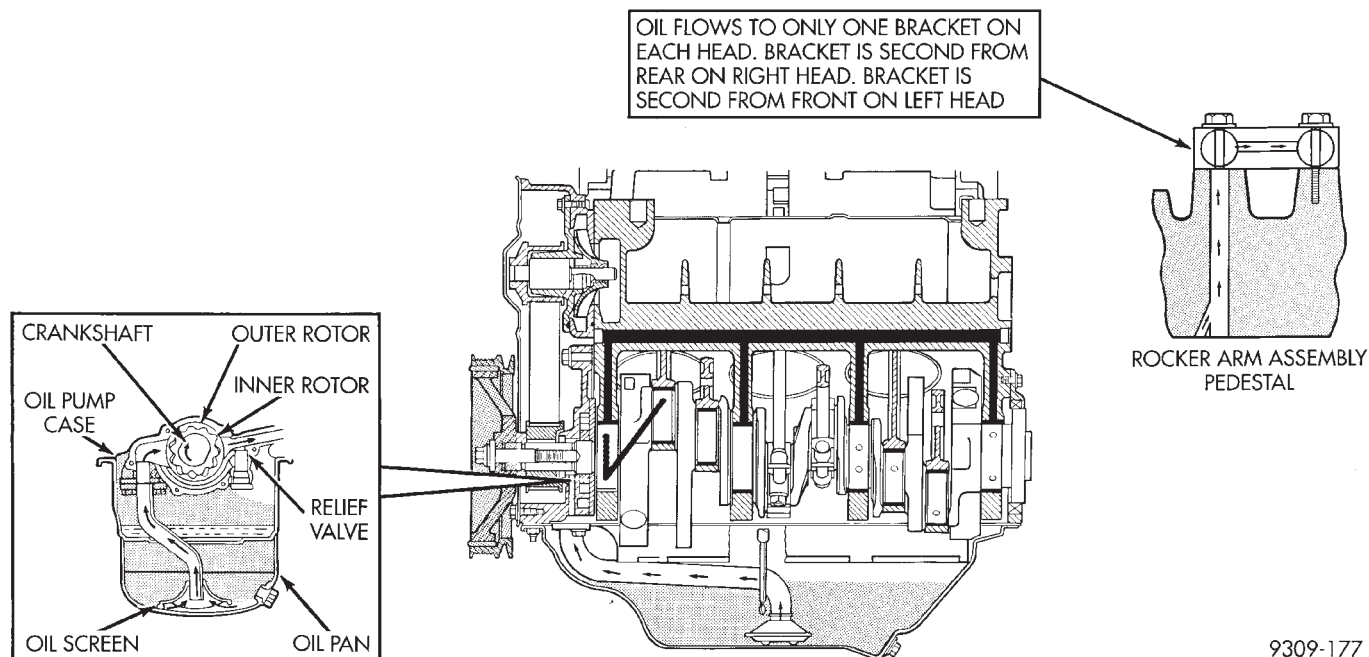
- (1) Clean oil pan in solvent and wipe dry with a clean cloth. Clean all gasket material from mounting surfaces of pan and block.



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Fig. 2 Oil Pump Pick-up Tube Service

- (2) Inspect oil drain plug and plug hole for stripped or damaged threads and repair as necessary. Install a new drain plug gasket. 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.



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Fig. 1 Engine Oiling



WINDAGE TRAY/OIL PAN GASKET

The windage tray and oil pan gaskets are integral (Fig. 4). 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 the oil pump body and the rear seal retainer (Fig. 3).
- (2) Install the windage tray/oil pan gasket (Fig. 4).
- (3) Install oil pick-up tube into oil pump body and tighten screw to 12 N•m (105 in. lbs.) (Fig. 2).
- (4) Install pan and tighten fasteners to 23 N•m (200 in. lb.).

