

GENERAC[®]
POWER SYSTEMS, INC.

3.9 LITER

***CHRYSLER
GAS
ENGINE***

***SERVICE
MANUAL***

FOREWORD

This manual has been published by GENERAC® POWER SYSTEMS, INC. to aid our dealers' mechanics, company service personnel and general consumers when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products, manufactured and marketed by GENERAC® POWER SYSTEMS, INC. It is also assumed that they have been trained in the recommended servicing procedures for these products, which includes the use of mechanics hand tools and any special tools that might be required.

Proper service and repair is important to the safe, economical and reliable operation of the products described herein. The troubleshooting, testing, service and repair procedures recommended by GENERAC® POWER SYSTEMS, INC. and described in this manual are effective methods of performing such operations. Some of these operations or procedures may require the use of specialized equipment. Such equipment should be used when and as recommended.

We could not possibly know of and advise the service trade of all conceivable procedures or methods by which a service might be performed, nor of any possible hazards and/or results of each procedure or method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a procedure or method not recommended by the manufacturer must first satisfy himself that neither his safety, nor the product's safety, will be endangered by the service or operating procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. However, GENERAC® POWER SYSTEMS, INC. reserves the right to change, alter or otherwise improve the product at any time without prior notice.

Some components or assemblies of the product described in this manual may not be considered repairable. Disassembly, repair and reassembly of such components may not be included in this manual.

The engines described herein may be used to power a wide variety of products. Service and repair instructions relating to any such products are not covered in this manual. For information pertaining to use of these engines with other products, refer to any owner's or service manuals pertaining to said products.

SERVICE RECOMMENDATIONS	A_2
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This engine has been engineered for use in Generac Power Systems products. The contents of this manual have been reprinted from the original manufacturer's service and repair manual.

3.9 Liter Gas Engine Service Recommendations

◆ ENGINE OIL RECOMMENDATIONS

The unit has been filled with “break in” engine oil at the factory. Use a high-quality detergent oil classified “For Service CC, SD, SE or SF.” Detergent oils keep the engine cleaner and reduce carbon deposits. Use oil having the following SAE viscosity rating, based on the ambient temperature range anticipated before the next oil change:

Engine Lubrication System:

Type of Oil PumpGear
Oil FilterFull Flow, Cartridge
Crankcase Oil Capacity3.8 liters (4.0 U.S. quarts.)

Temperature	Oil Grade (Recommended)
Above 80° F (27° C)	SAE 15W-40
32° to 86° F (0° to 30° C)	SAE 15W-40
Below 32° F (0° C)	SAE 15W-40

◆ COOLANT

Use a mixture of half low silicate, ethylene glycol base antifreeze and half soft water. Use only soft water and only low silicate antifreeze. If desired, you may add a high quality rust inhibitor to the recommended coolant mixture. When adding coolant, always add the recommended 50-50 mixture.

Cooling System:

Type.....Pressurized, Closed Recovery
Coolant Capacity
System.....19.3 liters (5.0 U.S. gallons.)



DANGER



Do not remove the radiator pressure cap while the engine is hot or serious burns from boiling liquid or steam could result.



Ethylene glycol base antifreeze is poisonous. Do not use your mouth to siphon coolant from the radiator, recovery bottle or any container. Wash your hands thoroughly after handling. Never store used antifreeze in an open container because animals are attracted to the smell and taste of antifreeze even though it is poisonous to them.



CAUTION



Do not use any chromate base rust inhibitor with ethylene glycol base antifreeze, or chromium hydroxide (“green slime”) will form and cause overheating. Engines that have been operated with a chromate base rust inhibitor must be chemically cleaned before adding ethylene glycol base antifreeze. Using any high silicate antifreeze boosters or additives also will cause overheating. We also recommend that you DO NOT use any soluble oil inhibitor for this equipment.

PERIODIC MAINTENANCE SCHEDULE:

SCHEDULED MAINTENANCE

Following is a recommended maintenance schedule for Generac small standby and residential generator sets. The established intervals in the schedule are the *maximum* recommended when the unit is used in an average service application. They will need to be decreased (performed more frequently) if the unit is used in a severe application. Use the unit hour meter or calendar time, whichever occurs first, from the previous maintenance interval to determine the next required maintenance interval.

Service Maintenance Interval Information:

The various service maintenance intervals are designated by interval numbers as follows:

- 1 An early inspection of the generator set to ensure it is ready to operate when required and to identify any potential problem areas.

*Performed monthly or following each 10 hours of operation of the unit and requires approximately **.5 man-hours** per unit to complete.*

This inspection may be performed by the end user providing the following safety steps are taken to prevent the engine from starting automatically without warning:

To prevent injury, perform the following steps in the order indicated before starting any maintenance:

- **Disable the generator set from starting and/or connecting to the load by setting the control panel AUTO-OFF-MANUAL switch to the "OFF" position.**
- **Remove the control panel fuse.**
- **Turn off the battery charger.**
- **Remove the negative battery cable.**

The battery charger must be turned off BEFORE removing the battery cable to prevent an over current condition from burning out sensitive control panel components and circuits.

Following all maintenance, reverse these steps to insure the unit is returned to standby setup for normal operation when required.

- 2 A break-in service inspection of the generator set to ensure it is ready to operate and carry the load when required, and to identify any potential problem areas.

*Performed **ONLY ONCE** following the first three months or the first 30 hours of operation after purchase of the unit and requires approximately **2.5 man-hours** per unit to complete.*

This inspection contains some maintenance tasks which require special tools, equipment, and/or knowledge to accomplish and should be performed only by an authorized Generac Service Dealer.

- 3 An operational inspection of the generator set to ensure it is ready to operate and carry the load when required, and to identify any potential problem areas.

*Performed semi-annually or following each 50 hours of operation of the unit and requires approximately **1.5 man-hours** per unit to complete.*




































This inspection contains some maintenance tasks which require special tools, equipment, and/or knowledge to accomplish and should be performed only by an authorized Generac Service Dealer.

- 4 A mid-level inspection of the generator set to ensure it is ready to operate and carry the load when required, and to identify any potential problem areas.



















*Performed annually or following each 100 hours of operation of the unit and requires approximately **4.0 man-hours** per unit to complete.*

This inspection contains some maintenance tasks which require special tools, equipment, and/or knowledge to accomplish and should be performed only by an authorized Generac Service Dealer.

3.9 Liter Gas Engine Service Recommendations

Maintenance Tasks	Level 1		Level 2		Level 3		Level 4	
	Recommended to be done monthly/ 10 hrs.	Task Comp. (Date-Initials)	Required to be done 3 months/ Break-in 30 hrs.	Task Comp. (Date-Initials)	Required to be done Semi-annually/ 50 hrs.	Task Comp. (Date-Initials)	Required to be done Annually/ 100 hrs.	Task Comp. (Date-Initials)
1. Disable the unit from operating per the first page warning.								
2. Check the engine oil level. Adjust as necessary.								
3. Check the engine coolant level. Adjust as necessary.								
4. Check the engine coolant thermal protection level. Correct as necessary.								
5. Check the natural gas delivery system on gas engine driven units. Tighten connections as necessary.								
6. Check the air inlets and outlets for debris. Clean as necessary.								
7. Check the battery electrolyte level if accessible. Adjust as necessary.								
8. Check the battery posts, cables, and charger for loose connections, corrosion, and proper operation. Correct as necessary.								
9. Check the unit wiring for loose connections, corrosion, and damage. Correct as necessary.								
10. Check the engine accessory drive belts for wear, weather cracking, and damage. Replace as necessary.								
11. Visually inspect the unit looking for leaks, wear or damage, loose connections or components, and corrosion. Correct as necessary.								
12. Test the engine and transfer switch safety devices. Correct and/or adjust as necessary.								

3.9 Liter Gas Engine Service Recommendations

Maintenance Tasks	Level 1	Task Comp.	Level 2	Task Comp.	Level 3	Task Comp.	Level 4	Task Comp.
	Recommended to be done monthly/ 10 hrs.	(Date-Initials)	Required to be done 3 months/ Break-in 30 hrs.	(Date-Initials)	Required to be done Semi-annually/ 50 hrs.	(Date-Initials)	Required to be done Annually/ 100 hrs.	(Date-Initials)
13. Initiate an automatic start and transfer of the unit to site load and exercise it for at least 1 hour looking for leaks, loose connections or components, and abnormal operating conditions. Correct as necessary.								
14. Start and exercise the unit at full rated load (use a load bank if the site load is not enough) for at least 2 hours looking for leaks, loose connections or components, and abnormal operating conditions. Correct as necessary.								
15. Change the engine oil.								
16. Replace the engine oil filter(s).								
17. Replace the engine air filter(s).								
18. Replace the engine fuel filter(s) on diesel engine driven units and re-prime the fuel system.								
19. Check the engine spark plugs on gas engine driven units. Clean and re-gap or replace as necessary.								
20. Perform a 5 minute no-load operational run of the unit looking for any post service problems.								
21. Return the unit to standby setup for operation when required.								

COOLING

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COOLING

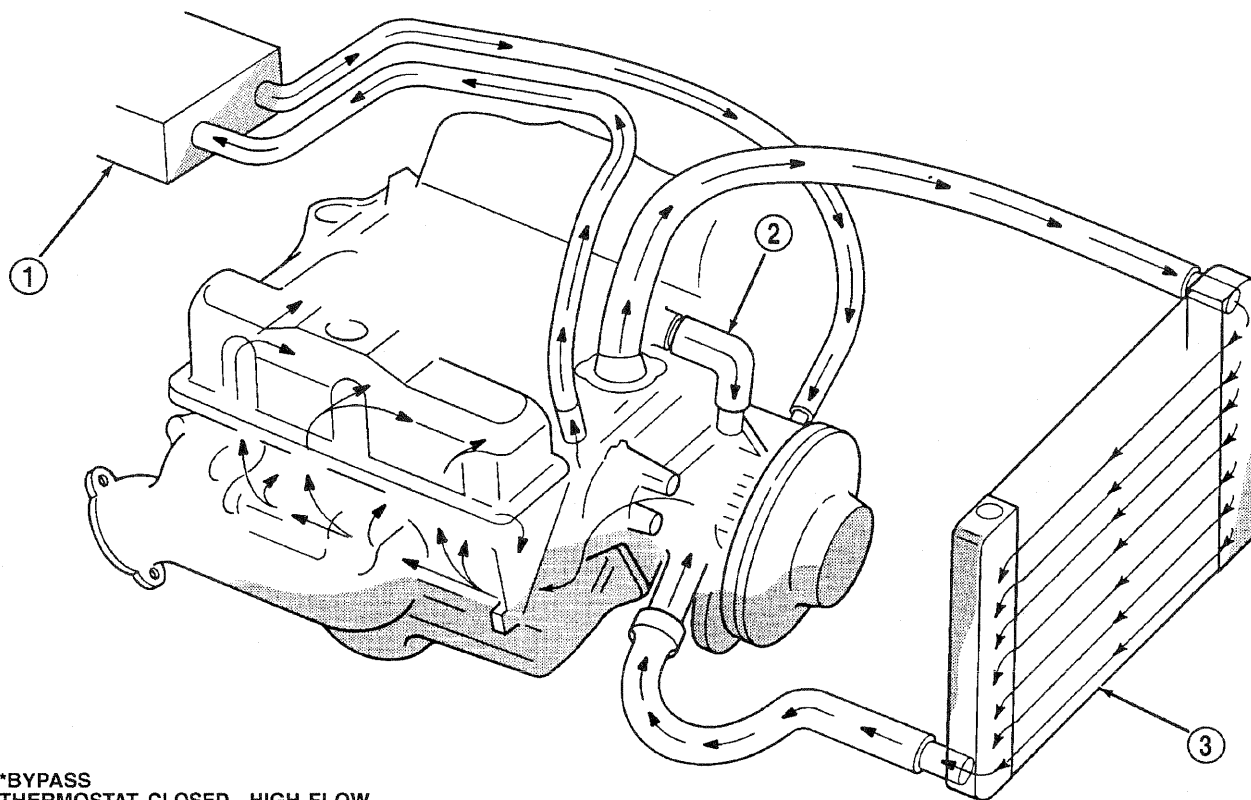
DESCRIPTION

DESCRIPTION — COOLING SYSTEM FLOW - 3.9L/5.9L ENGINE

The cooling system regulates engine operating temperature. It allows the engine to reach normal operating temperature as quickly as possible. It also maintains normal operating temperature and prevents overheating.

The cooling system also provides a means of heating the passenger compartment and cooling the automatic transmission fluid (if equipped). The cooling system is pressurized and uses a centrifugal water pump to circulate coolant throughout the system.

An optional factory installed maximum duty cooling package is available on most models. This package will provide additional cooling capacity for vehicles used under extreme conditions such as trailer towing in high ambient temperatures (Fig. 1).

COOLING (Continued)

*BYPASS
THERMOSTAT CLOSED—HIGH FLOW
THERMOSTAT OPEN—LOW FLOW

J9407-1

Fig. 1 Engine Cooling System Flow – 5.9L

- 1 - HEATER
- 2 - BYPASS*
- 3 - CROSSFLOW RADIATOR

COOLING (Continued)**DESCRIPTION—COOLING SYSTEM FLOW –
4.7L ENGINE**

The cooling system consists of (Fig. 2):

- Radiator
- Cooling fan (mechanical/Electrical)
- Thermal viscous fan drive
- Fan shroud
- Radiator pressure cap
- Thermostat
- Coolant reserve/overflow system (integral to upper fan shroud)
- Transmission oil cooler (if equipped with an automatic transmission)
- Coolant
- Water pump
- Hoses and hose clamps

DESCRIPTION—HOSE CLAMPS

The cooling system utilizes both worm drive and spring type hose clamps. If a spring type clamp replacement is necessary, replace with the original Mopar® equipment spring type clamp.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps. If replacement is necessary, use only a original equipment clamp with matching number or letter (Fig. 3).

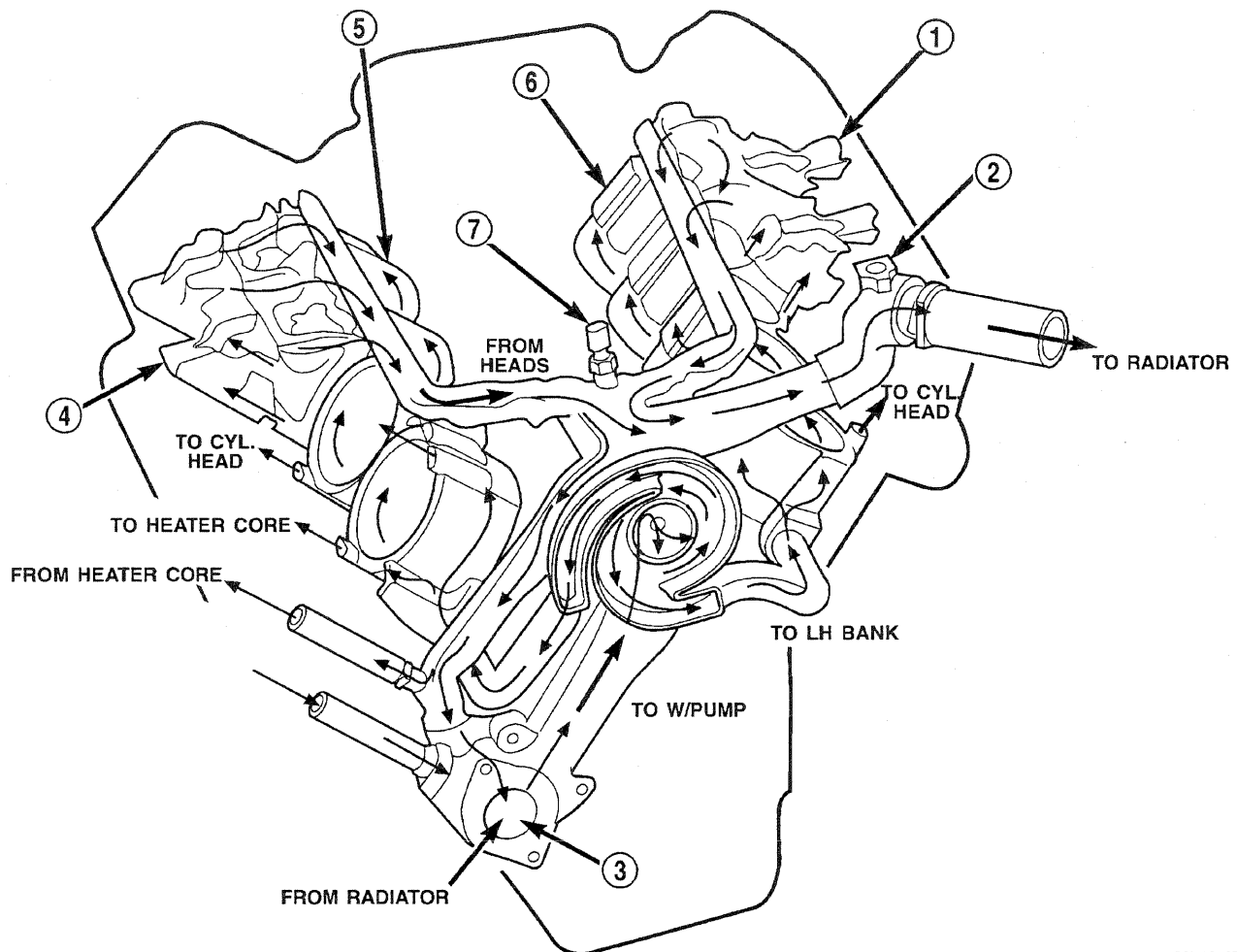
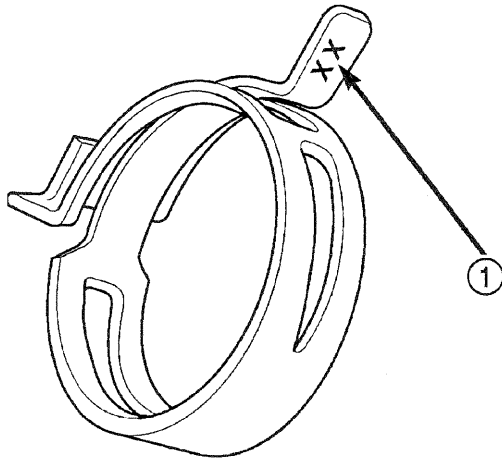


Fig. 2 Engine Cooling System Flow

- 1 - LH CYL. HEAD
- 2 - BLEED
- 3 - THERMOSTAT LOCATION
- 4 - RH CYL. HEAD

- 5 - RH BANK CYL. BLOCK
- 6 - LH BANK CYL. BLOCK
- 7 - COOLANT TEMP. SENSOR

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COOLING (Continued)

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Fig. 3 Spring Clamp Size Location

1 - SPRING CLAMP SIZE LOCATION

OPERATION**OPERATION—COOLING SYSTEM**

The cooling system regulates engine operating temperature. It allows the engine to reach normal operating temperature as quickly as possible. It also maintains normal operating temperature and prevents overheating.

The cooling system also provides a means of heating the passenger compartment and cooling the automatic transmission fluid (if equipped). The cooling system is pressurized and uses a centrifugal water pump to circulate coolant throughout the system.

An optional factory installed maximum duty cooling package is available on most models. This package will provide additional cooling capacity for vehicles used under extreme conditions such as trailer towing in high ambient temperatures.

OPERATION—HOSE CLAMPS

The worm type hose clamp uses a specified torque value to maintain proper tension on a hose connection.

The spring type hose clamp applies constant tension on a hose connection. To remove a spring type hose clamp, only use constant tension clamp pliers designed to compress the hose clamp.

DIAGNOSIS AND TESTING**DIAGNOSIS AND TESTING—ON-BOARD DIAGNOSTICS (OBD)****COOLING SYSTEM RELATED DIAGNOSTICS**

The powertrain control module (PCM) has been programmed to monitor certain cooling system components:

- If the engine has remained cool for too long a period, such as with a stuck open thermostat, a Diagnostic Trouble Code (DTC) can be set.
- If an open or shorted condition has developed in the relay circuit controlling the electric radiator fan, a Diagnostic Trouble Code (DTC) can be set.

If the problem is sensed in a monitored circuit often enough to indicated an actual problem, a DTC is stored. The DTC will be stored in the PCM memory for eventual display to the service technician. (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION).

ACCESSING DIAGNOSTIC TROUBLE CODES

To read DTC's and to obtain cooling system data, (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION).

ERASING TROUBLE CODES

After the problem has been repaired, use the DRB scan tool to erase a DTC. Refer to the appropriate Powertrain Diagnostic Procedures service information for operation of the DRB scan tool.

DIAGNOSIS AND TESTING—COOLING SYSTEM - TESTING FOR LEAKS**ULTRAVIOLET LIGHT METHOD**

A leak detection additive is available through the parts department that can be added to cooling system. The additive is highly visible under ultraviolet light (black light). Pour one ounce of additive into cooling system. Place heater control unit in HEAT position. Start and operate engine until radiator upper hose is warm to touch. Aim the commercially available black light tool at components to be checked. If leaks are present, black light will cause additive to glow a bright green color.

The black light can be used in conjunction with a pressure tester to determine if any external leaks exist (Fig. 4).

COOLING (Continued)

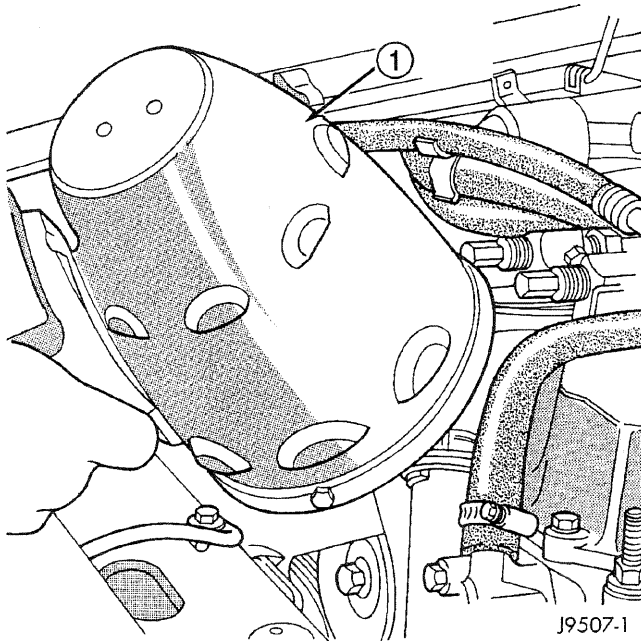


Fig. 4 Leak Detection Using Black Light—Typical

1 - TYPICAL BLACK LIGHT TOOL

PRESSURE TESTER METHOD

The engine should be at normal operating temperature. Recheck the system cold if cause of coolant loss is not located during the warm engine examination.

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING.

Carefully remove radiator pressure cap from filler neck and check coolant level. Push down on cap to disengage it from stop tabs. Wipe inside of filler neck and examine lower inside sealing seat for nicks, cracks, paint, dirt and solder residue. Inspect radiator-to- reserve/overflow tank hose for internal obstructions. Insert a wire through the hose to be sure it is not obstructed.

Inspect cams on outside of filler neck. If cams are damaged, seating of pressure cap valve and tester seal will be affected.

Attach pressure tester (7700 or an equivalent) to radiator filler neck (Fig. 5).

Operate tester pump to apply 103.4 kPa (15 psi) pressure to system. If hoses enlarge excessively or bulges while testing, replace as necessary. Observe gauge pointer and determine condition of cooling system according to following criteria:

Holds Steady: If pointer remains steady for two minutes, serious coolant leaks are not present in system. However, there could be an internal leak that does not appear with normal system test pressure. If

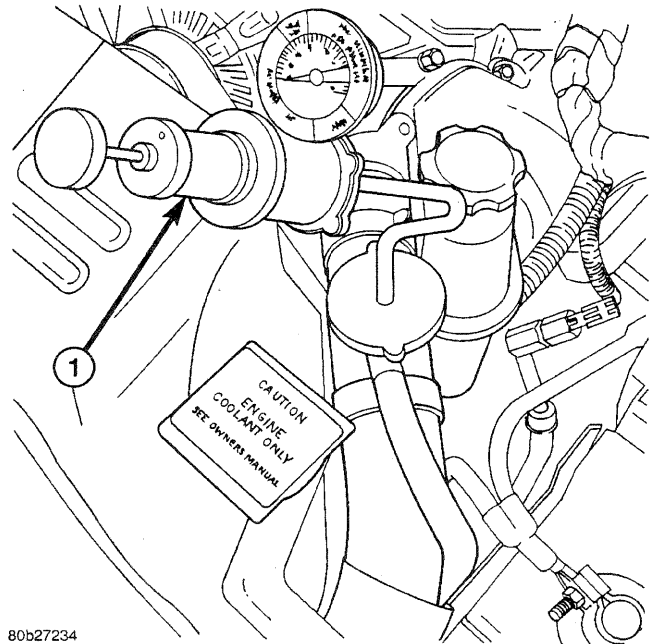


Fig. 5 PRESSURE TEST POINT 5.9L AND 4.7L ENGINES

1 - TYPICAL COOLING SYSTEM PRESSURE TESTER

it is certain that coolant is being lost and leaks cannot be detected, inspect for interior leakage or perform Internal Leakage Test. Refer to INTERNAL LEAKAGE INSPECTION.

Drops Slowly: Indicates a small leak or seepage is occurring. Examine all connections for seepage or slight leakage with a flashlight. Inspect radiator, hoses, gasket edges and heater. Seal small leak holes with a Sealer Lubricant (or equivalent). Repair leak holes and inspect system again with pressure applied.

Drops Quickly: Indicates that serious leakage is occurring. Examine system for external leakage. If leaks are not visible, inspect for internal leakage. Large radiator leak holes should be repaired by a reputable radiator repair shop.

INTERNAL LEAKAGE INSPECTION

Remove engine oil pan drain plug and drain a small amount of engine oil. If coolant is present in the pan, it will drain first because it is heavier than oil. An alternative method is to operate engine for a short period to churn the oil. After this is done, remove engine dipstick and inspect for water globules. Also inspect transmission dipstick for water globules and transmission fluid cooler for leakage.

COOLING (Continued)

WARNING: WITH RADIATOR PRESSURE TESTER TOOL INSTALLED ON RADIATOR, DO NOT ALLOW PRESSURE TO EXCEED 145 KPA (21 PSI). PRESSURE WILL BUILD UP QUICKLY IF A COMBUSTION LEAK IS PRESENT. TO RELEASE PRESSURE, ROCK TESTER FROM SIDE TO SIDE. WHEN REMOVING TESTER, DO NOT TURN TESTER MORE THAN 1/2 TURN IF SYSTEM IS UNDER PRESSURE.

Operate engine without pressure cap on radiator until thermostat opens. Attach a Pressure Tester to filler neck. If pressure builds up quickly it indicates a combustion leak exists. This is usually the result of a cylinder head gasket leak or crack in engine. Repair as necessary.

If there is not an immediate pressure increase, pump the Pressure Tester. Do this until indicated pressure is within system range of 145 kPa (21 psi). Fluctuation of gauge pointer indicates compression or combustion leakage into cooling system.

Because the vehicle is equipped with a catalytic converter, **do not** remove spark plug cables or short out cylinders to isolate compression leak.

If the needle on dial of pressure tester does not fluctuate, race engine a few times to check for an abnormal amount of coolant or steam. This would be emitting from exhaust pipe. Coolant or steam from exhaust pipe may indicate a faulty cylinder head gasket, cracked engine cylinder block or cylinder head.

A convenient check for exhaust gas leakage into cooling system is provided by a commercially available Block Leak Check tool. Follow manufacturers instructions when using this product.

COMBUSTION LEAKAGE TEST—WITHOUT PRESSURE TESTER

DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

WARNING: DO NOT REMOVE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN RADIATOR DRAIN-COCK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

Drain sufficient coolant to allow thermostat removal. (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - REMOVAL). Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

Add coolant to radiator to bring level to within 6.3 mm (1/4 in) of top of thermostat housing.

CAUTION: Avoid overheating. Do not operate engine for an excessive period of time. Open drain-cock immediately after test to eliminate boil over.

Start engine and accelerate rapidly three times, to approximately 3000 rpm while observing coolant. If internal engine combustion gases are leaking into cooling system, bubbles will appear in coolant. If bubbles do not appear, internal combustion gas leakage is not present.

DIAGNOSIS AND TESTING - PRELIMINARY CHECKS**ENGINE COOLING SYSTEM OVERHEATING**

Establish what driving conditions caused the complaint. Abnormal loads on the cooling system such as the following may be the cause:

- PROLONGED IDLE
- VERY HIGH AMBIENT TEMPERATURE
- SLIGHT TAIL WIND AT IDLE
- SLOW TRAFFIC
- TRAFFIC JAMS
- HIGH SPEED OR STEEP GRADES

Driving techniques that avoid overheating are:

- Idle with A/C off when temperature gauge is at end of normal range.
- Increasing engine speed for more air flow is recommended.

TRAILER TOWING:

Consult Trailer Towing section of owners manual. Do not exceed limits.

AIR CONDITIONING; ADD-ON OR AFTER MARKET:

A maximum cooling package should have been ordered with vehicle if add-on or after market A/C is installed. If not, maximum cooling system components should be installed for model involved per manufacturer's specifications.

RECENT SERVICE OR ACCIDENT REPAIR:

Determine if any recent service has been performed on vehicle that may effect cooling system. This may be:

- Engine adjustments (incorrect timing)
- Slipping engine accessory drive belt(s)
- Brakes (possibly dragging)
- Changed parts. Incorrect water pump or pump rotating in wrong direction due to belt not correctly routed
- Reconditioned radiator or cooling system refilling (possibly under filled or air trapped in system).

COOLING (Continued)

NOTE: If investigation reveals none of the previous items as a cause for an engine overheating complaint, refer to COOLING SYSTEM DIAGNOSIS CHART BELOW.

These charts are to be used as a quick-reference only. Refer to COOLING SYSTEM DIAGNOSIS CHART

COOLING SYSTEM DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READS LOW	<ol style="list-style-type: none"> 1. Has a Diagnostic Trouble Code (DTC) been set indicating a stuck open thermostat? 2. Is the temperature sending unit connected? 3. Is the temperature gauge operating OK? 4. Coolant level low in cold ambient temperatures accompanied with poor heater performance. 5. Improper operation of internal heater doors or heater controls. 	<ol style="list-style-type: none"> 1. (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION) for On-Board Diagnostics and DTC information. Replace thermostat if necessary. 2. Check the temperature sensor connector. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - SCHEMATIC - ELECTRICAL) Repair connector if necessary. 3. Check gauge operation. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER/ENGINE TEMPERATURE GAUGE - DESCRIPTION). Repair as necessary. 4. Check coolant level in the coolant reserve/overflow tank or degas bottle and the radiator. Inspect system for leaks. Repair leaks as necessary. Refer to the Coolant section of the manual text for WARNINGS and CAUTIONS associated with removing the radiator cap. 5. Inspect heater and repair as necessary. (Refer to 24 - HEATING & AIR CONDITIONING - DIAGNOSIS AND TESTING) for procedures.

COOLING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
<p>TEMPERATURE GAUGE READS HIGH OR THE COOLANT WARNING LAMP ILLUMINATES. COOLANT MAY OR MAY NOT BE LOST OR LEAKING FROM THE COOLING SYSTEM</p>	<p>1. Trailer is being towed, a steep hill is being climbed, vehicle is operated in slow moving traffic, or engine is being idled with very high ambient (outside) temperatures and the air conditioning is on. Higher altitudes could aggravate these conditions.</p> <p>2. Is the temperature gauge reading correctly?</p> <p>3. Is the temperature warning illuminating unnecessarily?</p> <p>4. Coolant low in coolant reserve/overflow tank and radiator?</p> <p>5. Pressure cap not installed tightly. If cap is loose, boiling point of coolant will be lowered. Also refer to the following Step 6.</p> <p>6. Poor seals at the radiator cap.</p> <p>7. Coolant level low in radiator but not in coolant reserve/overflow tank. This means the radiator is not drawing coolant from the coolant reserve/overflow tank as the engine cools</p>	<p>1. This may be a temporary condition and repair is not necessary. Turn off the air conditioning and attempt to drive the vehicle without any of the previous conditions. Observe the temperature gauge. The gauge should return to the normal range. If the gauge does not return to the normal range, determine the cause for overheating and repair. Refer to Possible Causes (2-18).</p> <p>2. Check gauge. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - SCHEMATIC - ELECTRICAL). Repair as necessary.</p> <p>3. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - SCHEMATIC - ELECTRICAL).</p> <p>4. Check for coolant leaks and repair as necessary. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).</p> <p>5. Tighten cap</p> <p>6. (a) Check condition of cap and cap seals. Refer to Radiator Cap. Replace cap if necessary. (b) Check condition of radiator filler neck or degas bottle. If neck is bent or damaged, replace radiator or degas bottle.</p> <p>7. (a) Check condition of radiator cap and cap seals. Refer to Radiator Cap in this Group. Replace cap if necessary. (b) Check condition of radiator filler neck. If neck is bent or damaged, replace radiator. (c) Check condition of the hose from the radiator to the coolant tank. It should fit tight at both ends without any kinks or tears. Replace hose if necessary. (d) Check coolant reserve/overflow tank and tanks hoses for blockage. Repair as necessary.</p>

COOLING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	8. Incorrect coolant concentration	8. Check coolant. (Refer to LUBRICATION & MAINTENANCE/ FLUID TYPES - DESCRIPTION).
	9. Coolant not flowing through system	9. Check for coolant flow at radiator filler neck with some coolant removed, engine warm and thermostat open. Coolant should be observed flowing through radiator. If flow is not observed, determine area of obstruction and repair as necessary.
	10. Radiator or A/C condenser fins are dirty or clogged.	10. Remove insects and debris. (Refer to 7 - COOLING - STANDARD PROCEDURE).
	11. Radiator core is corroded or plugged.	11. Have radiator re-cored or replaced.
	12. Fuel or ignition system problems.	12. Refer to 14 - Fuel System or 8 - Electrical for diagnosis and testing procedures.
	13. Dragging brakes.	13. Check and correct as necessary. (Refer to 5 - BRAKES - DIAGNOSIS AND TESTING) for correct procedures.
	14. Bug screen or cardboard is being , reducing airflow.	14. Remove bug screen or cardboard.
	15. Thermostat partially or completely shut.	15. Check thermostat operation and replace as necessary. (Refer to 7 - COOLING/ENGINE/ENGINE COOLANT THERMOSTAT - REMOVAL).
	16. Viscous fan drive not operating properly.	16. Check fan drive operation and replace as necessary. (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL) .
	17. Cylinder head gasket leaking.	17. Check for cylinder head gasket leaks. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).
	18. Heater core leaking.	18. Check heater core for leaks. (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING - DIAGNOSIS AND TESTING). Repair as necessary.

COOLING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
TEMPERATURE GAUGE READING IS INCONSISTANT (FLUCUATES, CYCLES, OR IS ERRATIC)	<ol style="list-style-type: none"> 1. During cold weather operation, with the heater in the high position, the gauge reading may drop slightly. 2. Temperature gauge or engine mounted gauge sensor defective or shorted. Also, corroded or loose wiring in this circuit. 3. Gauge reading rises when vehicle is brought to a stop after heavy use (engine still running) 4. Gauge reading high after re-starting a warmed up (hot) engine. 5. Coolant level low in radiator (air will build up in the cooling system causing the thermostat to open late). 6. Cylinder head gasket leaking allowing exhaust gas to enter cooling system causing a thermostat to open late. 7. Water pump impeller loose on shaft. 8. Loose accessory drive belt. (water pump slipping) 9. Air leak on the suction side of the water pump allows air to build up in cooling system causing thermostat to open late. 	<ol style="list-style-type: none"> 1. A normal condition. No correction is necessary. 2. Check operation of gauge and repair if necessary. (Refer to 8 - ELECTRICAL/INSTRUMENT CLUSTER - DIAGNOSIS AND TESTING). 3. A normal condition. No correction is necessary. Gauge should return to normal range after vehicle is driven. 4. A normal condition. No correction is necessary. The gauge should return to normal range after a few minutes of engine operation. 5. Check and correct coolant leaks. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING). 6. (a) Check for cylinder head gasket leaks. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING). (b) Check for coolant in the engine oil. Inspect for white steam emitting from the exhaust system. Repair as necessary. 7. Check water pump and replace as necessary. (Refer to 7 - COOLING/ENGINE/WATER PUMP - REMOVAL). 8. (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - DIAGNOSIS AND TESTING). Check and correct as necessary. 9. Locate leak and repair as necessary.
PRESSURE CAP IS BLOWING OFF STEAM AND/OR COOLANT TO COOLANT TANK. TEMPERATURE GAUGE READING MAY BE ABOVE NORMAL BUT NOT HIGH. COOLANT LEVEL MAY BE HIGH IN COOLANT RESERVE/OVERFLOW TANK	<ol style="list-style-type: none"> 1. Pressure relief valve in radiator cap is defective. 	<ol style="list-style-type: none"> 1. Check condition of radiator cap and cap seals. (Refer to 7 - COOLING/ENGINE/RADIATOR PRESSURE CAP - DIAGNOSIS AND TESTING). Replace cap as necessary.

COOLING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
COOLANT LOSS TO THE GROUND WITHOUT PRESSURE CAP BLOWOFF. GAUGE READING HIGH OR HOT	1. Coolant leaks in radiator, cooling system hoses, water pump or engine.	1. Pressure test and repair as necessary. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING).
DETONATION OR PRE-IGNITION (NOT CAUSED BY IGNITION SYSTEM). GAUGE MAY OR MAY NOT BE READING HIGH	1. Engine overheating. 2. Freeze point of coolant not correct. Mixture is too rich or too lean.	1. Check reason for overheating and repair as necessary. 2. Check coolant concentration. (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION).
HOSE OR HOSES COLLAPSE WHILE ENGINE IS RUNNING	1. Vacuum created in cooling system on engine cool-down is not being relieved through coolant reserve/overflow system.	1. (a) Radiator cap relief valve stuck. (Refer to 7 - COOLING/ENGINE/RADIATOR PRESSURE CAP - DIAGNOSIS AND TESTING). Replace if necessary (b) Hose between coolant reserve/overflow tank and radiator is kinked. Repair as necessary. (c) Vent at coolant reserve/overflow tank is plugged. Clean vent and repair as necessary. (d) Reserve/overflow tank is internally blocked or plugged. Check for blockage and repair as necessary.
NOISY VISCOUS FAN/DRIVE	1. Fan blades loose. 2. Fan blades striking a surrounding object. 3. Air obstructions at radiator or air conditioning condenser. 4. Thermal viscous fan drive has defective bearing. 5. A certain amount of fan noise may be evident on models equipped with a thermal viscous fan drive. Some of this noise is normal.	1. Replace fan blade assembly. (Refer to 7 - COOLING/ENGINE/RADIATOR FAN - REMOVAL) 2. Locate point of fan blade contact and repair as necessary. 3. Remove obstructions and/or clean debris or insects from radiator or A/C condenser. 4. Replace fan drive. Bearing is not serviceable. (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL). 5. (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - DESCRIPTION) for an explanation of normal fan noise.

COOLING (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
INADEQUATE HEATER PERFORMANCE. THERMOSTAT FAILED IN OPEN POSITION	<ol style="list-style-type: none"> 1. Has a Diagnostic trouble Code (DTC) been set? 2. Coolant level low 3. Obstructions in heater hose/ fittings 4. Heater hose kinked 5. Water pump is not pumping water to/through the heater core. When the engine is fully warmed up, both heater hoses should be hot to the touch. If only one of the hoses is hot, the water pump may not be operating correctly or the heater core may be plugged. Accessory drive belt may be slipping causing poor water pump operation. 	<ol style="list-style-type: none"> 1. (Refer to 25 - EMISSIONS CONTROL - DESCRIPTION) for correct procedures and replace thermostat if necessary 2. (Refer to 7 - COOLING - DIAGNOSIS AND TESTING). 3. Remove heater hoses at both ends and check for obstructions 4. Locate kinked area and repair as necessary 5. (Refer to 7 - COOLING/ENGINE/ WATER PUMP - REMOVAL). If a slipping belt is detected, (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - DIAGNOSIS AND TESTING). If heater core obstruction is detected, (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/ HEATER CORE - REMOVAL).
STEAM IS COMING FROM THE FRONT OF VEHICLE NEAR THE GRILL AREA WHEN WEATHER IS WET, ENGINE IS WARMED UP AND RUNNING, AND VEHICLE IS STATIONARY. TEMPERATURE GAUGE IS IN NORMAL RANGE	<ol style="list-style-type: none"> 1. During wet weather, moisture (snow, ice or rain condensation) on the radiator will evaporate when the thermostat opens. This opening allows heated water into the radiator. When the moisture contacts the hot radiator, steam may be emitted. This usually occurs in cold weather with no fan or airflow to blow it away. 	<ol style="list-style-type: none"> 1. Occasional steam emitting from this area is normal. No repair is necessary.
COOLANT COLOR	<ol style="list-style-type: none"> 1. Coolant color is not necessarily an indication of adequate corrosion or temperature protection. Do not rely on coolant color for determining condition of coolant. 	<ol style="list-style-type: none"> 1. (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION). Adjust coolant mixture as necessary.
COOLANT LEVEL CHANGES IN COOLANT RESERVE/OVERFLOW TANK. TEMPERATURE GAUGE IS IN NORMAL RANGE	<ol style="list-style-type: none"> 1. Level changes are to be expected as coolant volume fluctuates with engine temperature. If the level in the tank was between the FULL and ADD marks at normal operating temperature, the level should return to within that range after operation at elevated temperatures. 	<ol style="list-style-type: none"> 1. A normal condition. No repair is necessary.

COOLING (Continued)**STANDARD PROCEDURE****STANDARD PROCEDURE—DRAINING COOLING SYSTEM 3.9L/5.9L ENGINE**

WARNING: DO NOT REMOVE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

- (1) Remove radiator pressure cap.
- (2) Loosen radiator petcock.
- (3) Remove cylinder block drain plugs. Refer to (Fig. 6).

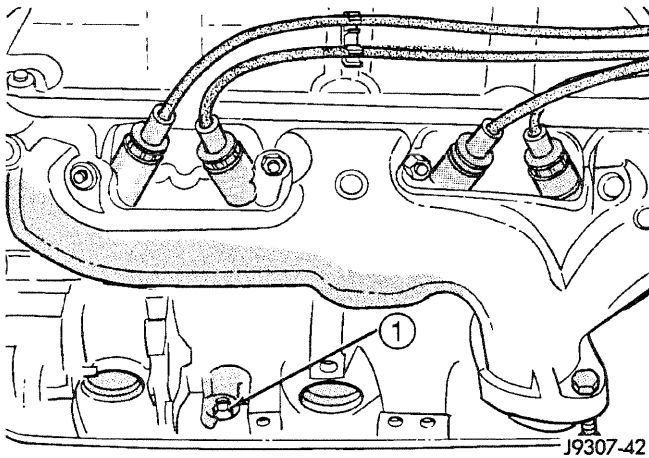


Fig. 6 Cylinder Block Drain Plug - 5.9L Engines

1 - BLOCK DRAIN PLUG

STANDARD PROCEDURE—REFILLING COOLING SYSTEM 3.9L/5.9L ENGINE

WARNING: DO NOT REMOVE CYLINDER BLOCK DRAIN PLUGS OR LOOSEN RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

DO NOT WASTE reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

Clean cooling system prior to refilling. (Refer to 7 - COOLING - STANDARD PROCEDURE).

- (1) Install cylinder block drain plugs. Coat the threads with Mopar® Thread Sealant with Teflon.
- (2) Close radiator petcock.
- (3) Fill cooling system with a 50/50 mixture of water and antifreeze.
- (4) Fill coolant reserve/overflow tank to FULL mark on indicator stick.
- (5) Start and operate engine until thermostat opens (upper radiator hose warm to touch).

(6) If necessary, add a 50/50 water and antifreeze mixture to the coolant reserve/overflow tank. This is done to maintain coolant level between the FULL and ADD marks. The level in the reserve/overflow tank may drop below the ADD mark after three or four warm-up and cool-down cycles.

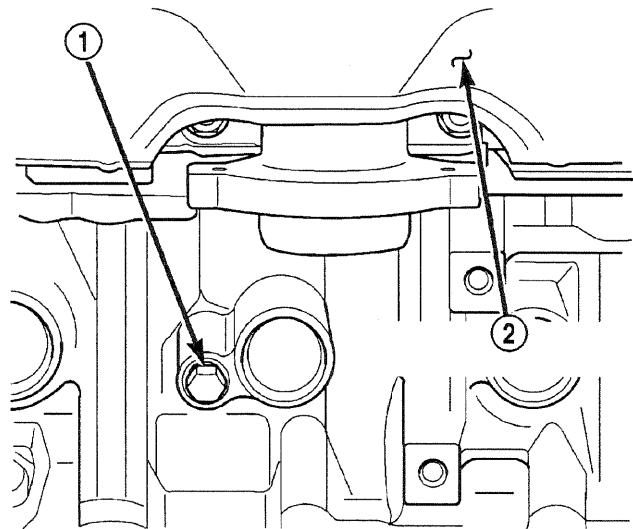
STANDARD PROCEDURE—DRAINING COOLING SYSTEM 4.7L ENGINE

WARNING: DO NOT REMOVE THE CYLINDER BLOCK DRAIN PLUGS (Fig. 7) OR LOOSEN THE RADIATOR DRAINCOCK WITH SYSTEM HOT AND UNDER PRESSURE. SERIOUS BURNS FROM COOLANT CAN OCCUR.

- (1) DO NOT remove radiator cap first. With engine cold, raise vehicle on a hoist and locate radiator draincock.

NOTE: Radiator draincock is located on the left/lower side of radiator facing to rear of vehicle.

(2) Attach one end of a hose to the draincock. Put the other end into a clean container. Open draincock and drain coolant from radiator. This will empty the coolant reserve/overflow tank. The coolant does not have to be removed from the tank unless the system is being refilled with a fresh mixture. When tank is empty, remove radiator cap and continue draining cooling system.



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Fig. 7 Drain Plug - 4.7L Engine

1 - CYLINDER BLOCK DRAIN PLUG
2 - EXHAUST MANIFOLD AND HEAT SHIELD

COOLING (Continued)**STANDARD PROCEDURE - REFILLING COOLING SYSTEM 4.7L ENGINE**

(1) Tighten the radiator draincock and the cylinder block drain plug(s) (if removed).

CAUTION: Failure to purge air from the cooling system can result in an overheating condition and severe engine damage.

(2) Remove the cooling system bleed plug from the radiator upper hose inlet housing. (Fig. 8) Fill system using a 50/50 mixture of ethylene-glycol antifreeze and low mineral content water, until coolant begins coming out of the cooling system bleed hole. Install the cooling system bleed plug. Fill radiator to top and install radiator cap. Add sufficient coolant to the reserve/overflow tank to raise level to FULL mark.