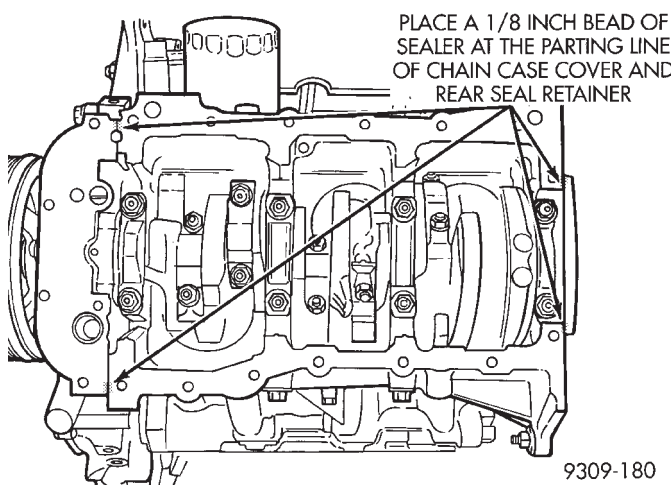


Fig. 3 Oil Pan Sealing

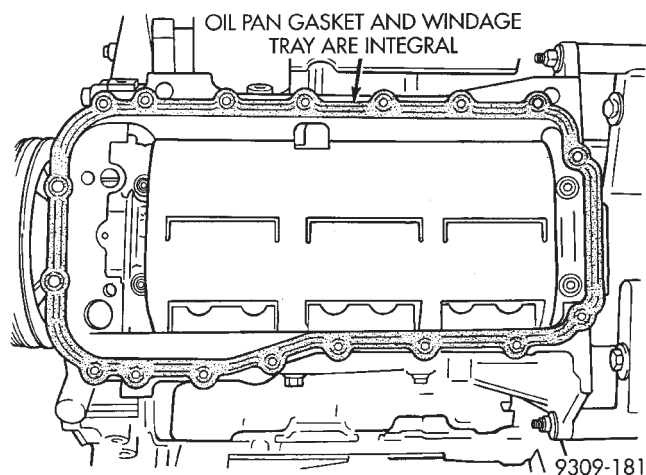


Fig. 4 Windage Tray/Oil Pan Gasket

- (5) Lower vehicle and install oil dipstick.
- (6) Connect negative battery cable.
- (7) Fill crankcase with oil to proper level.

OIL PUMP SERVICE

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 and oil pickup tube.

REMOVAL

- (1) Drain cooling system and remove upper radiator hose for access to timing belt covers. Refer to Cooling Systems Group 7 for procedure.
- (2) Remove the accessory drive belts. Refer to Accessory Drive System in Group 7 for service 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.

DISASSEMBLY

- (1) To remove the relief valve, proceed as follows:
 - (a) Remove cotter pin. Drill a 3.175mm (1/8 inch) hole into the relief valve retainer cap and insert a self-threading sheet metal screw into cap.
 - (b) 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. 5).

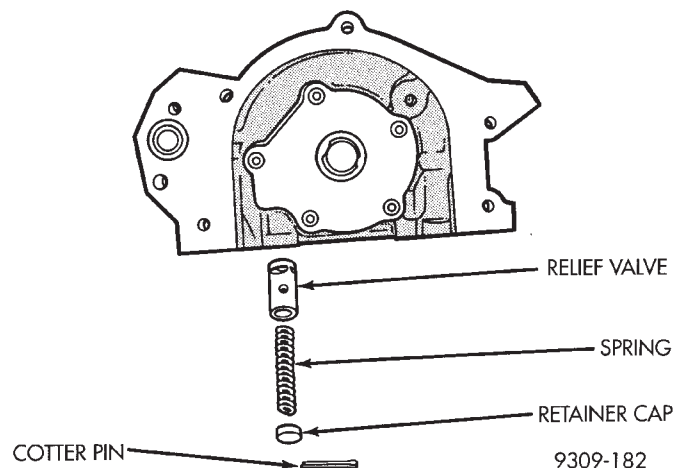
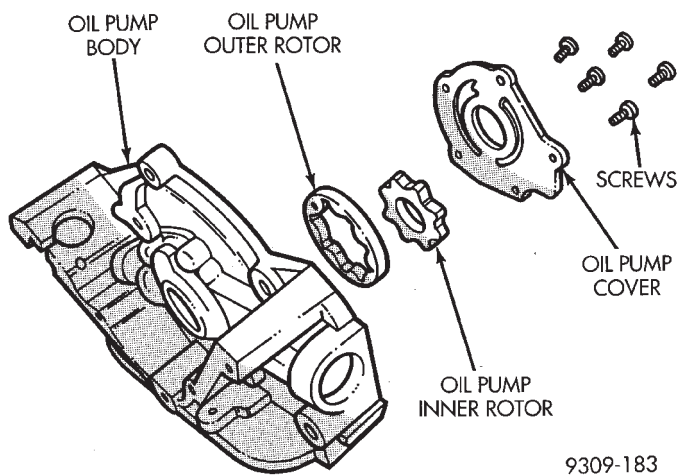


Fig. 5 Oil Pressure Relief Valve

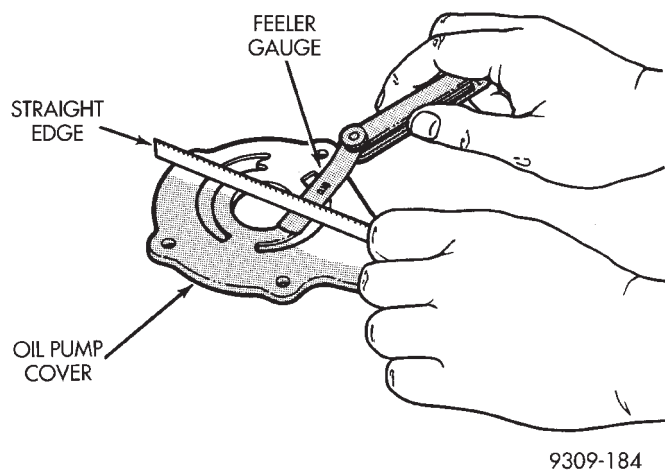
- (2) Remove oil pump cover screws, and lift off cover.
- (3) Remove pump rotors.
- (4) Wash all parts in a suitable solvent and inspect carefully for damage or wear (Fig. 6).

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. 7). If a .076mm (.003 inch) feeler gauge can be inserted between cover and straight edge, cover should be replaced.



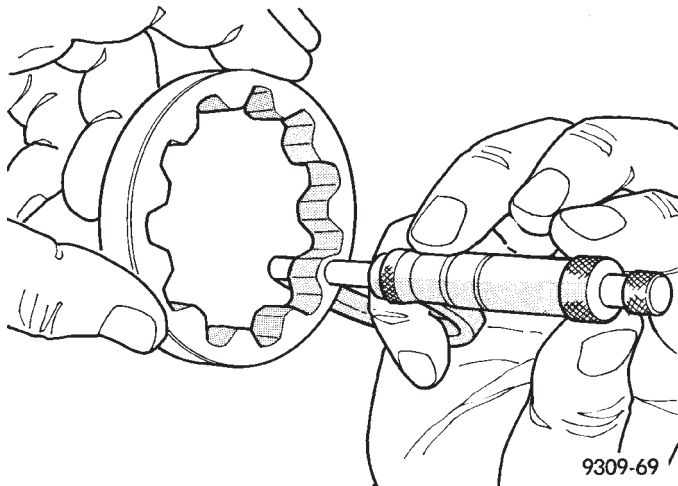
9309-183

Fig. 6 Oil Pump

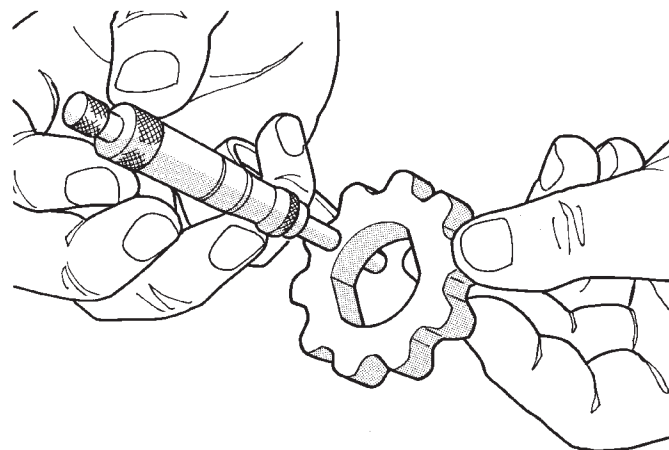
9309-184

Fig. 7 Checking Oil Pump Cover Flatness

(3) Measure thickness and diameter of outer rotor. If outer rotor thickness measures 9.39mm (.3695 inch.) or less (Fig. 8), or if the diameter is 79.78mm (3.141 inches.) or less, replace outer rotor.