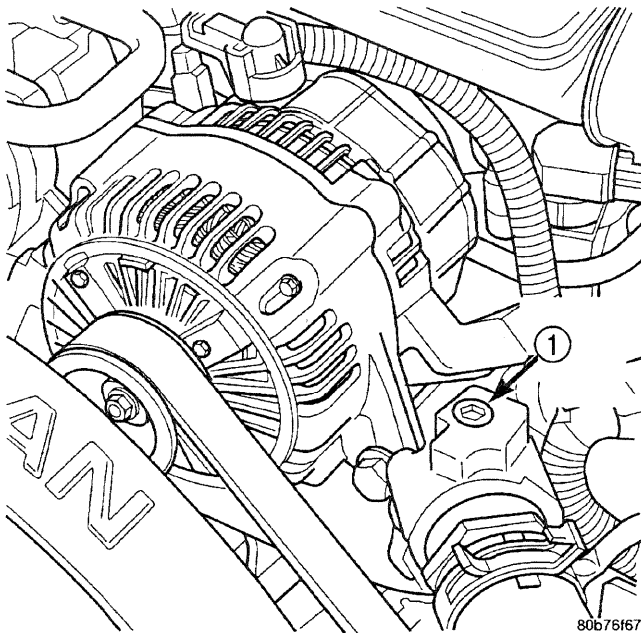


Fig. 8 Cooling System Bleed Plug - 4.7L

1 - COOLING SYSTEM BLEED PLUG

(3) With heater control unit in the HEAT position, operate engine with radiator cap in place.

(4) After engine has reached normal operating temperature, shut engine off and allow it to cool. When engine is cooling down, coolant will be drawn into the radiator from the reserve/overflow tank.

(5) Add coolant to reserve/overflow tank as necessary. **Only add coolant to the reserve/overflow tank when the engine is cold. Coolant level in a warm engine will be higher due to thermal expansion.** To purge the cooling system of all air, this heat up/cool down cycle (adding coolant to cold engine) must be performed three times. Add necessary coolant to raise tank level to the FULL mark after each cool down period.

STANDARD PROCEDURE - ADDING ADDITIONAL COOLANT

The use of aluminum cylinder blocks, cylinder heads and water pumps requires special corrosion protection. Only Mopar® Antifreeze/Coolant, 5 Year/100,000 Mile Formula (glycol base coolant with corrosion inhibitors called HOAT, for Hybrid Organic Additive Technology) is recommended. This coolant offers the best engine cooling without corrosion when mixed with 50% distilled water to obtain a freeze point of -37°C (-35°F). If it loses color or becomes contaminated, drain, flush, and replace with fresh properly mixed coolant solution.

CAUTION: Do not use coolant additives that are claimed to improve engine cooling.

STANDARD PROCEDURE—COOLANT LEVEL CHECK

NOTE: Do not remove radiator cap for routine coolant level inspections. The coolant level can be checked at coolant recovery bottle (Fig. 9).

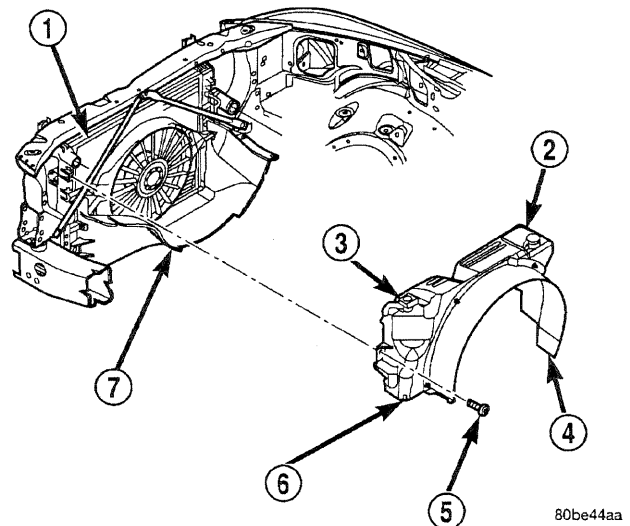


Fig. 9 Coolant Recovery Bottle Location

- 1 - RADIATOR
- 2 - WASHER FLUID RESERVOIR
- 3 - COOLANT OVERFLOW/RESERVOIR
- 4 - FAN SHROUD (UPPER)
- 5 - SCREW
- 6 - INTERLOCKING PINS
- 7 - FAN SHROUD (LOWER)

The coolant reserve/overflow system provides a quick method for determining coolant level without removing radiator pressure cap. With engine not running, open the coolant recovery bottle cap and remove coolant level indicator dipstick to observe coolant level in coolant recovery bottle. The coolant

COOLING (Continued)

level should be between ADD and FULL marks. If the coolant level is at or below the ADD mark, fill the recovery bottle with a 50/50 mixture of antifreeze and water ONE QUART AT A TIME. Repeat this procedure until the coolant level is at the FULL mark.

STANDARD PROCEDURE - COOLING SYSTEM CLEANING/REVERSE FLUSHING

CLEANING

Drain cooling system and refill with water. Run engine with radiator cap installed until upper radiator hose is hot. Stop engine and drain water from system. If water is dirty, fill system with water, run engine and drain system. Repeat until water drains clean.

REVERSE FLUSHING

Reverse flushing of cooling system is the forcing of water through the cooling system. This is done using air pressure in the opposite direction of normal coolant flow. It is usually only necessary with very dirty systems with evidence of partial plugging.

REVERSE FLUSHING RADIATOR

Disconnect radiator hoses from radiator inlet and outlet. Attach a section of radiator hose to radiator bottom outlet fitting and insert flushing gun. Connect a water supply hose and air supply hose to flushing gun.

CAUTION: Internal radiator pressure must not exceed 138 kPa (20 psi) as damage to radiator may result.

Allow radiator to fill with water. When radiator is filled, apply air in short blasts. Allow radiator to refill between blasts. Continue this reverse flushing until clean water flows out through rear of radiator cooling tube passages. Have radiator cleaned more extensively by a radiator repair shop.

REVERSE FLUSHING ENGINE

Drain cooling system. Remove thermostat housing and thermostat. Install thermostat housing. Disconnect radiator upper hose from radiator and attach flushing gun to hose. Disconnect radiator lower hose from water pump and attach a lead-away hose to water pump inlet fitting.

CAUTION: On vehicles equipped with a heater water control valve, be sure heater control valve is closed (heat off). This will prevent coolant flow with scale and other deposits from entering heater core.

Connect water supply hose and air supply hose to flushing gun. Allow engine to fill with water. When engine is filled, apply air in short blasts, allowing system to fill between air blasts. Continue until clean water flows through the lead away hose.

Remove lead away hose, flushing gun, water supply hose and air supply hose. Remove thermostat housing and install thermostat. Install thermostat housing with a replacement gasket. Refer to Thermostat Replacement. Connect radiator hoses. Refill cooling system with correct antifreeze/water mixture. Refer to Refilling the Cooling System.

CHEMICAL CLEANING

In some instances, use a radiator cleaner (Mopar Radiator Kleen or equivalent) before flushing. This will soften scale and other deposits and aid flushing operation.

CAUTION: Follow manufacturers instructions when using these products.

SPECIFICATIONS

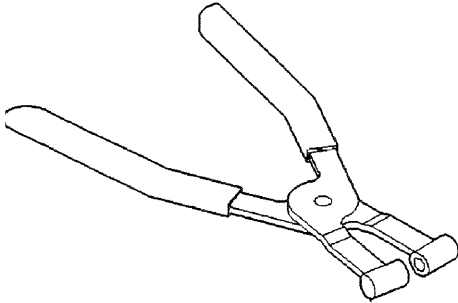
TORQUE

DESCRIPTION	N-m	Ft. Lbs.	In. Lbs.
Automatic Belt Tensioner to Block—Bolts	41	30	—
Automatic Belt Tensioner Pulley—Bolt	61	45	—
Block Heater—Bolt	2	—	17
Generator/Compressor Mounting Bracket—Bolts			
# 1 and 2	54	40	—
# 3	40	30	—
Fan Shroud Mounting—Bolts	6	—	50
Fan Blade to Fan Drive—Bolts	23	17	—
Idler Pulley—Bolt	54	40	—
Radiator to Support—Bolts	23	—	200
Thermostat Housing—Bolts - All Except 4.7L	23	—	200
Thermostat Housing—Bolts - 4.7L	13	—	112
Transmission Auxiliary Oil Cooler—Bolts	10	—	90
Upper Radiator Closure Panel—Bolts	10	—	90
Water Pump—Bolts	58	43	—

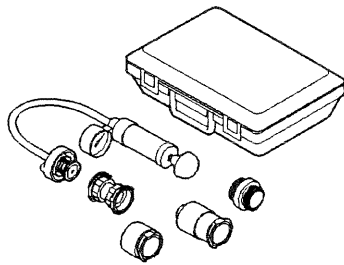
COOLING (Continued)

SPECIAL TOOLS

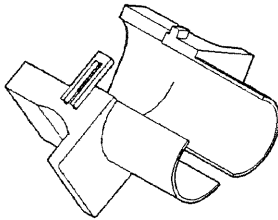
COOLING



Pliers Constant Pressure Hose Clamp - 6094



Cooling System Pressure Tester - 7700A



3/8" Quick Connect Release Tool - 6935

ACCESSORY DRIVE

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BELT TENSIONERS

DESCRIPTION

Correct drive belt tension is required to ensure optimum performance of the belt driven engine accessories. If specified tension is not maintained, belt slippage may cause; engine overheating, lack of power steering assist, loss of air conditioning capacity, reduced generator output rate, and greatly reduced belt life.

It is not necessary to adjust belt tension on the 3.9L, 4.7L or 5.9L engines. These engines are equipped with an automatic belt tensioner (Fig. 2) or (Fig. 1). The tensioner maintains correct belt tension at all times. Due to use of this belt tensioner, do not attempt to use a belt tension gauge on 3.9L, 4.7L or 5.9L engines.

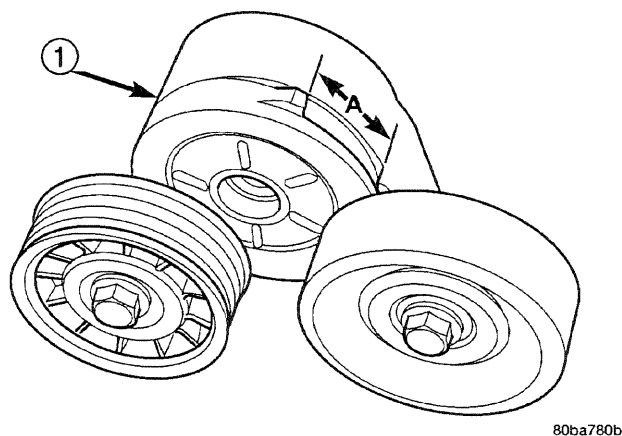


Fig. 1 AUTOMATIC BELT TENSIONER

1 - AUTOMATIC TENSIONER ASSEMBLY

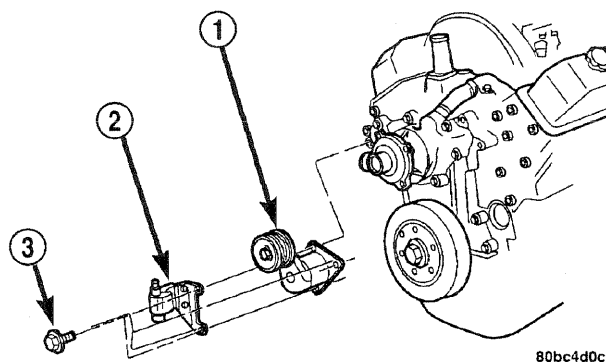


Fig. 2 Automatic Belt Tensioner - 5.9L Engines

- 1 - AUTOMATIC TENSIONER
- 2 - COIL AND BRACKET
- 3 - SCREW AND WASHER

OPERATION

The automatic belt tensioner maintains belt tension by using internal spring pressure, a pivoting arm and pulley to press against the drive belt.

REMOVAL

REMOVAL

WARNING: BECAUSE OF HIGH SPRING PRESSURE, DO NOT ATTEMPT TO DISASSEMBLE AUTOMATIC TENSIONER. UNIT IS SERVICED AS AN ASSEMBLY (EXCEPT FOR PULLEY).

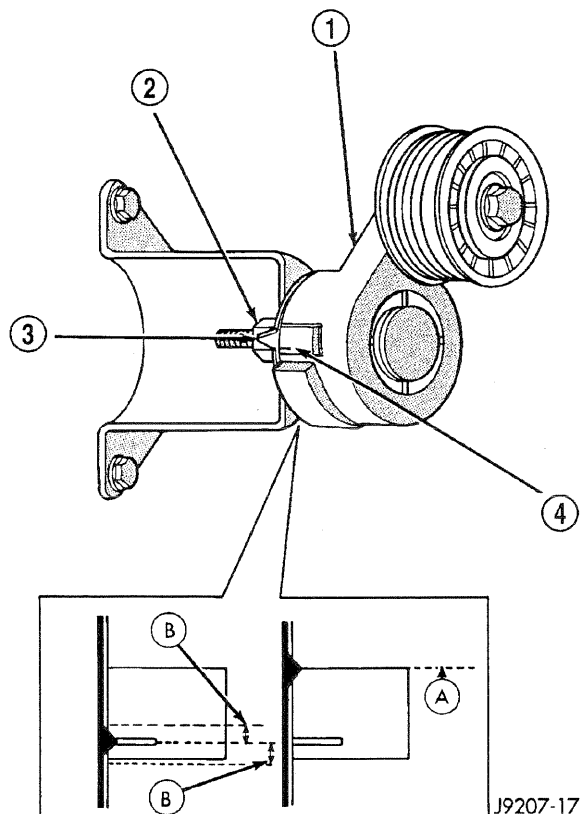
(1) Remove accessory drive belt. (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(2) Disconnect wiring and secondary cable from ignition coil.

BELT TENSIONERS (Continued)

(3) Remove ignition coil from coil mounting bracket (two bolts). Do not remove coil mounting bracket from cylinder head.

(4) Remove tensioner assembly from mounting bracket (one nut) (Fig. 3).



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Fig. 3 Tensioner Indexing Marks And Mounting Nut

- 1 - TENSIONER ASSEMBLY
- 2 - TENSIONER MOUNTING NUT
- 3 - INDEXING ARROW
- 4 - INDEXING MARK

(5) Remove pulley bolt. Remove pulley from tensioner.

REMOVAL

On 4.7L engines, the tensioner is equipped with an indexing tang on back of tensioner and an indexing stop on tensioner housing. If a new belt is being installed, tang must be within approximately 24 mm (.94 inches) of indexing stop. Belt is considered new if it has been used 15 minutes or less.

If the above specification cannot be met, check for:

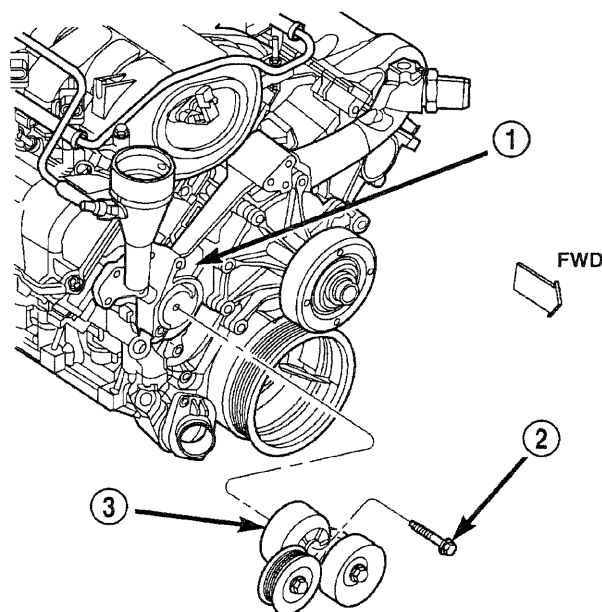
- The wrong belt being installed (incorrect length/width)
- Worn bearings on an engine accessory (A/C compressor, power steering pump, water pump, idler pulley or generator)
- A pulley on an engine accessory being loose

- Misalignment of an engine accessory
- Belt incorrectly routed.

NOTE: A used belt should be replaced if tensioner indexing arrow has moved to the minimum tension indicator. Tensioner travel stops at this point.

(1) Remove accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(2) Remove tensioner assembly from mounting bracket (Fig. 4).



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Fig. 4 Automatic Belt Tensioner - 4.7L Engine

- 1 - TIMING CHAIN COVER
- 2 - BOLT TORQUE TO 41 N·m (30 FT LBS)
- 3 - AUTOMATIC BELT TENSIONER

WARNING: BECAUSE OF HIGH SPRING PRESSURE, DO NOT ATTEMPT TO DISASSEMBLE AUTOMATIC TENSIONER. UNIT IS SERVICED AS AN ASSEMBLY EXCEPT FOR PULLEY ON TENSIONER.

(3) Remove pulley bolt. Remove pulley from tensioner.

INSTALLATION**INSTALLATION**

(1) Install pulley and pulley bolt to tensioner. Tighten bolt to 61 N·m (45 ft. lbs.) torque.

(2) Install tensioner assembly to mounting bracket. An indexing tab is located on back of tensioner. Align this tab to slot in mounting bracket. Tighten nut to 67 N·m (50 ft. lbs.) torque.

BELT TENSIONERS (Continued)

(3) Connect all wiring to ignition coil.

CAUTION: To prevent damage to coil case, coil mounting bolts must be torqued.

(4) Install coil to coil bracket. If nuts and bolts are used to secure coil to coil bracket, tighten to 11 N·m (100 in. lbs.) torque. If coil mounting bracket has been tapped for coil mounting bolts, tighten bolts to 5 N·m (50 in. lbs.) torque.

(5) Install drive belt. (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(6) Check belt indexing marks (Fig. 3).

INSTALLATION

(1) Install pulley and pulley bolt to tensioner. Tighten bolt to 61 N·m (45 ft. lbs.) torque.

(2) An indexing slot is located on back of tensioner. Align this slot to the head of the bolt on the front cover. Install the mounting bolt. Tighten bolt to 41 N·m (30 ft. lbs.).

(3) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(4) Check belt indexing marks (Fig. 4).

DRIVE BELTS

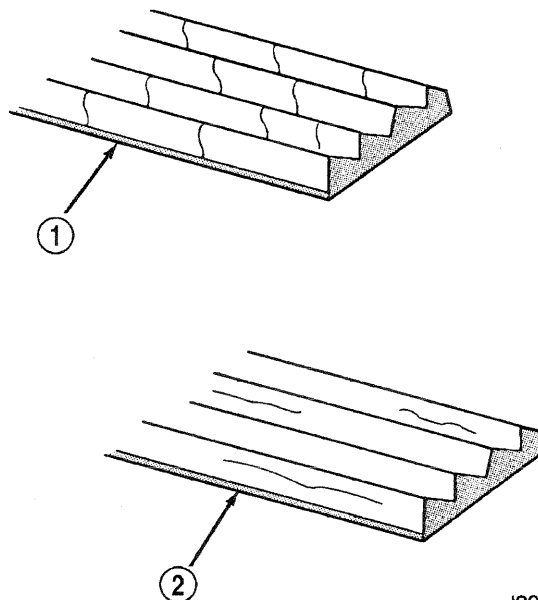
DIAGNOSIS AND TESTING - ACCESSORY DRIVE BELT

VISUAL DIAGNOSIS

When diagnosing serpentine accessory drive belts, small cracks that run across the ribbed surface of the belt from rib to rib (Fig. 5), are considered normal. These are not a reason to replace the belt. However,

cracks running along a rib (not across) are **not** normal. Any belt with cracks running along a rib must be replaced (Fig. 5). Also replace the belt if it has excessive wear, frayed cords or severe glazing.

Refer to ACCESSORY DRIVE BELT DIAGNOSIS CHART for further belt diagnosis.



J9007-44

Fig. 5 Belt Wear Patterns

- 1 - NORMAL CRACKS BELT OK
2 - NOT NORMAL CRACKS REPLACE BELT

NOISE DIAGNOSIS

Noises generated by the accessory drive belt are most noticeable at idle. Before replacing a belt to resolve a noise condition, inspect all of the accessory drive pulleys for alignment, glazing, or excessive end play.

ACCESSORY DRIVE BELT DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSES	CORRECTION
RIB CHUNKING (One or more ribs has separated from belt body)	1. Foreign objects imbedded in pulley grooves. 2. Installation damage	1. Remove foreign objects from pulley grooves. Replace belt. 2. Replace belt
RIB OR BELT WEAR	1. Pulley misaligned 2. Abrasive environment 3. Rusted pulley(s) 4. Sharp or jagged pulley groove tips 5. Belt rubber deteriorated	1. Align pulley(s) 2. Clean pulley(s). Replace belt if necessary 3. Clean rust from pulley(s) 4. Replace pulley. Inspect belt. 5. Replace belt

DRIVE BELTS (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
BELT SLIPS	<ol style="list-style-type: none"> 1. Belt slipping because of insufficient tension 2. Belt or pulley exposed to substance that has reduced friction (belt dressing, oil, ethylene glycol) 3. Driven component bearing failure (seizure) 4. Belt glazed or hardened from heat and excessive slippage 	<ol style="list-style-type: none"> 1. Inspect/Replace tensioner if necessary 2. Replace belt and clean pulleys 3. Replace faulty component or bearing 4. Replace belt.
LONGITUDAL BELT CRACKING	<ol style="list-style-type: none"> 1. Belt has mistracked from pulley groove 2. Pulley groove tip has worn away rubber to tensile member 	<ol style="list-style-type: none"> 1. Replace belt 2. Replace belt
"GROOVE JUMPING" (Belt does not maintain correct position on pulley)	<ol style="list-style-type: none"> 1. Incorrect belt tension 2. Pulley(s) not within design tolerance 3. Foreign object(s) in grooves 4. Pulley misalignment 5. Belt cordline is broken 	<ol style="list-style-type: none"> 1. Inspect/Replace tensioner if necessary 2. Replace pulley(s) 3. Remove foreign objects from grooves 4. Align component 5. Replace belt
BELT BROKEN (Note: Identify and correct problem before new belt is installed)	<ol style="list-style-type: none"> 1. Incorrect belt tension 2. Tensile member damaged during belt installation 3. Severe misalignment 4. Bracket, pulley, or bearing failure 	<ol style="list-style-type: none"> 1. Replace Inspect/Replace tensioner if necessary 2. Replace belt 3. Align pulley(s) 4. Replace defective component and belt
NOISE (Objectionable squeal, squeak, or rumble is heard or felt while drive belt is in operation)	<ol style="list-style-type: none"> 1. Incorrect belt tension 2. Bearing noise 3. Belt misalignment 4. Belt to pulley mismatch 5. Driven component induced vibration 	<ol style="list-style-type: none"> 1. Inspect/Replace tensioner if necessary 2. Locate and repair 3. Align belt/pulley(s) 4. Install correct belt 5. Locate defective driven component and repair
TENSION SHEETING FABRIC FAILURE (Woven fabric on outside, circumference of belt has cracked or separated from body of belt)	<ol style="list-style-type: none"> 1. Tension sheeting contacting stationary object 2. Excessive heat causing woven fabric to age 3. Tension sheeting splice has fractured 	<ol style="list-style-type: none"> 1. Correct rubbing condition 2. Replace belt 3. Replace belt

DRIVE BELTS (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
CORD EDGE FAILURE (Tensile member exposed at edges of belt or separated from belt body)	<ol style="list-style-type: none"> 1. Incorrect belt tension 2. Belt contacting stationary object 3. Pulley(s) out of tolerance 4. Insufficient adhesion between tensile member and rubber matrix 	<ol style="list-style-type: none"> 1. Inspect/Replace tensioner if necessary 2. Replace belt 3. Replace pulley 4. Replace belt

REMOVAL**REMOVAL — 3.9L/5.9L**

NOTE: The belt routing schematics are published from the latest information available at the time of publication. If anything differs between these schematics and the Belt Routing Label, use the schematics on Belt Routing Label. This label is located in the engine compartment.

CAUTION: Do not attempt to check belt tension with a belt tension gauge on vehicles equipped with an automatic belt tensioner. Refer to Automatic Belt Tensioner in this group.

Drive belts on these engines are equipped with a spring loaded automatic belt tensioner (Fig. 6). This belt tensioner will be used on all belt configurations, such as with or without power steering or air conditioning. For more information, (Refer to 7 - COOLING/ACCESSORY DRIVE/BELT TENSIONERS - DESCRIPTION).

- (1) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 6).
- (2) Rotate tensioner assembly clockwise (as viewed from front) until tension has been relieved from belt.
- (3) Remove belt from idler pulley first.
- (4) Remove belt from vehicle.

REMOVAL — 3.7L/4.7L

CAUTION: DO NOT LET TENSIONER ARM SNAP BACK TO THE FREEARM POSITION, SEVER DAMAGE MAY OCCUR TO THE TENSIONER.

Belt tension is not adjustable. Belt adjustment is maintained by an automatic (spring load) belt tensioner.

- (1) Disconnect negative battery cable from battery.
- (2) Rotate belt tensioner until it contacts it's stop. Remove belt, then slowly rotate the tensioner into the freearm position. (Fig. 7).

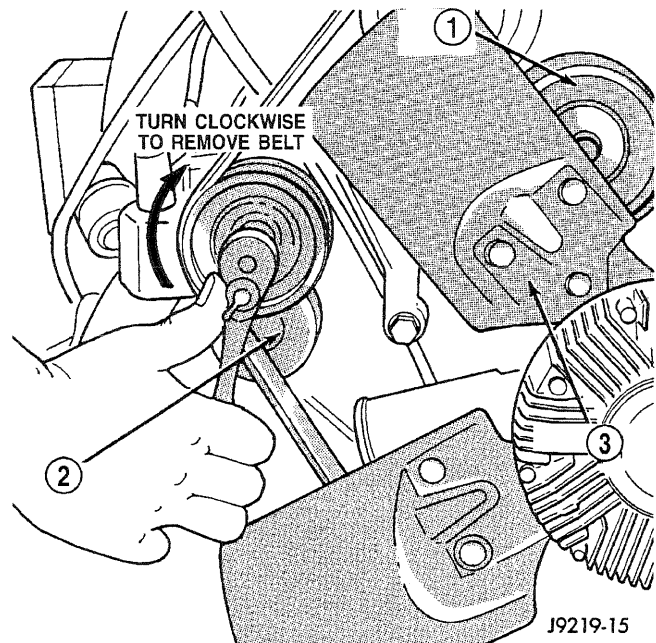


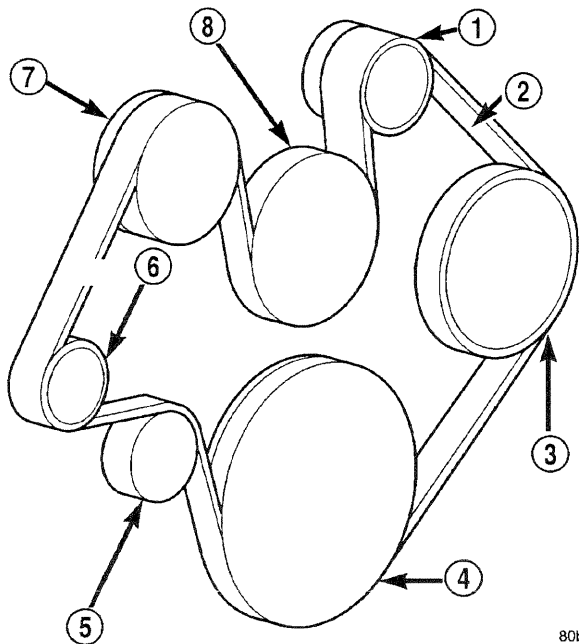
Fig. 6 Belt Tensioner - 5.9L Gas Engines

- 1 - IDLER PULLEY
- 2 - TENSIONER
- 3 - FAN BLADE

INSTALLATION**INSTALLATION**

CAUTION: When installing the accessory drive belt, the belt must be routed correctly. If not, engine may overheat due to water pump rotating in wrong direction. Refer to (Fig. 8) (Fig. 9) for correct engine belt routing. The correct belt with correct length must be used.

- (1) Position drive belt over all pulleys **except** idler pulley. This pulley is located between generator and A/C compressor.
- (2) Attach a socket/wrench to pulley mounting bolt of automatic tensioner (Fig. 6).
- (3) Rotate socket/wrench clockwise. Place belt over idler pulley. Let tensioner rotate back into place.

DRIVE BELTS (Continued)

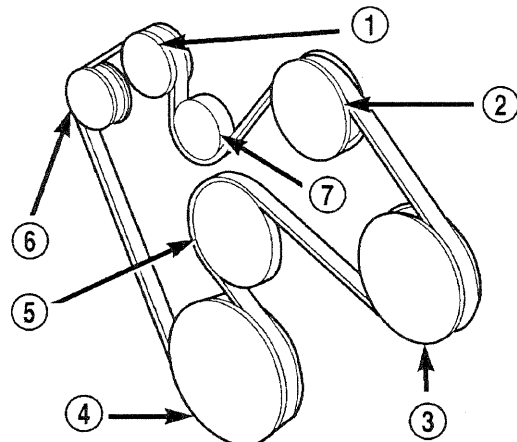
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Fig. 7 Belt Routing - 4.7L

- 1 - GENERATOR PULLEY
- 2 - ACCESSORY DRIVE BELT
- 3 - POWER STEERING PUMP PULLEY
- 4 - CRANKSHAFT PULLEY
- 5 - IDLER PULLEY
- 6 - TENSIONER
- 7 - A/C COMPRESSOR PULLEY
- 8 - WATER PUMP PULLEY

Remove wrench. Be sure belt is properly seated on all pulleys.

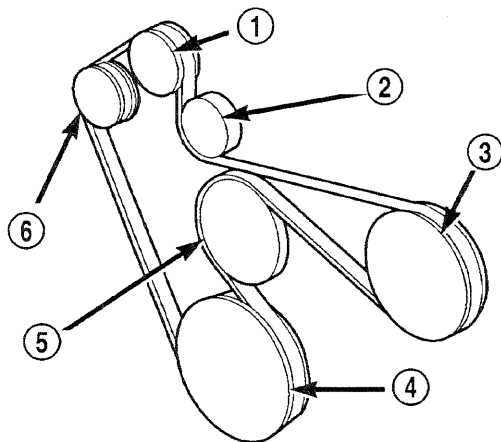
(4) Check belt indexing marks (Refer to 7 - COOLING/ACCESSORY DRIVE/BELT TENSIONERS - DESCRIPTION).



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Fig. 8 Belt Routing - 5.9L Engines with A/C

- 1 - GENERATOR PULLEY
- 2 - A/C PULLEY
- 3 - POWER STEERING PULLEY
- 4 - CRANKSHAFT PULLEY
- 5 - WATER PUMP PULLEY
- 6 - TENSIONER PULLEY
- 7 - IDLER PULLEY



80bdbd05

Fig. 9 Belt Routing - 5.9L Engines Without A/C

- 1 - GENERATOR PULLEY
- 2 - IDLER PULLEY
- 3 - POWER STEERING PULLEY
- 4 - CRANKSHAFT PULLEY
- 5 - WATER PUMP PULLEY
- 6 - TENSIONER PULLEY

DRIVE BELTS (Continued)**INSTALLATION — 4.7L**

Belt tension is not adjustable. Belt adjustment is maintained by an automatic (spring load) belt tensioner.

(1) Check condition of all pulleys.

CAUTION: When installing the serpentine accessory drive belt, the belt **MUST** be routed correctly. If not, the engine may overheat due to the water pump rotating in the wrong direction (Fig. 7).

(2) Install new belt. Route the belt around all pulleys except the idler pulley. Rotate the tensioner arm until it contacts it's stop position. Route the belt around the idler and slowly let the tensioner rotate into the belt. Make sure the belt is seated onto all pulleys.

(3) With the drive belt installed, inspect the belt wear indicator (Fig. 10). On 4.7L Engines only, the gap between the tang and the housing stop (measurement A) must not exceed 24 mm (.94 inches). If the

measurement exceeds this specification replace the serpentine accessory drive belt.

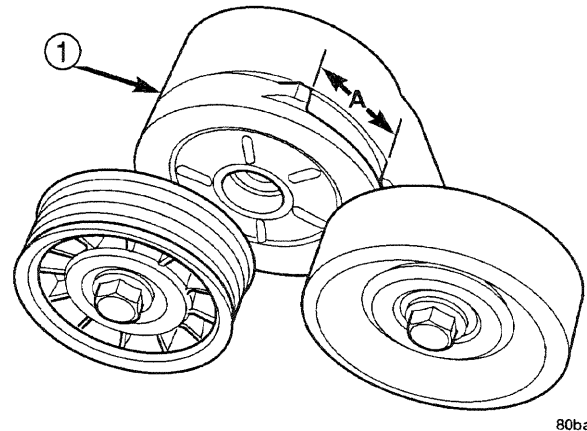
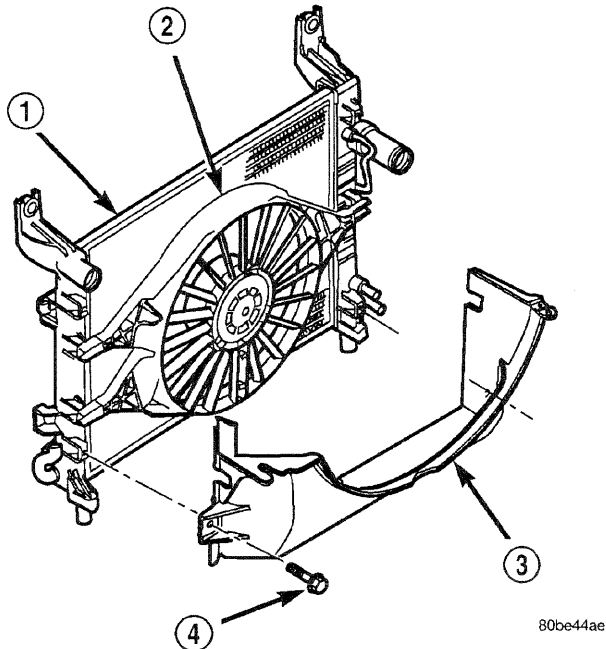


Fig. 10 Accessory Drive Belt Wear Indicator

1 - AUTOMATIC TENSIONER ASSEMBLY

RADIATOR FAN MOTOR (Continued)**Fig. 32 Electrical Cooling Fan**

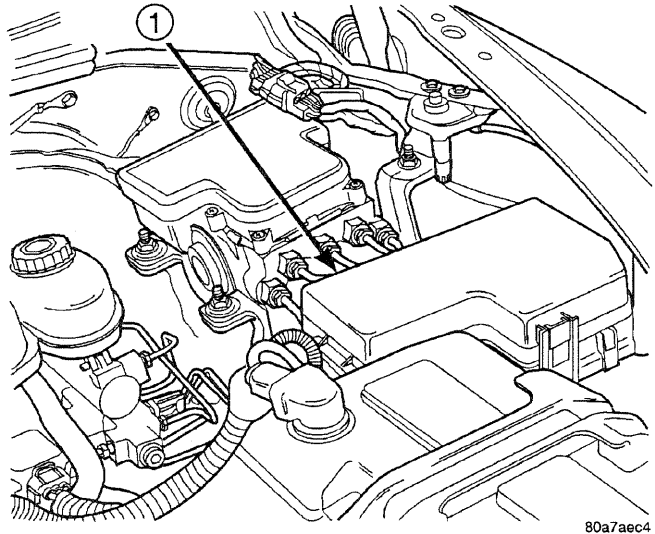
- 1 - RADIATOR
- 2 - ELECTRIC FAN ASSEMBLY
- 3 - FAN SHROUD (LOWER)
- 4 - SCREW

Test Procedure:

(1) Inspect 10A fuse in junction block and 40A maxi fuse in PDC (Fig. 33).

(2) Remove Cooling Fan Relay from the PDC and make the following checks at the relay connector:

- Apply 12 volts (using a fused 14-gauge wire) to circuit C25 (relay terminal 87). If fan does not come on, check for open in circuit C25 or Z1. If circuits are o.k., replace the cooling fan motor.
- With the ignition key "off" check for battery voltage at circuit C28 (relay terminal 30). If no battery voltage present check for open/shorted circuit C28 between the PDC and relay.
- With the ignition key in the "run" position check for battery voltage at circuit F18 (relay terminal 86). If no battery voltage present, check for open/short in circuit F18 between the junction block and the relay.
- If no problems are detected, install the DRB (refer to the appropriate Powertrain Diagnostic Procedures manual for DRB scan tool operating instructions) and start the engine. Clip a 12V test light to the battery positive terminal and probe circuit C27 (relay terminal 85). When the engine temperature reaches 110° C (230° F), or A/C is requested, the test light should light. If not, check circuit C27 for open.
- If no problems are detected at this point, replace the cooling fan relay.

**Fig. 33 Power Distribution Center (PDC)**

1 - POWER DISTRIBUTION CENTER (PDC)

RADIATOR FAN RELAY**DESCRIPTION**

The radiator cooling fan relay is a 5-pin, solenoid type, mini-relay. It is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

OPERATION

The electric radiator cooling fan is controlled by the Powertrain Control Module (PCM) through the radiator cooling fan relay. The PCM will activate the relay after receiving inputs from the engine coolant temperature sensor and/or an air conditioning on/off signal. **Not Equipped With A/C:** The relay is energized when coolant temperature is above approximately 103°C (217°F). It will then de-energize when coolant temperature drops to approximately 98°C (208°F). **Equipped With A/C:** In addition to using coolant temperatures to control cooling fan operation, the cooling fan will also be engaged when the air conditioning system has been activated. Refer to 24 - HEATING & AIR CONDITIONING for additional information.

WATER PUMP - 3.9L/5.9L**DESCRIPTION**

The water pump is located on the engine front cover, and has an integral pulley attached (Fig. 34).

The water pump impeller is pressed onto the rear of a shaft that rotates in a bearing pressed into the water pump body. The body has a small hole for ven-

WATER PUMP - 3.9L/5.9L (Continued)

tilation. The water pump seals are lubricated by antifreeze in the coolant mixture. Additional lubrication is not necessary.

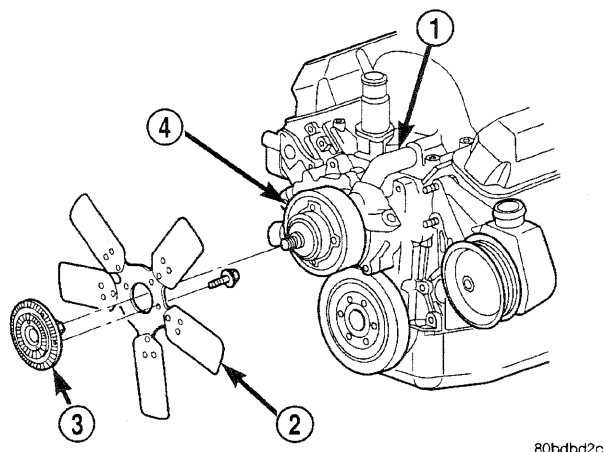


Fig. 34 Water Pump

- 1 - WATER PUMP BYPASS HOSE
- 2 - FAN BLADE ASSEMBLY
- 3 - VISCOUS FAN DRIVE
- 4 - WATER PUMP AND PULLEY

OPERATION—WATER PUMP

A centrifugal water pump circulates coolant through the water jackets, passages, intake manifold, radiator core, cooling system hoses and heater core, this coolant absorbs the heat generated when the engine is running. The pump is driven by the engine crankshaft via a drive belt.

REMOVAL

The water pump can be removed and installed without discharging the air conditioning system (if equipped).

- (1) Disconnect battery negative cable.
- (2) Drain cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE).
- (3) Do not waste reusable coolant. If solution is clean, drain coolant into a clean container for reuse.

WARNING: CONSTANT TENSION HOSE CLAMPS ARE USED ON MOST COOLING SYSTEM HOSES. WHEN REMOVING OR INSTALLING, USE ONLY TOOLS DESIGNED FOR SERVICING THIS TYPE OF CLAMP, SUCH AS SPECIAL CLAMP TOOL (NUMBER 6094). SNAP-ON CLAMP TOOL (NUMBER HPC-20) MAY BE USED FOR LARGER CLAMPS. ALWAYS WEAR SAFETY GLASSES WHEN SERVICING CONSTANT TENSION CLAMPS.

CAUTION: A number or letter is stamped into the tongue of constant tension clamps. If replacement

is necessary, use only an original equipment clamp with matching number or letter.

- (4) Remove upper radiator hose clamp and hose at radiator.

(5) The thermal viscous fan drive is attached (threaded) to the water pump hub shaft (Fig. 36). Remove fan/viscous fan drive assembly from water pump by turning mounting nut counterclockwise as viewed from front. Threads on viscous fan drive are **RIGHT HAND**. A Snap-On 36 MM Fan Wrench (number SP346 from Snap-On Cummins Diesel Tool Set number 2017DSP) and Special Tool 6958 Spanner Wrench with Adapter Pins 8346 can be used. Place Special Tool 6958 Spanner Wrench onto the water pump pulley with Adapter Pins 8346 inserted into the holes on the pulley (Fig. 35) to prevent pulley from rotating. Do not attempt to remove fan/viscous fan drive assembly from vehicle at this time.

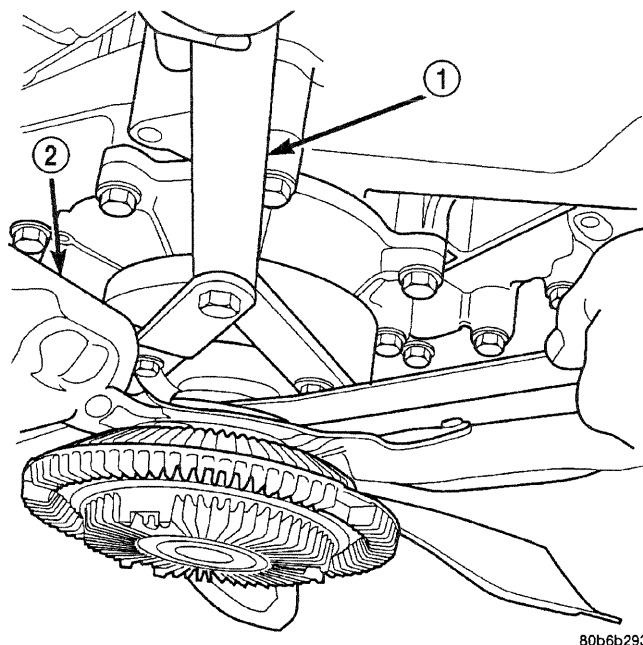


Fig. 35 Viscous Fan Drive Removal/Installation

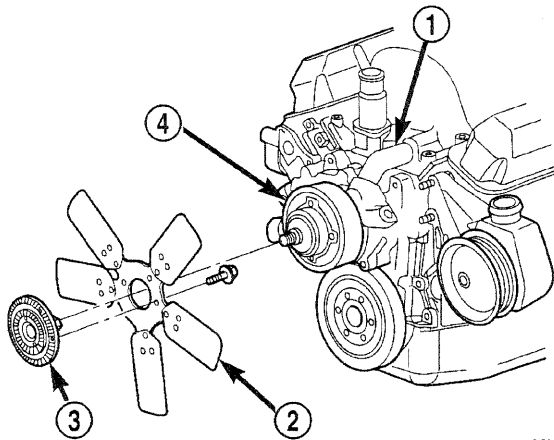
- 1 - SPECIAL TOOL 6958 SPANNER WRENCH WITH ADAPTER PINS 8346
- 2 - FAN

- (6) If water pump is being replaced, do not unbolt fan blade assembly (Fig. 36) from thermal viscous fan drive.

- (7) Remove fan shroud attaching hardware (two bolts at bottom-two clips at top).

- (8) Remove fan shroud and fan blade/viscous fan drive assembly from vehicle as a complete unit.

- (9) After removing fan blade/viscous fan drive assembly, **do not** place thermal viscous fan drive in horizontal position. If stored horizontally, silicone fluid in viscous fan drive could drain into its bearing assembly and contaminate lubricant.

WATER PUMP - 3.9L/5.9L (Continued)

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Fig. 36 Fan Blade and Viscous Fan Drive

- 1 - WATER PUMP BYPASS HOSE
- 2 - FAN BLADE ASSEMBLY
- 3 - VISCOUS FAN DRIVE
- 4 - WATER PUMP AND PULLEY

(10) Remove the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).

(11) Remove lower radiator hose clamp and remove lower hose at water pump.

(12) Remove heater hose clamp and heater hose from heater hose coolant return tube.

(13) Loosen heater hose coolant return tube mounting bolt (Fig. 37) and remove tube from water pump. Discard the old tube O-ring.

(14) Remove seven water pump mounting bolts.

(15) Loosen clamp at water pump end of bypass hose (Fig. 36). Slip bypass hose from water pump while removing pump from vehicle. Discard old gasket.

CAUTION: Do not pry water pump at timing chain case/cover. The machined surfaces may be damaged resulting in leaks.

CLEANING

Clean the gasket mating surface. Use caution not to damage the gasket sealing surface.

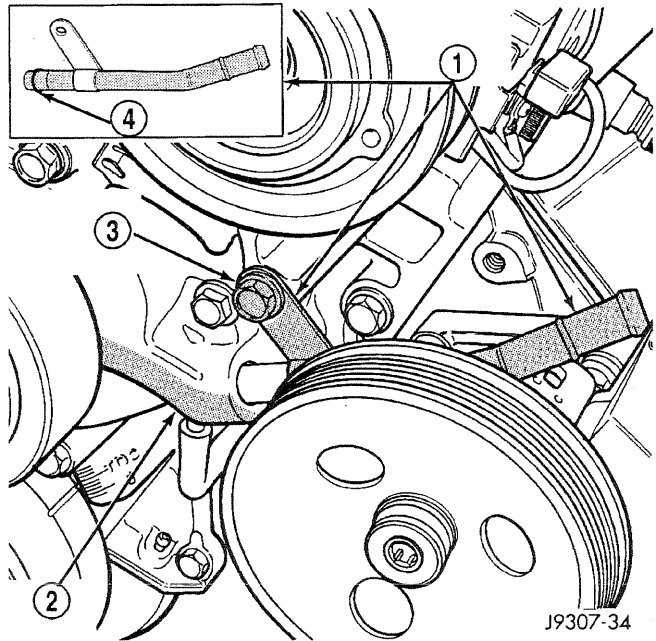
INSPECTION

Inspect the water pump assembly for cracks in the housing, water leaks from shaft seal, worn bearing or impeller rubbing either the pump body or timing chain case/cover.

INSTALLATION

(1) Clean gasket mating surfaces.

(2) Using a new gasket, install water pump to engine as follows: Guide water pump nipple into bypass hose as pump is being installed. Install water



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Fig. 37 Coolant Return Tube—Typical

- 1 - COOLANT RETURN TUBE
- 2 - WATER PUMP
- 3 - TUBE MOUNTING BOLT
- 4 - O-RING

pump bolts. Tighten water pump mounting bolts to 40 N·m (30 ft. lbs.) torque.