**Fig. 8 Measuring Outer Rotor Thickness**

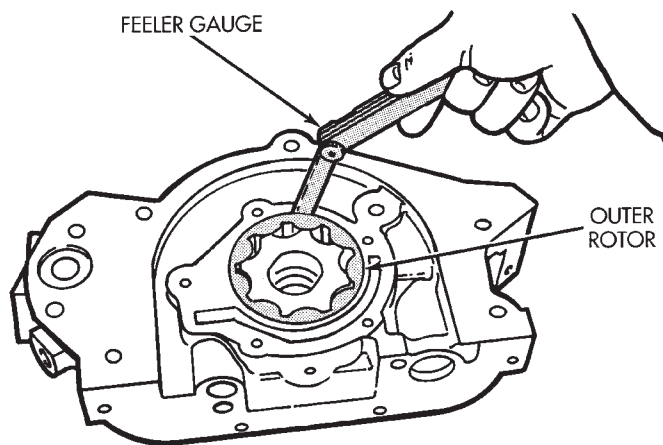
(4) If inner rotor measures 9.39mm (.3695 inch.) or less replace inner rotor (Fig. 9).



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Fig. 9 Measuring Inner Rotor Thickness

(5) Slide outer rotor into body, press to one side with fingers and measure clearance between rotor and body (Fig. 10). If measurement is .39 mm (.015 inch.) or more, replace body only if outer rotor is in specifications.



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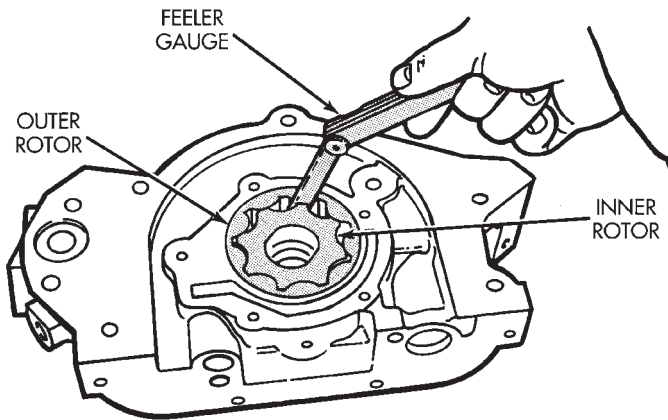
Fig. 10 Measuring Outer Rotor Clearance in Housing

(6) Install inner rotor into body. If clearance between inner and outer rotors (Fig. 11) is .20 mm (.008 inch) or more, replace both rotors.

(7) Place a straightedge across the face of the body, between bolt holes. If a feeler gauge of .102mm (.004 inch) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 12). **ONLY** if rotors are in specs.

(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 49.5mm (1.95 inches) it should test be-



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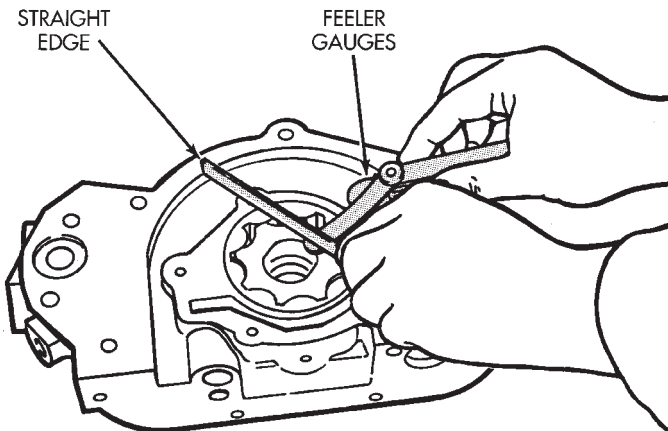
Fig. 11 Measuring Clearance Between Rotors

tween 19.5 and 20.5 pounds when compressed to 34mm (1-11/32 inches). Replace spring that fails to meet specifications.

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

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.



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Fig. 12 Measuring Clearance Over Rotors

INSTALLATION

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

- M8 Screws to 28 N•m (250 in. lbs.)
- M10 Screw to 55 N•m (40 ft. lbs.)

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

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

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

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

(6) Install upper radiator hose and fill cooling system. Refer to Cooling Systems Group 7 for procedure.

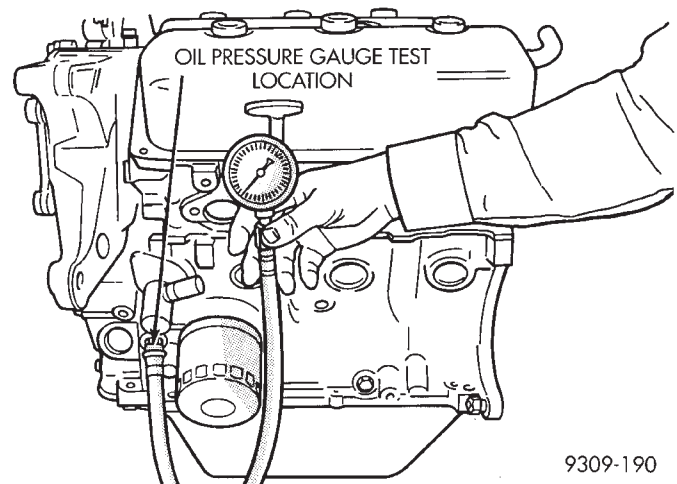
CHECKING ENGINE OIL PRESSURE

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. 13).

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

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



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Fig. 13 Checking Oil Pump Pressure



OIL FILTER

When servicing oil filter avoid deforming the filter can by installing the remove/install tool band strap against the can to base lockseam. The lockseam joining the can to the base is reinforced by the base plate.

- (1) Using Tool C-4065, unscrew filter from base and discard (Fig. 14).
- (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.

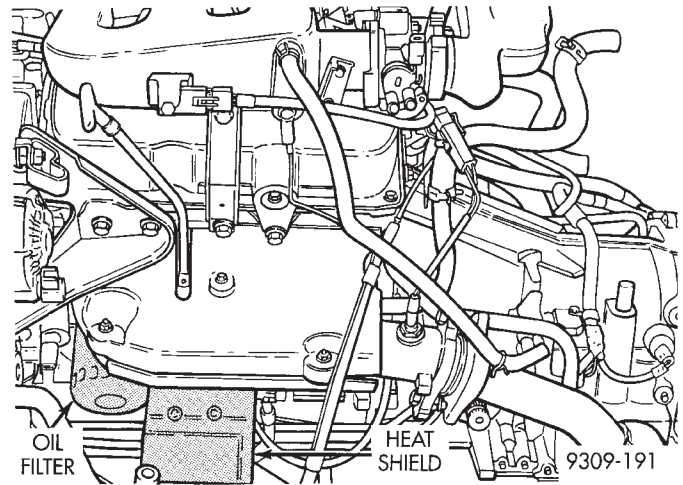


Fig. 14 Oil Filter



ENGINE SPECIFICATIONS

Type	60° V-6 Engine
Bore	96 mm (3.780 Inch)
Stroke	81 mm (3.189 Inch)
Compression Ratio	10.45:1
Displacement	3.5 Liters (215 Cubic Inch)
Brake Horsepower	214 @5800 RPM
Torque	221 Lb. Ft. @2800 RPM
Firing Order	1, 2, 3, 4, 5, 6,
Compression Pressure	1069 - 1172 kPa (155 - 170 psi)

Maximum Variation Between Cylinders	25 percent
Lubrication	Pressure Feed-Full Flow Filtration (Direct Crankshaft Driven Pump)
Engine Oil Capacity Including Oil Filter, ...	5.2 Liter (5.5 Qts.)
Without Oil Filter	4.7 Liter (5.0 Qts.)

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	0.019 - 0.051 mm (0.0007 - 0.0020 in.)
Weight	A Size 519 - 524 grams (18.30 - 18.48 oz.) B Size 514 - 519 grams (18.12 - 18.30 oz.)
Land Clearance (Diametrical)	0.508 - 0.660 mm (0.020 - 0.026 in.)
Piston Ring Groove Diameter No. 1	86.3 - 86.5 mm (3.397 - 3.4055 in.)
No. 2	86.3 - 86.5 mm (3.397 - 3.4055 in.)
No. 3	85.8 - 86.0 mm (3.378 - 3.385 in.)