(3) Position bypass hose clamp to bypass hose.

(4) Spin water pump to be sure that pump impeller does not rub against timing chain case/cover.

(5) Install a new O-ring to the heater hose coolant return tube (Fig. 37). Coat the new O-ring with anti-freeze before installation.

(6) Install coolant return tube and its mounting bolt to engine (Fig. 37). Be sure the slot in tube bracket is bottomed to mounting bolt. This will properly position return tube.

(7) Connect radiator lower hose to water pump.

(8) Connect heater hose and hose clamp to coolant return tube.

(9) Install accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(10) Position fan shroud and fan blade/viscous fan drive assembly to vehicle as a complete unit.

(11) Install fan shroud.

(12) Install fan blade/viscous fan drive assembly to water pump shaft.

(13) Fill cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE).

(14) Connect battery negative cable.

(15) Start and warm the engine. Check for leaks.

STARTING

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STARTING

DESCRIPTION

The starting system consists of:

- Starter relay
 - Starter motor (including an integral starter solenoid)
- Other components to be considered as part of starting system are:
- Battery
 - Battery cables
 - Ignition switch and key lock cylinder
 - Clutch pedal position switch (manual transmission)
 - Park/neutral position switch (automatic transmission)
 - Wire harnesses and connections.

The Battery, Starting, and Charging systems operate in conjunction with one another, and must be tested as a complete system. For correct operation of starting/charging systems, all components used in these 3 systems must perform within specifications. When attempting to diagnose any of these systems, it is important that you keep their interdependency in mind.

The diagnostic procedures used in each of these groups include the most basic conventional diagnostic methods, to the more sophisticated On-Board Diagnostics (OBD) built into the Powertrain Control Module (PCM). Use of an induction-type milliamperere ammeter, volt/ohmmeter, battery charger, carbon pile rheostat (load tester), and 12-volt test lamp may be required.

Certain starting system components are monitored by the PCM and may produce a Diagnostic Trouble Code (DTC).

OPERATION

The starting system components form two separate circuits. A high-amperage feed circuit that feeds the starter motor between 150 and 350 amperes (700 amperes - diesel engine), and a low-amperage control circuit that operates on less than 20 amperes. The high-amperage feed circuit components include the battery, the battery cables, the contact disc portion of the starter solenoid, and the starter motor. The low-amperage control circuit components include the ignition switch, the clutch pedal position switch (manual transmission), the park/neutral position switch (automatic transmission), the starter relay, the electromagnetic windings of the starter solenoid, and the connecting wire harness components.

If the vehicle is equipped with a manual transmission, it has a clutch pedal position switch installed in series between the ignition switch and the coil battery terminal of the starter relay. This normally open switch prevents the starter relay from being energized when the ignition switch is turned to the momentary Start position, unless the clutch pedal is depressed. This feature prevents starter motor operation while the clutch disc and the flywheel are engaged. The starter relay coil ground terminal is always grounded on vehicles with a manual transmission.

If the vehicle is equipped with an automatic transmission, battery voltage is supplied through the low-amperage control circuit to the coil battery terminal of the starter relay when the ignition switch is turned to the momentary Start position. The park/neutral position switch is installed in series between the starter relay coil ground terminal and ground. This normally open switch prevents the starter relay from being energized and the starter motor from

STARTING (Continued)

operating unless the automatic transmission gear selector is in the Neutral or Park positions.

When the starter relay coil is energized, the normally open relay contacts close. The relay contacts connect the relay common feed terminal to the relay normally open terminal. The closed relay contacts energize the starter solenoid coil windings.

The energized solenoid pull-in coil pulls in the solenoid plunger. The solenoid plunger pulls the shift lever in the starter motor. This engages the starter overrunning clutch and pinion gear with the starter ring gear on the manual transmission flywheel or on the automatic transmission torque converter or torque converter drive plate.

As the solenoid plunger reaches the end of its travel, the solenoid contact disc completes the high-amperage starter feed circuit and energizes the solenoid plunger hold-in coil. Current now flows between the solenoid battery terminal and the starter motor, energizing the starter.

Once the engine starts, the overrunning clutch protects the starter motor from damage by allowing the

starter pinion gear to spin faster than the pinion shaft. When the driver releases the ignition switch to the On position, the starter relay coil is de-energized. This causes the relay contacts to open. When the relay contacts open, the starter solenoid plunger hold-in coil is de-energized.

When the solenoid plunger hold-in coil is de-energized, the solenoid plunger return spring returns the plunger to its relaxed position. This causes the contact disc to open the starter feed circuit, and the shift lever to disengage the overrunning clutch and pinion gear from the starter ring gear.

DIAGNOSIS AND TESTING - STARTING SYSTEM

The battery, starting, and charging systems operate in conjunction with one another, and must be tested as a complete system. For correct starting/charging system operation, all of the components involved in these 3 systems must perform within specifications.

Starting System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
STARTER FAILS TO OPERATE.	1. Battery discharged or faulty.	1. Refer to Battery. Charge or replace battery, if required.
	2. Starting circuit wiring faulty.	2. Refer to 8, Wiring Diagrams. Test and repair starter feed and/or control circuits, if required.
	3. Starter relay faulty.	3. Refer to Starter Relay in Diagnosis and Testing. Replace starter relay if required.
	4. Ignition switch faulty.	4. Refer to Ignition Switch and Key Lock Cylinder. Replace ignition switch if required.
	5. Clutch pedal position switch faulty.	5. Refer to Clutch Pedal Position Switch.
	6. Park/Neutral position switch faulty or misadjusted.	6. Refer to Park/Neutral Position Switch. Replace park/neutral position switch if required.
	7. Starter solenoid faulty.	7. Refer to Starter Motor. Replace starter motor assembly if required.
	8. Starter motor faulty.	8. If all other starting system components and circuits test OK, replace starter motor.
STARTER ENGAGES, FAILS TO TURN ENGINE.	1. Battery discharged or faulty.	1. Refer to Battery. Charge or replace battery if required.
	2. Starting circuit wiring faulty.	2. Refer to 8, Wiring Diagrams. Test and repair starter feed and/or control circuits if required.
	3. Starter motor faulty.	3. If all other starting system components and circuits test OK, replace starter motor assembly.
	4. Engine seized.	4. Refer to Engine Diagnosis in the Diagnosis and Testing section of 9, Engine.

STARTING (Continued)

Starting System Diagnosis		
CONDITION	POSSIBLE CAUSE	CORRECTION
STARTER ENGAGES, SPINS OUT BEFORE ENGINE STARTS.	1. Starter ring gear faulty.	1. Refer to Starter Motor Removal and Installation. Remove starter motor to inspect starter ring gear. Replace starter ring gear if required.
	2. Starter motor faulty.	2. If all other starting system components and circuits test OK, replace starter motor assembly.
STARTER DOES NOT DISENGAGE.	1. Starter motor improperly installed.	1. Refer to Starter Motor Removal and Installation. Tighten starter mounting hardware to correct torque specifications.
	2. Starter relay faulty.	2. Refer to Starter Relay Diagnosis and Testing. Replace starter relay if required.
	3. Ignition switch faulty.	3. Refer to Ignition Switch and Key Lock Cylinder. Replace ignition switch if required.
	4. Starter motor faulty.	4. If all other starting system components and circuits test OK, replace starter motor.

INSPECTION

For complete starter wiring circuit diagrams, refer to 8, Wiring Diagrams. Before removing any unit from starting system for repair or diagnosis, perform the following inspections:

WARNING: ON VEHICLES EQUIPPED WITH AIRBAGS, REFER TO 8, PASSIVE RESTRAINT SYSTEMS, BEFORE ATTEMPTING ANY STEERING WHEEL, STEERING COLUMN, OR INSTRUMENT PANEL COMPONENT DIAGNOSIS OR SERVICE. FAILURE TO TAKE THE PROPER PRECAUTIONS COULD RESULT IN ACCIDENTAL AIRBAG DEPLOYMENT AND POSSIBLE PERSONAL INJURY.

- **Battery** - Visually inspect battery for indications of physical damage and loose or corroded cable connections. Determine state-of-charge and cranking capacity of battery. Charge or replace battery if required. Refer to **Battery** in 8, Battery. **Note: If equipped with diesel engine, a dual battery system may be used, and both batteries must be inspected.**

- **Ignition Switch** - Visually inspect ignition switch for indications of physical damage and loose or corroded wire harness connections. Refer to **Ignition Switch and Key Lock Cylinder**.

- **Clutch Pedal Position Switch** - If equipped with manual transmission, visually inspect clutch pedal position switch for indications of physical damage and loose or corroded wire harness connections. Refer to **Clutch Pedal Position Switch** in 6, Clutch.

- **Park/Neutral Position Switch** - If equipped with automatic transmission, visually inspect park/neutral position switch for indications of physical damage and loose or corroded wire harness connections.

Refer to **Park/Neutral Position Switch** in 21, Transmission.

- **Starter Relay** - Visually inspect starter relay for indications of physical damage and loose or corroded wire harness connections.

- **Starter Motor** - Visually inspect starter motor for indications of physical damage and loose or corroded wire harness connections.

- **Starter Solenoid** - Visually inspect starter solenoid for indications of physical damage and loose or corroded wire harness connections.

- **Wiring** - Visually inspect wire harnesses for damage. Repair or replace any faulty wiring, as required. Refer to 8, Wiring Diagrams.

TESTING**COLD CRANKING TEST**

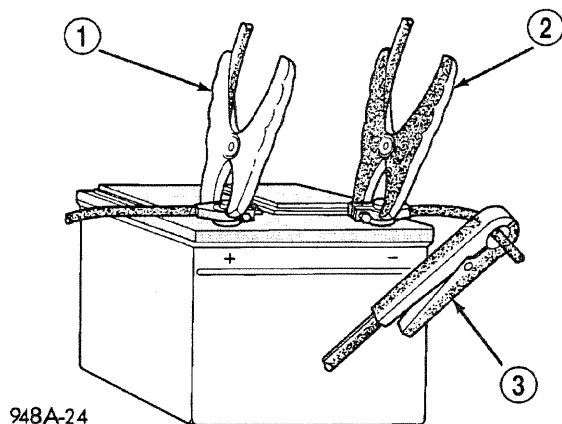
For complete starter wiring circuit diagrams, refer to 8, Wiring Diagrams. The battery must be fully-charged and load-tested before proceeding. Refer to **Battery** in 8, Battery.

(1) Connect volt-ampere tester to battery terminals (Fig. 1). See instructions provided by manufacturer of volt-ampere tester being used. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, tester should be connected to battery on left side of vehicle only. Also, tester current reading must be taken from positive battery cable lead that connects to starter motor.**

(2) Fully engage parking brake.

(3) If equipped with manual transmission, place gearshift selector lever in Neutral position and block clutch pedal in fully depressed position. If equipped

STARTING (Continued)



948A-24

Fig. 1 Volts-Amps Tester Connections - Typical

- 1 - POSITIVE CLAMP
- 2 - NEGATIVE CLAMP
- 3 - INDUCTION AMMETER CLAMP

with automatic transmission, place gearshift selector lever in Park position.

(4) Verify that all lamps and accessories are turned off.

(5) To prevent a gasoline engine from starting, remove Automatic ShutDown (ASD) relay. To prevent a diesel engine from starting, remove Fuel Pump Relay. These relays are located in Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

WARNING: IF EQUIPPED WITH DIESEL ENGINE, ATTEMPT TO START ENGINE A FEW TIMES BEFORE PROCEEDING WITH FOLLOWING STEP.

(6) Rotate and hold ignition switch in Start position. Note cranking voltage and current (amperage) draw readings shown on volt-ampere tester.

(a) If voltage reads below 9.6 volts, refer to **Starter Motor** in Diagnosis and Testing. If starter motor is OK, refer to **Engine Diagnosis** in 9, Engine for further testing of engine. If starter motor is not OK, replace faulty starter motor.

(b) If voltage reads above 9.6 volts and current (amperage) draw reads below specifications, refer to **Feed Circuit Test** in this section.

(c) If voltage reads 12.5 volts or greater and starter motor does not turn, refer to **Control Circuit Testing** in this section.

(d) If voltage reads 12.5 volts or greater and starter motor turns very slowly, refer to **Feed Circuit Test** in this section.

NOTE: A cold engine will increase starter current (amperage) draw reading, and reduce battery voltage reading.

FEED CIRCUIT TEST

The starter feed circuit test (voltage drop method) will determine if there is excessive resistance in high-amperage feed circuit. For complete starter wiring circuit diagrams, refer 8, Wiring Diagrams.

When performing these tests, it is important to remember that voltage drop is giving an indication of resistance between two points at which voltmeter probes are attached.

Example: When testing resistance of positive battery cable, touch voltmeter leads to positive battery cable clamp and cable connector at starter solenoid. If you probe positive battery terminal post and cable connector at starter solenoid, you are reading combined voltage drop in positive battery cable clamp-to-terminal post connection and positive battery cable.

The following operation will require a voltmeter accurate to 1/10 (0.10) volt. Before performing tests, be certain that following procedures are accomplished:

- Battery is fully-charged and load-tested. Refer to **Battery** in 8, Battery.
- Fully engage parking brake.
- If equipped with manual transmission, place gearshift selector lever in Neutral position and block clutch pedal in fully depressed position. If equipped with automatic transmission, place gearshift selector lever in Park position.
- Verify that all lamps and accessories are turned off.
- To prevent a gasoline engine from starting, remove Automatic ShutDown (ASD) relay. To prevent a diesel engine from starting, remove Fuel Pump Relay. These relays are located in Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

(1) Connect positive lead of voltmeter to negative battery cable terminal post. Connect negative lead of voltmeter to negative battery cable clamp (Fig. 2). Rotate and hold ignition switch in Start position. Observe voltmeter. If voltage is detected, correct poor contact between cable clamp and terminal post. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, procedure must be performed twice, once for each battery.**

(2) Connect positive lead of voltmeter to positive battery terminal post. Connect negative lead of voltmeter to battery positive cable clamp (Fig. 3). Rotate and hold ignition switch in Start position. Observe voltmeter. If voltage is detected, correct poor contact between cable clamp and terminal post. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, this procedure must be performed twice, once for each battery.**

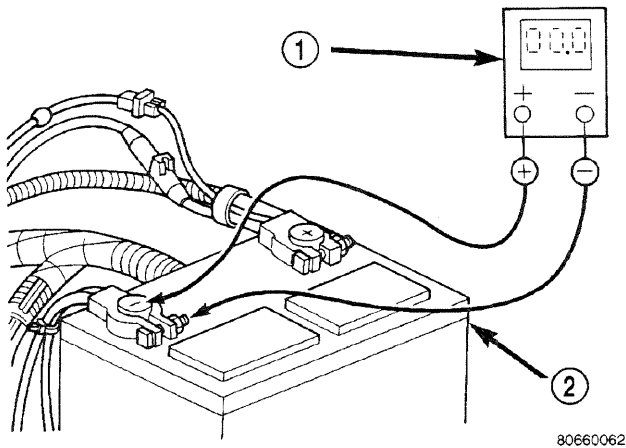
STARTING (Continued)

Fig. 2 Test Negative Battery Cable Connection Resistance - Typical

- 1 - VOLTMETER
2 - BATTERY

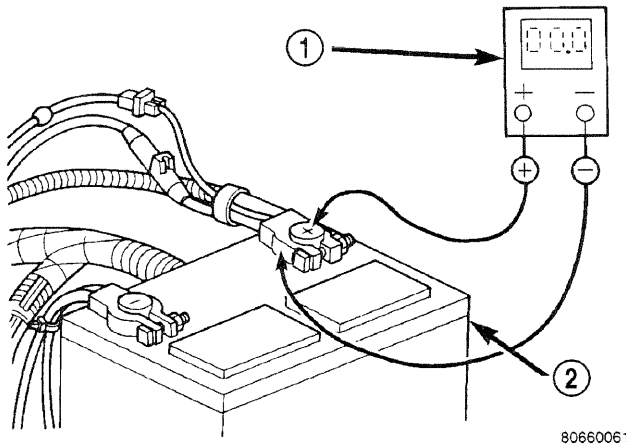


Fig. 3 Test Positive Battery Cable Connection Resistance - Typical

- 1 - VOLTMETER
2 - BATTERY

(3) Connect voltmeter to measure between battery positive terminal post and starter solenoid battery terminal stud (Fig. 4). Rotate and hold ignition switch in Start position. Observe voltmeter. If reading is above 0.2 volt, clean and tighten battery cable connection at solenoid. Repeat test. If reading is still above 0.2 volt, replace faulty positive battery cable. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, this procedure must be performed on driver side battery only.**

(4) Connect voltmeter to measure between negative battery terminal post and a good clean ground on engine block (Fig. 5). Rotate and hold ignition switch in Start position. Observe voltmeter. If reading is above 0.2 volt, clean and tighten negative bat-

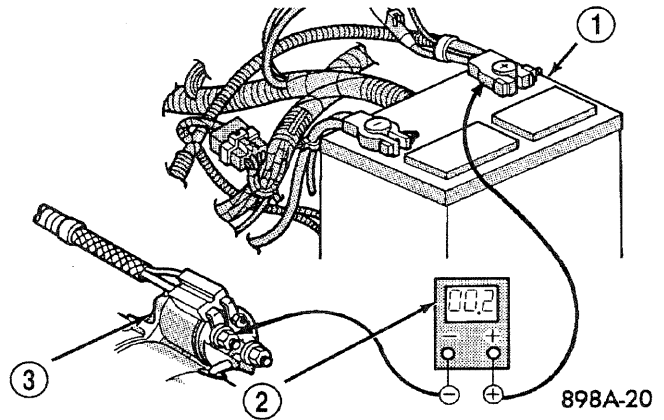


Fig. 4 Test Positive Battery Cable

- 1 - BATTERY
2 - VOLTMETER
3 - STARTER MOTOR

tery cable attachment on engine block. Repeat test. If reading is still above 0.2 volt, replace faulty negative battery cable. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, this procedure must be performed twice, once for each battery.**

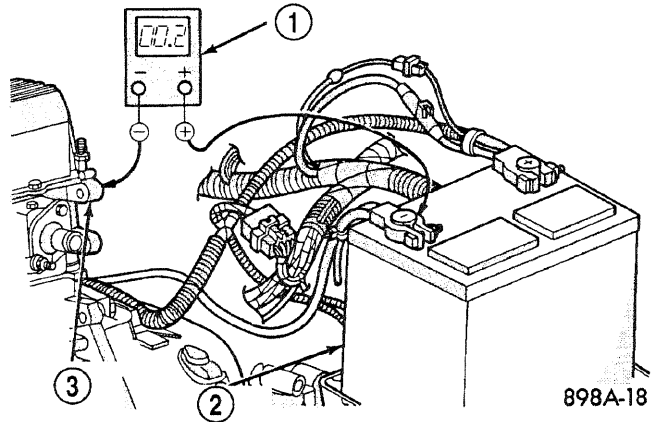
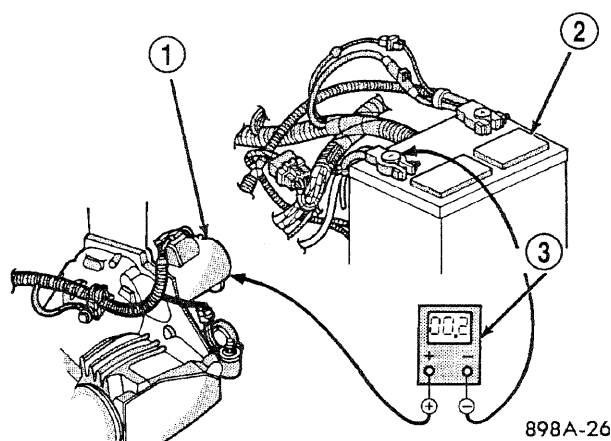


Fig. 5 Test Ground Circuit Resistance - Typical

- 1 - VOLTMETER
2 - BATTERY
3 - ENGINE GROUND

(5) Connect positive lead of voltmeter to starter housing. Connect negative lead of voltmeter to negative battery terminal post (Fig. 6). Rotate and hold ignition switch in Start position. Observe voltmeter. If reading is above 0.2 volt, correct poor starter to engine block ground contact. **Note: Certain diesel equipped models use dual batteries. If equipped with dual battery system, this procedure must be performed on driver side battery only.**

(6) If equipped with dual battery system (certain diesel equipped models), connect positive lead of volt-

STARTING (Continued)**Fig. 6 Test Starter Ground - Typical**

- 1 - STARTER MOTOR
2 - BATTERY
3 - VOLTMETER

meter to positive battery cable clamp on battery located on left side of vehicle. Connect negative lead of voltmeter to positive battery terminal post on battery located on right side of vehicle. Rotate and hold ignition switch in Start position. Observe voltmeter. If reading is above 0.2 volt, clean and tighten battery

cables at both batteries. Repeat test. If reading is still above 0.2 volt, replace faulty positive battery cable.

If resistance tests detect no feed circuit problems, refer to **Starter Motor** in the Diagnosis and Testing.

CONTROL CIRCUIT TESTING

The starter control circuit components should be tested in the order in which they are listed, as follows:

- **Starter Relay** - Refer to **Starter Relay** Diagnosis and Testing.
- **Starter Solenoid** - Refer to **Starter Motor** Diagnosis and Testing.
- **Ignition Switch** - Refer to **Ignition Switch and Key Lock Cylinder**
- **Clutch Pedal Position Switch** - If equipped with manual transmission, refer to **Clutch Pedal Position Switch** in 6, Clutch.
- **Park/Neutral Position Switch** - If equipped with automatic transmission, refer to **Park/Neutral Position Switch** in 21, Transmission.
- **Wire harnesses and connections** - Refer to 8, Wiring Diagrams.

SPECIFICATIONS**SPECIFICATIONS - STARTING SYSTEM**

Starter Motor and Solenoid			
Manufacturer	Mitsubishi	Denso	Denso
Part Number	56041013AC	56027702AC	56028715
Engine Application	2.5L	3.9L, 4.7L (Manual), 5.9L	4.7L (Auto)
Power Rating	1.2 Kilowatt - (1.6 Horsepower)	1.4 Kilowatt - (1.9 Horsepower)	1.4 Kilowatt - (1.9 Horsepower)
Voltage	12 Volts	12 Volts	12 Volts
Pinion Teeth	9	10	10
Number of Fields	4	4	4
Number of Poles	4	4	4
Number of Brushes	4	4	4
Drive Type	Planetary Gear Reduction	Reduction Gear Train	Reduction Gear Train
Free Running Test Voltage	11.2 Volts	11 Volts	11 Volts
Free Running Test Maximum Amperage Draw	90 Amperes	73 Amperes	73 Amperes
Free Running Test Minimum Speed	2600 rpm	3601 rpm	3601 rpm

STARTING (Continued)

Starter Motor and Solenoid			
Solenoid Closing Maximum Voltage Required	7.8 Volts	7.5 Volts	7.5 Volts
* Cranking Amperage Draw Test	130 Amperes	125 - 250 Amperes	125 - 250 Amperes
* Test at operating temperature. Cold engine, tight (new) engine, or heavy oil will increase starter amperage draw.			

SPECIFICATIONS - TORQUE - STARTING SYSTEM

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Battery Cable Eyelet Nut at Solenoid Stud	14		120
Starter Mounting Bolts – 2.5L Engine	54	40	
Starter Mounting Nuts/Bolts – V-6/V-8 Engines	68	50	

STARTER MOTOR**DESCRIPTION**

The 2.5L starter is mounted with two bolts to the clutch housing on the right side of the engine. The 4.7L automatic transmission starter motor is mounted with two bolts to the torque converter housing on the left side of the engine. The starter motors for all of the remaining engine and transmission combinations are mounted with one bolt, a stud and a nut to the clutch or convertor housing, and are located on the left side of the engine.

The electric motors of both starters have four brushes contacting the motor commutator. The 2.5L starter motor uses four permanent magnets for the field poles, while the other starter motors feature four electromagnetic field coils wound around four pole shoes.

The starter motors are serviced only as a unit with starter solenoids, and cannot be repaired. If either component is faulty or damaged, the entire starter motor and starter solenoid unit must be replaced.

OPERATION

The starter motor is equipped with a gear reduction (intermediate transmission) system. The gear reduction system consists of a gear that is integral to the output end of the electric motor armature shaft that is in continual engagement with a larger gear that is splined to the input end of the starter pinion gear shaft. This feature makes it possible to reduce the dimensions of the starter. At the same time, it

allows higher armature rotational speed, and delivers increased torque through the starter pinion gear to the starter ring gear.

The starter motor is activated by an integral heavy duty starter solenoid switch mounted to the overrunning clutch housing. This electromechanical switch connects and disconnects the feed of battery voltage to the starter motor, and actuates a shift fork that engages and disengages the starter pinion gear with the starter ring gear.

The starter motor uses an overrunning clutch and starter pinion gear unit to engage and drive the gears on the flywheel (or flywheel ring gear).

DIAGNOSIS AND TESTING - STARTER MOTOR

Correct starter motor operation can be confirmed by performing following free running bench test. This test can only be performed with starter motor removed from vehicle. Refer to Starting Specifications for starter motor specifications.

(1) Remove starter motor from vehicle. Refer to **Starter Motor Removal and Installation**.

(2) Mount starter motor securely in a soft-jawed bench vise. The vise jaws should be clamped on mounting flange of starter motor. Never clamp on starter motor by field frame.

(3) Connect suitable volt-ampere tester and 12-volt battery to starter motor in series, and set ammeter to 100 ampere scale. See instructions provided by manufacturer of volt-ampere tester being used.

(4) Install jumper wire from solenoid terminal to solenoid battery terminal. The starter motor should

STARTER MOTOR (Continued)

operate. If starter motor fails to operate, replace faulty starter motor assembly.

(5) Adjust carbon pile load of tester to obtain free running test voltage. Refer to Starting Specifications for starter motor free running test voltage specifications.

(6) Note reading on ammeter and compare reading to free running test maximum amperage draw. Refer to Starting Specifications section for starter motor free running test maximum amperage draw specifications.

(7) If ammeter reading exceeds maximum amperage draw specification, replace faulty starter motor assembly.

STARTER MOTOR SOLENOID

This test can only be performed with starter motor removed from vehicle.

(1) Remove starter motor from vehicle. Refer to **Starter Motor Removal and Installation**.

(2) Disconnect wire from solenoid field coil terminal.

(3) Check for continuity between solenoid terminal and solenoid field coil terminal with continuity tester (Fig. 7) or (Fig. 8). There should be continuity. If not OK, replace faulty starter motor assembly.

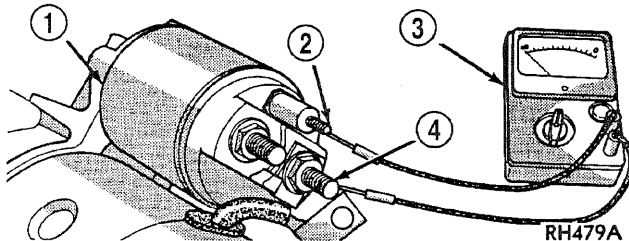


Fig. 7 Continuity Test - 2.5L Engine - Typical

- 1 - SOLENOID
- 2 - SOLENOID TERMINAL
- 3 - OHMMETER
- 4 - FIELD COIL TERMINAL

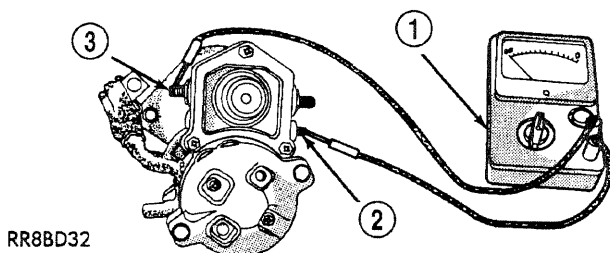


Fig. 8 Continuity Test - 3.9L/4.7L/5.9L Engine - Typical

- 1 - OHMMETER
- 2 - SOLENOID TERMINAL
- 3 - FIELD COIL TERMINAL

(4) Check for continuity between solenoid terminal and solenoid case (Fig. 9) or (Fig. 10). There should be continuity. If not OK, replace faulty starter motor assembly.

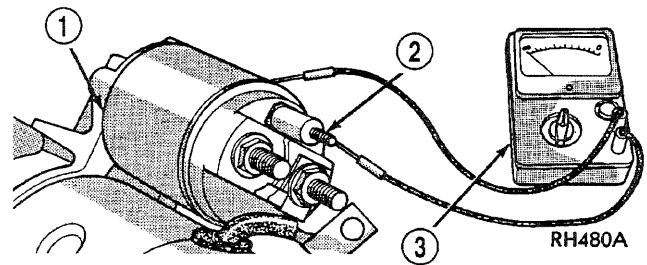


Fig. 9 Continuity Test - 2.5L Engine - Typical

- 1 - SOLENOID
- 2 - SOLENOID TERMINAL
- 3 - OHMMETER

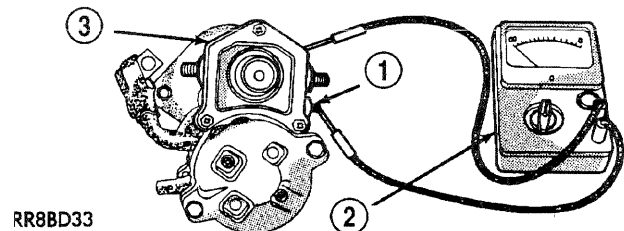


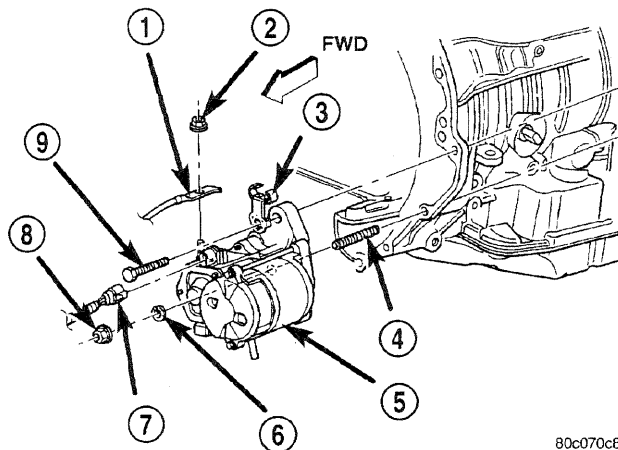
Fig. 10 Continuity Test - 3.9L/4.7L/5.9L Engine - Typical

- 1 - SOLENOID TERMINAL
- 2 - OHMMETER
- 3 - SOLENOID

REMOVAL

All 3.9L/5.9L, or 4.7L With Manual Transmission

- (1) Disconnect and isolate negative battery cable.
- (2) Raise and support vehicle.
- (3) Remove nut securing starter motor to stud on transmission housing (Fig. 11).
- (4) While supporting starter motor, remove bolt securing starter motor to transmission housing.
- (5) If equipped with automatic transmission, slide transmission cooler tube bracket forward on tubes far enough for starter motor to be removed from lower mounting stud.
- (6) Lower starter motor from front transmission housing far enough to access and remove nut securing battery cable eyelet to starter solenoid stud. Always support starter motor during this process. Do not let starter motor hang from wire harness.
- (7) Remove solenoid wire solenoid terminal stud.
- (8) Disconnect battery cable solenoid wire from receptacle on starter solenoid.
- (9) Remove starter motor from transmission housing.

STARTER MOTOR (Continued)

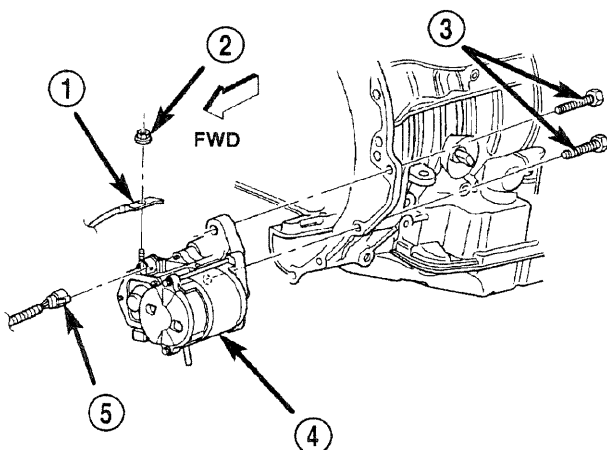
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Fig. 11 Starter Motor Remove/Install - All 3.9L/5.9L, or 4.7L Engine with Man. Trans.

- 1 - EYELET TERMINAL
- 2 - NUT
- 3 - BRACKET
- 4 - STUD
- 5 - STARTER MOTOR
- 6 - LOCK WASHER
- 7 - WIRE HARNESS CONNECTOR
- 8 - NUT
- 9 - SCREW AND WASHER

4.7L With Automatic Transmission

- (1) Disconnect and isolate negative battery cable.
- (2) Raise and support vehicle.
- (3) Remove bolt and washer (rearward facing) securing starter motor to the transmission housing (Fig. 12).



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Fig. 12 Starter Motor Remove/Install - 4.7L Engine with Automatic Transmission

- 1 - EYELET TERMINAL
- 2 - NUT
- 3 - SCREW AND WASHER (2)
- 4 - STARTER MOTOR
- 5 - WIRE HARNESS CONNECTOR

(4) While supporting starter motor, remove bolt and washer (rearward facing) securing starter motor to the transmission housing.

(5) Lower starter motor from front of transmission housing far enough to access and remove nut securing battery positive cable eyelet terminal to the starter solenoid B(+) terminal stud. Always support starter motor during this process. Do not let starter motor hang from wire harness.

(6) Remove battery cable eyelet terminal from solenoid B(+) terminal stud.

(7) Disconnect battery cable solenoid terminal wire harness connector from receptacle on starter solenoid.

(8) Remove starter motor from transmission housing.

INSTALLATION**All 3.9L/5.9L, or 4.7L With Manual Trans.**

(1) Position starter motor to transmission housing.

(2) Connect battery cable solenoid terminal wire harness connector to connector receptacle on starter solenoid. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(3) Install battery cable eyelet terminal onto solenoid B(+) terminal stud.

(4) Install and tighten nut securing battery cable eyelet terminal to starter solenoid B(+) terminal stud. Tighten nut to 13.6 N·m (120 in. lbs.).

(5) Position starter motor over stud on transmission housing.

(6) If equipped with automatic transmission, slide automatic transmission cooler tube bracket rearward on tubes and into position over starter motor flange.

(7) Loosely install the washers, bolt, and nut to starter. Tighten bolt and nut to 67.8 N·m (50 ft. lbs.).

(8) Lower vehicle.

(9) Connect negative battery cable.

4.7L With Automatic Trans.

(1) Position starter motor to transmission housing.

(2) Connect battery cable solenoid terminal wire harness connector to connector receptacle on starter solenoid. Always support the starter motor during this process. Do not let the starter motor hang from the wire harness.

(3) Install battery cable eyelet terminal onto solenoid B(+) terminal stud.

(4) Install and tighten nut securing battery cable eyelet terminal to starter solenoid B(+) terminal stud. Tighten nut to 13.6 N·m (120 in. lbs.).

(5) Position starter motor to transmission housing and loosely install two bolts/washers.

(6) Tighten bolts to 67.8 N·m (50 ft. lbs.).

(7) Lower vehicle.

(8) Connect negative battery cable.

STARTER MOTOR RELAY

DESCRIPTION

The starter relay is an electromechanical device that switches battery current to the pull-in coil of the starter solenoid when ignition switch is turned to Start position. The starter relay is located in the Power Distribution Center (PDC) in the engine compartment. See PDC cover for relay identification and location.

The starter relay is a International Standards Organization (ISO) relay. Relays conforming to ISO specifications have common physical dimensions, current capacities, terminal patterns, and terminal functions.

The starter relay cannot be repaired or adjusted and, if faulty or damaged, it must be replaced.

OPERATION

The ISO relay consists of an electromagnetic coil, a resistor or diode, and three (two fixed and one movable) electrical contacts. The movable (common feed) relay contact is held against one of the fixed contacts (normally closed) by spring pressure. When electromagnetic coil is energized, it draws the movable contact away from normally closed fixed contact, and holds it against the other (normally open) fixed contact.

When electromagnetic coil is de-energized, spring pressure returns movable contact to normally closed position. The resistor or diode is connected in parallel with electromagnetic coil within relay, and helps to dissipate voltage spikes produced when coil is de-energized.

DIAGNOSIS AND TESTING - STARTER RELAY

The starter relay (Fig. 13) is located in Power Distribution Center (PDC). Refer to PDC cover for relay identification and location. For complete starter relay wiring circuit diagrams, refer to 8, Wiring Diagrams.

(1) Remove starter relay from PDC.

(2) A relay in de-energized position should have continuity between terminals 87A and 30, and no continuity between terminals 87 and 30. If OK, go to Step 3. If not OK, replace faulty relay.

(3) Resistance between terminals 85 and 86 (electromagnet) should be 75 ± 5 ohms. If OK, go to Step 4. If not OK, replace faulty relay.

(4) Connect 12V battery to terminals 85 and 86. There should now be continuity between terminals 30 and 87, and no continuity between terminals 87A and 30. If OK, perform Relay Circuit Test that follows. If not OK, replace faulty relay.

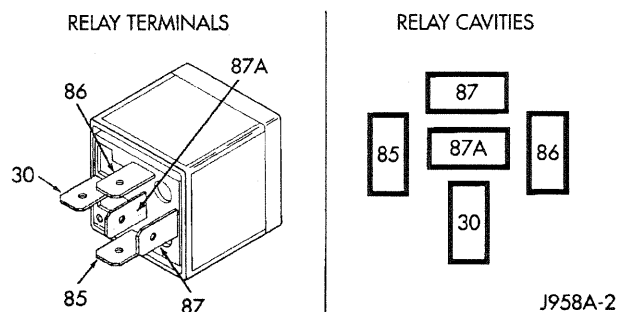


Fig. 13 Starter Relay

TERMINAL LEGEND

NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

RELAY CIRCUIT TEST

(1) The relay common feed terminal cavity (30) is connected to battery voltage and should be hot at all times. If OK, go to Step 2. If not OK, repair open circuit to fuse in PDC as required.

(2) The relay normally closed terminal (87A) is connected to terminal 30 in the de-energized position, but is not used for this application. Go to Step 3.

(3) The relay normally open terminal (87) is connected to common feed terminal (30) in the energized position. This terminal supplies battery voltage to starter solenoid field coils. There should be continuity between cavity for relay terminal 87 and starter solenoid terminal at all times. If OK, go to Step 4. If not OK, repair open circuit to starter solenoid as required.

(4) The coil battery terminal (86) is connected to electromagnet in relay. It is energized when ignition switch is held in Start position. On vehicles with manual transmission, clutch pedal must be fully depressed for this test. Check for battery voltage at cavity for relay terminal 86 with ignition switch in Start position, and no voltage when ignition switch is released to On position. If OK, go to Step 5. If not OK with automatic transmission, check for open or short circuit to ignition switch and repair, if required. If circuit to ignition switch is OK, refer to **Ignition Switch and Key Lock Cylinder**. If not OK with a manual transmission, check circuit between relay and clutch pedal position switch for open or a short. If circuit is OK, refer to **Clutch Pedal Position Switch** in 6, Clutch.

STARTER MOTOR RELAY (Continued)

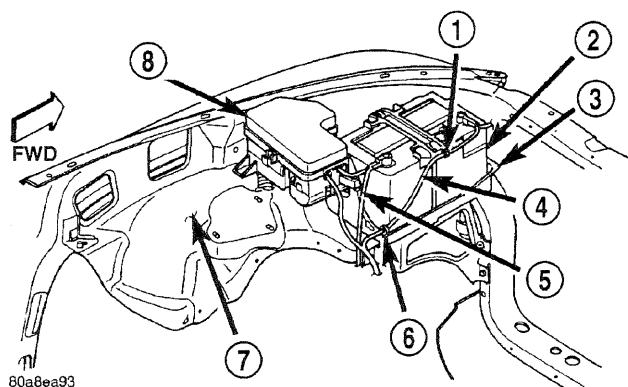
(5) The coil ground terminal (85) is connected to the electromagnet in the relay. On vehicles with manual transmission, it is grounded at all times. On vehicles with automatic transmission, it is grounded through park/neutral position switch only when gear-shift selector lever is in Park or Neutral positions. Check for continuity to ground at cavity for relay terminal 85. If not OK with manual transmission, repair circuit to ground as required. If not OK with automatic transmission, check for pen or short circuit to park/neutral position switch and repair, if required. If circuit to park/neutral position switch is OK, refer to **Park/Neutral Position Switch** in 21, Transmission.

REMOVAL

- (1) Disconnect and isolate negative battery cable.
- (2) Remove cover from Power Distribution Center (PDC) (Fig. 14).
- (3) See fuse and relay layout label affixed to underside of PDC cover for starter relay identification and location.
- (4) Remove starter relay from PDC.

INSTALLATION

- (1) See fuse and relay layout label affixed to underside of PDC cover for proper starter relay location.
- (2) Position starter relay in proper receptacle in PDC.

**Fig. 14 Power Distribution Center**

- 1 - CLIP
- 2 - BATTERY
- 3 - TRAY
- 4 - NEGATIVE CABLE
- 5 - POSITIVE CABLE
- 6 - CLIP
- 7 - FENDER INNER SHIELD
- 8 - POWER DISTRIBUTION CENTER

- (3) Align starter relay terminals with terminal cavities in PDC receptacle.
- (4) Push down firmly on starter relay until terminals are fully seated in terminal cavities in PDC receptacle.
- (5) Install cover onto PDC.
- (6) Reconnect negative battery cable.

IGNITION CONTROL

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IGNITION CONTROL

DESCRIPTION

Two different ignition systems are used. One type of system is for the 3.9L V-6 engine and the 5.9L V-8 engine. The other is for the 4.7L V-8 engine.

The ignition systems used on 3.9L V-6 and 5.9L V-8 engines are basically identical using a conventional distributor and remotely mounted coil. The 4.7L V-8 engine does not use a distributor and has 8 separate coils.

IGNITION CONTROL (Continued)**OPERATION**

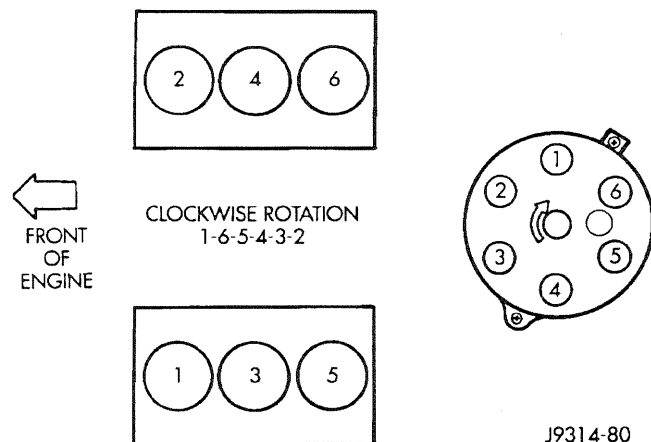
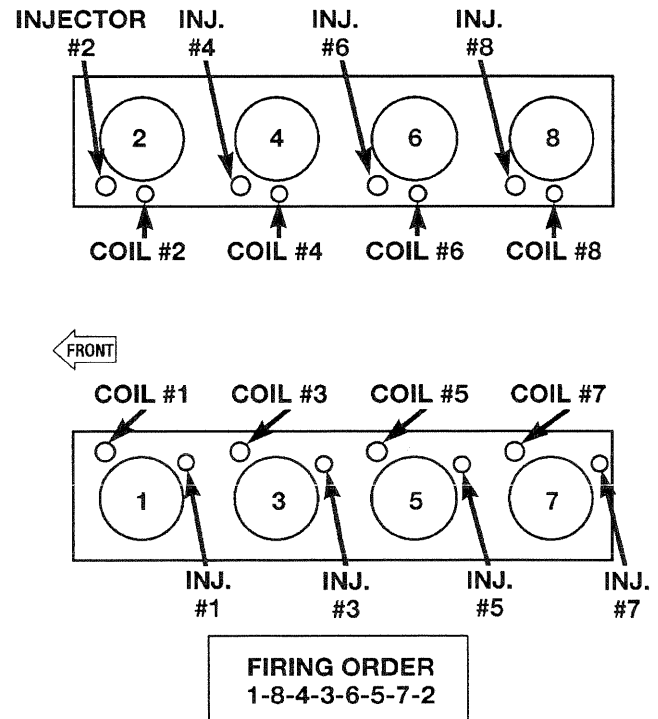
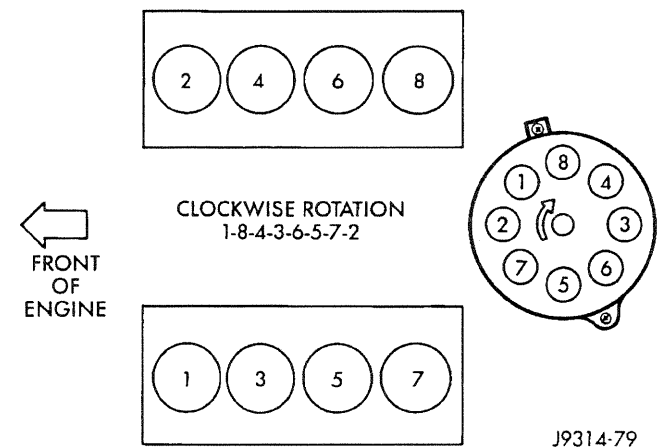
The ignition system is controlled by the Powertrain Control Module (PCM) on all engines.

The ignition system consists of:

- Spark Plugs
- Ignition Coil(s)
- Secondary Ignition Cables (3.9L/5.9L engines)
- Distributor (contains rotor and camshaft position sensor) (3.9L/5.9L engines)
- Powertrain Control Module (PCM)
- Crankshaft Position and Camshaft Position Sensors
- The MAP, TPS, IAC and ECT also have an effect on the control of the ignition system.

SPECIFICATIONS**IGNITION TIMING**

Ignition timing is not adjustable on any engine.