PISTON PINS

Type	Full Floating
Clearance In Piston	0.005 - 0.015 mm (0.0002 - 0.0006 in.)
Clearance In Rod	0.007 - 0.018 mm (0.0003 - 0.007 in.)
Diameter	23.997 - 24.000 mm (.9448 - .9449 in.)

PISTON RINGS

Ring Gap Top Compression Ring	0.30 - 0.46 mm (0.012 - 0.018 in.)
2nd Compression Ring	0.30 - 0.55 mm (0.012 - 0.022 in.)
Oil Control (Steel Rails)	0.25 - 0.75 mm (0.010 - 0.030 in.)
Ring Side Clearance Top and 2nd Compression Rings	0.030 - 0.080 mm (0.0012 - 0.0031 in.)
Oil Ring (Steel Rails)	0.047 - 0.196 mm (0.0019 - 0.0077 in.)
Ring Width Compression Rings	1.47 - 1.50 mm (0.058 - 0.059 in.)
Oil Ring (Steel Rails)	0.435 - 0.510 mm (0.017 - 0.020 in.)

CONNECTING RODS

Bearing Clearance	0.019 - 0.087 mm (0.0007 - 0.0034 in.)
Piston Pin Bore Diameter	24.953 - 24.0076 mm (0.9823 - 0.9451 in.)
Side Clearance	0.13 - 0.38 mm (0.005 - 0.015 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 - 64.013 mm (2.519 - 2.520 in.)
Main Bearing Diametrical Clearance No.1 - 4	0.011 - 0.050 mm (0.0007 - 0.0022 in.)
Max. Allowable	0.072 mm (0.0028 in.)
Out-of-Round (Max.)	0.003 mm (0.00012 in.)
Taper (Max.)	0.0057 mm (0.00025 in.)
End Play	0.10 - 0.30 mm (0.004 - 0.012 in.)
Max. Allowable	0.43 mm (0.017 in.)
Bearings for Service	Std., 0.025 mm (.001), 0.051 mm (0.002), 0.0254 mm (0.010), 0.275 mm (0.011), 0.300 mm (0.012 inches)

CONNECTING ROD JOURNALS

Diameter	57.979 - 58.005 mm (2.282 - 2.283 in.)
Bearing Diametrical Clearance	.019 - .087 mm (.00075 - .0034 in.)
Out-of-Round (Max.)	0.003 mm (0.0001 in.)
Taper (Max.)	0.0057 mm (0.00025 in.)



ENGINE SPECIFICATIONS (CONT.)

CAMSHAFT

Bore Diameter	
No. 1 - 4	43.038 - 43.059 mm (1.6944 - 1.6952 in.)
Diametrical Clearance	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.)

Bearing Journal Diameter	
No. 1 - 4	42.939 - 42.960 mm (1.6905 - 1.6913 in.)

VALVE TIMING

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

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

CYLINDER HEAD

Gasket Thickness (Compressed)	1.78 mm (0.070 in.)
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Valve Seat	
Angle	45 - 45 1/2°
Runout (Max.)	0.051 mm (0.002 in.)

Width (Finish) -	
Intake and Exhaust	1.25 - 1.75 mm (0.0492 - 0.0689 in.)

Guide Bore Diameter (Std)	6.975 - 7.00 mm (0.2746 - 0.2756 in.)
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Valve Guide Height	9.5 - 10.5 mm (0.3740 - 0.4134 in.)
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Measured from cylinder head surface.

VALVES

Face Angle	44 1/2° - 45°
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Head Diameter	
Intake	34.87 - 35.13 mm (1.3728 - 1.3831 in.)
Exhaust	28.87 - 29.13 mm (1.1366 - 1.1469 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 (.2730 - .2737 in.)

Exhaust	6.906 - 6.924 mm (0.2719 - 0.2726 in.)
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Stem-to-Guide Clearance	
Intake	0.022 - .065 mm (.0009 - .00256 in.)

Exhaust	0.051 - 0.094 mm (0.002 - 0.0037 in.)
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Max. Allowable (Rocking Method)	
Intake	0.29 mm (0.0114 in.)

Exhaust	0.370 mm (0.0146 in.)
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Lift (Zero Lash)	
Intake	8.15 mm (0.3209 in.)

Exhaust	6.53 mm (0.2571 in.)
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Valve Stem Tip Height	
Intake	42.366 - 43.655 mm (1.6680 - 1.7187 in.)

Exhaust	44.705 - 45.986 mm (1.760 - 1.8105 in.)
---------	--

VALVE SPRINGS

Free Length (Approx.)	
Intake	45.24 mm (1.7811 in.)

Exhaust	45.70 mm (1.7992 in.)
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Spring Tension (Valve Closed)	
Intake	402 - 444 N @ 38.0 mm (90.3 - 99.7 lbs. @ 1.4961 in.)

Exhaust	359 - 397 N @ 38.0 mm (80.7 - 89.3 lbs. @ 1.4961 in.)
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Spring Tension (Valve Open)	
Intake	898 - 972 N @ 29.85 mm (201.7 - 218.3 lbs. @ 1.1752 in.)

Exhaust	705 - 763 N @ 31.47 mm (158.5 - 171.5 lbs. @ 1.239 in.)
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**ENGINE SPECIFICATIONS (CONT.)**

Number of Coils	
Intake	6.88
Exhaust	7.21
Color of Springs (Top of Coils)	
Intake	White
Exhaust	Pink
Wire Diameter	
Intake	4.29 - 4.34 mm
Exhaust	4.16 - 4.22 mm
Installed Height (Spring Seat to Bottom of Retainer)	
Intake	38.0 mm
Exhaust	38.0 mm

Oil Pump

Clearance over Rotors (Max.)	0.077 mm
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Cover Out-of-Flat (Max.)	0.025 mm
Inner and Outer Rotor Thickness (Min.)	9.401 mm
Outer Rotor Clearance (Max.)	0.19 mm
Diameter (Min.)	79.997 mm
Tip Clearance between Rotors (Max.)	0.02 mm

Oil Pressure

At Curb Idle Speed *	0.3 Bars
At 3000 rpm	1.3 - 4.8 Bars

* CAUTION: If pressure is ZERO at curb idle, DO NOT run engine at 3,000 rpm.

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TORQUE

DESCRIPTION	TORQUE
A/C Compressor Bracket to Engine Block	41 N·m (30 ft. lbs.)
A/C Compressor to Bracket	23 N·m (200 in. lbs.)
Alternator Bracket Bolts	41 N·m (30 ft. lbs.)
Alternator Mounting Bolt	41 N·m (30 ft. lbs.)
(M8 x 1.25 Bolt)	31 N·m (270 in. lbs.)
Camshaft Bolt w/Loctite 277	127 N·m (95 ft. lbs.)
Camshaft Thrust Plate 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 Pulley Bolt	115 N·m (85 ft. lbs.)
Cylinder Head Bolts	Refer to Procedure outlined in this section
Cylinder Head Cover Bolts	12 N·m (105 in. lbs.)
Exhaust Manifold-to-Cylinder Bolts	23 N·m (200 in. lbs.)
Exhaust Manifold Heat Shields	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 Stud Nuts	61 N·m (45 ft. lbs.)
Intake Manifold Bolts	28 N·m (250 in. lbs.)
Oil Filter	20 N·m (15 ft. lbs.)
Oil Pan Bolts	12 N·m (105 in. lbs.)
Oil Pan Drain Plug	34 N·m (25 ft. lbs.)
Oil Pump Cover Bolts	12 N·m (105 in. lbs.)
Oil Pump Pick-Up Tube Screw	28 N·m (250 in. lbs.)
PCV 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.)
Spark Plugs	28 N·m (20 ft. lbs.)
Spark Plug Tubes	41 N·m (30 ft. lbs.)
Starter Mounting Bolt	41 N·m (30 ft. lbs.)
Throttle Body Bolts	12 N·m (105 in. lbs.)
Timing Belt Tensioner	28 N·m (250 in. lbs.)
Timing Belt Tensioner Pulley Assembly	41 N·m (30 ft. lbs.)
Water Pump-to-Timing Belt Cover Bolts	12 N·m (105 in. lbs.)
Water Outlet Elbow Bolt	28 N·m (250 in. lbs.)
Water Inlet Connector Bolt	28 N·m (250 in. lbs.)

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