ENGINE FIRING ORDER—3.9L V-6 ENGINE**ENGINE FIRING ORDER – 4.7L V-8****ENGINE FIRING ORDER—5.2L/5.9L V-8 ENGINES**

IGNITION CONTROL (Continued)**SPECIFICATIONS - TORQUE - IGNITION**

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Position Sensor Bolt—4.7L V-8 Engine	12		106
Crankshaft Position Sensor—2.5L Engine	12	9	
Crankshaft Position Sensor—3.9L/5.2L/5.9L Engines	8		70
Crankshaft Position Sensor Bolt—4.7L V-8 Engine	28	21	
Distributor Hold Down Bolt	23	17	
Ignition Coil Mounting (except 4.7L) (if tapped bolts are used)	5		50
Ignition Coil Mounting (except 4.7L) (if nuts/bolts are used)	11		100
Ignition Coil Mounting Nut—4.7L V-8 Engine	8		70
Spark Plugs—Except 4.7L	35-41	26-30	
Spark Plugs—4.7L V-8 Engine	27	20	

IGNITION COIL RESISTANCE - 4.7L V-8

PRIMARY RESISTANCE 21-27°C (70-80°F)	SECONDARY RESISTANCE 21-27°C (70-80°F)
0.6 - 0.9 Ohms	6,000 - 9,000 Ohms

SPECIFICATIONS - IGNITION COIL RESISTANCE—EXCEPT 4.7L

COIL MANUFACTURER	PRIMARY RESISTANCE @ 21-27°C (70-80°F)	SECONDARY RESISTANCE @ 21-27°C (70-80°F)
Diamond	0.97 - 1.18 Ohms	11,300 - 15,300 Ohms
Toyodenso	0.95 - 1.20 Ohms	11,300 - 13,300 Ohms

IGNITION CONTROL (Continued)**SPECIFICATIONS - SPARK PLUG CABLE RESISTANCE**

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

SPECIFICATIONS - SPARK PLUGS

ENGINE	PLUG TYPE	ELECTRODE GAP
2.5L 4-CYL.	RC12ECC	0.89 mm (.035 in.)
3.9L V-6	RC12LC4	1.01 mm (.040 in.)
4.7L V-8	RC12MCC4	1.01 mm (.040 in.)
5.2L V-8	RC12LC4	1.01 mm (.040 in.)
5.9L V-8	RC12LC4	1.01 mm (.040 in.)

AUTO SHUT DOWN RELAY**DESCRIPTION - PCM OUTPUT**

The 5-pin, 12-volt, Automatic Shutdown (ASD) relay is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

OPERATION**OPERATION - ASD SENSE - PCM INPUT**

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The relay is used to connect the oxygen sensor heater element, ignition coil and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the Powertrain Control Module (PCM) does not see 12 volts at this input when the ASD should be activated, it will set a Diagnostic Trouble Code (DTC).

OPERATION - PCM OUTPUT

The ASD relay supplies battery voltage (12+ volts) to the fuel injectors and ignition coil(s). With certain emissions packages it also supplies 12-volts to the oxygen sensor heating elements.

The ground circuit for the coil within the ASD relay is controlled by the Powertrain Control Module (PCM). The PCM operates the ASD relay by switching its ground circuit on and off.

The ASD relay will be shut-down, meaning the 12-volt power supply to the ASD relay will be de-activated by the PCM if:

- the ignition key is left in the ON position. This is if the engine has not been running for approximately 1.8 seconds.
- there is a crankshaft position sensor signal to the PCM that is lower than pre-determined values.

DIAGNOSIS AND TESTING - ASD AND FUEL PUMP RELAYS

The following description of operation and tests apply only to the Automatic Shutdown (ASD) and fuel pump relays. The terminals on the bottom of each relay are numbered. Two different types of relays may be used, (Fig. 1) or (Fig. 2).

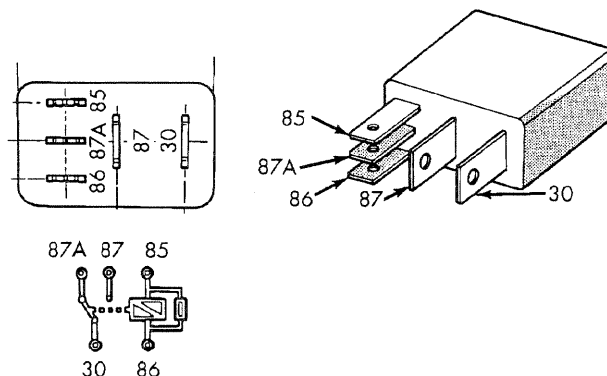
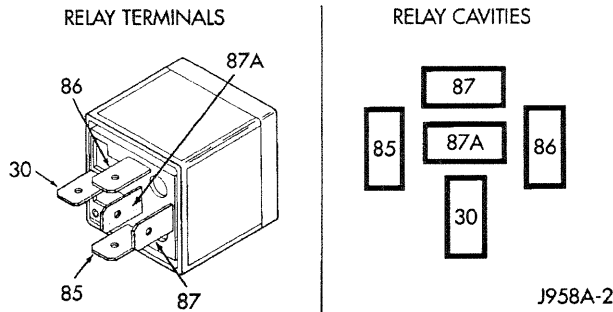


Fig. 1 ASD and Fuel Pump Relay Terminals—Type 1

AUTO SHUT DOWN RELAY (Continued)**Fig. 2 ASD and Fuel Pump Relay Terminals—Type 2****TERMINAL LEGEND**

NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

- Terminal number 30 is connected to battery voltage. For both the ASD and fuel pump relays, terminal 30 is connected to battery voltage at all times.
- The PCM grounds the coil side of the relay through terminal number 85.
- Terminal number 86 supplies voltage to the coil side of the relay.
- When the PCM de-energizes the ASD and fuel pump relays, terminal number 87A connects to terminal 30. This is the Off position. In the off position, voltage is not supplied to the rest of the circuit. Terminal 87A is the center terminal on the relay.
- When the PCM energizes the ASD and fuel pump relays, terminal 87 connects to terminal 30. This is the On position. Terminal 87 supplies voltage to the rest of the circuit.

The following procedure applies to the ASD and fuel pump relays.

- (1) Remove relay from connector before testing.
- (2) With the relay removed from the vehicle, use an ohmmeter to check the resistance between terminals 85 and 86. The resistance should be 75 ohms \pm 5 ohms.
- (3) Connect the ohmmeter between terminals 30 and 87A. The ohmmeter should show continuity between terminals 30 and 87A.
- (4) Connect the ohmmeter between terminals 87 and 30. The ohmmeter should not show continuity at this time.
- (5) Connect one end of a jumper wire (16 gauge or smaller) to relay terminal 85. Connect the other end

of the jumper wire to the ground side of a 12 volt power source.

- (6) Connect one end of another jumper wire (16 gauge or smaller) to the power side of the 12 volt power source. **Do not attach the other end of the jumper wire to the relay at this time.**

WARNING: DO NOT ALLOW OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THIS TEST. DAMAGE TO OHMMETER MAY RESULT.

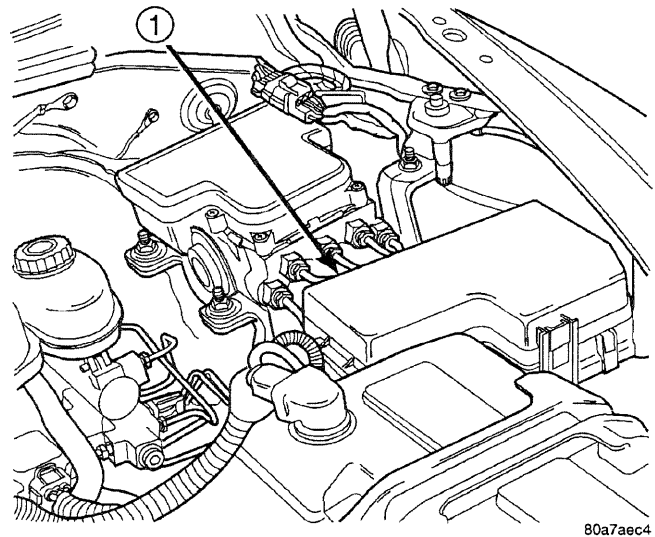
- (7) Attach the other end of the jumper wire to relay terminal 86. This activates the relay. The ohmmeter should now show continuity between relay terminals 87 and 30. The ohmmeter should not show continuity between relay terminals 87A and 30.

- (8) Disconnect jumper wires.

- (9) Replace the relay if it did not pass the continuity and resistance tests. If the relay passed the tests, it operates properly. Check the remainder of the ASD and fuel pump relay circuits. Refer to 8, Wiring Diagrams.

REMOVAL

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 3). Refer to label on PDC cover for relay location.

**Fig. 3 Power Distribution Center (PDC) Location**

1 - POWER DISTRIBUTION CENTER (PDC)

- (1) Remove PDC cover.
- (2) Remove relay from PDC.
- (3) Check condition of relay terminals and PDC connector terminals for damage or corrosion. Repair if necessary before installing relay.
- (4) Check for pin height (pin height should be the same for all terminals within the PDC connector). Repair if necessary before installing relay.

AUTO SHUT DOWN RELAY (Continued)**INSTALLATION**

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 3). Refer to label on PDC cover for relay location.

- (1) Install relay to PDC.
- (2) Install cover to PDC.

CAMSHAFT POSITION SENSOR**DESCRIPTION****DESCRIPTION - EXCEPT 4.7L**

The Camshaft Position (CMP) sensor is located in the distributor.

DESCRIPTION - 4.7L

The Camshaft Position Sensor (CMP) on the 4.7L V-8 engine is bolted to the front/top of the right cylinder head (Fig. 4).

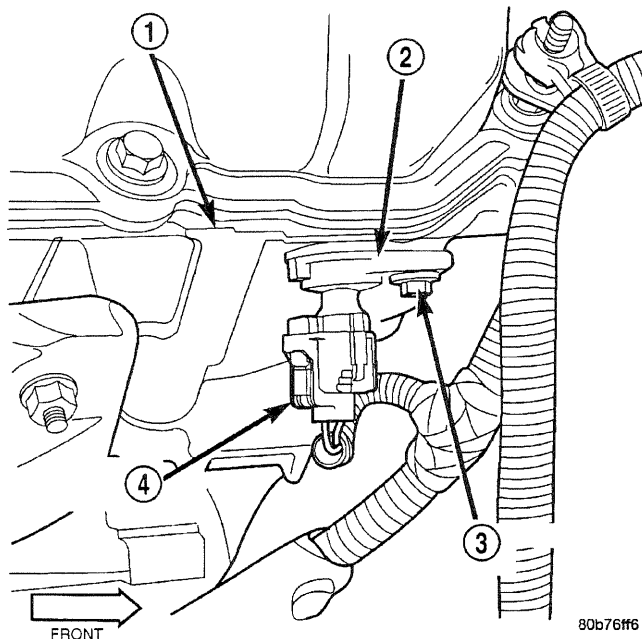


Fig. 4 CMP Location—4.7L Engine

- 1 - RIGHT CYLINDER HEAD
- 2 - CAMSHAFT POSITION SENSOR
- 3 - MOUNTING BOLT
- 4 - ELEC. CONNECTOR

OPERATION**OPERATION - EXCEPT 4.7L**

The sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects a rotating pulse ring (shutter) on the distributor shaft. The pulse ring rotates 180 degrees through the sync signal generator. Its signal is used in conjunction with the Crankshaft Position (CKP) sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

When the leading edge of the pulse ring (shutter) enters the sync signal generator, the following occurs: The interruption of magnetic field causes the voltage to switch high resulting in a sync signal of approximately 5 volts.

When the trailing edge of the pulse ring (shutter) leaves the sync signal generator, the following occurs: The change of the magnetic field causes the sync signal voltage to switch low to 0 volts.

OPERATION - 4.7L

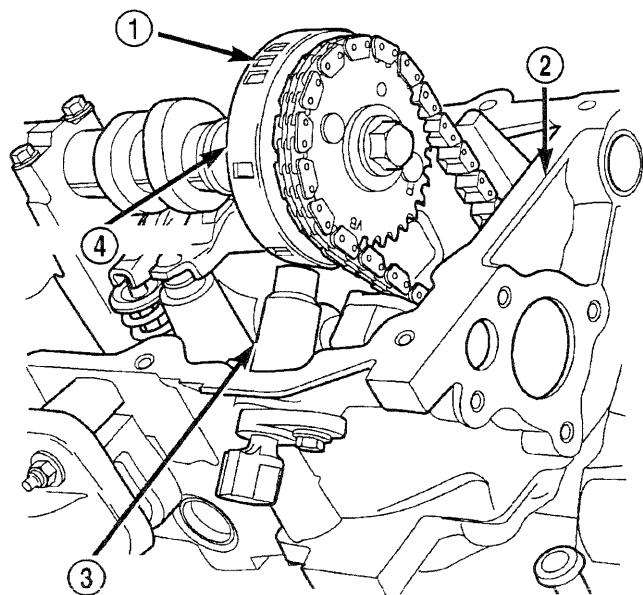
The CMP sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects notches located on a tonewheel. The tonewheel is located at the front of the camshaft for the right cylinder head (Fig. 5). As the tonewheel rotates, the notches pass through the sync signal generator. The pattern of the notches (viewed counter-clockwise from front of engine) is: 1 notch, 2 notches, 3 notches, 3 notches, 2 notches 1 notch, 3 notches and 1 notch. The signal from the CMP sensor is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

REMOVAL**REMOVAL - EXCEPT 4.7L**

The camshaft position sensor is located in the distributor on all 2.5/3.9/5.2/5.9L engines (Fig. 6).

Distributor removal is not necessary to remove camshaft position sensor.

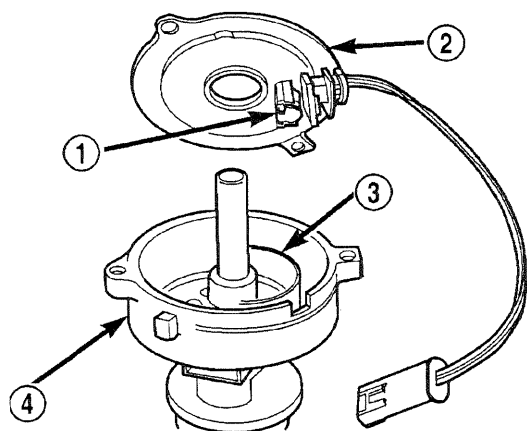
- (1) Remove air cleaner assembly.

CAMSHAFT POSITION SENSOR (Continued)

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Fig. 5 CMP Sensor and Tonewheel—4.7L Engine

- 1 - NOTCHES
- 2 - RIGHT CYLINDER HEAD
- 3 - CAMSHAFT POSITION SENSOR
- 4 - TONEWHEEL



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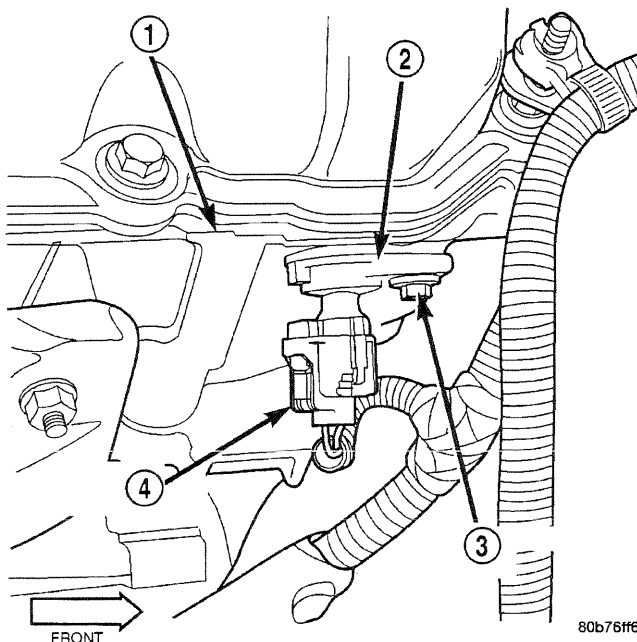
Fig. 6 Camshaft Position Sensor—Typical (3.9/5.2/5.9L Shown)

- 1 - SYNC SIGNAL GENERATOR
- 2 - CAMSHAFT POSITION SENSOR
- 3 - PULSE RING
- 4 - DISTRIBUTOR ASSEMBLY

- (2) Disconnect negative cable from battery.
- (3) Remove distributor cap from distributor (two screws).
- (4) Disconnect camshaft position sensor wiring harness from main engine wiring harness.
- (5) Remove distributor rotor from distributor shaft.
- (6) Lift the camshaft position sensor assembly from the distributor housing (Fig. 6).

REMOVAL - 4.7L

The Camshaft Position Sensor (CMP) on the 4.7L V-8 engine is bolted to the front/top of the right cylinder head (Fig. 7).



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Fig. 7 CMP Location—4.7L Engine

- 1 - RIGHT CYLINDER HEAD
- 2 - CAMSHAFT POSITION SENSOR
- 3 - MOUNTING BOLT
- 4 - ELEC. CONNECTOR

It is easier to remove/install sensor from under vehicle.

- (1) Raise and support vehicle.
- (2) Disconnect electrical connector at CMP sensor (Fig. 7).
- (3) Remove sensor mounting bolt (Fig. 7).
- (4) Carefully twist sensor from cylinder head.
- (5) Check condition of sensor o-ring.

INSTALLATION**INSTALLATION - EXCEPT 4.7L**

The camshaft position sensor is located in the distributor on all 2.5/3.9/5.2/5.9L engines (Fig. 6).

- (1) Install camshaft position sensor to distributor. Align sensor into notch on distributor housing.
- (2) Connect wiring harness.
- (3) Install rotor.
- (4) Install distributor cap. Tighten mounting screws.
- (5) Install air cleaner assembly.

CAMSHAFT POSITION SENSOR (Continued)**INSTALLATION - 4.7L**

The Camshaft Position Sensor (CMP) on the 4.7L V-8 engine is bolted to the front/top of the right cylinder head (Fig. 7).

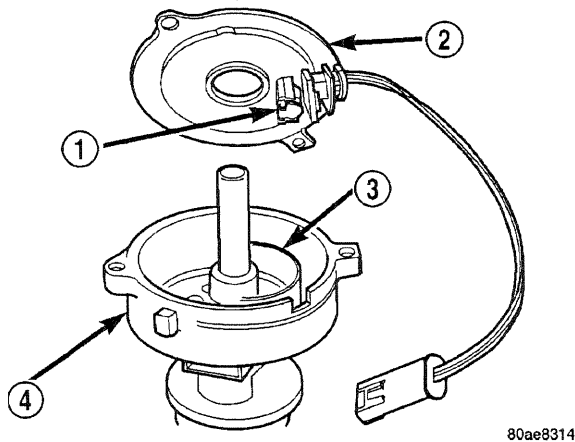
- (1) Clean out machined hole in cylinder head.
- (2) Apply a small amount of engine oil to sensor o-ring.
- (3) Install sensor into cylinder head with a slight rocking action. Do not twist sensor into position as damage to o-ring may result.

CAUTION: Before tightening sensor mounting bolt, be sure sensor is completely flush to cylinder head. If sensor is not flush, damage to sensor mounting tang may result.

- (4) Install mounting bolt and tighten to 12 N·m (106 in. lbs.) torque.
- (5) Connect electrical connector to sensor.
- (6) Lower vehicle.

DISTRIBUTOR**DESCRIPTION**

All 2.5L/3.9L/5.9L engines are equipped with a camshaft driven mechanical distributor (Fig. 8) containing a shaft driven distributor rotor. All distributors are equipped with an internal camshaft position (fuel sync) sensor (Fig. 8).



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**Fig. 8 Distributor and Camshaft Position Sensor-
Typical (3.9L/5.9L Shown)**

- 1 - SYNC SIGNAL GENERATOR
- 2 - CAMSHAFT POSITION SENSOR
- 3 - PULSE RING
- 4 - DISTRIBUTOR ASSEMBLY

OPERATION

The camshaft position sensor provides fuel injection synchronization and cylinder identification.

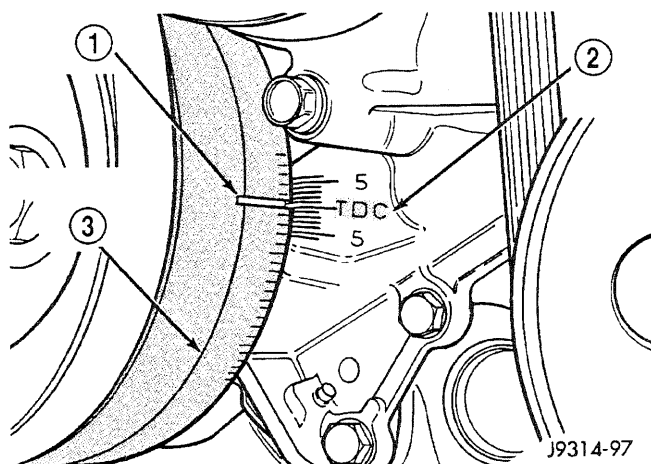
The distributor does not have built in centrifugal or vacuum assisted advance. Base ignition timing and all timing advance is controlled by the Powertrain Control Module (PCM). Because ignition timing is controlled by the PCM, **base ignition timing is not adjustable on any of these engines.**

All 2.5L/3.9L/5.9L distributors contain an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

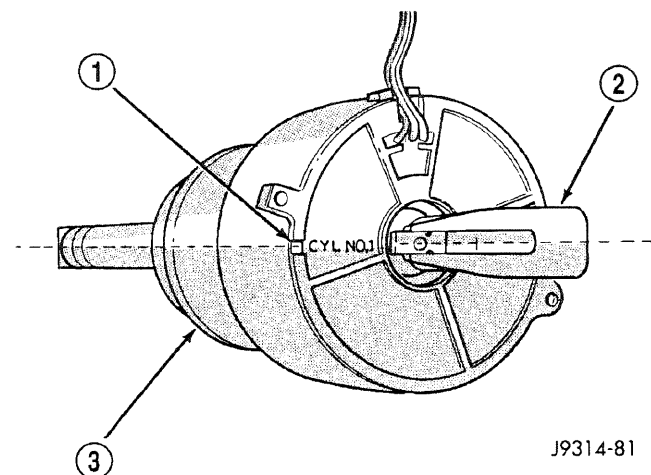
REMOVAL - 3.9L/5.2L/5.9L

CAUTION: Base ignition timing is not adjustable on any engine. Distributors do not have built in centrifugal or vacuum assisted advance. Base ignition timing and timing advance are controlled by the Powertrain Control Module (PCM). Because a conventional timing light can not be used to adjust distributor position after installation, note position of distributor before removal.

- (1) Remove air cleaner assembly.
- (2) Disconnect negative cable from battery.
- (3) Remove distributor cap from distributor (two screws).
- (4) Mark the position of distributor housing in relationship to engine or dash panel. This is done to aid in installation.
- (5) Before distributor is removed, the number one cylinder must be brought to the Top Dead Center (TDC) firing position.
- (6) Attach a socket to the Crankshaft Vibration Damper mounting bolt.
- (7) Slowly rotate engine clockwise, as viewed from front, until indicating mark on crankshaft vibration damper is aligned to 0 degree (TDC) mark on timing chain cover (Fig. 9).
- (8) The distributor rotor should now be aligned to the CYL. NO. 1 alignment mark (stamped) into the camshaft position sensor (Fig. 10). If not, rotate the crankshaft through another complete 360 degree turn. Note the position of the number one cylinder spark plug cable (on the cap) in relation to rotor. Rotor should now be aligned to this position.
- (9) Disconnect camshaft position sensor wiring harness from main engine wiring harness.
- (10) Remove distributor rotor from distributor shaft.

DISTRIBUTOR (Continued)**Fig. 9 Damper-To-Cover Alignment Marks—Typical**

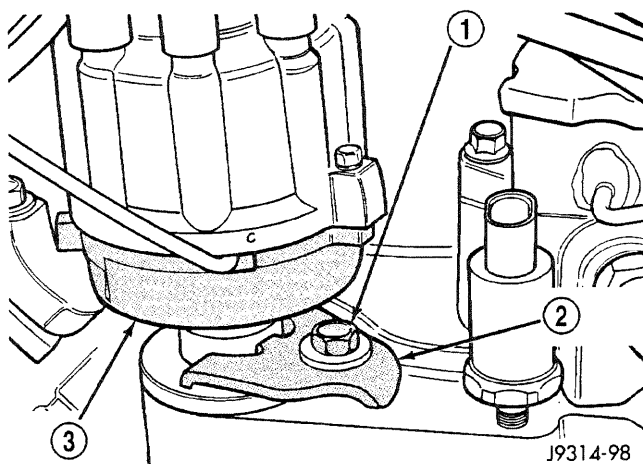
- 1 - ALIGNMENT MARK
- 2 - TIMING CHAIN COVER MARKS
- 3 - CRANKSHAFT VIBRATION DAMPER

**Fig. 10 Rotor Alignment Mark—3.9/5.2/5.9L Engines**

- 1 - CAMSHAFT POSITION SENSOR ALIGNMENT MARK
- 2 - ROTOR
- 3 - DISTRIBUTOR

(11) Remove distributor holddown clamp bolt and clamp (Fig. 11). Remove distributor from vehicle.

CAUTION: Do not crank engine with distributor removed. Distributor/crankshaft relationship will be lost.

**Fig. 11 Distributor Holddown Clamp—3.9/5.2/5.9L Engines**

- 1 - CLAMP BOLT
- 2 - HOLDDOWN CLAMP
- 3 - DISTRIBUTOR HOUSING

INSTALLATION - 3.9L/5.2L/5.9L

If engine has been cranked while distributor is removed, establish the relationship between distributor shaft and number one piston position as follows:

Rotate crankshaft in a clockwise direction, as viewed from front, until number one cylinder piston is at top of compression stroke (compression should be felt on finger with number one spark plug removed). Then continue to slowly rotate engine clockwise until indicating mark (Fig. 9) is aligned to 0 degree (TDC) mark on timing chain cover.

(1) Clean top of cylinder block for a good seal between distributor base and block.

(2) Lightly oil the rubber o-ring seal on the distributor housing.

(3) Install rotor to distributor shaft.

(4) Position distributor into engine to its original position. Engage tongue of distributor shaft with slot in distributor oil pump drive gear. Position rotor to the number one spark plug cable position.

(5) Install distributor holddown clamp and clamp bolt. Do not tighten bolt at this time.

(6) Rotate the distributor housing until rotor is aligned to CYL. NO. 1 alignment mark on the camshaft position sensor (Fig. 10).

DISTRIBUTOR (Continued)

(7) Tighten clamp holddown bolt (Fig. 11) to 22.5 N·m (200 in. lbs.) torque.

(8) Connect camshaft position sensor wiring harness to main engine harness.

(9) Install distributor cap. Tighten mounting screws.

(10) Refer to the following, Checking Distributor Position.

Checking Distributor Position

To verify correct distributor rotational position, the DRB scan tool must be used.

WARNING: WHEN PERFORMING THE FOLLOWING TEST, THE ENGINE WILL BE RUNNING. BE CAREFUL NOT TO STAND IN LINE WITH THE FAN BLADES OR FAN BELT. DO NOT WEAR LOOSE CLOTHING.

(1) Connect DRB scan tool to data link connector. The data link connector is located in passenger compartment, below and to left of steering column.

(2) Gain access to SET SYNC screen on DRB.

(3) Follow directions on DRB screen and start engine. Bring to operating temperature (engine must be in "closed loop" mode).

(4) With engine running at **idle speed**, the words **IN RANGE** should appear on screen along with 0°. This indicates correct distributor position.

(5) If a plus (+) or a minus (-) is displayed next to degree number, and/or the degree displayed is not zero, loosen but do not remove distributor holddown clamp bolt. Rotate distributor until **IN RANGE** appears on screen. Continue to rotate distributor until achieving as close to 0° as possible. After adjustment, tighten clamp bolt to 22.5 N·m (200 in. lbs.) torque.

The degree scale on SET SYNC screen of DRB is referring to fuel synchronization only. **It is not referring to ignition timing.** Because of this, do not attempt to adjust ignition timing using this method. Rotating distributor will have no effect on ignition timing. All ignition timing values are controlled by Powertrain Control Module (PCM).

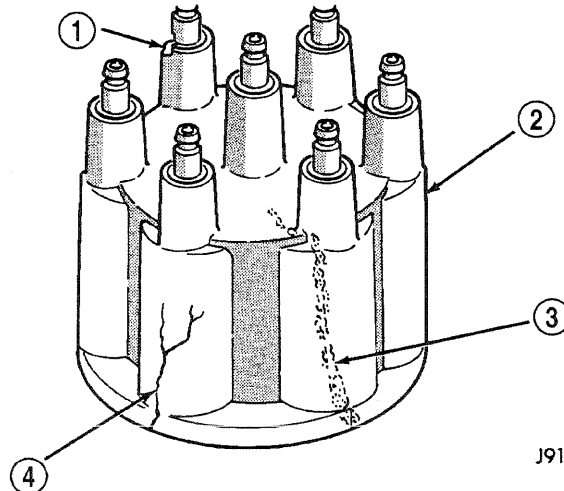
After testing, install air cleaner assembly.

DISTRIBUTOR CAP

DIAGNOSIS AND TESTING - DISTRIBUTOR CAP

Remove the distributor cap and wipe it clean with a dry lint free cloth. Visually inspect the cap for cracks, carbon paths, broken towers or damaged rotor button (Fig. 12) or (Fig. 13). Also check for white deposits on the inside (caused by condensation entering the cap through cracks). Replace any cap

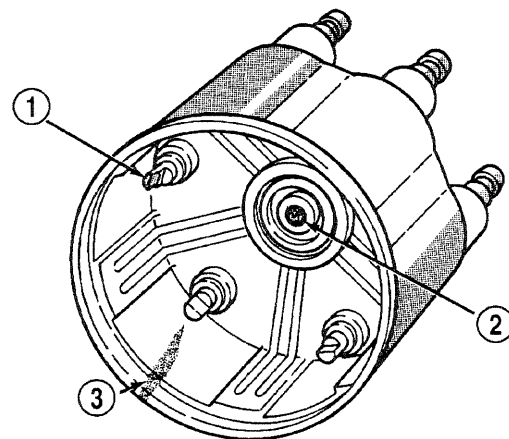
that displays charred or eroded terminals. The machined surface of a terminal end (faces toward rotor) will indicate some evidence of erosion from normal operation. Examine the terminal ends for evidence of mechanical interference with the rotor tip.



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Fig. 12 Cap Inspection—External—Typical

- 1 - BROKEN TOWER
- 2 - DISTRIBUTOR CAP
- 3 - CARBON PATH
- 4 - CRACK



J918D-10

Fig. 13 Cap Inspection—Internal—Typical

- 1 - CHARRED OR ERODED TERMINALS
- 2 - WORN OR DAMAGED ROTOR BUTTON
- 3 - CARBON PATH

DISTRIBUTOR ROTOR

DIAGNOSIS AND TESTING - DISTRIBUTOR ROTOR

Visually inspect the rotor (Fig. 14) for cracks, evidence of corrosion or the effects of arcing on the metal tip. Also check for evidence of mechanical interference with the cap. Some charring is normal

DISTRIBUTOR ROTOR (Continued)

on the end of the metal tip. The silicone-dielectric-varnish-compound applied to the rotor tip for radio interference noise suppression, will appear charred. This is normal. **Do not remove the charred compound.** Test the spring for insufficient tension. Replace a rotor that displays any of these adverse conditions.

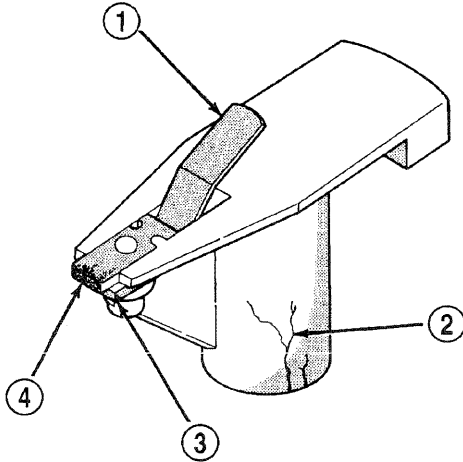


Fig. 14 Rotor Inspection—Typical

- 1 - INSUFFICIENT SPRING TENSION
- 2 - CRACKS
- 3 - EVIDENCE OF PHYSICAL CONTACT WITH CAP
- 4 - ROTOR TIP CORRODED

IGNITION COIL

DESCRIPTION

DESCRIPTION - EXCEPT 4.7L

A single ignition coil is used. The coil is not oil filled. The coil windings are embedded in an epoxy compound. This provides heat and vibration resistance that allows the coil to be mounted on the engine.

DESCRIPTION - 4.7L

The 4.7L V-8 engine uses 8 dedicated, and individually fired coil (Fig. 15) for each spark plug. Each coil is mounted directly to the top of each spark plug (Fig. 16).

OPERATION

OPERATION - EXCEPT 4.7L

The Powertrain Control Module (PCM) opens and closes the ignition coil ground circuit for ignition coil operation.

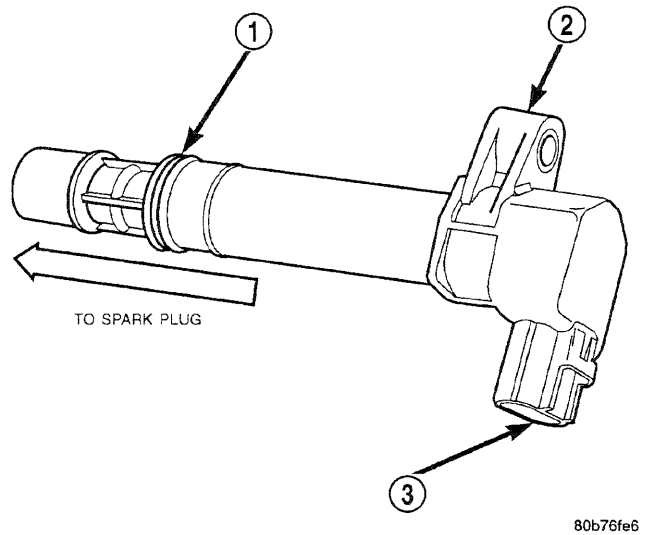


Fig. 15 Ignition Coil—4.7L Engine

- 1 - O-RING
- 2 - IGNITION COIL
- 3 - ELECTRICAL CONNECTOR

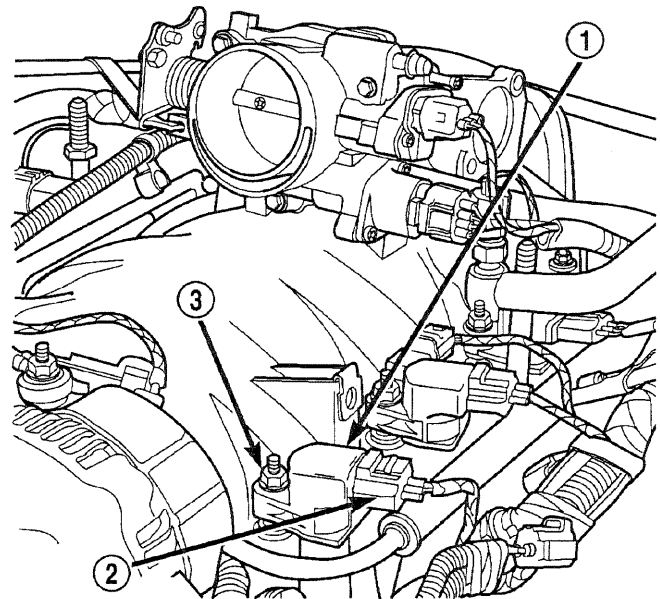


Fig. 16 Ignition Coil Location—4.7L Engine

- 1 - IGNITION COIL
- 2 - COIL ELECTRICAL CONNECTOR
- 3 - COIL MOUNTING STUD/NUT

Battery voltage is supplied to the ignition coil positive terminal from the ASD relay. If the PCM does not see a signal from the crankshaft and camshaft sensors (indicating the ignition key is ON but the engine is not running), it will shut down the ASD circuit.

IGNITION COIL (Continued)

Base ignition timing is not adjustable on any engine. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

OPERATION - 4.7L

Battery voltage is supplied to the 8 ignition coils from the ASD relay. The Powertrain Control Module (PCM) opens and closes each ignition coil ground circuit at a determined time for ignition coil operation.

Base ignition timing is not adjustable. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

The ignition coil is not oil filled. The windings are embedded in an epoxy compound. This provides heat and vibration resistance that allows the ignition coil to be mounted on the engine.

Because of coil design, spark plug cables (secondary cables) are not used.

REMOVAL

REMOVAL - 3.9L/5.2L/5.9L

The ignition coil is an epoxy filled type. If the coil is replaced, it must be replaced with the same type.

The coil is mounted to a bracket that is bolted to the front of the right engine cylinder head (Fig. 17). This bracket is mounted on top of the automatic belt tensioner bracket using common bolts.

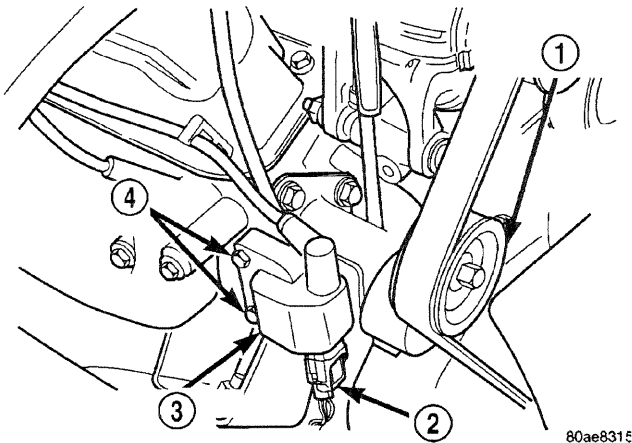


Fig. 17 Ignition Coil—3.9L V-6 or 5.2/5.9L V-8 Engines

- 1 - ACCESSORY DRIVE BELT TENSIONER
- 2 - COIL CONNECTOR
- 3 - IGNITION COIL
- 4 - COIL MOUNTING BOLTS

(1) Disconnect the primary wiring from the ignition coil.

(2) Disconnect the secondary spark plug cable from the ignition coil.

WARNING: DO NOT REMOVE THE COIL MOUNTING BRACKET-TO-CYLINDER HEAD MOUNTING BOLTS. THE COIL MOUNTING BRACKET IS UNDER ACCESSORY DRIVE BELT TENSION. IF THIS BRACKET IS TO BE REMOVED FOR ANY REASON, ALL BELT TENSION MUST FIRST BE RELIEVED. REFER TO THE BELT SECTION OF 7, COOLING SYSTEM.

(3) Remove ignition coil from coil mounting bracket (two bolts).

REMOVAL - 4.7L

An individual ignition coil is used for each spark plug (Fig. 18). The coil fits into machined holes in the cylinder head. A mounting stud/nut secures each coil to the top of the intake manifold (Fig. 19). The bottom of the coil is equipped with a rubber boot to seal the spark plug to the coil. Inside each rubber boot is a spring. The spring is used for a mechanical contact between the coil and the top of the spark plug. These rubber boots and springs are a permanent part of the coil and are not serviced separately. An o-ring (Fig. 18) is used to seal the coil at the opening into the cylinder head.

(1) Depending on which coil is being removed, the throttle body air intake tube or intake box may need to be removed to gain access to coil.

(2) Disconnect electrical connector (Fig. 19) from coil by pushing downward on release lock on top of connector and pull connector from coil.

(3) Clean area at base of coil with compressed air before removal.

(4) Remove coil mounting nut from mounting stud (Fig. 19).

(5) Carefully pull up coil from cylinder head opening with a slight twisting action.

(6) Remove coil from vehicle.

INSTALLATION

INSTALLATION - 3.9L/5.2L/5.9L

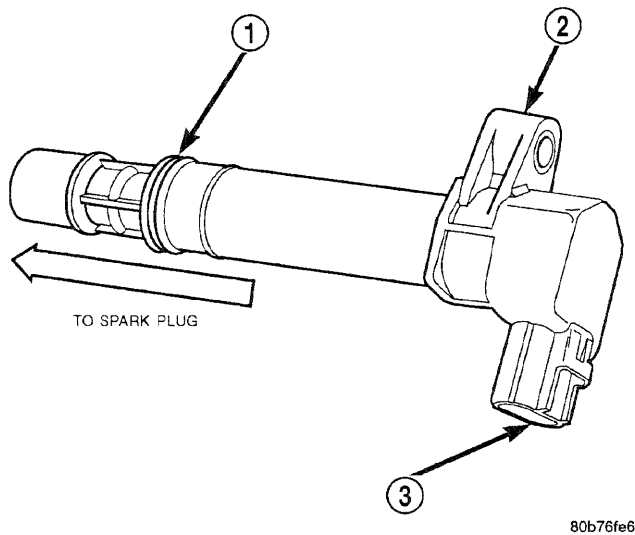
The ignition coil is an epoxy filled type. If the coil is replaced, it must be replaced with the same type.

(1) Install the ignition coil to coil bracket. If nuts and bolts are used to secure coil to coil bracket, tighten to 11 N·m (100 in. lbs.) torque. If the coil mounting bracket has been tapped for coil mounting bolts, tighten bolts to 5 N·m (50 in. lbs.) torque.

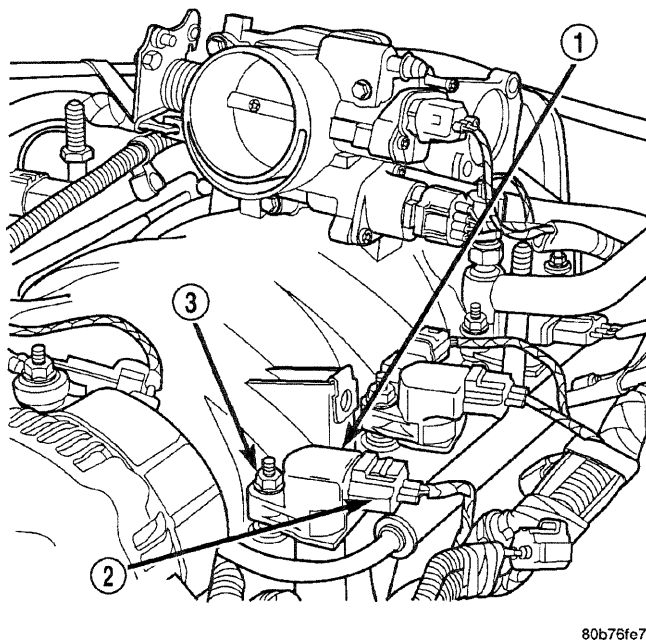
(2) Connect all wiring to ignition coil.

INSTALLATION - 4.7L

(1) Using compressed air, blow out any dirt or contaminants from around top of spark plug.

IGNITION COIL (Continued)**Fig. 18 Ignition Coil—4.7L V-8 Engine**

- 1 - O-RING
- 2 - IGNITION COIL
- 3 - ELECTRICAL CONNECTOR

**Fig. 19 Ignition Coil Location—4.7L V-8 Engine**

- 1 - IGNITION COIL
- 2 - COIL ELECTRICAL CONNECTOR
- 3 - COIL MOUNTING STUD/NUT

(2) Check condition of coil o-ring and replace as necessary. To aid in coil installation, apply silicone to coil o-ring.

(3) Position ignition coil into cylinder head opening and push onto spark plug. Do this while guiding coil base over mounting stud.

(4) Install mounting stud nut and tighten to 8 N·m (70 in. lbs.) torque.

(5) Connect electrical connector to coil by snapping into position.

(6) If necessary, install throttle body air tube or box.

SPARK PLUG**DESCRIPTION**

All engines use resistor type spark plugs. 4.7L V-8 engines are equipped with "fired in suppressor seal" type spark plugs using a copper core ground electrode.

Because of the use of an aluminum cylinder head on the 4.7L engine, spark plug torque is very critical.

To prevent possible pre-ignition and/or mechanical engine damage, the correct type/heat range/number spark plug must be used.

OPERATION

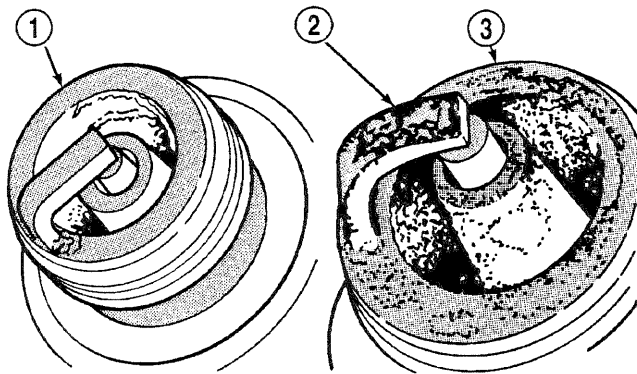
Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. A single plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Lubrication and Maintenance.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective, carbon or oil fouled. Also refer to Spark Plug Conditions.

CAUTION: Never use a motorized wire wheel brush to clean the spark plugs. Metallic deposits will remain on the spark plug insulator and will cause plug misfire.

DIAGNOSIS AND TESTING - SPARK PLUG CONDITIONS**NORMAL OPERATING**

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 20). There will not be evidence of electrode burning. On all engines except the 4.7L V-8, gap growth will not average more than approximately 0.025 mm (.001 in) per 3200 km (2000 miles) of operation. On the 4.7L V-8, gap growth will not average more than approximately .0015 in per 3200 km (2000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed, have the gap set and then be installed.

SPARK PLUG (Continued)

J908D-15

Fig. 20 Normal Operation and Cold (Carbon) Fouling

- 1 - NORMAL
- 2 - DRY BLACK DEPOSITS
- 3 - COLD (CARBON) FOULING

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT causes the entire tip of the spark plug to be coated with a rust colored deposit. This rust color can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance may be affected by MMT deposits.

COLD FOULING/CARBON FOULING

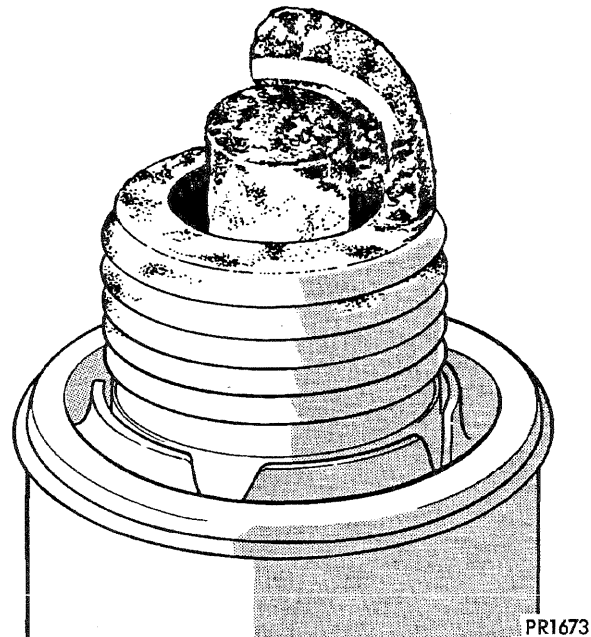
Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 20). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

WET FOULING OR GAS FOULING

A spark plug coated with excessive wet fuel or oil is wet fouled. In older engines, worn piston rings, leaking valve guide seals or excessive cylinder wear can cause wet fouling. In new or recently overhauled engines, wet fouling may occur before break-in (normal oil control) is achieved. This condition can usually be resolved by cleaning and reinstalling the fouled plugs.

OIL OR ASH ENCRUSTED

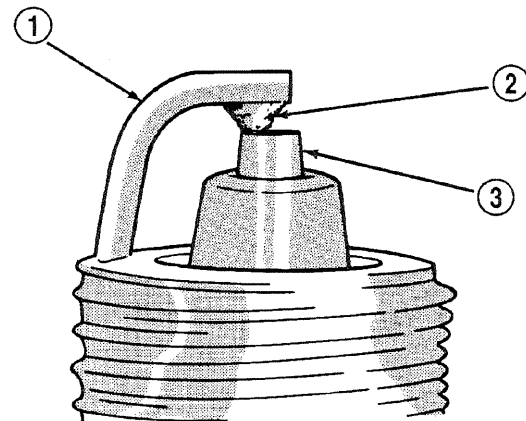
If one or more spark plugs are oil or oil ash encrusted (Fig. 21), evaluate engine condition for the cause of oil entry into that particular combustion chamber.



PR1673

Fig. 21 Oil or Ash Encrusted**ELECTRODE GAP BRIDGING**

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 22). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.



J908D-11

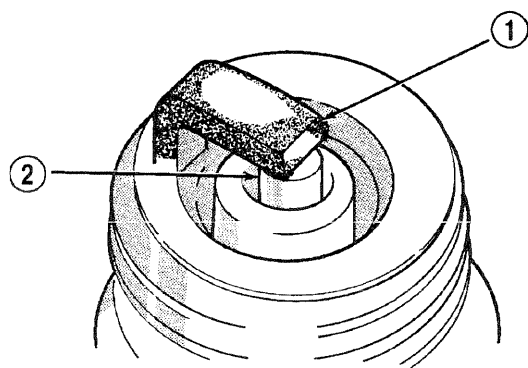
Fig. 22 Electrode Gap Bridging

- 1 - GROUND ELECTRODE
- 2 - DEPOSITS
- 3 - CENTER ELECTRODE

SPARK PLUG (Continued)

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 23). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy, but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.



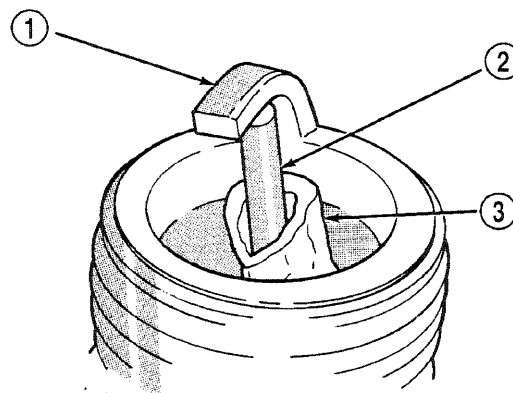
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Fig. 23 Scavenger Deposits

- 1 - GROUND ELECTRODE COVERED WITH WHITE OR YELLOW DEPOSITS
- 2 - CENTER ELECTRODE

CHIPPED ELECTRODE INSULATOR

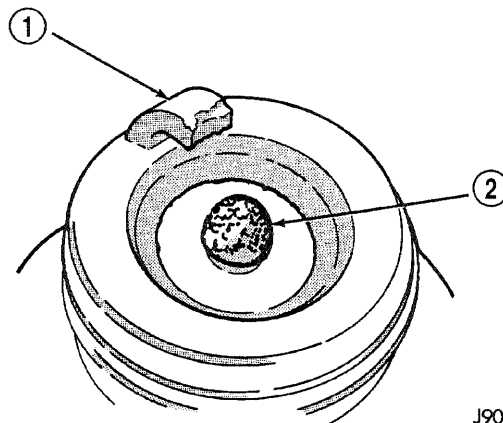
A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode (Fig. 24). Spark plugs with this condition must be replaced.



J908D-13

Fig. 24 Chipped Electrode Insulator

- 1 - GROUND ELECTRODE
- 2 - CENTER ELECTRODE
- 3 - CHIPPED INSULATOR



J908D-14

Fig. 25 Preignition Damage

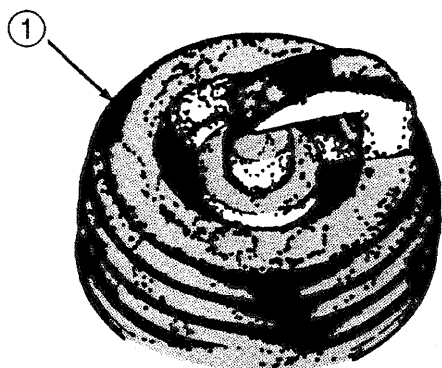
- 1 - GROUND ELECTRODE STARTING TO DISSOLVE
- 2 - CENTER ELECTRODE DISSOLVED

PREIGNITION DAMAGE

Preignition damage is usually caused by excessive combustion chamber temperature. The center electrode dissolves first and the ground electrode dissolves somewhat latter (Fig. 25). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine. Determine if ignition timing is over advanced or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug. Spark plugs are designed to operate within specific temperature ranges. This depends upon the thickness and length of the center electrodes porcelain insulator.)

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 26). The increase in electrode gap will be considerably in excess of 0.001 inch per 2000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions can also cause spark plug overheating.

SPARK PLUG (Continued)

J908D-16

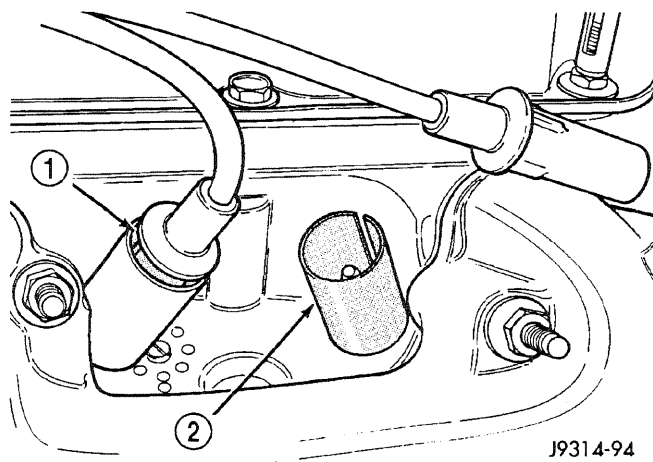
Fig. 26 Spark Plug Overheating

1 - BLISTERED WHITE OR GRAY COLORED INSULATOR

REMOVAL

On 3.9L V-6 and 5.2/5.9L V-8 engines, spark plug cable heat shields are pressed into the cylinder head to surround each cable boot and spark plug (Fig. 27).

If removal of the heat shield(s) is necessary,



J9314-94

Fig. 27 Heat Shields—3.9/5.2/5.9L Engines

1 - AIR GAP

2 - SPARK PLUG BOOT HEAT SHIELD

remove the spark plug cable and compress the sides of shield for removal. Each shield is slotted to allow for compression and removal. To install the shields, align shield to machined opening in cylinder head and tap into place with a block of wood.

4.7L V-8 Engine: Each individual spark plug is located under each ignition coil. Each individual ignition coil must be removed to gain access to each spark plug. Refer to Ignition Coil Removal/Installation.

(1) Except 4.7L Engine: Prior to removing spark plug, spray compressed air around spark plug hole and area around spark plug. This will help prevent foreign material from entering combustion chamber.

(2) 4.7L V-8 Engine: Prior to removing spark plug, spray compressed air around base of ignition coil at cylinder head. This will help prevent foreign material from entering combustion chamber.

(3) Remove spark plug from cylinder head using a quality socket with a rubber or foam insert. If equipped with a 4.7L V-8 engine, also check condition of coil o-ring and replace as necessary.

(4) Except 4.7L: Always remove spark plug or ignition coil cables by grasping at the cable boot (Fig. 29). Turn the cable boot 1/2 turn and pull straight back in a steady motion. Never pull directly on the cable. Internal damage to cable will result.

(5) Inspect spark plug condition. Refer to Spark Plug Conditions.

CLEANING

The plugs may be cleaned using commercially available spark plug cleaning equipment. After cleaning, file center electrode flat with a small point file or jewelers file before adjusting gap.

CAUTION: Never use a motorized wire wheel brush to clean spark plugs. Metallic deposits will remain on spark plug insulator and will cause plug misfire.

INSTALLATION

CAUTION: The 4.7L V-8 engine is equipped with copper core ground electrode spark plugs. They must be replaced with the same type/number spark plug as the original. If another spark plug is substituted, pre-ignition will result.

Special care should be taken when installing spark plugs into the cylinder head spark plug wells. Be sure the plugs do not drop into the plug wells as electrodes can be damaged.

Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap or a cracked porcelain insulator.

Except 4.7L Engine: When replacing the spark plug and ignition coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise. It could cause cross ignition of the spark plugs or short circuit the cables to ground.

SPARK PLUG (Continued)

(1) Start the spark plug into the cylinder head by hand to avoid cross threading.

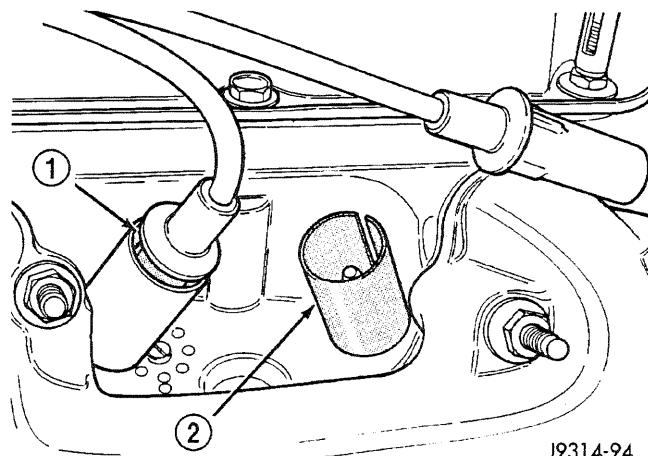
(2) Except 4.7L Engine: Tighten spark plugs to 35-41 N·m (26-30 ft. lbs.) torque.

(3) Except 4.7L Engine: Install spark plug cables over spark plugs.

(4) 4.7L V-8 Engine: Tighten spark plugs to 27 N·m (20 ft. lbs.) torque.

(5) 4.7L V-8 Engine: Before installing coil(s), check condition of coil o-ring and replace as necessary. To aid in coil installation, apply silicone to coil o-ring.

(6) 4.7L V-8 Engine: Install ignition coil(s). Refer to Ignition Coil Removal/Installation.



J9314-94

Fig. 28 Heat Shields—3.9/5.2/5.9L Engines

- 1 - AIR GAP
2 - SPARK PLUG BOOT HEAT SHIELD

SPARK PLUG CABLE

DESCRIPTION

Spark plug cables are sometimes referred to as secondary ignition wires.

OPERATION

The spark plug cables transfer electrical current from the ignition coil(s) and/or distributor, to individual spark plugs at each cylinder. The resistive spark plug cables are of nonmetallic construction. The cables provide suppression of radio frequency emissions from the ignition system.

DIAGNOSIS AND TESTING - SPARK PLUG CABLES

Check the spark plug cable connections for good contact at the coil(s), distributor cap towers, and spark plugs. Terminals should be fully seated. The insulators should be in good condition and should fit tightly on the coil, distributor and spark plugs. Spark plug cables with insulators that are cracked or torn must be replaced.

Clean high voltage ignition cables with a cloth moistened with a non-flammable solvent. Wipe the cables dry. Check for brittle or cracked insulation.

On 3.9L V-6 and 5.2/5.9L V-8 engines, spark plug cable heat shields are pressed into the cylinder head to surround each spark plug cable boot and spark plug (Fig. 28). These shields protect the spark plug boots from damage (due to intense engine heat generated by the exhaust manifolds) and should not be removed. After the spark plug cable has been installed, the lip of the cable boot should have a small air gap to the top of the heat shield (Fig. 28).

TESTING

When testing secondary cables for damage with an oscilloscope, follow the instructions of the equipment manufacturer.

If an oscilloscope is not available, spark plug cables may be tested as follows:

CAUTION: Do not leave any one spark plug cable disconnected for longer than necessary during testing. This may cause possible heat damage to the catalytic converter. Total test time must not exceed ten minutes.

With the engine running, remove spark plug cable from spark plug (one at a time) and hold next to a good engine ground. If the cable and spark plug are in good condition, the engine rpm should drop and the engine will run poorly. If engine rpm does not drop, the cable and/or spark plug may not be operating properly and should be replaced. Also check engine cylinder compression.

With the engine not running, connect one end of a test probe to a good ground. Start the engine and run the other end of the test probe along the entire length of all spark plug cables. If cables are cracked or punctured, there will be a noticeable spark jump from the damaged area to the test probe. The cable running from the ignition coil to the distributor cap can be checked in the same manner. Cracked, damaged or faulty cables should be replaced with resistance type cable. This can be identified by the words ELECTRONIC SUPPRESSION printed on the cable jacket.

SPARK PLUG CABLE (Continued)

Use an ohmmeter to test for open circuits, excessive resistance or loose terminals. If equipped, remove the distributor cap from the distributor. **Do not remove cables from cap.** Remove cable from spark plug. Connect ohmmeter to spark plug terminal end of cable and to corresponding electrode in distributor cap. Resistance should be 250 to 1000 Ohms per inch of cable. If not, remove cable from distributor cap tower and connect ohmmeter to the terminal ends of cable. If resistance is not within specifications as found in the SPARK PLUG CABLE RESISTANCE chart, replace the cable. Test all spark plug cables in this manner.

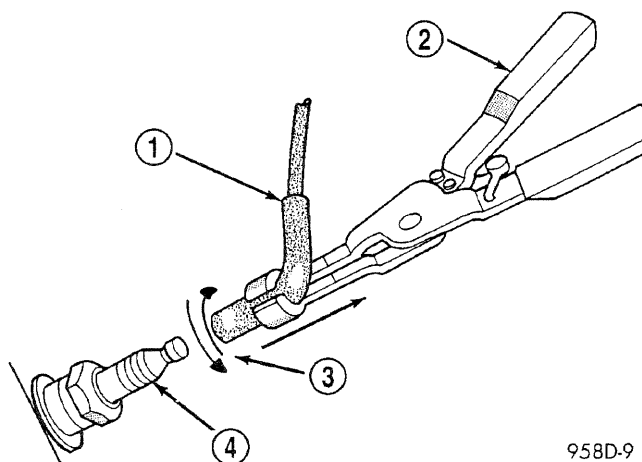
SPARK PLUG CABLE RESISTANCE

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

To test ignition coil-to-distributor cap cable, do not remove the cable from the cap. Connect ohmmeter to rotor button (center contact) of distributor cap and terminal at ignition coil end of cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, remove the cable from the distributor cap. Connect the ohmmeter to the terminal ends of the cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, replace the cable. Inspect the ignition coil tower for cracks, burns or corrosion.

REMOVAL

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 29). Grasp the boot (not the cable) and pull it off with a steady, even force.



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Fig. 29 Cable Removal

- 1 - SPARK PLUG CABLE AND BOOT
- 2 - SPARK PLUG BOOT PULLER
- 3 - TWIST AND PULL
- 4 - SPARK PLUG

Install cables into the proper engine cylinder firing order. Refer to Firing Order in Specifications.

INSTALLATION

Install cables into the proper engine cylinder firing order. Refer to Firing Order in Specifications.

When replacing the spark plug and coil cables, route the cables correctly and secure in the proper retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise. It could also cause cross ignition of the plugs or short circuit the cables to ground.

When installing new cables, make sure a positive connection is made. A snap should be felt when a good connection is made between the plug cable and the distributor cap tower.

ENGINE

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ENGINE 3.9L

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ENGINE 3.9L

DESCRIPTION

The 3.9 Liter (238 CID) six-cylinder engine is a V-Type, lightweight, single cam, overhead valve engine with hydraulic roller tappets. This engine is designed to use unleaded fuel.

The engine lubrication system consists of a rotor type oil pump and a full-flow oil filter.

The cylinders are numbered from front to rear; 1, 3, 5 on the left bank and 2, 4, 6 on the right bank. The firing order is 1-6-5-4-3-2 (Fig. 1).

The engine serial number is stamped into a machined pad located on the left front corner of the cylinder block. When component part replacement is necessary, use the engine type and serial number for reference (Fig. 2).

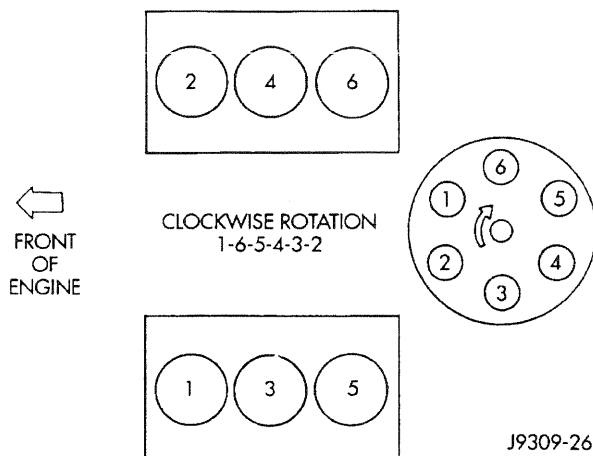


Fig. 1 Firing Order

X M AAA YYYY 0000

X = Last Digit of Model Year

M = Plant-M Mound Road

S Saltillo

T Trenton

K Toluca

AAA = Engine Displacement (CID)

YYYY = Month/Day

0000 = Engine Serial Code

80bbd9ce

Fig. 2 Engine Identification (Serial) Number

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING - ENGINE DIAGNOSIS - INTRODUCTION

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

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

(Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Performance) or (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING - Mechanical). Refer to 14 - FUEL SYSTEM for fuel system diagnosis.

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

- Cylinder Compression Pressure Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Combustion Pressure Leakage Test (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
- Cylinder Head Gasket Failure Diagnosis (Refer to 9 - ENGINE/CYLINDER HEAD - DIAGNOSIS AND TESTING)
- Intake Manifold Leakage Diagnosis (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING)
- Lash Adjuster (Tappet) Noise Diagnosis (Refer to 9 - ENGINE/ENGINE BLOCK/HYDRAULIC LIFTERS (CAM IN BLOCK) - DIAGNOSIS AND TESTING)
- Engine Oil Leak Inspection (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)

ENGINE 3.9L (Continued)**DIAGNOSIS AND TESTING—ENGINE DIAGNOSIS - PERFORMANCE****PERFORMANCE DIAGNOSIS CHART—GASOLINE ENGINES**

CONDITION	POSSIBLE CAUSES	CORRECTION
ENGINE WILL NOT CRANK	<ol style="list-style-type: none"> 1. Weak or dead battery 2. Corroded or loose battery connections 3. Faulty starter or related circuit(s) 4. Seized accessory drive component 5. Engine internal mechanical failure or hydro-static lock 	<ol style="list-style-type: none"> 1. Charge/Replace Battery. (Refer to 8 - ELECTRICAL/BATTERY SYSTEM/ BATTERY - STANDARD PROCEDURE). Check charging system. (Refer to 8 - ELECTRICAL/CHARGING - DIAGNOSIS AND TESTING). 2. Clean/tighten suspect battery/starter connections 3. Check starting system. (Refer to 8 - ELECTRICAL/STARTING - DIAGNOSIS AND TESTING) 4. Remove accessory drive belt and attempt to start engine. if engine starts, repair/replace seized component. 5. Refer to (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING)
ENGINE CRANKS BUT WILL NOT START	<ol style="list-style-type: none"> 1. No spark 2. No fuel 3. Low or no engine compression 	<ol style="list-style-type: none"> 1. Check for spark. (Refer to 8 - ELECTRICAL/IGNITION CONTROL - DESCRIPTION) 2. Perform fuel pressure test, and if necessary, inspect fuel injector(s) and driver circuits. (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/FUEL PUMP - DIAGNOSIS AND TESTING). 3. Perform cylinder compression pressure test. (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING).
ENGINE LOSS OF POWER	<ol style="list-style-type: none"> 1. Worn or burned distributor rotor 2. Worn distributor shaft 3. Worn or incorrect gapped spark plugs 4. Dirt or water in fuel system 5. Faulty fuel pump 6. Incorrect valve timing 7. Blown cylinder head gasket 8. Low compression 9. Burned, warped, or pitted valves 	<ol style="list-style-type: none"> 1. Install new distributor rotor 2. Remove and repair distributor (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ DISTRIBUTOR - REMOVAL). 3. Clean plugs and set gap. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/ SPARK PLUG - CLEANING). 4. Clean system and replace fuel filter 5. Install new fuel pump 6. Correct valve timing 7. Install new cylinder head gasket 8. Test cylinder compression (Refer to 9 - ENGINE - DIAGNOSIS AND TESTING). 9. Install/Reface valves as necessary

ENGINE 3.9L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	10. Plugged or restricted exhaust system 11. Faulty ignition cables 12. Faulty ignition coil	10. Install new parts as necessary 11. Replace any cracked or shorted cables 12. Test and replace, as necessary (Refer to 8 - ELECTRICAL/IGNITION CONTROL/IGNITION COIL - REMOVAL).
ENGINE STALLS OR ROUGH IDLE	1. Carbon build-up on throttle plate 2. Engine idle speed too low 3. Worn or incorrectly gapped spark plugs 4. Worn or burned distributor rotor 5. Spark plug cables defective or crossed 6. Faulty coil 7. Intake manifold vacuum leak	1. Remove throttle body and de-carbon. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - REMOVAL). 2. Check Idle Air Control circuit. (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/IDLE AIR CONTROL MOTOR - DESCRIPTION) 3. Replace or clean and re-gap spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - CLEANING) 4. Install new distributor rotor 5. Check for correct firing order or replace spark plug cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG CABLE - DIAGNOSIS AND TESTING) 6. Test and replace, if necessary (Refer to 8 - ELECTRICAL/IGNITION CONTROL/IGNITION COIL - REMOVAL) 7. Inspect intake manifold gasket and vacuum hoses (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - DIAGNOSIS AND TESTING).
ENGINE MISSES ON ACCELERATION	1. Worn or incorrectly gapped spark plugs 2. Spark plug cables defective or crossed 3. Dirt in fuel system 4. Burned, warped or pitted valves 5. Faulty coil	1. Replace spark plugs or clean and set gap. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - CLEANING) 2. Replace or rewire secondary ignition cables. (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG CABLE - REMOVAL) 3. Clean fuel system 4. Install new valves 5. Test and replace as necessary (Refer to 8 - ELECTRICAL/IGNITION CONTROL/IGNITION COIL - REMOVAL)

ENGINE 3.9L (Continued)**DIAGNOSIS AND TESTING— ENGINE DIAGNOSIS - MECHANICAL****ENGINE MECHANICAL DIAGNOSIS CHART**

CONDITION	POSSIBLE CAUSES	CORRECTION
NOISY VALVES/LIFTERS	<ol style="list-style-type: none"> 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 rod(s) 6. Worn rocker arms 7. Worn tappets/lash adjusters 8. Worn valve guides 9. Excessive runout of valve seats or valve faces 	<ol style="list-style-type: none"> 1. Check for correct oil level. Adjust oil level by draining or adding as needed 2. Change oil. (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE) 3. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) for engine oil pressure test/specifications 4. Clean/replace hydraulic tappets/lash adjusters 5. Install new push rods 6. Inspect oil supply to rocker arms and replace worn arms as needed 7. Install new hydraulic tappets/lash adjusters 8. Inspect all valve guides and replace as necessary 9. Grind valves and seats
CONNECTING ROD NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply 2. Low oil pressure 3. Thin or diluted oil 4. Excessive connecting rod bearing clearance 5. Connecting rod journal out of round 6. Misaligned connecting rods 	<ol style="list-style-type: none"> 1. Check engine oil level. 2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) engine oil pressure test/specifications 3. Change oil to correct viscosity. (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE) for correct procedure/engine oil specifications 4. Measure bearings for correct clearance with plasti-gage. Repair as necessary 5. Replace crankshaft or grind journals 6. Replace bent connecting rods
MAIN BEARING NOISE	<ol style="list-style-type: none"> 1. Insufficient oil supply 2. Low oil pressure 3. Thin or diluted oil 4. Excessive main bearing clearance 	<ol style="list-style-type: none"> 1. Check engine oil level. 2. Check engine oil level. If ok, Perform oil pressure test. (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING) 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair as necessary

ENGINE 3.9L (Continued)

CONDITION	POSSIBLE CAUSES	CORRECTION
	5. Excessive end play 6. Crankshaft main journal out of round or worn 7. Loose flywheel or torque converter	5. Check crankshaft thrust bearing for excessive wear on flanges 6. Grind journals or replace crankshaft 7. Inspect crankshaft, flexplate/flywheel and bolts for damage. Tighten to correct torque
LOW OIL PRESSURE	1. Low oil level 2. Faulty oil pressure sending unit 3. Clogged oil filter 4. Worn oil pump 5. Thin or diluted oil 6. Excessive bearing clearance 7. Oil pump relief valve stuck 8. Oil pump suction tube loose, broken, bent or clogged 9. Oil pump cover warped or cracked	1. Check oil level and fill if necessary 2. Install new sending unit 3. Install new oil filter 4. Replace oil pump assembly. 5. Change oil to correct viscosity. 6. Measure bearings for correct clearance 7. Remove valve to inspect, clean and reinstall 8. Inspect suction tube and clean or replace if necessary 9. Install new oil pump
OIL LEAKS	1. Misaligned or deteriorated gaskets 2. Loose fastener, broken or porous metal part 3. Front or rear crankshaft oil seal leaking 4. Leaking oil gallery plug or cup plug	1. Replace gasket 2. Tighten, repair or replace the part 3. Replace seal 4. Remove and reseal threaded plug. Replace cup style plug
EXCESSIVE OIL CONSUMPTION OR SPARK PLUGS OIL FOULED	1. CCV System malfunction 2. Defective valve stem seal(s) 3. Worn or broken piston rings 4. Scuffed pistons/cylinder walls 5. Carbon in oil control ring groove 6. Worn valve guides 7. Piston rings fitted too tightly in grooves	1. (Refer to 25 - EMISSIONS CONTROL/ EVAPORATIVE EMISSIONS - DESCRIPTION) for correct operation 2. Repair or replace seal(s) 3. Hone cylinder bores. Install new rings 4. Hone cylinder bores and replace pistons as required 5. Remove rings and de-carbon piston 6. Inspect/replace valve guides as necessary 7. Remove rings and check ring end gap and side clearance. Replace if necessary

ENGINE 3.9L (Continued)**DIAGNOSIS AND TESTING—ENGINE DIAGNOSIS - LUBRICATION**

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	<ol style="list-style-type: none"> 1. Gaskets and O-Rings. <ol style="list-style-type: none"> (a) Misaligned or damaged. (b) Loose fasteners, broken or porous metal parts. 2. Crankshaft rear seal 3. Crankshaft seal flange. Scratched, nicked or grooved. 4. Oil pan flange cracked. 5. Timing chain cover seal, damaged or misaligned. 6. Scratched or damaged vibration damper hub. 	<ol style="list-style-type: none"> 1. <ol style="list-style-type: none"> (a) Replace as necessary. (b) Tighten fasteners, Repair or replace metal parts. 2. Replace as necessary. 3. Polish or replace crankshaft. 4. Replace oil pan. 5. Replace seal. 6. Polish or replace damper.
OIL PRESSURE DROP	<ol style="list-style-type: none"> 1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Worn oil pump. 6. Thin or diluted oil. 7. Excessive bearing clearance. 8. Oil pump relief valve stuck. 9. Oil pump suction tube loose or damaged. 	<ol style="list-style-type: none"> 1. Check and correct oil level. 2. Replace sending unit. 3. Check pump and bearing clearance. 4. Replace oil filter. 5. Replace as necessary. 6. Change oil and filter. 7. Replace as necessary. 8. Clean or replace relief valve. 9. Replace as necessary.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	<ol style="list-style-type: none"> 1. Worn or damaged rings. 2. Carbon in oil ring slots. 3. Incorrect ring size installed. 4. Worn valve guides. 5. Leaking intake gasket. 6. Leaking valve guide seals. 	<ol style="list-style-type: none"> 1. Hone cylinder bores and replace rings. 2. Replace rings. 3. Replace rings. 4. Ream guides and replace valves. 5. Replace intake gaskets. 6. Replace valve guide seals.

DIAGNOSIS AND TESTING—CYLINDER COMPRESSION PRESSURE

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

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

(1) Clean the spark plug recesses with compressed air.

(2) Remove the spark plugs (Refer to 8 - ELECTRICAL/IGNITION CONTROL/SPARK PLUG - REMOVAL).

(3) Secure the throttle in the wide-open position.

(4) Disconnect the ignition coil.

(5) Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.

(6) Record the compression pressure on the third revolution. Continue the test for the remaining cylinders.

ENGINE 3.9L (Continued)

(Refer to 9 - ENGINE - SPECIFICATIONS) for the correct engine compression pressures.

DIAGNOSIS AND TESTING - CYLINDER COMBUSTION PRESSURE LEAKAGE

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

Combustion pressure leakage testing will detect:

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

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

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

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

Remove the spark plugs.

Remove the oil filler cap.

Remove the air cleaner.

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

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

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

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

CYLINDER COMBUSTION PRESSURE LEAKAGE DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	CORRECTION
AIR ESCAPES THROUGH THROTTLE BODY	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH TAILPIPE	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary
AIR ESCAPES THROUGH RADIATOR	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
MORE THAN 50% LEAKAGE FROM ADJACENT CYLINDERS	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	Remove cylinder head and inspect. Replace gasket, head, or block as necessary
MORE THAN 25% LEAKAGE AND AIR ESCAPES THROUGH OIL FILLER CAP OPENING ONLY	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper and out-of-round. Replace defective part as necessary

STANDARD PROCEDURE

STANDARD PROCEDURE - CYLINDER BORE HONING

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

(1) Used carefully, the Cylinder Bore Sizing 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 and scratches. Usually, a few strokes

will clean up a bore and maintain the required limits.

CAUTION: DO NOT use rigid type hones to remove cylinder wall glaze.

(2) Deglazing of the cylinder walls may be done if the cylinder bore is straight and round. Use a cylinder surfacing hone, Honing Tool C-3501, equipped with 280 grit stones (C-3501-3810), about 20-60 strokes, depending on the bore condition, will be sufficient to provide a satisfactory surface. Using honing oil C-3501-3880, or a light honing oil, available from major oil distributors.

ENGINE 3.9L (Continued)

CAUTION: 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 crosshatch pattern. The hone marks should **INTERSECT** at 40° to 60° for proper seating of rings (Fig. 3).

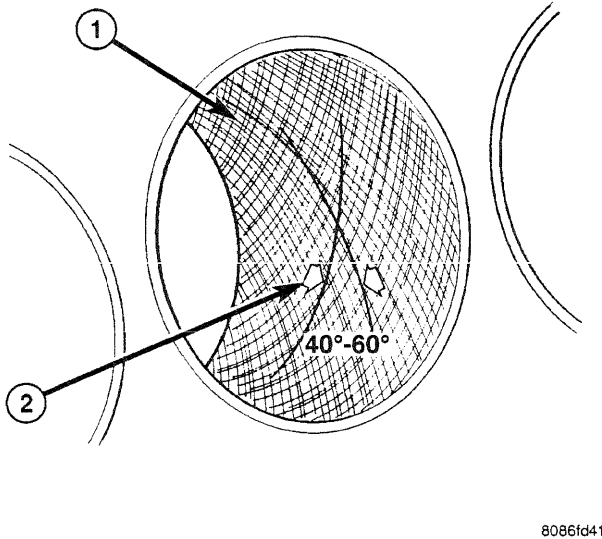


Fig. 3 Cylinder Bore Crosshatch Pattern

1 - CROSSHATCH PATTERN
2 - INTERSECT ANGLE

(4) A controlled hone motor speed between 200 and 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 40° to 60° angle. Faster up and down strokes increase the cross-hatch angle.

(5) After honing, it is necessary that the block be cleaned to remove all traces of abrasive. Use a brush to wash parts with a solution of hot water and detergent. Dry parts thoroughly. Use a clean, white, lint-free cloth to check that the bore is clean. Oil the bores after cleaning to prevent rusting.

STANDARD PROCEDURE - ENGINE GASKET SURFACE PREPARATION

To ensure engine gasket sealing, proper surface preparation must be performed.

Never use the following to clean gasket surfaces:

- Metal scraper
- Abrasive pad or paper to clean cylinder block and head
- High speed power tool with an abrasive pad or a wire brush (Fig. 4)

Only use the following for cleaning gasket surfaces:

- Solvent or a commercially available gasket remover

- Plastic or wood scraper (Fig. 4)
- Drill motor with 3M Roloc™ Bristle Disc (white or yellow) (Fig. 4)

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

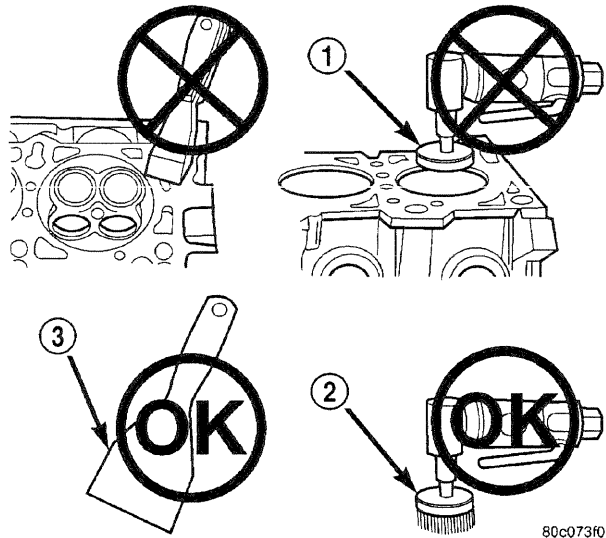


Fig. 4 Proper Tool Usage For Surface Preparation

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

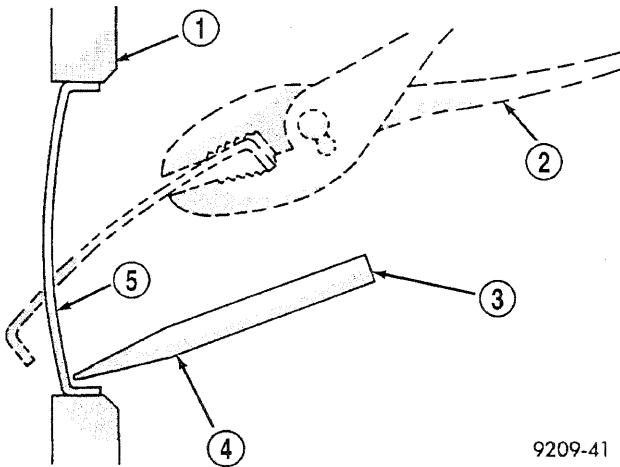
STANDARD PROCEDURE - ENGINE CORE AND OIL GALLERY PLUGS

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. 5).

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

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

ENGINE 3.9L (Continued)



9209-41

Fig. 5 Core Hole Plug Removal

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

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

STANDARD PROCEDURE—HYDROSTATIC LOCK

CAUTION: DO NOT use the starter motor to rotate the crankshaft. Severe damage could occur.

When an engine is suspected of hydrostatic lock (regardless of what caused the problem), follow the steps below.

- (1) Perform the Fuel Pressure Release Procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).
- (2) Disconnect the negative cable(s) from the battery.
- (3) Inspect air cleaner, induction system, and intake manifold to ensure system is dry and clear of foreign material.
- (4) Place a shop towel around the spark plugs to catch any fluid that may possibly be under pressure in the cylinder head. Remove the spark plugs.
- (5) With all spark plugs removed, rotate the crankshaft using a breaker bar and socket.
- (6) Identify the fluid in the cylinders (coolant, fuel, oil, etc.).
- (7) Be sure all fluid has been removed from the cylinders.
- (8) Repair engine or components as necessary to prevent this problem from occurring again.
- (9) Squirt a small amount of engine oil into the cylinders to lubricate the walls. This will prevent damage on restart.

(10) Install new spark plugs. Tighten the spark plugs to 41 N·m (30 ft. lbs.) torque.

(11) Drain engine oil. Remove and discard the oil filter.

(12) Install the drain plug. Tighten the plug to 34 N·m (25 ft. lbs.) torque.

(13) Install a new oil filter.

(14) Fill engine crankcase with the specified amount and grade of oil. (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).

(15) Connect the negative cable(s) to the battery.

(16) Start the engine and check for any leaks.

STANDARD PROCEDURE - REPAIR DAMAGED OR WORN THREADS

CAUTION: Be sure that the tapped holes maintain the original center line.

Damaged or worn threads can be repaired. Essentially, this repair consists of:

- Drilling out worn or damaged threads.
- Tapping the hole with a special Heli-Coil Tap, or equivalent.
- Installing an insert into the tapped hole to bring the hole back to its original thread size.

STANDARD PROCEDURE - FORM-IN-PLACE GASKETS AND SEALERS

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

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

MOPAR® ENGINE RTV GEN II

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

ENGINE 3.9L (Continued)**MOPAR® ATF RTV**

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

MOPAR® GASKET MAKER

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

MOPAR® GASKET SEALANT

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

FORM-IN-PLACE GASKET AND SEALER APPLICATION

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

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

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

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

REMOVAL

(1) Scribe hood hinge outlines on hood. Remove the hood.

(2) Remove the battery.

(3) Drain cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE).

(4) Remove the air cleaner, air in-let hose and resonator assembly.

(5) Disconnect the radiator and heater hoses. Remove radiator. (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).

(6) Disconnect the vacuum lines from the intake manifold.

(7) Remove the distributor cap and wiring.

(8) Disconnect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - REMOVAL).

(9) Remove throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - REMOVAL).

(10) Perform the Fuel System Pressure Release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).

(11) Disconnect the starter wires.

(12) Disconnect the oil pressure wire.

(13) Discharge the air conditioning system, if equipped. (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/REFRIGERANT - STANDARD PROCEDURE).

(14) Disconnect the air conditioning hoses.

(15) Disconnect the power steering hoses, if equipped.

(16) Remove starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - REMOVAL).

(17) Remove the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).

(18) Raise and support the vehicle on a hoist.

(19) Disconnect exhaust pipe at manifolds.

(20) Remove Transmission. Refer to 21 - TRANSMISSION AND TRANSFER CASE.

CAUTION: DO NOT lift the engine by the intake manifold.

(21) Install an engine lifting fixture.

(22) **2WD VEHICLES**—Remove engine front mount bolts.

ENGINE 3.9L (Continued)

(23) **4WD VEHICLES**—The engine and front driving axle (engine/axle/transmission) are connected through insulators and support brackets. Separate the engine as follows:

- **LEFT SIDE**—Remove 2 bolts attaching (engine/pinion nose/transmission) bracket to transmission bell housing. Remove 2 bracket to pinion nose adaptor bolts. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.

- **RIGHT SIDE**—Remove 2 bracket to axle (disconnect housing) bolts and 1 bracket to bell housing bolt. Separate engine from insulator by removing upper nut washer assembly and bolt from engine support bracket.

(24) Lower the vehicle.

(25) On automatic transmission vehicles, disconnect the engine from the torque converter drive plate. On manual transmission vehicles, move engine forward until drive pinion shaft clears the clutch disc. Remove engine from engine compartment.

(26) Install engine assembly on engine repair stand.

INSTALLATION

(1) Remove engine from the repair stand and position in the engine compartment.

(2) Install an engine support fixture.

(3) Raise and support the vehicle on a hoist.

(4) Install transmission.

(5) Install the front engine mounts (Refer to 9 - ENGINE/ENGINE MOUNTING/FRONT MOUNT - INSTALLATION).

(6) Install exhaust pipe to manifold.

(7) Lower the vehicle.

(8) Remove engine lifting fixture.

(9) Install the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION).

(10) Install starter motor (Refer to 8 - ELECTRICAL/STARTING/STARTER MOTOR - INSTALLATION).

(11) Connect power steering hoses, if equipped.

(12) Connect air conditioning hoses.

(13) Evacuate and charge the air conditioning system, if equipped (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/REFRIGERANT - STANDARD PROCEDURE).

(14) Using a new gasket, install throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - INSTALLATION).

(15) Connect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - INSTALLATION).

(16) Connect the starter wires.

(17) Connect the oil pressure sensor wire.

(18) Install the distributor cap and wiring.

(19) Connect the vacuum lines.

(20) Connect the fuel supply line (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(21) Install the radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION). Connect the radiator hoses and heater hoses.

(22) Install fan shroud in position.

(23) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(24) Install the air cleaner, resonator assembly and air in-let hose. Tighten clamps to 4 N·m (35 in. lbs.).

(25) Install the battery.

(26) Warm engine and adjust.

(27) Install hood and line up with the scribe marks.

(28) Road test vehicle.

SPECIFICATIONS

TORQUE

TORQUE CHART 3.9L ENGINE

DESCRIPTION	N·m	In. Lbs.	Ft. Lbs.
Camshaft Sprocket Bolt	68	—	50
Camshaft Thrust Plate Bolts	24	210	—
Timing Chain Case Cover Bolts	41	—	30
Connecting Rod Cap Bolts	61	—	45
Main Bearing Cap Bolts	115	—	85
Crankshaft Pulley Bolts	24	210	—
Cylinder Head—Bolts			
Step 1	68	—	50
Step 2	143	—	105
Cylinder Head Cover Bolts	11	95	—
Engine Support Bracket to Block (4wd)—Bolts	41	—	30
Exhaust Manifold to CylinderHead—bolts/nuts	34	—	25
Flywheel Bolts	75	—	55
Front Insulator through Bolts	95	—	70
Front Insulator to Support Bracket (4wd)			
Stud Nut	41	—	30

ENGINE 3.9L (Continued)

DESCRIPTION	N·m	In. Lbs.	Ft. Lbs.
Through Bolt/Nut	102	—	75
Front Insulator to Block Bolts (2wd)	95	—	70
Generator Mounting Bolt	41	—	30
Intake Manifold Bolts	Refer to Procedure		
Oil Pan Bolts	24	215	—
Oil Pan Drain Plug	34	—	25
Oil Pump Mounting Bolts	41	—	30
Oil Pump Cover Bolts	11	95	—
Rear Insulator to Bracket through-Bolt (2WD)	68	—	50
Rear Insulator to Crossmember Support Bracket Nut (2WD)	41	—	30
Rear Insulator to Crossmember Bolts (4WD)	68	—	50
Rear Insulator to Transmission Bolts (4WD)	68	—	50
Rear Insulator Bracket Bolts (4WD Automatic)	68	—	50
Rear Support Bracket to Crossmember Flange Nuts	41	—	30
Rear Support Plate to Transfer Case Bolts	41	—	30
Rocker Arm Bolts	28	—	21
Spark Plugs	41	—	30
Starter Motor Mounting Bolts	68	—	50
Thermostat Housing Bolts	25	225	—
Throttle Body Bolts	23	200	—
Torque Converter Drive Plate Bolts	31	270	—
Transfer Case to Insulator Mounting Plate Nuts	204	—	150
Transmission Support Bracket Bolts (2WD)	68	—	50
Vibration Damper Bolt	183	—	135
Water Pump to Timing Chain Case Cover Bolts	41	—	30

3.9L ENGINE**GENERAL DESCRIPTION**

DESCRIPTION	SPECIFICATION
Engine Type	90° V-6 OHV
Bore and Stroke	99.3 x 84.0 mm (3.91 x 3.31 in.)
Displacement	3.9L (238 c.i.)
Compression Ratio	9.1:1
Firing Order	1-6-5-4-3-2
Cylinder Compression Pressure (Min.)	689.5 kPa (100 psi)
CAMSHAFT	
Bearing Diameter (Inside)	
No. 1	50.800 - 50.825 mm (2.000 - 2.001 in.)
No. 2	50.394 - 50.825 mm (1.984 - 1.985 in.)
No. 3	49.606 - 49.632 mm (1.953 - 1.954 in.)
No. 4	39.688 - 39.713 mm (1.5265 - 1.5653 in.)
Journal Diameter	
No. 1	50.749 - 50.775 mm (1.998 - 1.999 in.)
No. 2	50.343 - 50.368 mm (1.982 - 1.983 in.)
No. 3	49.555 - 49.581 mm (1.951 - 1.952 in.)
No. 4	39.637 - 39.662 mm (1.5605 - 1.5615 in.)
Bearing to Journal Clearance	
Standard	0.0254 - 0.0762 mm (0.001 - 0.003 in.)
Max Allowable	0.127 mm (0.005 in.)
End Play	0.051 - 0.254 mm (0.002 - 0.010 in.)

ENGINE 3.9L (Continued)

DESCRIPTION	SPECIFICATION
CONNECTING RODS	
Piston Pin Bore Diameter	24.940 - 24.978 mm (0.9819 - 0.9834 in.)
Side Clearance (Two Rods)	0.152 - 0.356 mm (0.006 - 0.014 in.)
Total Weight	762 grams (25.61 oz.)
CRANKSHAFT	
Rod Journal Diameter	53.950 - 53.975 mm (2.124 - 2.125 in.)
Rod Journal Out of Round (Max)	0.0254 mm (0.001 in.)
Rod Journal Taper (Max)	0.0254 mm (0.001 in.)
Rod Journal Bearing Clearance	0.013 - 0.056 mm (0.0005 - 0.0022 in.)
Rod Journal Service Limit	0.08 mm (0.003 in.)
Main Journal Diameter	63.487 - 63.513 mm (2.4995 - 2.5005 in.)
Main Journal Out of Round (Max)	0.0254 mm (0.001 in.)
Main Journal Taper (Max)	0.0254 mm (0.001 in.)
Main Journal Bearing Clearance No. 1	0.013 - 0.038 mm (0.0005 - 0.0015 in.)
No. 2 - 4	0.013 - 0.051 mm (0.0005 - 0.0020 in.)

DESCRIPTION	SPECIFICATION
Service Limit	0.064 mm (0.0025 in.)
End Play	0.051 - 0.178 mm (0.002 - 0.007 in.)
End Play Service Limit	0.254 mm (0.010 in.)
CYLINDER BLOCK	
Cylinder Bore Diameter	99.308 - 99.371 mm (3.9098 - 3.9122 in.)
Cylinder Bore Out of Round and taper (Max)	0.025 mm (0.001 in.)
Lifter Bore Diameter	22.99 - 23.01 mm (0.9501 - 0.9059 in.)
Distributor Drive Bushing to Bore Interference (Press Fit)	0.0127 - 0.3556 mm (0.0005 - 0.0140 in.)
Distributor Shaft to Bushing Clearance	0.0178 - 0.0686 mm (0.0007 - 0.0027 in.)
CYLINDER HEAD and VALVES	
Valve Seat Angle	44.25° - 44.75°
Valve Seat Runout (Max)	0.0762 mm (0.003 in.)
Valve Seat Width (Finish) Intake	1.016 - 1.542 mm (0.040 - 0.060 in.)
Exhaust	1.524 - 2.032 mm (0.040 - 0.060 in.)
Valve Face Angle	43.25° - 43.75°
Valve Head Diameter Intake	48.666 mm

ENGINE 3.9L (Continued)

DESCRIPTION	SPECIFICATION
Exhaust	(1.916 in.) 41.250 mm (1.624 in.)
Valve Length (Overall)	
Intake	124.28 - 125.92 mm (4.893 - 4.918 in.)
Exhaust	124.64 - 125.27 mm (4.907 - 4.932 in.)
Valve Lift (@ Zero Lash)	10.973 mm (0.432 in.)
Valve Stem Diameter	7.899 - 7.925 mm (0.311 - 0.312 in.)
Valve Guide Bore Diameter	7.950 - 7.976 mm (0.313 - 0.314 in.)
Valve Stem to Guide Clearance	0.0254 - 0.0762 mm (0.001 - 0.003 in.)
Valve Stem to Guide Clearance Service Limit (Rocking Method)	0.4318 mm (0.017 in.)
VALVE SPRINGS	
Free Length	49.962 mm (1.967 in.)
Spring Tension	
Valve Closed	378 N @ 41.66 mm (85 lbs. @ 1.64 in.)
Valve Open	890 N @ 30.89 mm (200 lbs. @ 1.212 in.)
Number of Coils	6.8
Installed Height	41.66 mm (1.64 in.)
Wire Diameter	4.50 mm (0.177 in.)

DESCRIPTION	SPECIFICATION
HYDRAULIC TAPPETS	
Body Diameter	22.949 - 22.962 mm (0.9035 - 0.9040 in.)
Clearance in Block	0.0279 - 0.0610 mm (0.0011 - 0.210 in.)
Dry Lash	1.524 - 5.334 mm (0.060 - 0.210 in.)
Push Rod Length	175.64 - 176.15 mm (6.915 - 6.935 in.)
OIL PRESSURE	
@ Curb Idle (Min.)*	41.4 kPa (6 psi)
@ 3000 rpm	207 - 552 kPa (30 - 80 psi)
Bypass Valve Setting	62 - 103 kPa (9 - 15 psi)
Switch Actuating Pressure	34.5 - 48.3 kPa (5 - 7 psi)
* If oil pressure is zero at curb idle, DO NOT RUN ENGINE.	
OIL PUMP	
Clearance Over Rotors (Max)	0.1016 mm (0.004 in.)
Cover Out of Flat (Max)	0.0381 mm (0.0015 in.)
Inner Rotor Thickness (Min)	20.955 mm (0.825 in.)
Outer Rotor Clearance (Max)	0.3556 mm (0.014 in.)

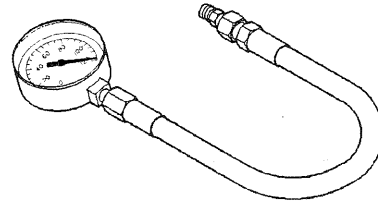
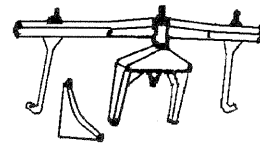
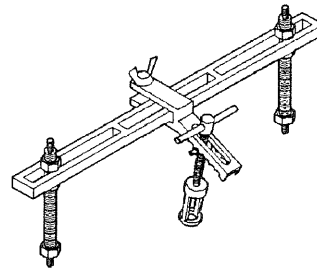
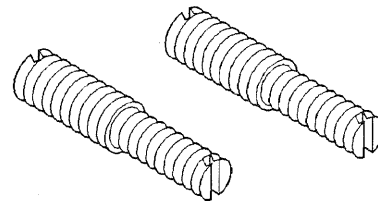
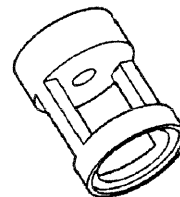
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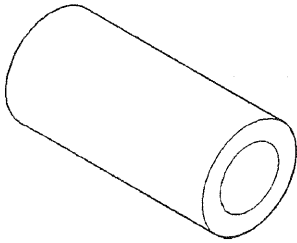
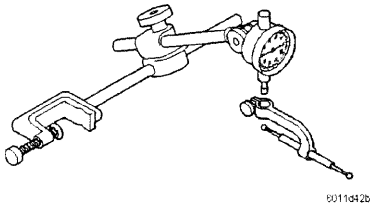
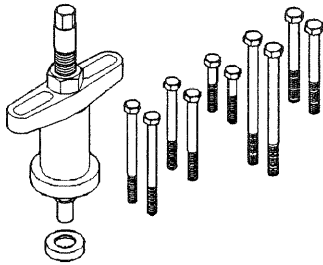
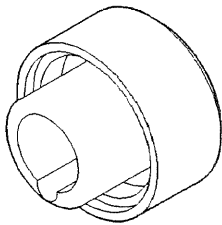
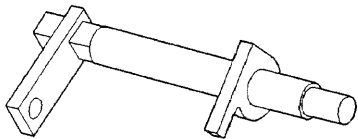
DESCRIPTION	SPECIFICATION
Outer Rotor Diameter (Min)	62.7126 mm (2.469 in.)
Outer Rotor Thickness (Min)	20.955 mm (0.825 in.)
Tip Clearance Between Rotors (Max)	0.2032 mm (0.008 in.)
PISTONS	
Clearance at Top of Skirt	0.0127 - 0.0381 mm (0.0005 - 0.0015 in.)
Land Clearance (Diameter)	0.635 - 1.016 mm (0.025 - 0.040 in.)
Piston Length	86.360 mm (3.40 in.)
Ring Groove Depth #1 & 2	4.572 - 4.826 mm (0.180 - 0.190 in.)
#3	3.810 - 4.064 mm (0.150 - 0.160 in.)
Weight	592.6 - 596.6 grams (20.90 - 21.04 oz.)
PISTON PINS	
Clearance in Piston	0.0064 - 0.0191 mm (0.00025 - 0.00075 in.)
Clearance in Rod (Interference)	0.0178 - 0.0356 mm (0.0007 - 0.0014 in.)
Diameter	24.996 - 25.001 mm (0.9841 - 0.9843 in.)

DESCRIPTION	SPECIFICATION
End Play	None
Length	75.946 - 76.454 mm (2.990 - 3.010 in.)
PISTON RINGS	
Ring Gap Compression Rings	0.254 - 0.508 mm (0.010 - 0.020 in.)
Oil Control (Steel Rails)	0.254 - 1.270 mm (0.010 - 0.050 in.)
Ring Side Clearance Compression Rings	0.038 - 0.076 mm (0.0015 - 0.0030 in.)
Oil Control (Steel Rails)	0.06 - 0.21 mm (0.002 - 0.008 in.)
Ring Width Compression Rings	1.971 - 1.989 mm (0.0776 - 0.0783 in.)
Oil Control (Steel Rails)	3.848 - 3.975 mm (0.1515 - 0.1565 in.)
VALVE TIMING	
Exhaust Valve Closes Opens Duration	16° (ATDC) 52° (BBDC) 248°
Intake Valve Closes Opens Duration	50° (ABDC) 10° (BTDC) 240°
Valve Overlap	26°

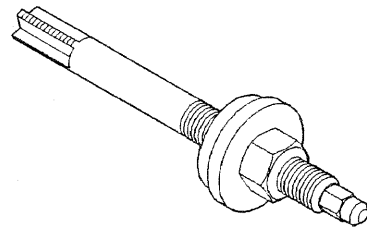
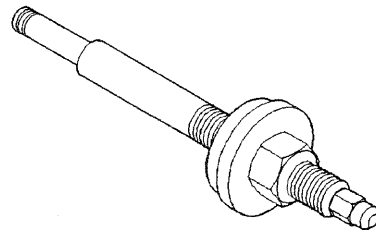
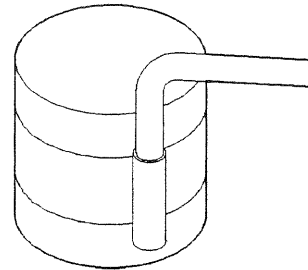
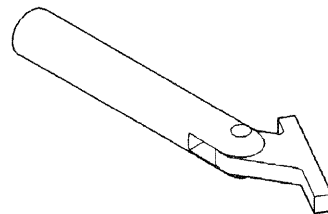
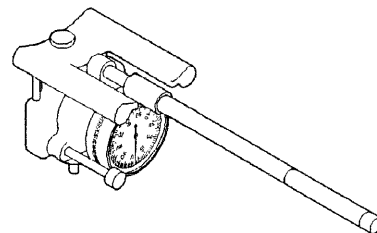
ENGINE 3.9L (Continued)**OVERSIZE AND UNDERSIZE ENGINE
COMPONENT MARKINGS CHART**

OS-US	Item	Identification	Location of Identification
U/S .0254 MM (.001 IN.)	Crankshaft	R or M M-2-3 ect. (indicating No. 2 & 3 main bearing journal) and/or R-1-4 ect. (indicating No. 1 & 4 connecting rod journal)	Milled flat on No. eight crankshaft counterweight.
O/S .2032 mm (.008 in.)	Tappets	◇	3/8" diamound -shaped stamp Top pad — Front of engine and flat ground on outside surface of each O/S tappet bore.
O/S .127 mm (0.005 in.)	Valve Stems	X	Milled pad adjacent to two 3/8" tapped holes on each end of cylinder head.

SPECIAL TOOLS**ENGINE—3.9L****Oil Pressure Gauge C-3292****Engine Support Fixture C-3487-A****Valve Spring Compressor MD-998772-A****Adapter 6633****Adapter 6716A**

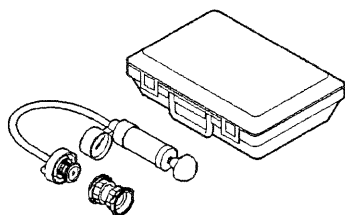
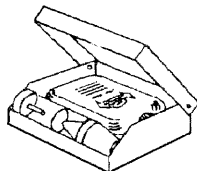
ENGINE 3.9L (Continued)**Valve Guide Sleeve C-3973****Dial Indicator C-3339****Puller C-3688****Front Oil Seal Installer 6635****Camshaft Holder C-3509**

c-3509-90110343

**Distributor Bushing Puller C-3052****Distributor Bushing Driver/Burnisher C-3053****Piston Ring Compressor C-385****Crankshaft Main Bearing Remover C-3059**

9011c9fa

Cylinder Bore Gauge C-119

ENGINE 3.9L (Continued)**Pressure Tester Kit 7700****Bloc-Chek-Kit C-3685-A****AIR CLEANER ELEMENT****REMOVAL**

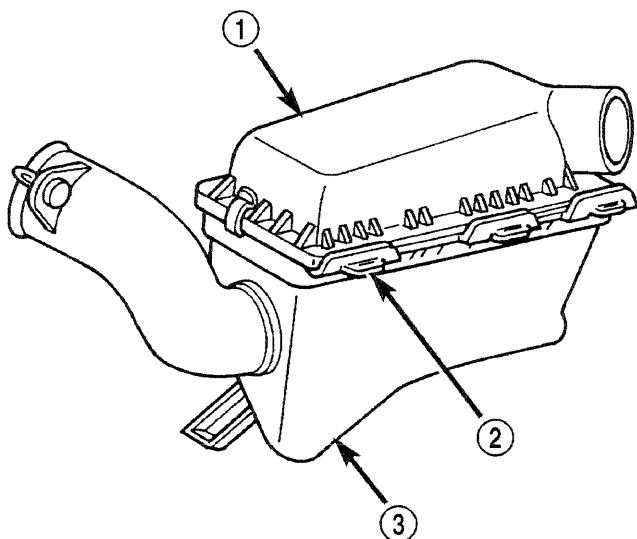
Housing removal is not necessary for element (filter) replacement.

(1) Pry up spring clips from housing cover (spring clips retain cover to housing).

(2) Release housing cover from locating tabs on housing (Fig. 6) and remove cover.

(3) Remove air cleaner element (filter) from housing.

(4) Clean inside of housing before replacing element.

**Fig. 6 Air Cleaner Housing Assembly**

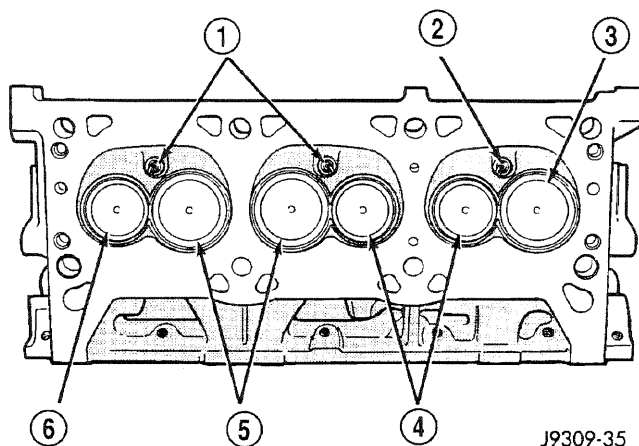
- 1 - AIR CLEANER ELEMENT COVER
- 2 - TABS
- 3 - HOUSING

INSTALLATION

- (1) Install element into housing.
- (2) Position housing cover into housing locating tabs.
- (3) Pry up spring clips and lock cover to housing.

CYLINDER HEAD**DESCRIPTION**

The cast iron cylinder heads (Fig. 7) are mounted to the cylinder block using eight bolts. The spark plugs are located in the peak of the wedge between the valves.

**Fig. 7 Cylinder Head Assembly—3.9L Engine**

- 1 - SPARK PLUGS
- 2 - SPARK PLUG
- 3 - INTAKE VALVE
- 4 - EXHAUST VALVES
- 5 - INTAKE VALVES
- 6 - EXHAUST VALVE

OPERATION

The cylinder head closes the combustion chamber allowing the pistons to compress the air fuel mixture to the correct ratio for ignition. The valves located in the cylinder head open and close to either allow clean air into the combustion chamber or to allow the exhaust gases out, depending on the stroke of the engine.

DIAGNOSIS AND TESTING—CYLINDER HEAD GASKET FAILURE

A cylinder head gasket leak can be located between adjacent cylinders or between a cylinder and the adjacent water jacket.

• Possible indications of the cylinder head gasket leaking between adjacent cylinders are:

- Loss of engine power
- Engine misfiring
- Poor fuel economy

CYLINDER HEAD (Continued)

• Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:

- Engine overheating
- Loss of coolant
- Excessive steam (white smoke) emitting from exhaust
- Coolant foaming

CYLINDER-TO-CYLINDER LEAKAGE TEST

To determine if an engine cylinder head gasket is leaking between adjacent cylinders, follow the procedures in Cylinder Compression Pressure Test in this section. An engine cylinder head gasket leaking between adjacent cylinders will result in approximately a 50–70% reduction in compression pressure.

CYLINDER-TO-WATER JACKET LEAKAGE TEST

WARNING: USE EXTREME CAUTION WHEN THE ENGINE IS OPERATING WITH COOLANT PRESSURE CAP REMOVED.

VISUAL TEST METHOD

With the engine cool, remove the coolant pressure cap. Start the engine and allow it to warm up until thermostat opens.

If a large combustion/compression pressure leak exists, bubbles will be visible in the coolant.

COOLING SYSTEM TESTER METHOD

WARNING: WITH COOLING SYSTEM TESTER IN PLACE, PRESSURE WILL BUILD UP FAST. EXCESSIVE PRESSURE BUILT UP, BY CONTINUOUS ENGINE OPERATION, MUST BE RELEASED TO A SAFE PRESSURE POINT. NEVER PERMIT PRESSURE TO EXCEED 158 kPa (23 psi).

Install Cooling System Tester 7700 or equivalent to pressure cap neck. Start the engine and observe the tester's pressure gauge. If gauge pulsates with every power stroke of a cylinder a combustion pressure leak is evident.

CHEMICAL TEST METHOD

Combustion leaks into the cooling system can also be checked by using Bloc-Chek Kit C-3685-A or equivalent. Perform test following the procedures supplied with the tool kit.

REMOVAL

The alloy cast iron cylinder heads (Fig. 8) are held in place by eight bolts. The spark plugs are located at the peak of the wedge between the valves.

(1) Disconnect the battery negative cable from the battery.

(2) Drain cooling system. (Refer to 7 - COOLING - STANDARD PROCEDURE).

(3) Remove the intake manifold-to-generator bracket support rod. Remove the generator.

(4) Remove closed crankcase ventilation system.

(5) Disconnect the evaporation control system.

(6) Remove the air cleaner, air in-let hose and resonator.

(7) Perform fuel system pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE).

(8) Disconnect the fuel supply line from the fuel rail (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(9) Disconnect accelerator linkage and if so equipped, the speed control and transmission kick-down cables.

(10) Remove distributor cap and wires.

(11) Disconnect the coil wires.

(12) Disconnect coolant temperature sending unit wire.

(13) Disconnect heater hoses and bypass hose.

(14) Disconnect the vacuum supply hoses from the intake manifold.

(15) Disconnect the fuel injector harness and secure out of the way.

(16) Remove cylinder head covers and gaskets (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(17) Remove intake manifold and throttle body as an assembly. Discard the flange side gaskets and the front and rear cross-over gaskets.

(18) Remove exhaust manifolds (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - REMOVAL).

(19) Remove rocker arm assemblies and push rods. Identify to ensure installation in original locations.

(20) Remove the head bolts from each cylinder head and remove cylinder heads. Discard the cylinder head gasket.

(21) Remove spark plugs.

CLEANING

Clean all surfaces of cylinder block and cylinder heads.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

INSPECTION

Inspect all surfaces with a straightedge if there is any reason to suspect leakage. If out-of-flatness exceeds 0.00075mm/mm (0.0001in/in.) times the span

CYLINDER HEAD (Continued)

length in any direction, either replace head or lightly machine the head surface.

FOR EXAMPLE:—A 305 mm (12 in.) span is 0.102 mm (0.004 in.) out-of-flat. The allowable out-of-flat is 305×0.00075 (12 x 0.00075) equals 0.23 mm (0.009 in.). This amount of out-of-flat is acceptable.

The cylinder head surface finish should be 1.78-3.00 microns (70-125 microinches).

Inspect push rods. Replace worn or bent rods.

INSTALLATION

The alloy cast iron cylinder heads (Fig. 8) are held in place by eight bolts. The spark plugs are located at the peak of the wedge between the valves.

(1) Position the new cylinder head gaskets onto the cylinder block.

(2) Position the cylinder heads onto head gaskets and cylinder block.

(3) Starting at top center, tighten all cylinder head bolts, in sequence, to 68 N·m (50 ft. lbs.) torque (Fig. 8). Repeat procedure, tighten all cylinder head bolts to 143 N·m (105 ft. lbs.) torque. Repeat procedure to confirm that all bolts are at 143 N·m (105 ft. lbs.) torque.

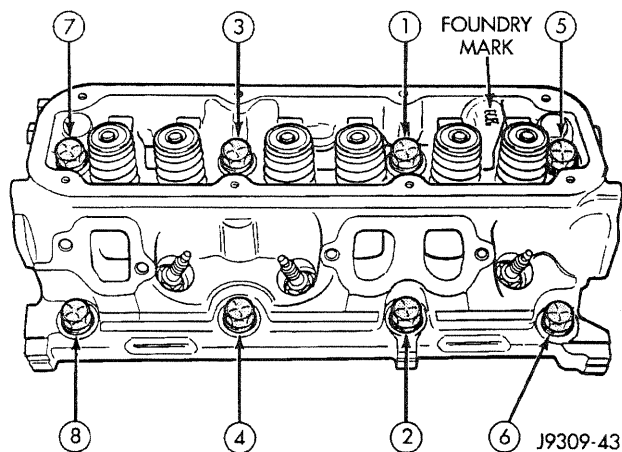


Fig. 8 Cylinder Head Bolt -Tightening Sequence

CAUTION: When tightening the rocker arm bolts, be sure the piston in that cylinder is NOT at TDC. Contact between the valves and piston could occur.

(4) Install push rods and rocker arm assemblies in their original positions. Tighten the bolts to 28 N·m (21 ft. lbs.) torque.

(5) Install the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION) and throttle body assembly.

(6) Install exhaust manifolds (Refer to 9 - ENGINE/MANIFOLDS/EXHAUST MANIFOLD - INSTALLATION).

(7) Adjust spark plugs to specifications. Install the plugs and tighten to 41 N·m (30 ft. lbs.) torque.

(8) Install coil wires.

(9) Connect coolant temperature sending unit wire.

(10) Connect the fuel injector harness.

(11) Connect the vacuum supply hoses to the intake manifold.

(12) Connect the heater hoses and bypass hose.

(13) Install distributor cap and wires.

(14) Connect the accelerator linkage and, if so equipped, the speed control and transmission kick-down cables.

(15) Install the fuel supply line.

(16) Install the generator and accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION). Tighten generator mounting bolt to 41 N·m (30 ft. lbs.) torque.

(17) Install the intake manifold-to-generator bracket support rod. Tighten the bolts.

(18) Install cylinder head covers. (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(19) Install closed crankcase ventilation system.

(20) Connect the evaporation control system.

(21) Install the resonator assembly, air in-let hose and air cleaner.

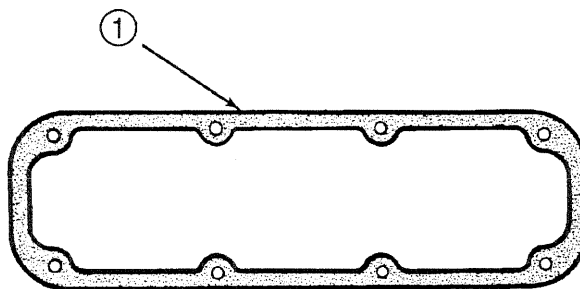
(22) Install the heat shields. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(23) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(24) Connect the battery negative cable.

CYLINDER HEAD COVER(S)**DESCRIPTION—CYLINDER HEAD COVER GASKET**

The cylinder head cover gasket (Fig. 9) is a steel-backed silicone gasket, designed for long life usage.



J9209-104

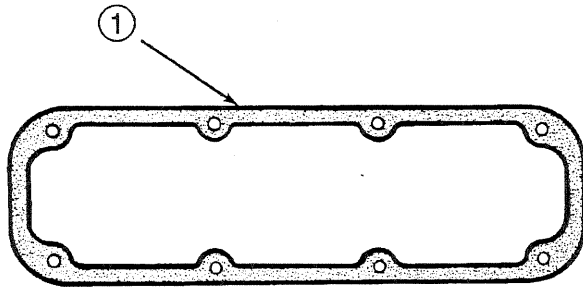
Fig. 9 Cylinder Head Cover Gasket

1 - CYLINDER HEAD COVER GASKET

CYLINDER HEAD COVER(S) (Continued)

REMOVAL

A steel-backed silicone gasket is used with the cylinder head cover (Fig. 10). This gasket can be used again.



J9209-104

Fig. 10 Cylinder Head Cover Gasket

1 - CYLINDER HEAD COVER GASKET

- (1) Disconnect the negative cable from the battery.
- (2) Disconnect closed ventilation system and evaporation control system from cylinder head cover.
- (3) Remove cylinder head cover bolts, cover and gasket. The gasket may be used again.

CLEANING

Clean cylinder head cover gasket surface.
Clean head rail, if necessary.

INSPECTION

Inspect cover for distortion and straighten, if necessary.

Check the gasket for use in head cover installation. If damaged, use a new gasket.

INSTALLATION

A steel-backed silicone gasket is used with the cylinder head cover (Fig. 10). This gasket can be used again.

- (1) Position the cylinder head cover gasket onto the head rail.
- (2) Position the cylinder head cover onto the gasket and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.
- (3) Install closed crankcase ventilation system and evaporation control system.
- (4) Connect the negative cable to the battery.
- (5) Start engine and check for leaks.

INTAKE/EXHAUST VALVES & SEATS

DESCRIPTION

Both the intake and exhaust valves are made of steel. The intake valve is 48.768 mm (1.92 inches) in diameter and the exhaust valve is 41.148 mm (1.62 inches) in diameter and has a 2.032 mm (0.080 inch) wafer interia welded to the tip for durability. These valves are not splayed.

STANDARD PROCEDURE—VALVES, GUIDES AND SPRINGS

VALVE CLEANING

Clean valves thoroughly. Discard burned, warped, or cracked valves.

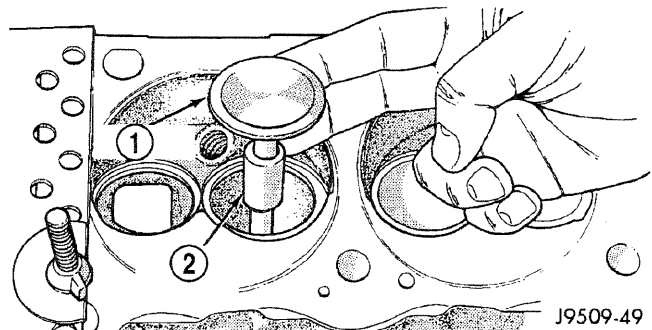
Remove carbon and varnish deposits from inside of valve guides with a reliable guide cleaner.

VALVE GUIDES

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 in.), replace the valve.

Measure valve stem guide clearance as follows:

- (1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 11). The special sleeve places the valve at the correct height for checking with a dial indicator.

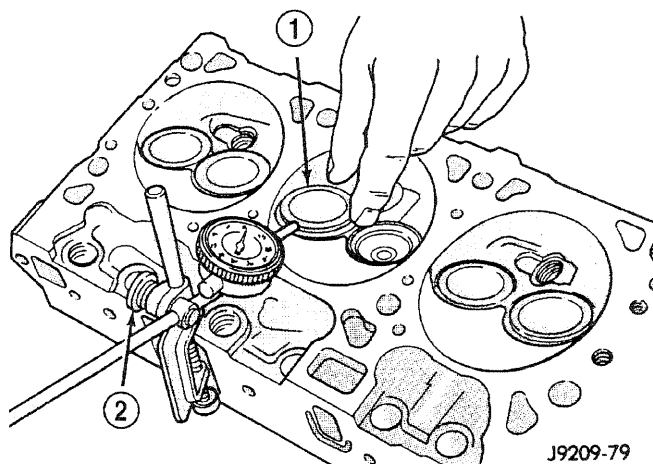


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Fig. 11 Positioning Valve with Tool C-3973

1 - VALVE
2 - SPACER TOOL

- (2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 12).

INTAKE/EXHAUST VALVES & SEATS (Continued)**Fig. 12 Measuring Valve Guide Wear**

- 1 - VALVE
2 - SPECIAL TOOL C-3339

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 in.). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

VALVE GUIDES

Service valves with oversize stems are available. Refer to REAMER SIZES CHART

REAMER SIZES CHART

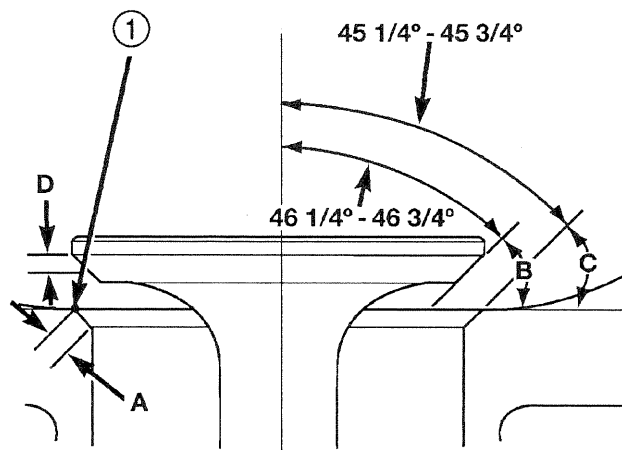
REAMER O/S	VALVE GUIDE SIZE
0.076 mm (0.003 in.)	8.026 - 8.052 mm (0.316 - 0.317 in.)
0.381 mm (0.015 in.)	8.331 - 8.357 mm (0.328 - 0.329 in.)

(1) Slowly turn reamer by hand and clean guide thoroughly before installing new valve. **Ream the valve guides from standard to 0.381 mm (0.015 in.). Use a two step procedure so the valve guides are reamed true in relation to the valve seat:**

- Step 1—Ream to 0.0763 mm (0.003 inch).
- Step 2—Ream to 0.381 mm (0.015 inch).

REFACING VALVES AND VALVE SEATS

The intake and exhaust valves have a 43-1/4° to 43-3/4° face angle and a 44-1/4° to 44-3/4° seat angle (Fig. 13).

**Fig. 13 Valve Face and Seat Angles**

- 1 - CONTACT POINT
A,B,C and D

80ba7a5f

VALVE FACE AND VALVE SEAT ANGLE CHART

ITEM	DESCRIPTION	SPECIFICATION
A	SEAT WIDTH INTAKE	1.016 - 1.524 mm (0.040 - 0.060 in.)
	EXHAUST	1.524 - 2.032 mm (0.060 - 0.080 in.)
B	FACE ANGLE (INT. AND EXT.)	43 1/4° - 43 3/4°
C	SEAT ANGLE (INT. AND EXT.)	44 1/4° - 44 3/4°
D	CONTACT SURFACE	—

VALVES

Inspect the remaining margin after the valves are refaced (Fig. 14). Valves with less than 1.190 mm (0.047 in.) margin should be discarded.

INTAKE/EXHAUST VALVES & SEATS (Continued)

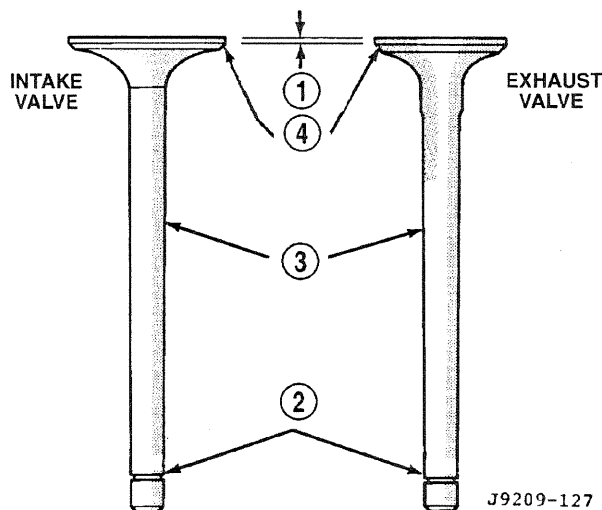


Fig. 14 Intake and Exhaust Valves

- 1 - MARGIN
- 2 - VALVE SPRING RETAINER LOCK GROOVE
- 3 - STEM
- 4 - FACE

VALVE SEATS

CAUTION: DO NOT un-shroud valves during valve seat refacing (Fig. 15).

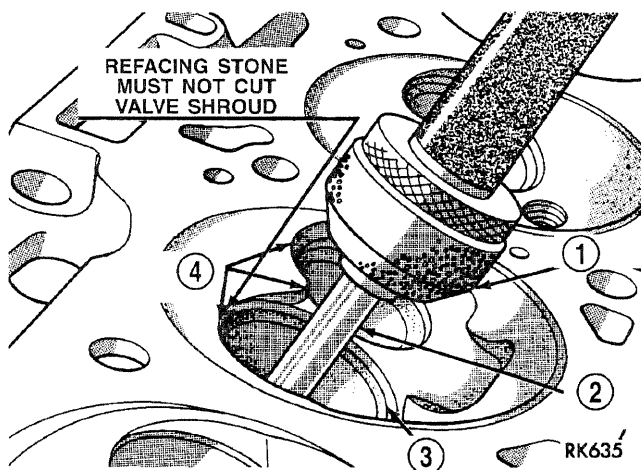


Fig. 15 Refacing Valve Seats

- 1 - STONE
- 2 - PILOT
- 3 - VALVE SEAT
- 4 - SHROUD

(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.

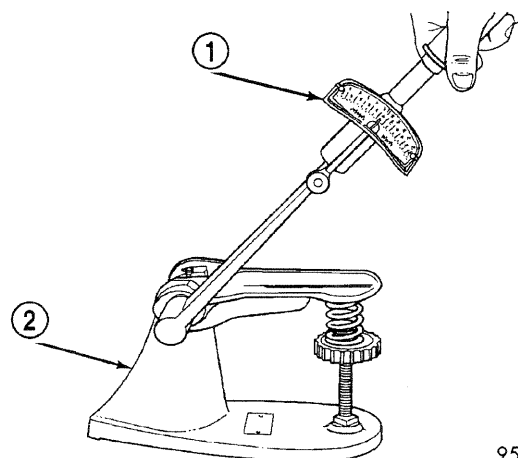
(2) Measure the concentricity of valve seat using a dial indicator. Total runout should not exceed 0.051 mm (0.002 in.) total indicator reading.

(3) Inspect the valve seat with Prussian blue, to determine where the valve contacts the seat. To do this, coat valve seat **LIGHTLY** with Prussian blue then set valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of valve face, contact is satisfactory. If the blue is transferred to the top edge of valve face, lower valve seat with a 15° stone. If the blue is transferred to bottom edge of valve face raise valve seat with a 60° stone.

(4) When seat is properly positioned the width of intake seats should be 1.016-1.524 mm (0.040-0.060 in.). The width of the exhaust seats should be 1.524-2.032 mm (0.060-0.080 in.).

VALVE SPRINGS

Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested. As an example the compression length of the spring to be tested is 1-5/16 in.. Turn table of Universal Valve Spring Tester Tool until surface is in line with the 1-5/16 in. mark on the threaded stud. Be sure the zero mark is to the front (Fig. 16). 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 2. 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.



9509-79

Fig. 16 Testing Valve Spring for Compressed Length

- 1 - TORQUE WRENCH
- 2 - VALVE SPRING TESTER

REMOVAL

(1) Remove the cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

INTAKE/EXHAUST VALVES & SEATS (Continued)

(2) Compress valve springs using Valve Spring Compressor Tool MD- 998772A and adapter 6716A.

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

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

CLEANING

Clean valves thoroughly. Discard burned, warped, or cracked valves.

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

INSPECTION

Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 in.), replace the valve.

Measure valve stem guide clearance as follows:

(1) Install Valve Guide Sleeve Tool C-3973 over valve stem and install valve (Fig. 17). The special sleeve places the valve at the correct height for checking with a dial indicator.

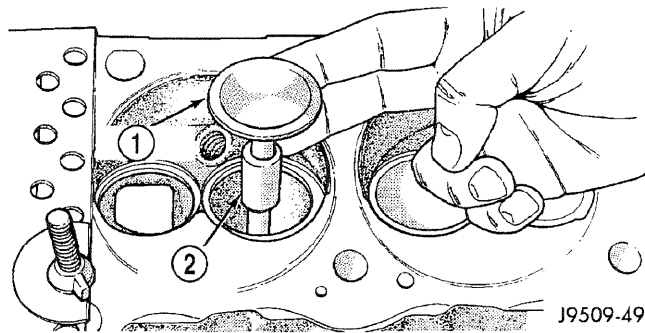


Fig. 17 Positioning Valve with Tool C-3973

- 1 - VALVE
- 2 - SPACER TOOL

(2) Attach dial indicator Tool C-3339 to cylinder head and set it at right angles to valve stem being measured (Fig. 18).

(3) Move valve to and from the indicator. The total dial indicator reading should not exceed 0.432 mm (0.017 in.). Ream the guides for valves with oversize stems if dial indicator reading is excessive or if the stems are scuffed or scored.

INSTALLATION

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

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

(3) Measure valve stems for wear. If wear exceeds 0.051 mm (0.002 inch), replace the valve.

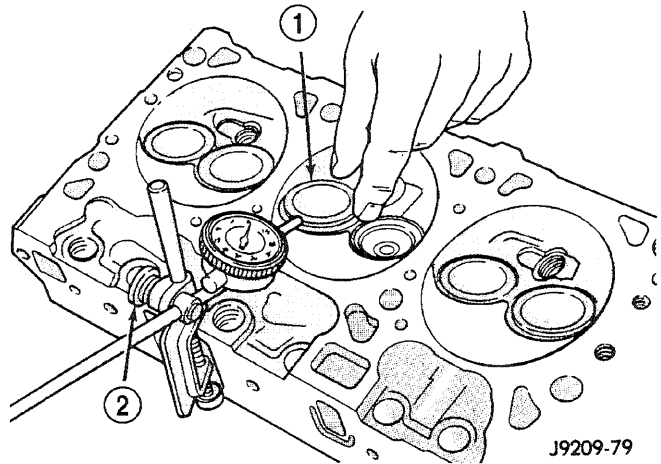


Fig. 18 Measuring Valve Guide Wear

- 1 - VALVE
- 2 - SPECIAL TOOL C-3339

(4) Coat valve stems with lubrication oil and insert them in cylinder head.

(5) If valves or seats are reground, check valve stem height. If valve is too long, replace cylinder head.

(6) Install new seals on all valve guides. Install valve springs and valve retainers.

(7) Compress valve springs with Valve Spring Compressor Tool MD-998772A and adapter 6716A, install locks and release tool. If valves and/or seats are ground, measure the installed height of springs. Make sure the measurement is taken from bottom of spring seat in cylinder head to the bottom surface of spring retainer. If spacers are installed, measure from the top of spacer. If height is greater than 42.86 mm (1-11/16 inches), install a 1.587 mm (1/16 inch) spacer in head counterbore. This should bring spring height back to normal 41.27 to 42.86 mm (1-5/8 to 1-11/16 inch).

(8) Install cylinder head (Refer to 9 - ENGINE/ CYLINDER HEAD - INSTALLATION).

ENGINE BLOCK

CLEANING

Clean cylinder block thoroughly and check all core hole plugs for evidence of leakage.

INSPECTION

Examine block for cracks or fractures.

The cylinder walls should be checked for out-of-round and taper. Refer to Honing Cylinder Bores in the Service Procedures portion of this Section.

ENGINE BLOCK (Continued)

Inspect the oil line plug, the oil line plug is located in the vertical passage at the rear of the block between the oil-to-filter and oil-from-filter passages (Fig. 19). Improper installation or missing plug could cause erratic, low, or no oil pressure.

The oil plug must come out the bottom. Use flat dowel, down the oil pressure sending unit hole from the top, to remove oil plug.

(1) Remove oil pressure sending unit from back of block.

(2) Insert a 3.175 mm (1/8 in.) finish wire, or equivalent, into passage.

(3) Plug should be 190.0 to 195.2 mm (7-1/2 to 7-11/16 in.) from machined surface of block (Fig. 19). If plug is too high, use a suitable flat dowel to position properly.

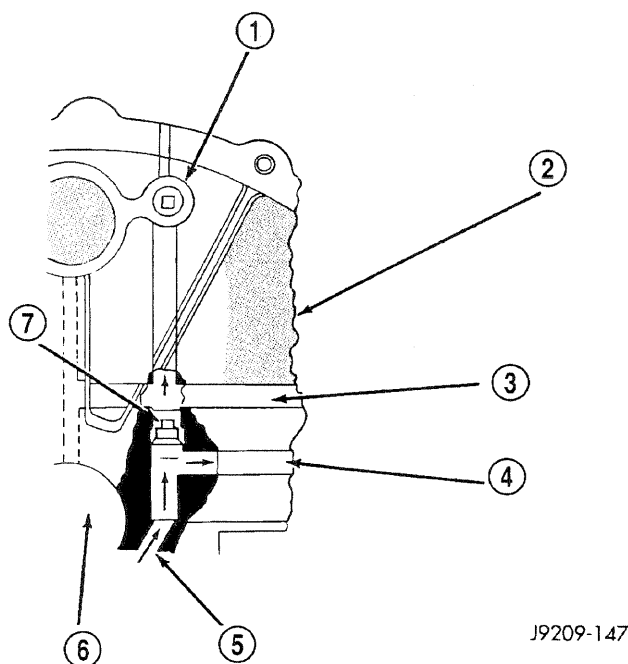


Fig. 19 Oil Line Plug

- 1 - RIGHT OIL GALLERY
- 2 - CYLINDER BLOCK
- 3 - OIL FROM FILTER TO SYSTEM
- 4 - OIL TO FILTER
- 5 - FROM OIL PUMP
- 6 - CRANKSHAFT
- 7 - PLUG

(4) If plug is too low, remove oil pan and No. 4 main bearing cap. Use suitable flat dowel to position properly. Coat outside diameter of plug with Mopar® Stud and Bearing Mount Adhesive. Plug should be 54.0 to 57.7 mm (2-1/8 to 2-5/16 in.) from bottom of the block.

CAMSHAFT & BEARINGS (IN BLOCK)

REMOVAL

REMOVAL—CAMSHAFT BEARINGS

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

(2) Install proper size adapters and horseshoe washers (part of Camshaft Bearing Remover/Installer Tool C-3132-A) at back of each bearing shell. Drive out bearing shells (Fig. 20).

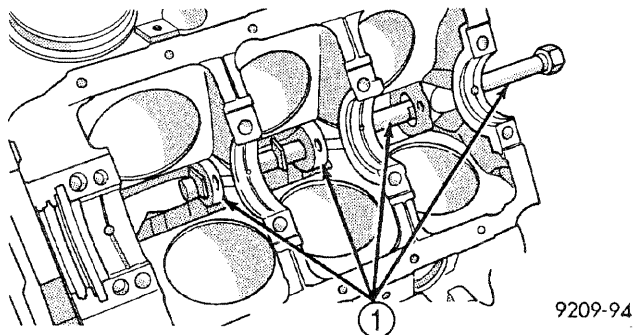


Fig. 20 Camshaft Bearings Removal and Installation with Tool C-3132-A

1 - SPECIAL TOOL C-3132A

REMOVAL—CAMSHAFT

(1) Disconnect battery negative cable.

(2) Remove radiator. (Refer to 7 - COOLING/ENGINE/RADIATOR - REMOVAL).

(3) Remove intake manifold. (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(4) Remove distributor assembly (Refer to 8 - ELECTRICAL/IGNITION CONTROL/DISTRIBUTOR - REMOVAL).

(5) Remove cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(6) Remove rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL).

(7) Remove push rods and tappets (Refer to 9 - ENGINE/ENGINE BLOCK/HYDRAULIC LIFTERS (CAM IN BLOCK) - REMOVAL). Identify each part so it can be installed in the original locations.

(8) Remove timing chain cover. (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(9) Align timing marks (Fig. 21) and remove timing chain and sprockets.

CAMSHAFT & BEARINGS (IN BLOCK) (Continued)

(10) Remove the three tensioner to block mounting bolts and remove tensioner.

(11) Install a long bolt into front of camshaft to aid in removal of the camshaft. Remove camshaft, being careful not to damage cam bearings with the cam lobes.

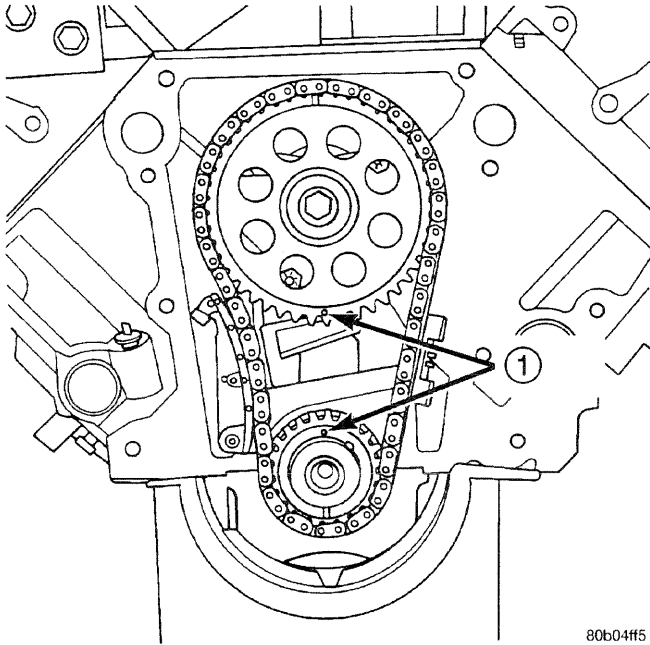


Fig. 21 Alignment of Timing Marks

1 - TIMING MARKS

INSTALLATION**INSTALLATION—CAMSHAFT BEARINGS**

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

(2) Position rear bearing in the tool. Install horse-shoe 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. If the camshaft bearing shell oil holes are not in exact alignment, remove and install them correctly. Install a new core hole plug at the rear of camshaft. **Be sure this plug does not leak.**

INSTALLATION—CAMSHAFT

(1) Lubricate camshaft lobes and camshaft bearing journals and insert the camshaft to within 51 mm (2 inches) of its final position in cylinder block.

(2) Install Camshaft Holding Tool C-3509 with tongue back of distributor drive gear (Fig. 22).

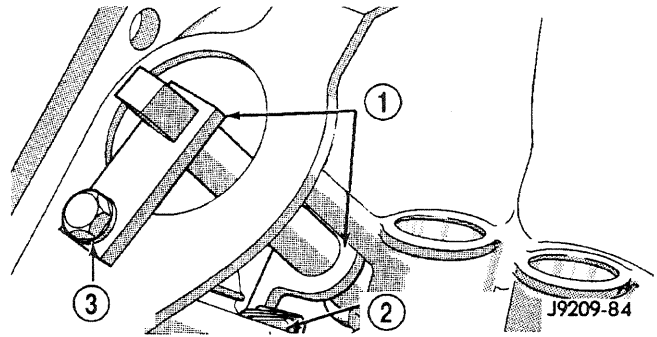


Fig. 22 Camshaft Holding Tool C-3509 (Installed Position)

1 - SPECIAL TOOL C-3509
2 - DRIVE GEAR
3 - DISTRIBUTOR LOCK BOLT

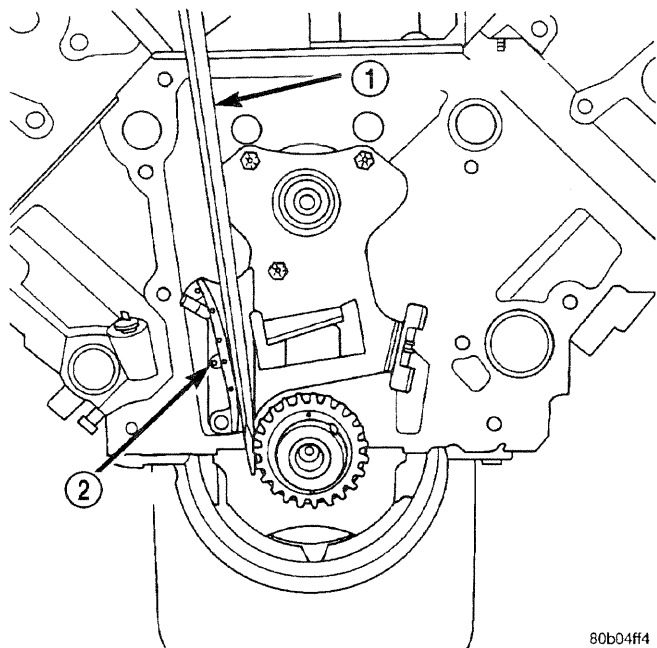


Fig. 23 Compressing Tensioner Shoe For Timing Chain Installation

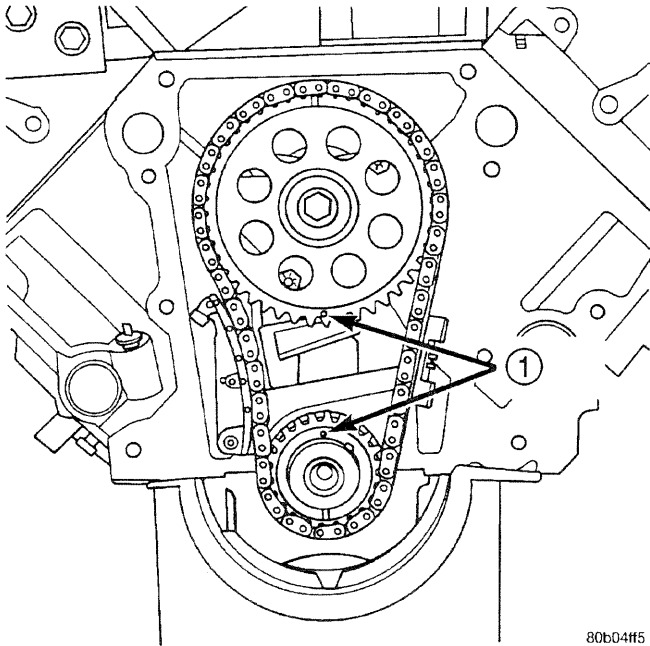
1 - SCREWDRIVER
2 - INSERT PIN HERE

(3) Hold tool in position with a distributor lock-plate bolt. This tool will restrict camshaft from being pushed in too far and prevent knocking out the welch plug in rear of cylinder block. **Tool should remain installed until the camshaft and crankshaft sprockets and timing chain have been installed.**

(4) Install timing chain tensioner. Torque bolts to 24 N·m (210 in. lbs.) torque.

(5) Compress tensioner shoe (Fig. 23) and install a suitable sized pin to retain shoe for chain installation.

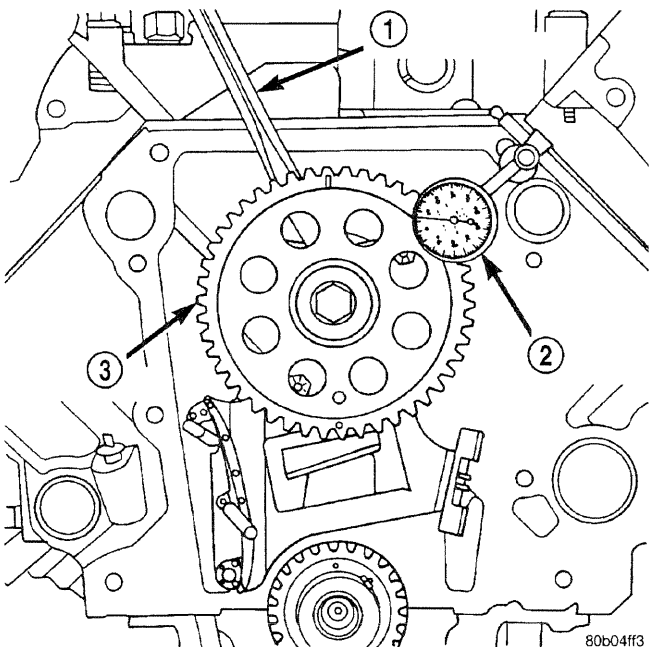
CAMSHAFT & BEARINGS (IN BLOCK) (Continued)



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Fig. 24 Alignment of Timing Marks

1 - TIMING MARKS



80b04ff3

Fig. 25 Checking Camshaft End Play

1 - SCREWDRIVER
2 - DIAL INDICATOR
3 - CAM SPROCKET

(6) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on an exact imaginary center line through both camshaft and crankshaft bores.

(7) Place timing chain around both sprockets.

(8) Turn crankshaft and camshaft to line up with keyway location in crankshaft sprocket and in camshaft sprocket.

(9) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(10) Slide both sprockets evenly over their respective shafts and use a straightedge to check alignment of timing marks (Fig. 24).

(11) Install the camshaft bolt/cup washer. Tighten bolt to 68 N·m (50 ft. lbs.) torque.

(12) Measure camshaft end play (Fig. 25). (Refer to 9 - ENGINE - SPECIFICATIONS) for proper clearance. If not within limits, install a new timing chain tensioner.

(13) Each tappet reused must be installed in the same position at which it was removed. **When camshaft is replaced, all of the tappets must be replaced.** Install hydraulic tappets (Refer to 9 - ENGINE/ENGINE BLOCK/HYDRAULIC LIFTERS (CAM IN BLOCK) - INSTALLATION).

(14) Install timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(15) Install intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(16) Install distributor (Refer to 8 - ELECTRICAL/IGNITION CONTROL/DISTRIBUTOR - INSTALLATION).

(17) Install cylinder head covers (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(18) Install radiator (Refer to 7 - COOLING/ENGINE/RADIATOR - INSTALLATION).

(19) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(20) Connect battery negative cable.

(21) Start engine and check for leaks.

CONNECTING ROD BEARINGS

STANDARD PROCEDURE - CONNECTING ROD BEARING FITTING

Fit all rods on a bank until completed. DO NOT alternate from one bank to another, because connecting rods and pistons are not interchangeable from one bank to another.

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

Each bearing cap has a small V-groove across the parting face. When installing the lower bearing shell, be certain that the V-groove in the shell is in line with the V-groove in the cap. This provides lubrication of the cylinder wall in the opposite bank.

CONNECTING ROD BEARINGS (Continued)

The bearing shells must be installed so that the tangs are in the machined grooves in the rods and caps.

Limits of taper or out-of-round on any crankshaft journals should be held to 0.025 mm (0.001 in.). Bearings are available in 0.025 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.) undersize. **Install the bearings in pairs. DO NOT use a new bearing half with an old bearing half. DO NOT file the rods or bearing caps.**

CRANKSHAFT

DESCRIPTION

The crankshaft (Fig. 26) is of a forged steel splayed type design, with four main bearing journals. The crankshaft is located at the bottom of the engine block and is held in place with four main bearing caps.

Undersize Journal	Identification Stamp
ROD - 0.025mm (0.001 in.)	R1-R2-R3-Etc.
MAIN - 0.025mm (0.001 in.)	M1-M2-M3 or M4

STEEL STAMP IDENTIFICATION
R (ROD) AND/OR M (MAIN) FOLLOWED
BY THE ROD OR MAIN NUMBER

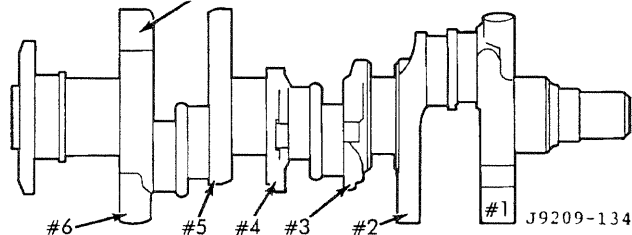


Fig. 26 Crankshaft—3.9L Engine

Undersize Journal	Identification Stamp
ROD - 0.025mm (0.001 in.)	R1-R2-R3-Etc.
MAIN - 0.025mm (0.001 in.)	M1-M2-M3 or M4

OPERATION

The crankshaft transfers force generated by combustion within the cylinder bores to the flywheel or flexplate.

REMOVAL

- (1) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).
- (2) Remove the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).
- (3) Identify bearing caps before removal. Remove bearing caps and bearings one at a time.
- (4) Lift the crankshaft out of the block.

- (5) Remove and discard the crankshaft rear oil seals.

- (6) Remove and discard the front crankshaft oil seal.

INSTALLATION

- (1) Lightly oil the new upper seal lips with engine oil.
- (2) Install the new upper rear bearing oil seal with the white paint facing towards the rear of the engine.
- (3) Position the crankshaft into the cylinder block.
- (4) Lightly oil the new lower seal lips with engine oil.
- (5) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.
- (6) Apply 5 mm (0.20 in.) drop of Loctite 518, or equivalent, on each side of the rear main bearing cap (Fig. 27). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

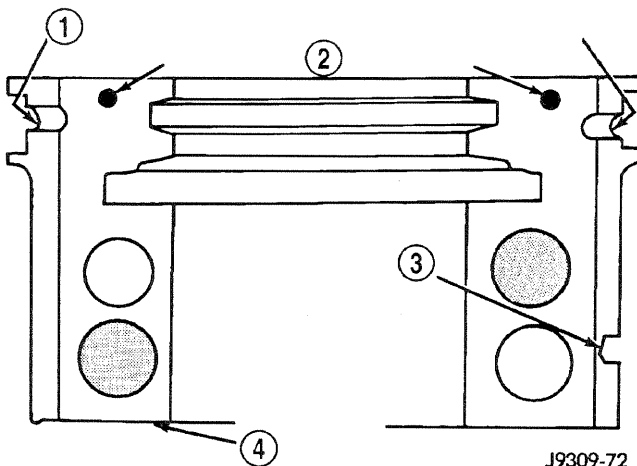


Fig. 27 Sealant Application to Bearing Cap

- 1 - MOPAR SILICONE RUBBER ADHESIVE SEALANT SLOTS
- 2 - LOCTITE 515 (OR EQUIVALENT)
- 3 - CAP ALIGNMENT SLOT
- 4 - REAR MAIN BEARING CAP

- (7) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

- (8) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

- (9) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

CRANKSHAFT (Continued)

(10) Apply Mopar® Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 28). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(11) Install new front crankshaft oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - INSTALLATION).

(12) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(13) Install new rear oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - INSTALLATION).

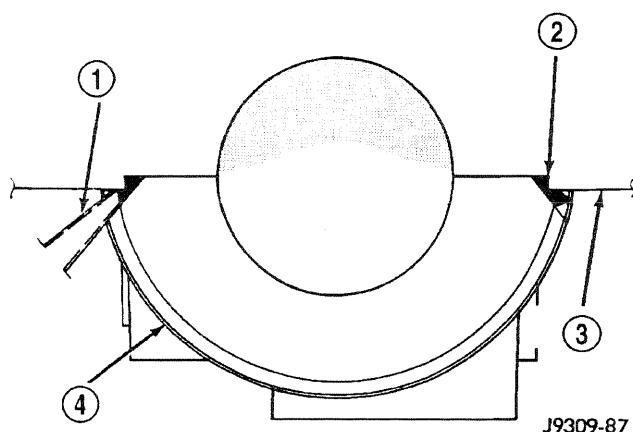


Fig. 28 Apply Sealant to Bearing Cap-to-Block Joint

- 1 - MOPAR® GEN II SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
- 2 - SEALANT APPLIED
- 3 - CYLINDER BLOCK
- 4 - REAR MAIN BEARING CAP

CRANKSHAFT MAIN BEARINGS

DESCRIPTION

Main bearings (Fig. 29) are located in the cylinder block. One half of the main bearing is located in the crankshaft main bore the other half of the matching bearing is located in the main bearing cap. there are four main bearings. Number two main bearing is flanged, this flange controls crankshaft thrust.

OPERATION

The main bearings encircle the crankshaft main bearing journals, this aligns the crankshaft to the centerline of the engine and allows the crankshaft to turn without wobbling or shaking therefore eliminating vibration. The main bearings are available in standard and undersizes.

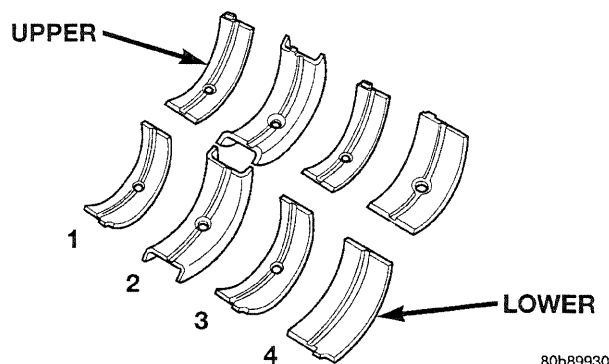


Fig. 29 Main Bearing Orientation

STANDARD PROCEDURE - MAIN BEARING FITTING

Bearing caps are NOT interchangeable and should be marked at removal to ensure correct assembly. Upper and lower bearing halves are NOT interchangeable. Lower main bearing halves of No. 1 and 3 are interchangeable.

Upper and lower No. 2 bearing halves are flanged to carry the crankshaft thrust loads. They are NOT interchangeable with any other bearing halves in the engine (Fig. 30). Bearing shells are available in standard and the following undersizes: 0.25 mm (0.001 in.), 0.051 mm (0.002 in.), 0.076 mm (0.003 in.), 0.254 mm (0.010 in.) and 0.305 mm (0.012 in.). Never install an undersize bearing that will reduce clearance below specifications.

STEEL STAMP IDENTIFICATION R (ROD) AND/OR M (MAIN) FOLLOWED BY THE ROD OR MAIN NUMBER

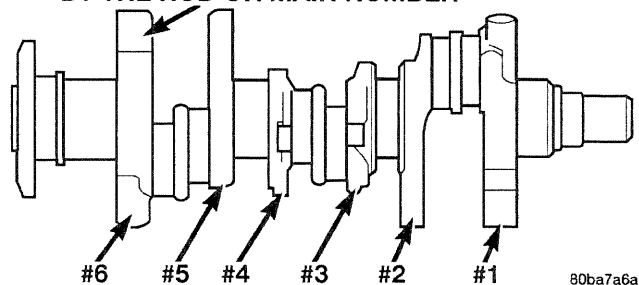


Fig. 30 Main Bearing Identification

CRANKSHAFT MAIN BEARINGS (Continued)**CRANKSHAFT IDENTIFICATION LOCATION CHART**

ITEM	MEASUREMENT	IDENTIFICATION
ROD U/S	0.025 mm (0.001 in.)	R1-R2-R3 ect. indicates rod journal No. 1, 2 and 3.
MAIN U/S	0.025 mm (0.001 in.)	M1-M2-M3 or M4 indicates main journal No. 1, 2, 3, and 4.

REMOVAL

(1) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(2) Remove the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

(3) Identify bearing caps before removal. Remove bearing caps one at a time.

(4) Remove upper half of bearing by inserting Crankshaft Main Bearing Remover/Installer Tool C-3059 into the oil hole of crankshaft (Fig. 31).

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

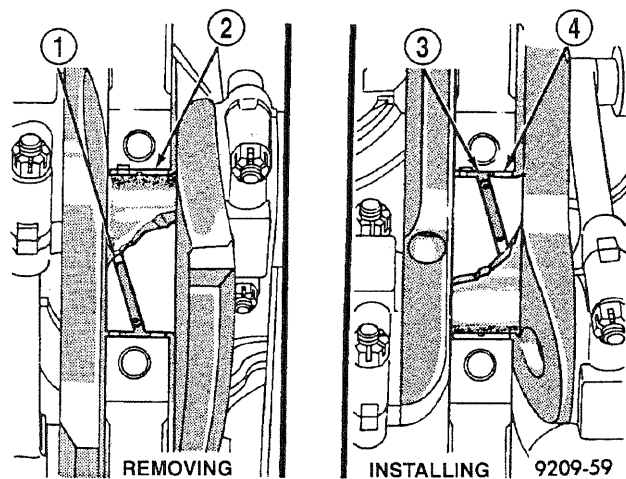


Fig. 31 Upper Main Bearing Removal and Installation with Tool C-3059

- 1 - SPECIAL TOOL C-3059
- 2 - BEARING
- 3 - SPECIAL TOOL C-3059
- 4 - BEARING

INSTALLATION

Only one main bearing should be selectively fitted while all other main bearing caps are properly tightened. All bearing capbolts removed during service procedures are to be cleaned and oiled before instal-

lation. DO NOT use a new bearing half with an old bearing half.

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

(1) Start bearing in place, and insert Crankshaft Main Bearing Remover/Installer Tool C-3059 into oil hole of crankshaft (Fig. 31).

(2) Slowly rotate crankshaft counterclockwise sliding the bearing into position. Remove Tool C-3059.

(3) Install the bearing caps. Clean and oil the bolts. Tighten the capbolts to 115 N·m (85 ft. lbs.) torque.

(4) Install the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(5) Install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

CRANKSHAFT OIL SEAL - FRONT**DESCRIPTION**

The crankshaft front seal is a one piece viton seal with a steel housing. The front seal is located in the engine front cover.

OPERATION

The crankshaft seals prevent oil from leaking from around the crankshaft, either from the rear of the engine or from the engine front cover.

REMOVAL

The oil seal can be replaced without removing the timing chain cover, provided that the cover is not misaligned.

(1) Disconnect the negative cable from the battery.

(2) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).

(3) If front seal is suspected of leaking, check front oil seal alignment to crankshaft. The seal installation/alignment Tool 6635, should fit with minimum interference. If tool does not fit, the cover must be removed and installed properly.

(4) Place a suitable tool behind the lips of the oil seal to pry the oil seal outward. Be careful not to damage the crankshaft seal bore of cover.

INSTALLATION

(1) Place the smaller diameter of the oil seal over Front Oil Seal Installation Tool 6635 (Fig. 32). Seat the oil seal in the groove of the tool.

(2) Position the seal and tool onto the crankshaft (Fig. 33).

CRANKSHAFT OIL SEAL - FRONT (Continued)

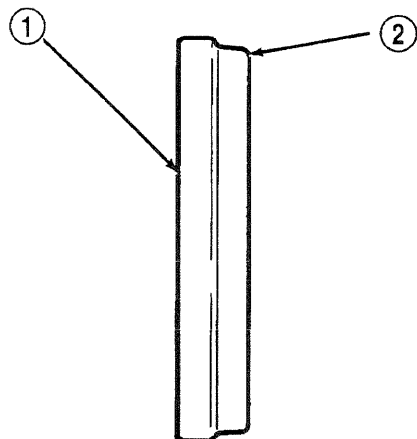
(3) Using the vibration damper bolt, tighten the bolt to draw the seal into position on the crankshaft (Fig. 34).

(4) Remove the vibration damper bolt and seal installation tool.

(5) Inspect the seal flange on the vibration damper.

(6) Install the vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).

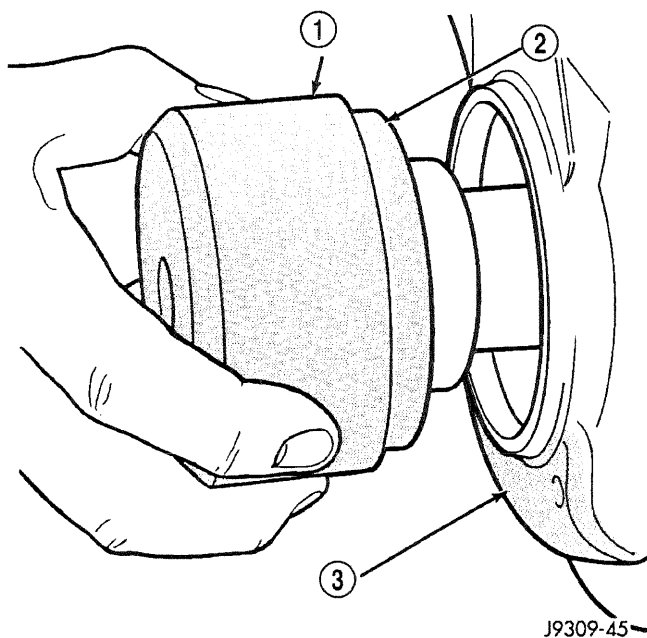
(7) Connect the negative cable to the battery.



J9309-44

Fig. 32 Placing Oil Seal on Installation Tool 6635

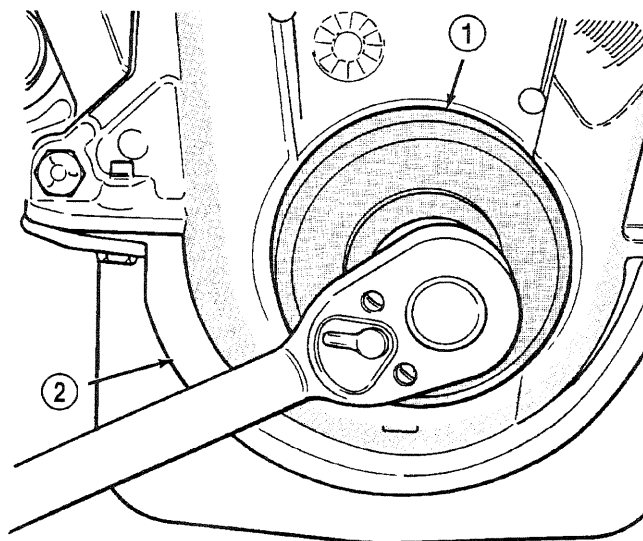
- 1 - CRANKSHAFT FRONT OIL SEAL
2 - INSTALL THIS END INTO SPECIAL TOOL 6635



J9309-45

Fig. 33 Position Tool and Seal onto Crankshaft

- 1 - SPECIAL TOOL 6635
2 - OIL SEAL
3 - TIMING CHAIN COVER



J9309-46

Fig. 34 Installing Oil Seal

- 1 - SPECIAL TOOL 6635
2 - TIMING CHAIN COVER

CRANKSHAFT OIL SEAL - REAR

DESCRIPTION

The crankshaft rear seal is a two piece viton seal. One part of the two piece rear seal is located in a slot in the number four (4) crankshaft main bore, the second part of the two piece seal is located in the number four (4) main bearing cap.

OPERATION

The crankshaft seals prevent oil from leaking from around the crankshaft, either from the rear of the engine or from the engine front cover.

DIAGNOSIS AND TESTING—REAR SEAL AREA LEAKS

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

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

- (1) Disconnect the battery.
- (2) Raise the vehicle.

CRANKSHAFT OIL SEAL - REAR (Continued)

(3) Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:

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

(b) Where leakage tends to run straight down, possible causes are a porous block, distributor seal, camshaft bore cup plugs, oil galley pipe plugs, oil filter runoff, and main bearing cap to cylinder block mating surfaces.

(4) If no leaks are detected, pressurized the crankcase as outlined in (Refer to 9 - ENGINE/LUBRICATION - DIAGNOSIS AND TESTING)

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

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

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

(6) For bubbles that remain steady with shaft rotation, no further inspection can be done until disassembled. Refer to the service Diagnosis—Mechanical, under the Oil Leak row, for components inspections on possible causes and corrections.

(7) After the oil leak root cause and appropriate corrective action have been identified, (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - REAR - REMOVAL), for proper replacement procedures.

REMOVAL

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

(1) Remove the crankshaft (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT - REMOVAL). Discard the old upper seal.

UPPER SEAL—CRANKSHAFT INSTALLED

(1) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(2) Remove the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

(3) Remove the rear main bearing cap. Remove and discard the old lower oil seal.

(4) Carefully remove and discard the old upper oil seal.

LOWER SEAL

(1) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(2) Remove the oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - REMOVAL).

(3) Remove the rear main bearing cap and discard the old lower seal.

INSTALLATION

The service seal is a two piece, Viton seal. The upper seal half can be installed with crankshaft removed from engine or with crankshaft installed. When a new upper seal is installed, install a new lower seal. The lower seal half can be installed only with the rear main bearing cap removed.

UPPER SEAL —CRANKSHAFT REMOVED

(1) Clean the cylinder block rear cap mating surface. Be sure the seal groove is free of debris. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil.

(3) Install the new upper rear bearing oil seal with the white paint facing toward the rear of the engine.

(4) Position the crankshaft into the cylinder block.

(5) Lightly oil the new lower seal lips with engine oil.

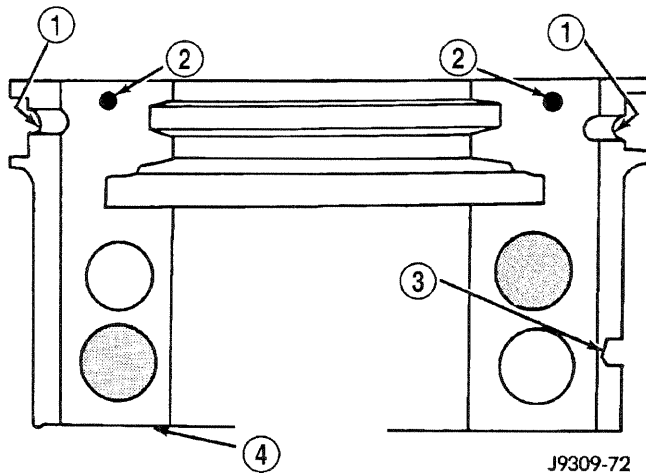
(6) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing towards the rear of the engine.

(7) Apply 5 mm (0.20 in.) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 35). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(8) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(9) Clean and oil all cap bolts. Install all main bearing caps. Install all cap bolts and alternately tighten to 115 N·m (85 ft. lbs.) torque.

(10) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

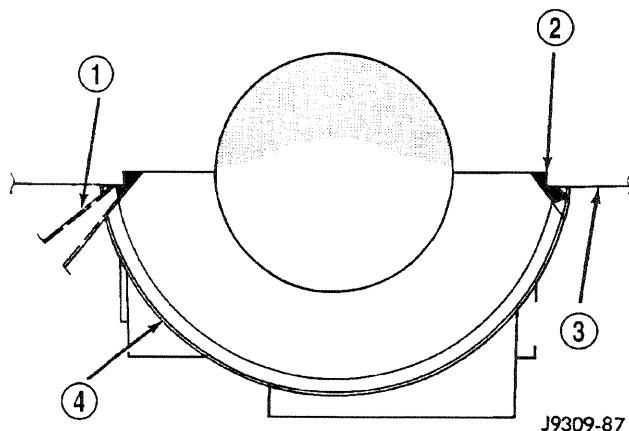
CRANKSHAFT OIL SEAL - REAR (Continued)**Fig. 35 Sealant Application to Bearing Cap**

- 1 - MOPAR SILICONE RUBBER ADHESIVE SEALANT SLOTS
- 2 - MOPAR® GASKET MAKER (OR EQUIVALENT)
- 3 - CAP ALIGNMENT SLOT
- 4 - REAR MAIN BEARING CAP

(11) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing (Fig. 36). Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(12) Install new front crankshaft oil seal (Refer to 9 - ENGINE/ENGINE BLOCK/CRANKSHAFT OIL SEAL - FRONT - INSTALLATION).

(13) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

**Fig. 36 Apply Sealant to Bearing Cap-to-Block Joint**

- 1 - MOPAR® GEN II SILICONE RUBBER ADHESIVE SEALANT NOZZLE TIP
- 2 - SEALANT APPLIED
- 3 - CYLINDER BLOCK
- 4 - REAR MAIN BEARING CAP

UPPER SEAL—CRANKSHAFT INSTALLED

(1) Clean the cylinder block mating surfaces before oil seal installation. Check for burrs at the oil hole on the cylinder block mating surface to rear cap.

(2) Lightly oil the new upper seal lips with engine oil. To allow ease of installation of the seal, loosen at least the two main bearing caps forward of the rear bearing cap.

(3) Rotate the new upper seal into the cylinder block, being careful not to shave or cut the outer surface of the seal. To ensure proper installation, use the installation tool provided with the kit. Install the new seal with the white paint facing toward the rear of the engine.

(4) Install the new lower rear bearing oil seal into the bearing cap with the white paint facing toward the rear of the engine.

(5) Apply 5 mm (0.20 in.) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 35). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application. Be sure the white paint faces toward the rear of the engine.

(6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten ALL cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(9) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap-to-block and oil pan sealing (Fig. 36). Apply enough sealant until a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

LOWER SEAL

(1) Clean the rear main cap mating surfaces including the oil pan gasket groove.

(2) Carefully install a new upper seal. Refer to UPPER SEAL—CRANKSHAFT INSTALLED.

(3) Lightly oil the new lower seal lips with engine oil.

(4) Install a new lower seal in bearing cap with the white paint facing the rear of engine.

CRANKSHAFT OIL SEAL - REAR (Continued)

(5) Apply 5 mm (0.20 in.) drop of Mopar® Gasket Maker, or equivalent, on each side of the rear main bearing cap (Fig. 35). DO NOT over-apply sealant or allow the sealant to contact the rubber seal. Assemble bearing cap to cylinder block immediately after sealant application.

(6) To align the bearing cap, use cap slot, alignment dowel, and cap bolts. DO NOT remove excess material after assembly. DO NOT strike rear cap more than two times for proper engagement.

(7) Install the rear main bearing cap with cleaned and oiled cap bolts. Alternately tighten the cap bolts to 115 N·m (85 ft. lbs.) torque.

(8) Install oil pump (Refer to 9 - ENGINE/LUBRICATION/OIL PUMP - INSTALLATION).

(9) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at bearing cap-to-block joint to provide cap to block and oil pan sealing. Apply enough sealant so that a small amount is squeezed out. Withdraw nozzle and wipe excess sealant off the oil pan seal groove.

(10) Immediately install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

DISTRIBUTOR BUSHING**REMOVAL**

(1) Remove distributor (Refer to 8 - ELECTRICAL/IGNITION CONTROL/DISTRIBUTOR - REMOVAL).

(2) Remove the intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(3) Insert Distributor Drive Shaft Bushing Puller Tool C-3052 into old bushing and thread down until a tight fit is obtained (Fig. 37).

(4) Hold puller screw and tighten puller nut until bushing is removed.

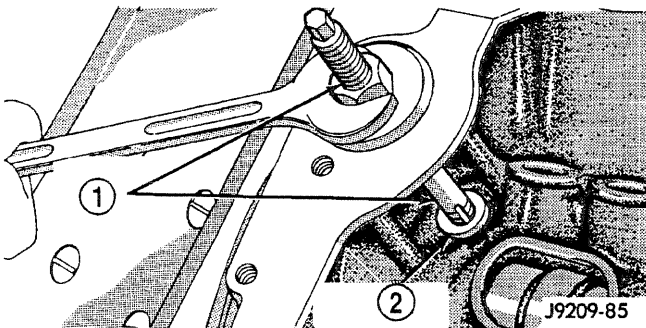


Fig. 37 Distributor Driveshaft Bushing Removal

1 - SPECIAL TOOL C-3052
2 - BUSHING

INSTALLATION

(1) Slide new bushing over burnishing end of Distributor Drive Shaft Bushing Driver/Burnisher Tool C-3053. Insert the tool and bushing into the bore.

(2) Drive bushing and tool into position, using a hammer (Fig. 38).

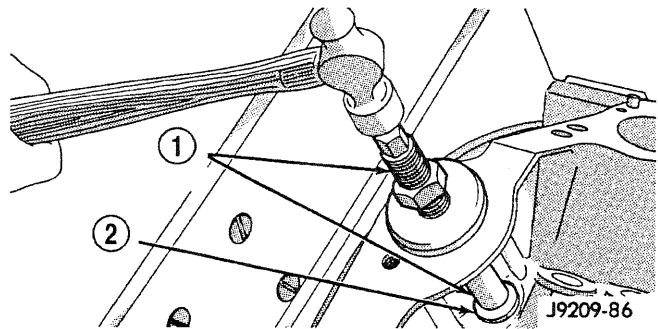


Fig. 38 Distributor Driveshaft Bushing Installation

1 - SPECIAL TOOL C-3053
2 - BUSHING

(3) As the burnisher is pulled through the bushing, the bushing is expanded tight in the block and burnished to correct size (Fig. 39). **DO NOT ream this bushing.**

CAUTION: This procedure **MUST** be followed when installing a new bushing or seizure to shaft may occur.

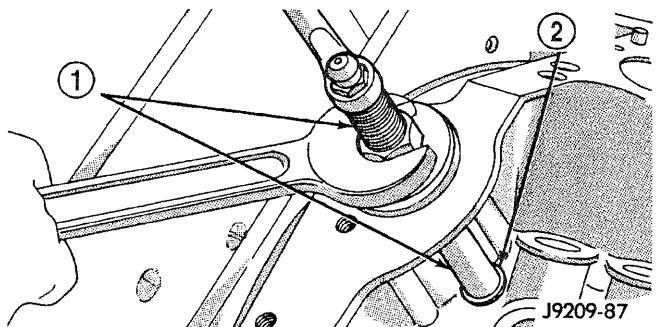


Fig. 39 Burnishing Distributor Bushing

1 - SPECIAL TOOL C-3053
2 - BUSHING

(4) Install the intake manifold. (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(5) Install the distributor.

HYDRAULIC LIFTERS (CAM IN BLOCK)

DIAGNOSIS AND TESTING—HYDRAULIC TAPPETS

Before disassembling any part of the engine to correct tappet noise, check the oil pressure. If vehicle has no oil pressure gauge, install a reliable gauge at the pressure sending-unit. The pressure should be between 207-552 kPa (30-80 psi) at 3,000 RPM.

Check the oil level after the engine reaches normal operating temperature. Allow 5 minutes to stabilize oil level, check dipstick. The oil level in the pan should never be above the FULL mark or below the ADD OIL mark on dipstick. Either of these two conditions could be responsible for noisy tappets.

OIL LEVEL

HIGH

If oil level is above the FULL mark, it is possible for the connecting rods to dip into the oil. With the engine running, this condition could create foam in the oil pan. Foam in oil pan would be fed to the hydraulic tappets by the oil pump causing them to lose length and allow valves to seat noisily.

LOW

Low oil level may allow oil pump to take in air. When air is fed to the tappets, they lose length, which allows valves to seat noisily. Any leaks on intake side of oil 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, operate the engine at fast idle. Run engine for a sufficient time to allow all of the air inside the tappets to be bled out.

TAPPET NOISE DIAGNOSIS

(1) To determine source of tappet noise, operate engine at idle with cylinder head covers removed.

(2) Feel each valve spring or rocker arm to detect noisy tappet. The noisy tappet will cause the affected spring and/or rocker arm to vibrate or feel rough in operation.

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

(3) Valve tappet noise ranges from light noise to a heavy click. A light noise is usually caused by excessive leak-down around the unit plunger, or by the plunger partially sticking in the tappet body cylinder. The tappet should be replaced. A heavy click is caused by a tappet check valve not seating, or by foreign particles wedged between the plunger and the tappet body. This will cause 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.

(4) The valve train generates a noise very much like a light tappet noise during normal operation. Care must be taken to ensure that tappets are making the noise. If more than one tappet seems to be noisy, it's probably not the tappets.

LEAK-DOWN TEST

After cleaning and inspection, test each tappet for specified leak-down rate tolerance to ensure zero-lash operation (Fig. 40).

Swing the weighted arm of the hydraulic valve tappet tester away from the ram of the Universal Leak-Down Tester.

(1) Place a 7.925-7.950 mm (0.312-0.313 inch) diameter ball bearing on the plunger cap of the tappet.

(2) Lift the ram and position the tappet (with the ball bearing) inside the tester cup.

(3) Lower the ram, then adjust the nose of the ram until it contacts the ball bearing. DO NOT tighten the hex nut on the ram.

(4) Fill the tester cup with hydraulic valve tappet test oil until the tappet is completely submerged.

(5) Swing the weighted arm onto the push rod and pump the tappet plunger up and down to remove air. When the air bubbles cease, swing the weighted arm away and allow the plunger to rise to the normal position.

HYDRAULIC LIFTERS (CAM IN BLOCK) (Continued)

(6) Adjust the nose of the ram to align the pointer with the SET mark on the scale of the tester and tighten the hex nut.

(7) Slowly swing the weighted arm onto the push rod.

(8) Rotate the cup by turning the handle at the base of the tester clockwise one revolution every 2 seconds.

(9) Observe the leak-down time interval from the instant the pointer aligns with the START mark on the scale until the pointer aligns with the 0.125 mark. A normally functioning tappet will require 20-110 seconds to leak-down. Discard tappets with leak-down time interval not within this specification.

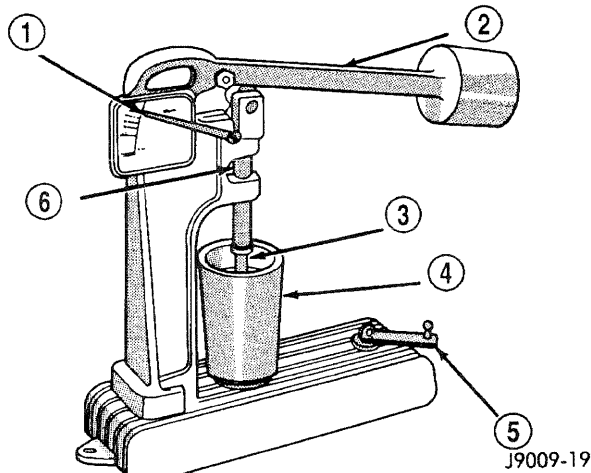


Fig. 40 Leak-Down Tester

- 1 - POINTER
- 2 - WEIGHTED ARM
- 3 - RAM
- 4 - CUP
- 5 - HANDLE
- 6 - PUSH ROD

REMOVAL

(1) Remove the air cleaner assembly and air in-let hose.

(2) Remove cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - REMOVAL).

(3) Remove rocker assembly and push rods (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - REMOVAL). Identify push rods to ensure installation in original locations.

(4) Remove intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - REMOVAL).

(5) Remove yoke retainer and aligning yokes.

(6) Slide Hydraulic Tappet Remover/Installer Tool C-4129-A through opening in cylinder head and seat tool firmly in the head of tappet.

(7) Pull tappet out of bore with a twisting motion. If all tappets are to be removed, identify tappets to ensure installation in original location.

(8) If the tappet or bore in cylinder block is scored, scuffed, or shows signs of sticking, ream the bore to next oversize. Replace with oversize tappet.

CLEANING

Clean tappet with a suitable solvent. Rinse in hot water and blow dry with a clean shop rag or compressed air.

INSTALLATION

(1) Lubricate tappets with Mopar® Engine Oil Supplement or equivalent.

(2) Install tappets and push rods in their original positions. Ensure that the oil feed hole in the side of the tappet body faces up (away from the crankshaft).

(3) Install aligning yokes with ARROW toward camshaft.

(4) Install yoke retainer. Tighten the bolts to 23 N·m (200 in. lbs.) torque. Install intake manifold (Refer to 9 - ENGINE/MANIFOLDS/INTAKE MANIFOLD - INSTALLATION).

(5) Install rocker arms (Refer to 9 - ENGINE/CYLINDER HEAD/ROCKER ARM / ADJUSTER ASSY - INSTALLATION).

(6) Install cylinder head cover (Refer to 9 - ENGINE/CYLINDER HEAD/CYLINDER HEAD COVER(S) - INSTALLATION).

(7) Install air cleaner assembly and air in-let hose.

(8) 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.

PISTON & CONNECTING ROD

DESCRIPTION

The pistons are made of aluminum and have three ring grooves, the top two grooves are for the compression rings and the bottom groove is for the oil control ring. The connecting rods are forged steel and are coined prior to heat treat. The piston pins are press fit.

STANDARD PROCEDURE—PISTON FITTING

Check the cylinder block bore for out-of-round, taper, scoring, or scuffing.

Check the pistons for taper and elliptical shape before they are fitted into the cylinder bore (Fig. 41).

Piston and cylinder wall must be clean and dry. Specified clearance between the piston and the cylinder wall is 0.013-0.038 mm (0.0005-0.0015 in.) at 21°C (70°F).

Piston diameter should be measured at the top of skirt, 90° to piston pin axis. Cylinder bores should be measured halfway down the cylinder bore and transverse to the engine crankshaft center line.

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

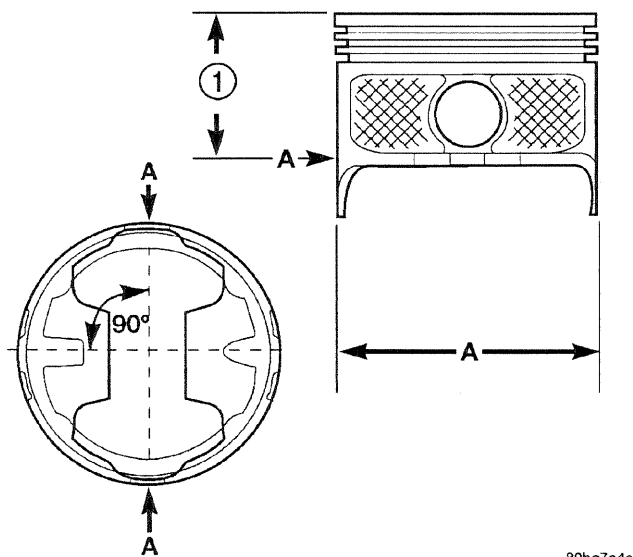


Fig. 41 Piston Measurements

1 - 62.230 mm
(2.45 IN.)

PISTON MEASUREMENTS CHART

PISTON SIZE	A DIA = PISTON DIAMETER		BORE DIAMETER	
	MIN. mm (in.)	MAX. mm (in.)	MIN. mm (in.)	MAX. mm (in.)
A	99.280 (3.9087)	99.294 (3.9092)	99.308 (3.9098)	99.320 (3.9103)
B	99.294 (3.9092)	99.306 (3.9097)	99.320 (3.9103)	99.333 (3.9108)
C	99.306 (3.9097)	99.319 (3.9102)	99.333 (3.9108)	99.345 (3.9113)
D	99.319 (3.9102)	99.332 (3.9107)	99.346 (3.9113)	99.358 (3.9118)
E	99.332 (3.9107)	99.344 (3.9112)	99.358 (3.9118)	99.371 (3.9123)
DESCRIPTION		SPECIFICATION		
PISTON PIN BORE		25.007 - 25.014 mm (.9845 - .9848 in.)		
RING GROOVE HEIGHT (OIL RAIL)		4.0309 - 4.0538 mm (.1587 - .1596 in.)		
RING GROOVE HEIGHT (COMPRESSION RAIL)		2.0294 - 2.0548 mm (.0799 - .0809 in.)		
TOTAL FINISHED WEIGHT		594.6 ± 2 grams (20.974 ± .0706 ounces)		

REMOVAL

(1) Remove the engine from the vehicle (Refer to 9 - ENGINE - REMOVAL).

(2) Remove the cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - REMOVAL).

(3) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(4) 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.

(5) Be sure each connecting rod and connecting rod cap is identified with the cylinder number. Remove connecting rod cap. Install connecting rod bolt guide set on connecting rod bolts.

(6) Pistons and connecting rods must be removed from top of cylinder block. When removing the assemblies from the engine, rotate crankshaft so that

PISTON & CONNECTING ROD (Continued)

the connecting rod is centered in cylinder bore and at BDC. **Be careful not to nick crankshaft journals.**

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

CLEANING

Clean the piston and connecting rod assembly using a suitable solvent.

INSPECTION

Check the connecting rod journal for excessive wear, taper and scoring (Refer to 9 - ENGINE/ENGINE BLOCK/CONNECTING ROD BEARINGS - STANDARD PROCEDURE).

Check the connecting rod for signs of twist or bending.

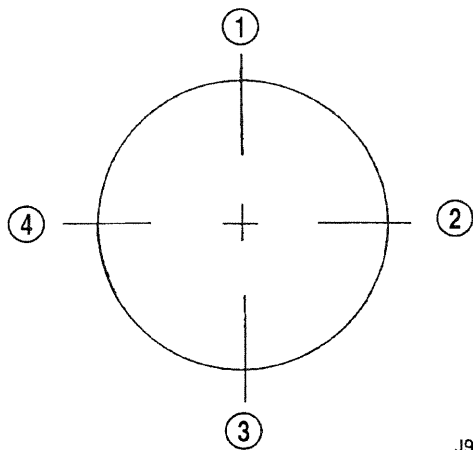
Check the piston for taper and elliptical shape before it is fitted into the cylinder bore (Refer to 9 - ENGINE/ENGINE BLOCK/PISTON & CONNECTING ROD - STANDARD PROCEDURE).

Check the piston for scoring, or scraping marks in the piston skirts. Check the ring lands for cracks and/or deterioration.

INSTALLATION

(1) Be sure that compression ring gaps are staggered so that neither is in line with oil ring rail gap.

(2) Before installing the ring compressor, be sure the oil ring expander ends are butted and the rail gaps located properly (Fig. 42).



J9309-80

Fig. 42 Proper Ring Installation

- 1 - OIL RING SPACER GAP
- 2 - SECOND COMPRESSION RING GAP OIL RING RAIL GAP (TOP)
- 3 - OIL RING RAIL GAP (BOTTOM)
- 4 - TOP COMPRESSION RING GAP

(3) Immerse the piston head and rings in clean engine oil. Slide Piston Ring Compressor Tool C-385 over the piston and tighten with the special wrench

(part of Tool C-385). **Be sure position of rings does not change during this operation.**

(4) Install connecting rod bolt protectors on rod bolts. The long protector should be installed on the numbered side of the connecting rod.

(5) Rotate crankshaft so that the connecting rod journal is on the center of the cylinder bore. Be sure connecting rod and cylinder bore number are the same. 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 crankshaft journal.

(7) The notch, or groove, on top of piston must be pointing toward front of engine. The larger chamfer of the connecting rod bore must be installed toward crankshaft journal fillet.

(8) Install rod caps. Be sure connecting rod, connecting rod cap, and cylinder bore number are the same. Install nuts on cleaned and oiled rod bolts and tighten nuts to 61 N·m (45 ft. lbs.) torque.

(9) Install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

(10) Install the cylinder head (Refer to 9 - ENGINE/CYLINDER HEAD - INSTALLATION).

(11) Install the engine into the vehicle (Refer to 9 - ENGINE - INSTALLATION).

PISTON RINGS

STANDARD PROCEDURE - PISTON RING FITTING

(1) Measurement of end gaps:

(a) Measure piston ring gap 2 in. from bottom of cylinder bore. An inverted piston can be used to push the rings down to ensure positioning rings squarely in the cylinder bore before measuring.

(b) Insert feeler gauge in the gap. The top compression ring gap should be between 0.254-0.508 mm (0.010-0.020 in.). The second compression ring gap should be between 0.508-0.762 mm (0.020-0.030 in.). The oil ring gap should be 0.254-1.270 mm (0.010-0.050 in.).

(c) Rings with insufficient end gap may be properly filed to the correct dimension. Rings with excess gaps should not be used.

(2) Install rings, and confirm ring side clearance:

(a) Install oil rings being careful not to nick or scratch the piston. Install the oil control rings according to instructions in the package. It is not necessary to use a tool to install the upper and lower rails. Insert oil rail spacer first, then side rails.

(b) Install the second compression rings using Installation Tool C-4184. The compression rings

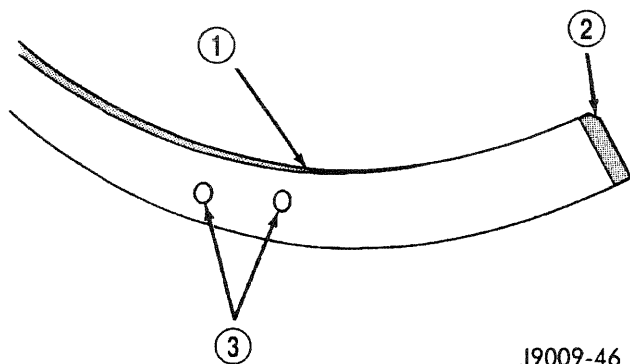
PISTON RINGS (Continued)

must be installed with the identification mark face up (toward top of piston) and chamfer facing down. An identification mark on the ring is a drill point, a stamped letter "O", an oval depression, or the word "TOP" (Fig. 43) (Fig. 45).

(c) Using a ring installer, install the top compression ring with the chamfer facing up (Fig. 44) (Fig. 45). An identification mark on the ring is a drill point, a stamped letter "O", an oval depression or the word "TOP" facing up.

(d) Measure side clearance between piston ring and ring land. Clearance should be 0.074-0.097 mm (0.0029-0.0038 in.) for the compression rings. The steel rail oil ring should be free in groove, but should not exceed 0.246 mm (0.0097 in.) side clearance.

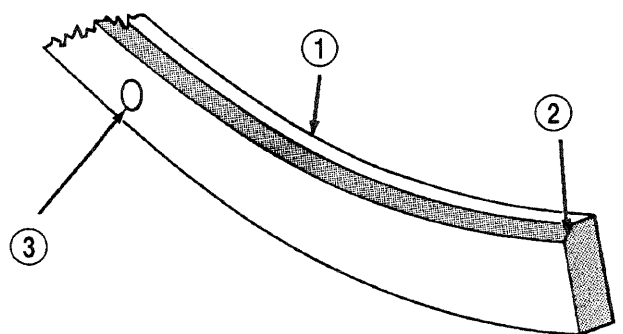
(e) Pistons with insufficient, or excessive, side clearance should be replaced.



J9009-46

Fig. 43 Second Compression Ring Identification (Typical)

- 1 - SECOND COMPRESSION RING (BLACK CAST IRON)
- 2 - CHAMFER
- 3 - TWO DOTS

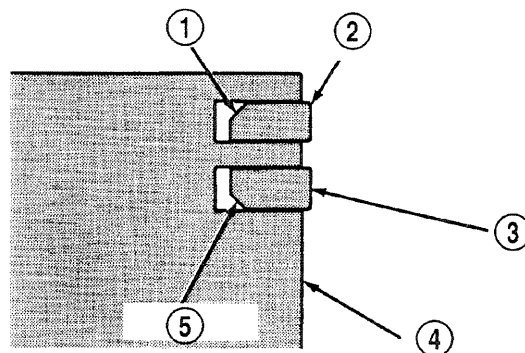


J9009-48

Fig. 44 Top Compression Ring Identification (Typical)

- 1 - TOP COMPRESSION RING (GRAY IN COLOR)
- 2 - CHAMFER
- 3 - ONE DOT

(3) Orient the rings:



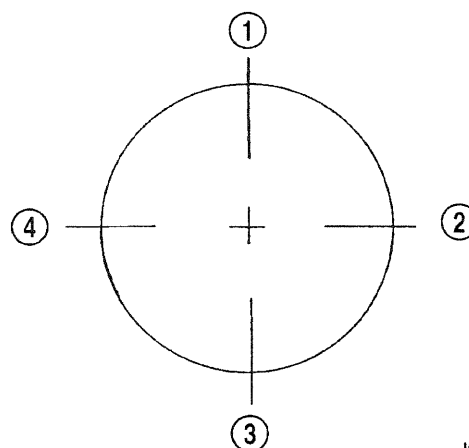
J9409-37

Fig. 45 Compression Ring Chamfer Location (Typical)

- 1 - CHAMFER
- 2 - TOP COMPRESSION RING
- 3 - SECOND COMPRESSION RING
- 4 - PISTON
- 5 - CHAMFER

(a) Arrange top compression ring 90° counter-clockwise from the oil ring rail gap (Fig. 46).

(b) Arrange second compression ring 90° clockwise from the oil ring rail gap (Fig. 46).



J9309-80

Fig. 46 Proper Ring Installation

- 1 - OIL RING SPACER GAP
- 2 - SECOND COMPRESSION RING GAP OIL RING RAIL GAP (TOP)
- 3 - OIL RING RAIL GAP (BOTTOM)
- 4 - TOP COMPRESSION RING GAP

VIBRATION DAMPER

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove fan, and fan drive (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - REMOVAL).
- (3) Remove the accessory drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
- (4) Remove the vibration damper pulley.

VIBRATION DAMPER (Continued)

(5) Remove vibration damper bolt and washer from end of crankshaft.

(6) Install bar and screw from Puller Tool Set C-3688. Install two bolts with washers through the puller tool and into the vibration damper (Fig. 47).

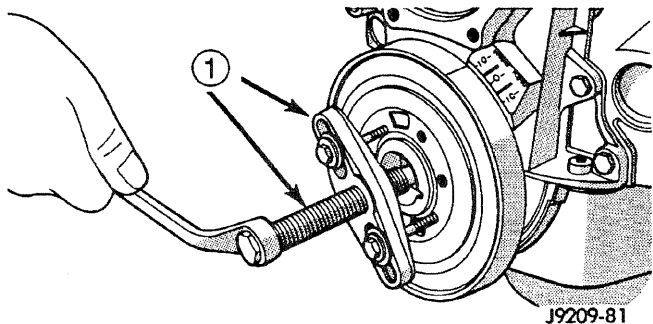


Fig. 47 Vibration Damper Assembly

1 - SPECIAL TOOL C-3688

(7) Pull vibration damper off of the crankshaft.

INSTALLATION

(1) Position the vibration damper onto the crankshaft.

(2) Place installing tool, part of Puller Tool Set C-3688, in position and press the vibration damper onto the crankshaft (Fig. 48).

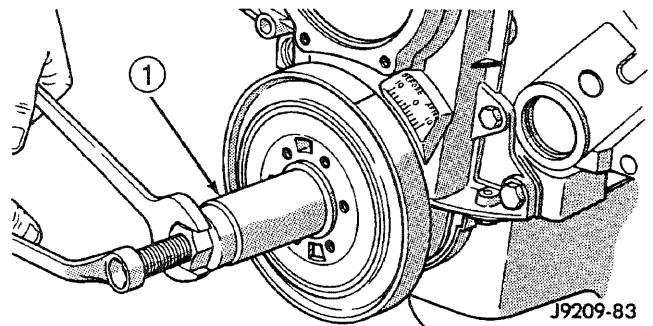


Fig. 48 Installing Vibration Damper

1 - SPECIAL TOOL C-3688

(3) Install the crankshaft bolt and washer. Tighten the bolt to 244 N·m (180 ft. lbs.) torque.

(4) Install the crankshaft pulley. Tighten the pulley bolts to 23 N·m (200 in. lbs.) torque.

(5) Install the serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

(6) Install viscous fan drive and fan (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(7) Install the fan shroud.

(8) Connect the negative cable to the battery.

FRONT MOUNT**REMOVAL****2WD**

(1) Disconnect the negative cable from the battery.

(2) Raise hood and position fan to assure clearance for radiator top tank and hose.

CAUTION: DO NOT lift the engine by the intake manifold.

(3) Install engine lifting fixture.

(4) Raise vehicle on hoist.

(5) Remove the insulator through bolt (Fig. 49) (Fig. 50) (Fig. 51).

(6) Raise engine with lifting fixture SLIGHTLY. Remove insulator retaining bolts and remove the insulator assembly.

(7) Remove insulator heat shield and transfer to new insulator.

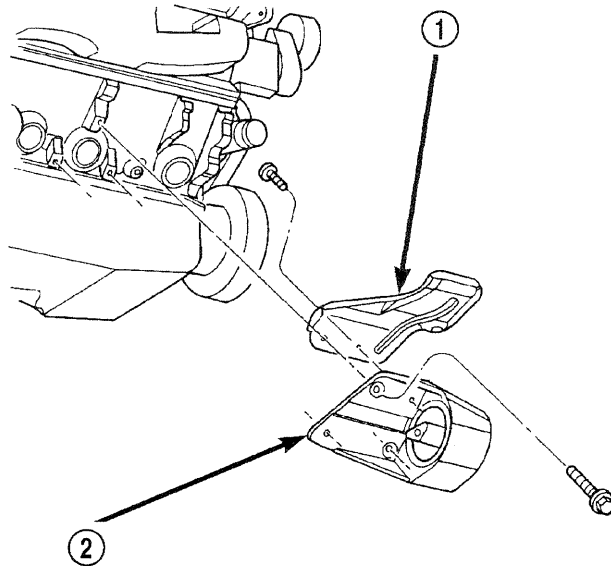


Fig. 49 Engine Right Front Insulator Mount—2WD Vehicles

1 - HEAT SHIELD
2 - INSULATOR

4WD

On 4-WD vehicles the engine front support brackets attach directly to engine block and the axle housing. The brackets provide a solid interconnection for these units (Fig. 52) (Fig. 53). Engine and front axle must be supported during any service procedures involving the front support assemblies.

(1) Disconnect the negative cable from the battery.

(2) Raise vehicle on hoist.

(3) Install engine lifting (support) fixture.

FRONT MOUNT (Continued)

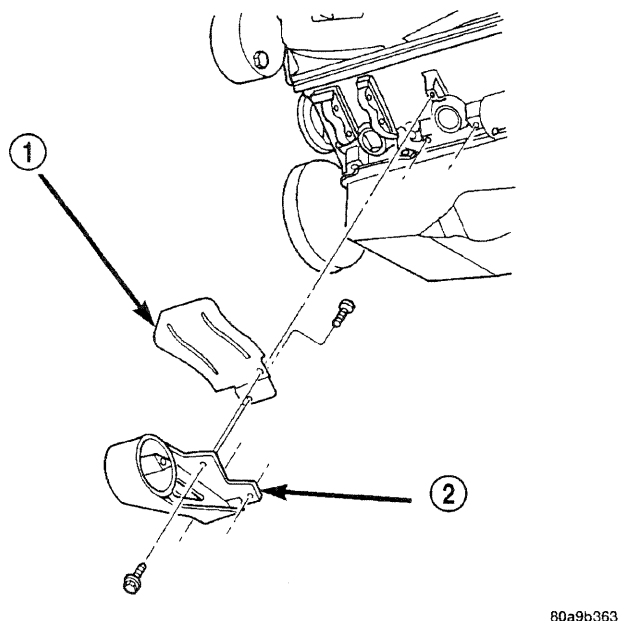


Fig. 50 Engine Left Front Insulator Mount—2WD Vehicles

- 1 - HEAT SHIELD
2 - INSULATOR

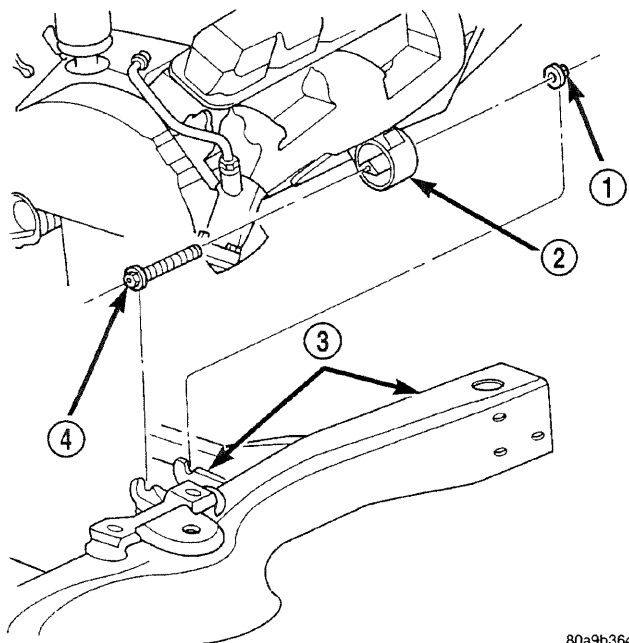


Fig. 51 Engine Mount Insulator at Frame

- 1 - NUT
2 - INSULATOR
3 - FRAME
4 - THROUGH BOLT

(4) Remove front axle. (Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - C205F - REMOVAL).

(5) **Left mount insulator only.** Remove starter wires and starter motor assembly.

(6) Remove insulator to frame through bolt (Fig. 54).

(7) Raise engine slightly.

(8) Remove upper insulator to support bracket stud nut and insulator to support through bolt.

(9) Remove engine mount insulator. (Fig. 52) (Fig. 53).

(10) If engine support bracket is to be removed/replaced, remove support bracket to transmission bell housing bolt(s) and three (3) support bracket to engine block bolts. Remove support bracket (Fig. 52) (Fig. 53).

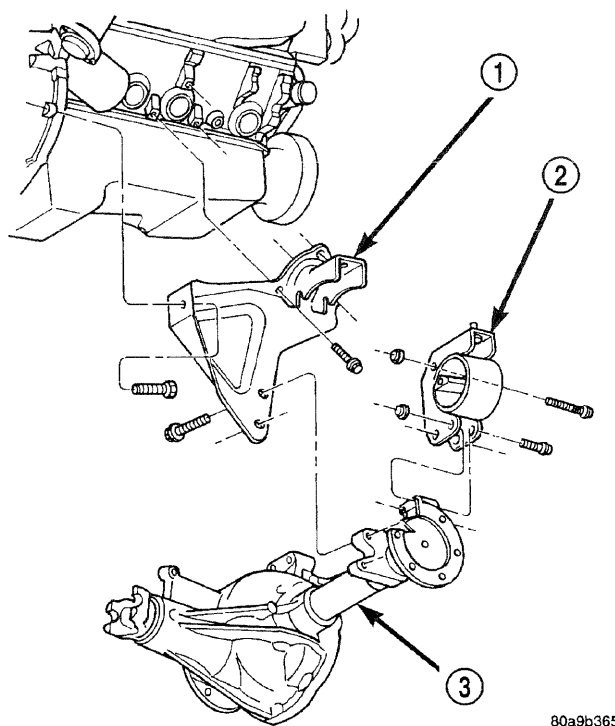


Fig. 52 Right Engine Mount Insulator and Support Bracket—4WD Vehicles

- 1 - ENGINE SUPPORT BRACKET
2 - INSULATOR
3 - FRONT AXLE

INSTALLATION

2WD

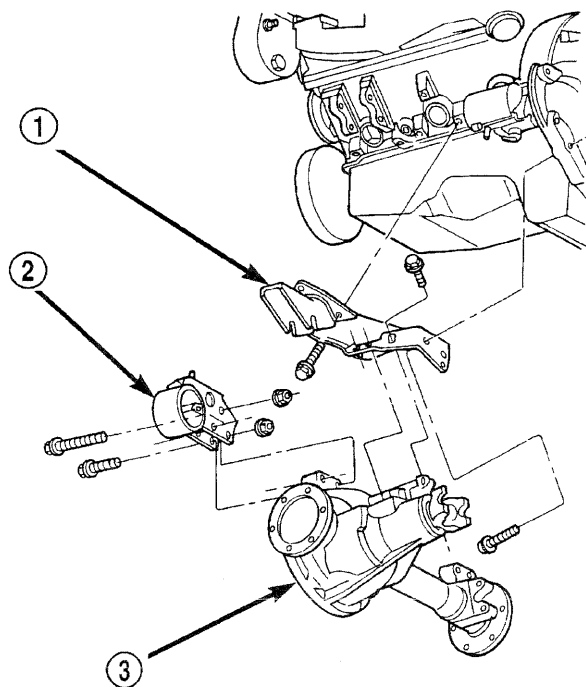
(1) With the engine raised SLIGHTLY, position insulator assembly onto the engine block and install bolts. Tighten the bolts to 41 N·m (30 ft. lbs.) torque.

(2) Lower engine with lifting fixture while guiding insulator assembly into the engine insulator bracket.

(3) Install insulator to bracket thru-bolt. Tighten the thru-bolt nut to 68 N·m (50 ft. lbs.) torque.

(4) Remove lifting fixture.

(5) Connect the negative cable to the battery.

FRONT MOUNT (Continued)

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Fig. 53 Left Engine Mount Insulator and Support Bracket—4WD Vehicles

- 1 - ENGINE SUPPORT BRACKET
- 2 - INSULATOR
- 3 - FRONT AXLE

4WD

(1) If engine support brackets were removed, install them and their fasteners. Tighten support bracket to block bolts to 41 N·m (30 ft. lbs.). Tighten support bracket to transmission bellhousing bolt(s) to 88 N·m (65 ft. lbs.).

(2) Install Engine mount insulator and tighten insulator to support bracket nut to 41 N·m (30 ft. lbs.). Tighten insulator to support bracket through bolt nut to 102 N·m (75 ft. lbs.).

(3) Lower engine and install insulator to frame through bolt and nut. Tighten nut to 95 N·m (70 ft. lbs.).

(4) Install starter motor and mounting bolts. Tighten bolts to 68 N·m (50 ft. lbs.).

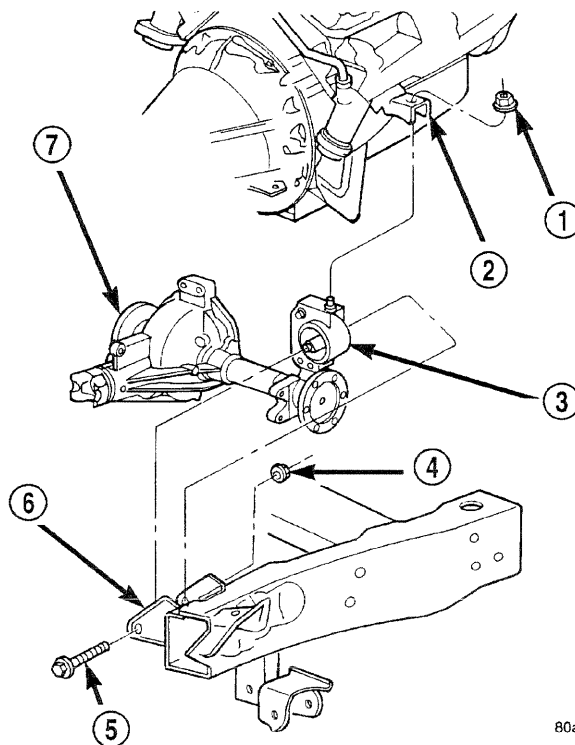
(5) Connect starter wires.

(6) Remove engine lifting (support) fixture.

(7) Install front axle assembly (Refer to 3 - DIFFERENTIAL & DRIVELINE/FRONT AXLE - C205F - INSTALLATION).

(8) Lower the vehicle.

(9) Connect the negative cable to the battery.



80a9b367

Fig. 54 Engine Mount

- 1 - NUT
- 2 - ENGINE SUPPORT BRACKET
- 3 - INSULATOR
- 4 - NUT
- 5 - THROUGH BOLT
- 6 - FRAME
- 7 - FRONT AXLE

REAR MOUNT**REMOVAL****2WD**

(1) Disconnect the negative cable from the battery.

(2) Raise the vehicle on a hoist.

(3) Support the transmission with a jack.

NOTE: AUTOMATIC TRANSMISSION

- Remove engine support bracket—insulator through bolt (Fig. 55).
- Raise the transmission and engine slightly.
- Remove stud nuts attaching insulator to cross-member (Fig. 55). Remove insulator.

NOTE: MANUAL TRANSMISSION

- Remove the stud nuts attaching the insulator to the transmission extension (Fig. 56).
- Raise the transmission and engine slightly.
- Remove stud nuts attaching insulator to cross-member (Fig. 56). Remove insulator.

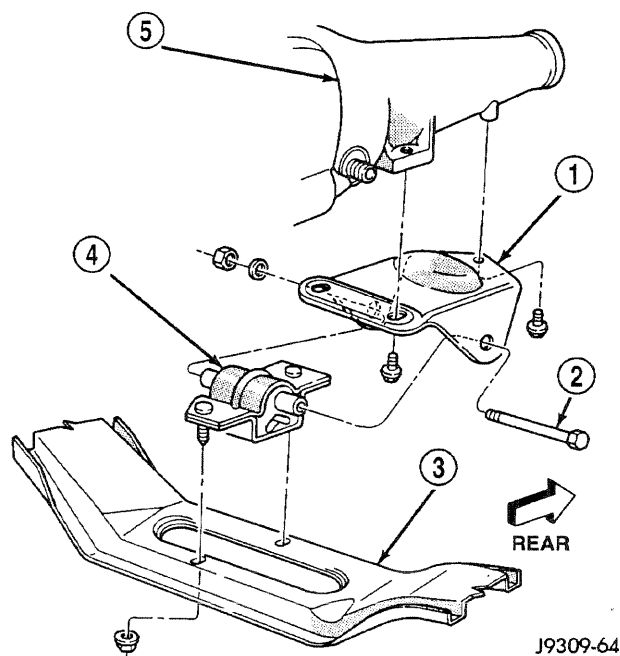
REAR MOUNT (Continued)

Fig. 55 Rear Insulator Automatic Transmission—2WD

- 1 - ENGINE SUPPORT BRACKET
- 2 - THROUGH BOLT
- 3 - CROSSMEMBER
- 4 - INSULATOR
- 5 - TRANSMISSION EXTENSION

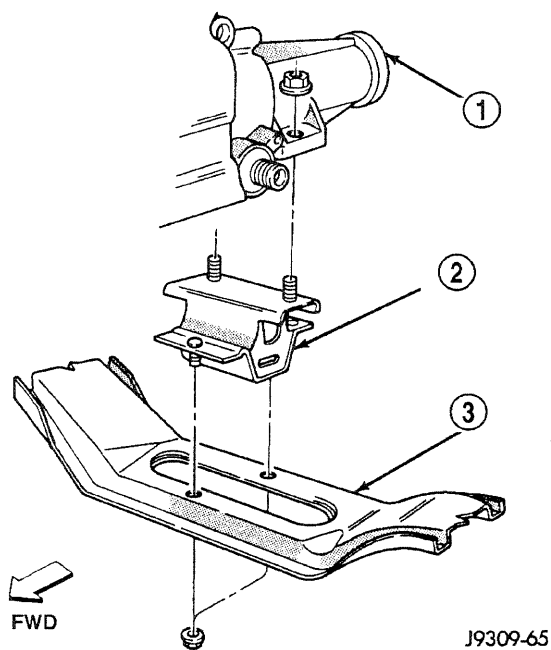


Fig. 56 Rear Insulator Manual Transmission—2WD

- 1 - TRANSMISSION EXTENSION
- 2 - INSULATOR
- 3 - CROSSMEMBER

4WD

- (1) Disconnect the negative cable from the battery.
- (2) Raise the vehicle on a hoist.
- (3) Support the transmission with a transmission jack.

NOTE: AUTOMATIC TRANSMISSION

- Remove stud nuts holding the insulator to the crossmember (Fig. 57).
- Raise rear of transmission SLIGHTLY.
- Remove bolts holding the insulator to the insulator bracket (Fig. 57). Remove the insulator.

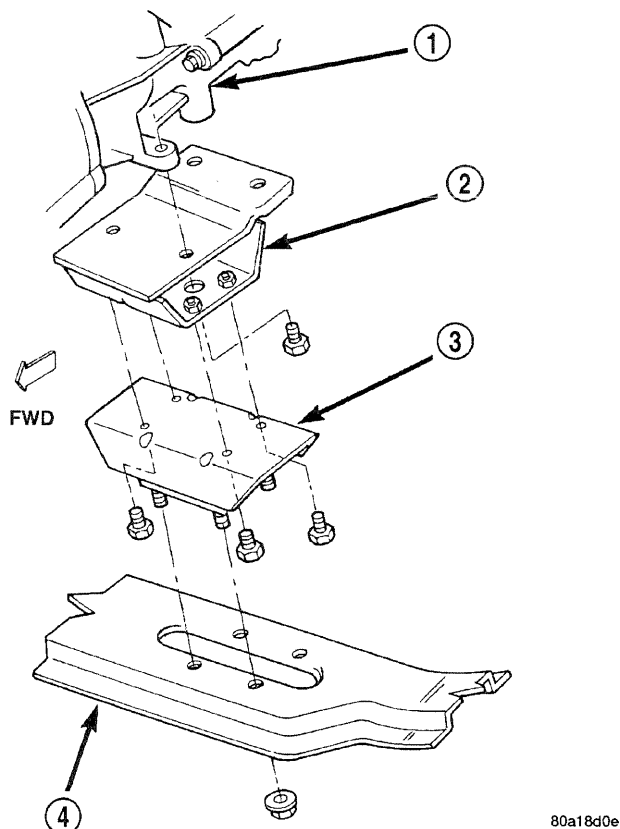
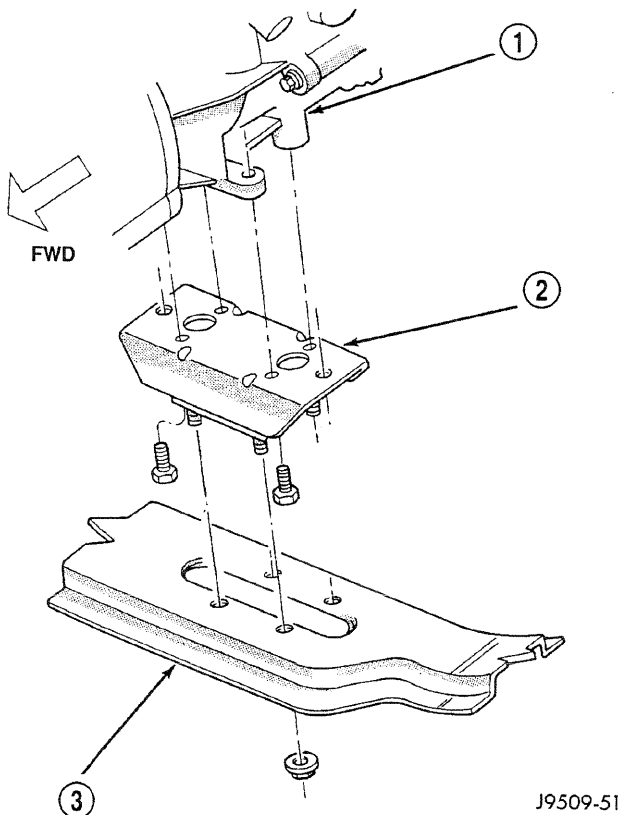


Fig. 57 Rear Insulator Automatic Transmission—4WD

- 1 - AUTOMATIC TRANSMISSION
- 2 - INSULATOR BRACKET
- 3 - INSULATOR
- 4 - CROSSMEMBER

NOTE: MANUAL TRANSMISSION

- Remove stud nuts holding the insulator to the crossmember (Fig. 58).
- Raise rear of transmission SLIGHTLY.
- Remove bolts holding the insulator to the transmission (Fig. 58). Remove the insulator.

REAR MOUNT (Continued)**Fig. 58 Rear Insulator Manual Transmission—4WD**

- 1 - MANUAL TRANSMISSION
 2 - INSULATOR
 3 - CROSSMEMBER

INSTALLATION**2WD**

(1) If the engine support bracket (Automatic Transmissions) was removed, position the bracket to the transmission extension (Fig. 55). Tighten the bolts to 68 N·m (50 ft. lbs.) torque.

NOTE: AUTOMATIC TRANSMISSION

- Install the insulator onto crossmember. Tighten the stud nuts to 41 N·m (30 ft. lbs) torque.
- Lower the transmission and engine while aligning the engine support bracket to the insulator.
- Install thru-bolt in bracket and insulator. Tighten thru-bolt nut to 68 N·m (50 ft. lbs.) torque.

NOTE: MANUAL TRANSMISSION

- Install the insulator onto crossmember. Tighten the stud nuts to 41 N·m (30 ft. lbs) torque.
- Lower the transmission and engine while aligning the insulator studs into the transmission extension.

- Install the stud nuts. Tighten the stud nuts to 41 N·m (30 ft. lbs) torque.

(2) Remove transmission jack.

(3) Lower the vehicle.

(4) Connect the negative cable to the battery.

4WD**NOTE: AUTOMATIC TRANSMISSION**

• If the insulator bracket was removed, install the bracket to the transmission (Fig. 57). Tighten the bolts to 68 N·m (50 ft. lbs.) torque.

• Install the bolts holding insulator to insulator bracket. Tighten the bolts to 68 N·m (50 ft. lbs.) torque.

• Lower rear of transmission while aligning the insulator studs into the mounting support bracket. Install stud nuts and tighten to 68 N·m (50 ft. lbs.) torque.

NOTE: MANUAL TRANSMISSION

• Install the bolts holding insulator to insulator bracket. Tighten the bolts to 68 N·m (50 ft. lbs.) torque.

• Lower rear of transmission while aligning the insulator studs into the mounting support bracket. Install stud nuts and tighten to 68 N·m (50 ft. lbs.) torque.

(1) Remove the transmission jack.

(2) Lower the vehicle.

(3) Connect the negative cable to the battery.

LUBRICATION**DESCRIPTION**

A gear-type positive displacement pump (Fig. 59) is mounted at the underside of the rear main bearing cap. The pump uses a pick-up tube and screen assembly to gather engine oil from the oil pan.

OPERATION

The pump draws oil through the screen and inlet tube from the sump at the rear of the oil pan. The oil is driven between the drive and idler gears and pump body, then forced through the outlet to the block. An oil gallery in the block channels the oil to the inlet side of the full flow oil filter. After passing through the filter element, the oil passes from the center outlet of the filter through an oil gallery that channels the oil up to the main gallery, which extends the entire length on the right side of the block. The oil then goes down to the No. 1 main bearing, back up to the left side of the block, and into the oil gallery on the left side of the engine.

LUBRICATION (Continued)

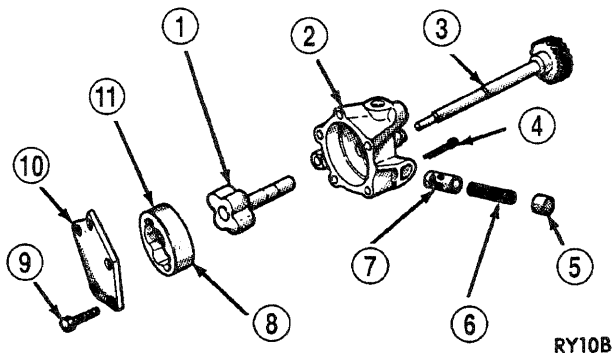


Fig. 59 Positive Displacement Oil Pump—Typical

- 1 - INNER ROTOR AND SHAFT
- 2 - BODY
- 3 - DISTRIBUTOR DRIVESHAFT (REFERENCE)
- 4 - COTTER PIN
- 5 - RETAINER CAP
- 6 - SPRING
- 7 - RELIEF VALVE
- 8 - LARGE CHAMFERED EDGE
- 9 - BOLT
- 10 - COVER
- 11 - OUTER ROTOR

Galleries extend downward from the main oil gallery to the upper shell of each main bearing. The crankshaft is drilled internally to pass oil from the main bearing journals to the connecting rod journals. Each connecting rod bearing has half a hole in it, oil passes through the hole when the rods rotate and the hole lines up, oil is then thrown off as the rod rotates. This oil throwoff lubricates the camshaft lobes, distributor drive gear, cylinder walls, and piston pins.

The hydraulic valve tappets receive oil directly from the main oil gallery. The camshaft bearings receive oil from the main bearing galleries. The front camshaft bearing journal passes oil through the camshaft sprocket to the timing chain. Oil drains back to the oil pan under the No. 1 main bearing cap.

The oil supply for the rocker arms and bridged pivot assemblies is provided by the hydraulic valve tappets, which pass oil through hollow push rods to a hole in the corresponding rocker arm. Oil from the rocker arm lubricates the valve train components. The oil then passes down through the push rod guide holes and the oil drain-back passages in the cylinder head, past the valve tappet area, and then returns to the oil pan (Fig. 60).

DIAGNOSIS AND TESTING

DIAGNOSIS AND TESTING—ENGINE OIL PRESSURE

- (1) Remove oil pressure sending unit.
- (2) Install Oil Pressure Line and Gauge Tool C-3292. Start engine and record pressure. (Refer to 9 - ENGINE - SPECIFICATIONS).

DIAGNOSIS AND TESTING—ENGINE OIL LEAKS

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

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

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

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

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

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

(6) Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.

(7) Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.

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

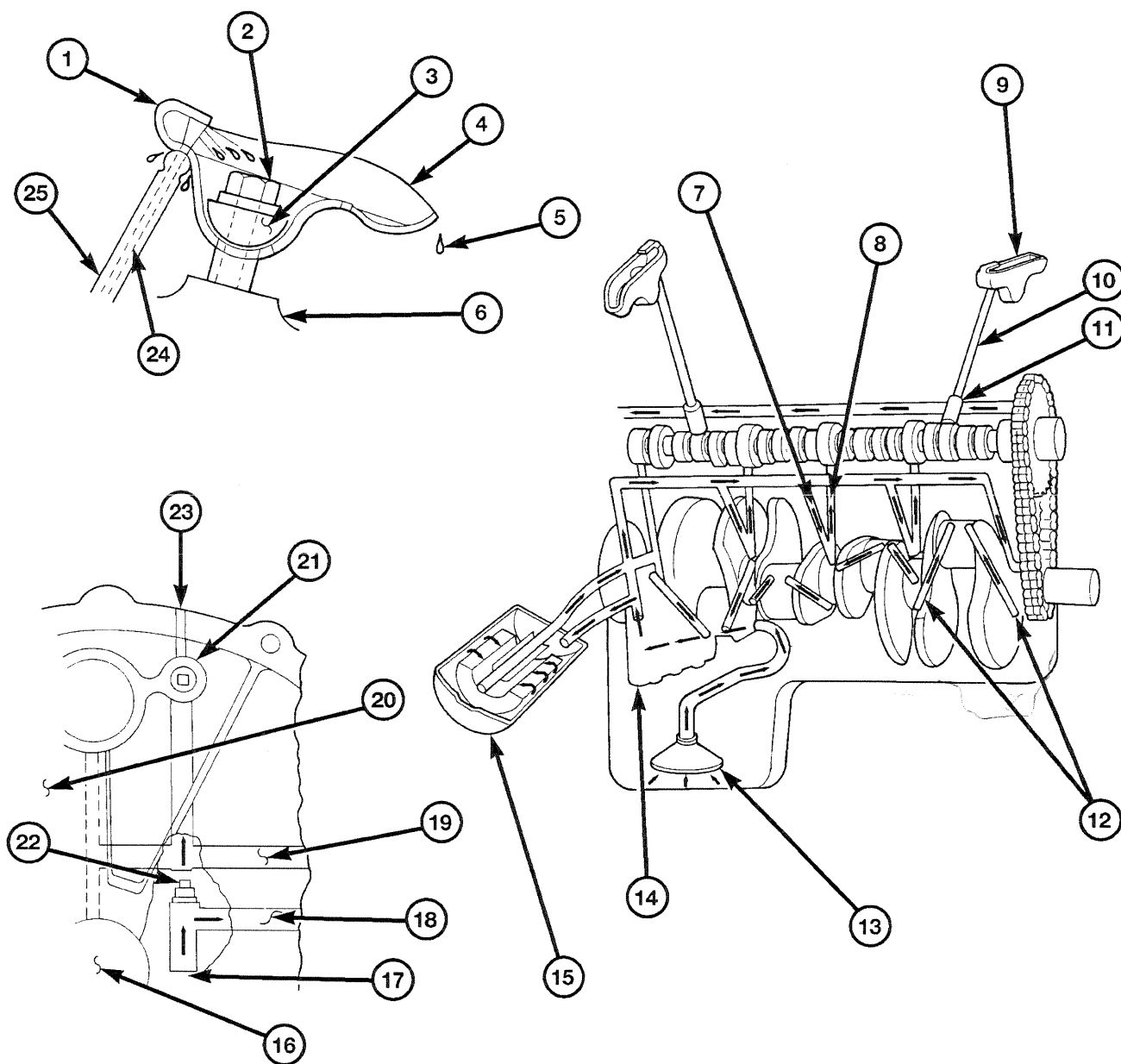
CAUTION: Do not subject the engine assembly to more than 20.6 kpa (3 PSI) of test pressure.

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

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

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

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

LUBRICATION (Continued)

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Fig. 60 Oil Lubrication System

- | | |
|---------------------------------|---|
| 1 - OIL DEFLECTOR TAB | 14 - OIL PUMP |
| 2 - BOLT | 15 - OIL FILTER |
| 3 - ROCKER ARM PIVOT | 16 - CRANKSHAFT |
| 4 - ROCKER ARM | 17 - FROM OIL PUMP |
| 5 - DRIP OILING FOR VALVE TIP | 18 - OIL TO FILTER |
| 6 - CYLINDER HEAD BOSS | 19 - OIL FROM FILTER TO SYSTEM |
| 7 - TO MAIN BEARINGS | 20 - PASSAGE TO CAMSHAFT REAR BEARING |
| 8 - TO CAMSHAFT BEARINGS | 21 - RIGHT OIL GALLERY |
| 9 - ROCKER ARM | 22 - PLUG |
| 10 - HOLLOW PUSH ROD | 23 - OIL PASSAGE FOR OIL PRESSURE INDICATOR LIGHT |
| 11 - TAPPET | 24 - OIL SUPPLY VIA HOLLOW PUSH ROD SUPPLY IS FROM OIL GALLERY METERED THROUGH HYDRAULIC TAPPET |
| 12 - TO CONNECTING ROD BEARINGS | 25 - OIL SUPPLY FROM HOLLOW PUSH ROD |
| 13 - OIL INTAKE | |

OIL

STANDARD PROCEDURE - ENGINE OIL

OIL LEVEL INDICATOR (DIPSTICK)

The engine oil level indicator is located at the right front of the engine, left of the generator (Fig. 61).

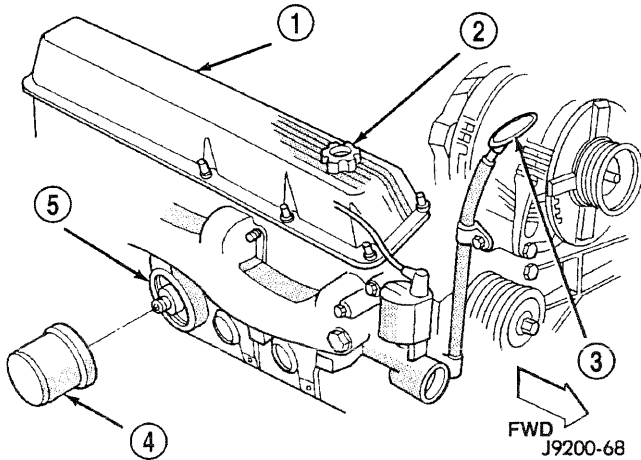


Fig. 61 Oil Level Indicator Location

- 1 - CYLINDER HEAD COVER
- 2 - ENGINE OIL FILL CAP
- 3 - DIPSTICK
- 4 - ENGINE OIL FILTER
- 5 - FILTER BOSS

CRANKCASE OIL LEVEL INSPECTION

CAUTION: Do not overfill crankcase with engine oil, oil foaming and oil pressure loss can result.

To ensure proper lubrication of an engine, the engine oil must be maintained at an acceptable level. The acceptable levels are indicated between the ADD and SAFE marks on the engine oil dipstick.

- (1) Position vehicle on level surface.
- (2) With engine OFF, allow approximately ten minutes for oil to settle to bottom of crankcase, remove engine oil dipstick.
- (3) Wipe dipstick clean.
- (4) Install dipstick and verify it is seated in the tube.
- (5) Remove dipstick, with handle held above the tip, take oil level reading.
- (6) Add oil only if level is below the ADD mark on dipstick.

ENGINE OIL CHANGE

Change engine oil at mileage and time intervals described in the Maintenance Schedule. This information can be found in the owner's manual.

TO CHANGE ENGINE OIL

Run engine until achieving normal operating temperature.

- (1) Position the vehicle on a level surface and turn engine off.
- (2) Hoist vehicle.
- (3) Remove oil fill cap.
- (4) Place a suitable drain pan under crankcase drain.
- (5) Remove drain plug from crankcase and allow oil to drain into pan. Inspect drain plug threads for stretching or other damage. Replace drain plug and gasket if damaged.
- (6) Install drain plug in crankcase.
- (7) Change oil filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - REMOVAL).
- (8) Lower vehicle and fill crankcase with specified type (Refer to LUBRICATION & MAINTENANCE/FLUID TYPES - DESCRIPTION) and amount of engine oil (Refer to LUBRICATION & MAINTENANCE - SPECIFICATIONS).
- (9) Install oil fill cap.
- (10) Start engine and inspect for leaks.
- (11) Stop engine and inspect oil level.

OIL FILTER

REMOVAL

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

- (1) Position a drain pan under the oil filter.
- (2) Using a suitable oil filter wrench loosen filter.
- (3) Rotate the oil filter counterclockwise to remove it from the cylinder block oil filter boss (Fig. 62).

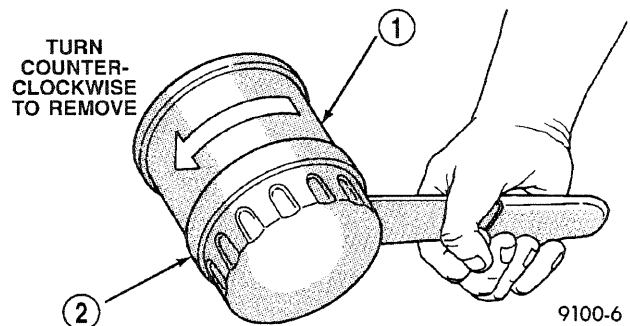


Fig. 62 Oil Filter Removal—Typical

- 1 - ENGINE OIL FILTER
- 2 - OIL FILTER WRENCH

- (4) When filter separates from adapter nipple, tip gasket end upward to minimize oil spill. Remove filter from vehicle.

OIL FILTER (Continued)

(5) With a wiping cloth, clean the gasket sealing surface (Fig. 63) of oil and grime.

(6) Install new filter (Refer to 9 - ENGINE/LUBRICATION/OIL FILTER - INSTALLATION).

INSTALLATION

(1) Lightly lubricate oil filter gasket with engine oil or chassis grease.

(2) Thread filter onto adapter nipple. When gasket makes contact with sealing surface, (Fig. 63) hand tighten filter one full turn, do not over tighten.

(3) Add oil (Refer to 9 - ENGINE/LUBRICATION/OIL - STANDARD PROCEDURE).

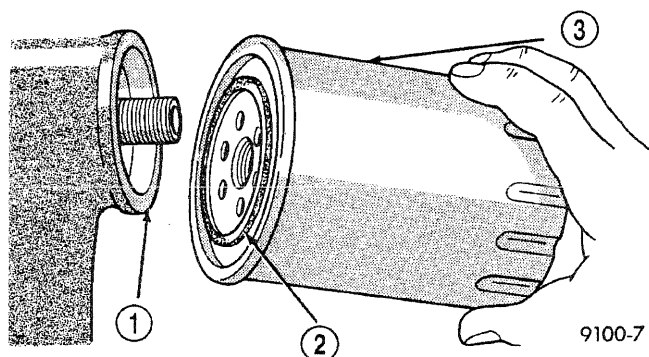


Fig. 63 Oil Filter Sealing Surface—Typical

- 1 - SEALING SURFACE
- 2 - RUBBER GASKET
- 3 - OIL FILTER

OIL PAN

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Remove engine oil dipstick.
- (3) Raise vehicle.
- (4) Drain engine oil.
- (5) Remove exhaust pipe.
- (6) Remove left engine to transmission strut.
- (7) Loosen the right side engine support bracket cushion through-bolt nut and raise the engine slightly. Remove oil pan by sliding backward and out.
- (8) Remove the one-piece gasket.

CLEANING

Clean the block and pan gasket surfaces.

Trim or remove excess sealant film in the rear main cap oil pan gasket groove. **DO NOT remove the sealant inside the rear main cap slots.**

If present, trim excess sealant from inside the engine.

Clean oil pan in solvent and wipe dry with a clean cloth.

Clean oil screen and pipe thoroughly in clean solvent. Inspect condition of screen.

INSPECTION

Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.

Inspect oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

INSTALLATION

(1) Clean the block and pan gasket surfaces.

(2) Fabricate four alignment dowels from 5/16 X 1 1/2 inch bolts. Cut the head off the bolts and cut a slot into the top of the dowel. This will allow easier installation and removal with a screwdriver (Fig. 64).

(3) Install the dowels in the cylinder block (Fig.

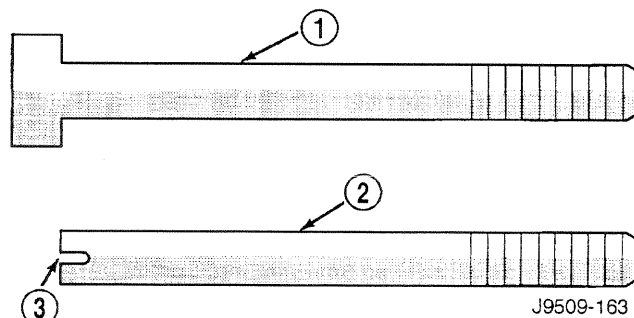


Fig. 64 Fabrication of Alignment Dowels

- 1 - 5/16" X 1 1/2" BOLT
- 2 - DOWEL
- 3 - SLOT

65).

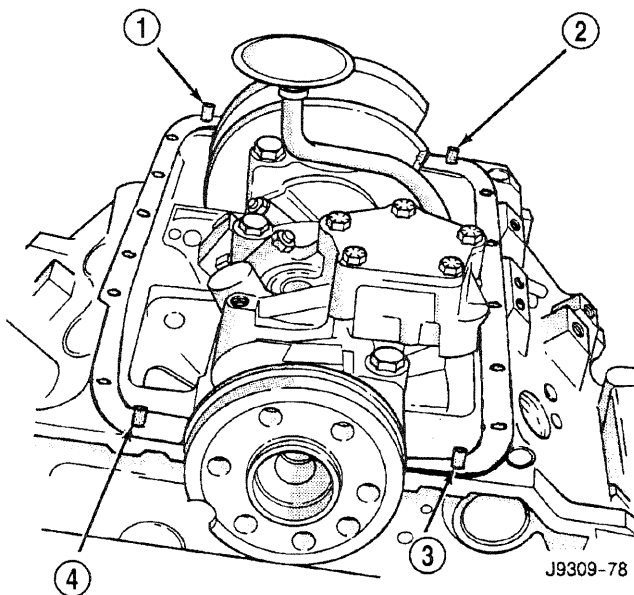


Fig. 65 Position of Dowels in Cylinder Block

- 1 - DOWEL
- 2 - DOWEL
- 3 - DOWEL
- 4 - DOWEL

OIL PAN (Continued)

(4) Apply small amount of Mopar® Silicone Rubber Adhesive Sealant, or equivalent, in the corner of the cap and the cylinder block.

(5) Slide the one-piece gasket over the dowels and onto the block.

(6) Position the oil pan over the dowels and onto the gasket.

(7) Install the oil pan bolts. Tighten the bolts to 24 N·m (215 in. lbs.) torque.

(8) Remove the dowels. Install the remaining oil pan bolts. Tighten these bolts to 24 N·m (215 in. lbs.) torque.

(9) Lower the engine into the support cushion brackets and tighten the through-bolt nut to the proper torque.

(10) Install the drain plug. Tighten drain plug to 34 N·m (27 ft. lbs.) torque.

(11) Install the engine to transmission strut.

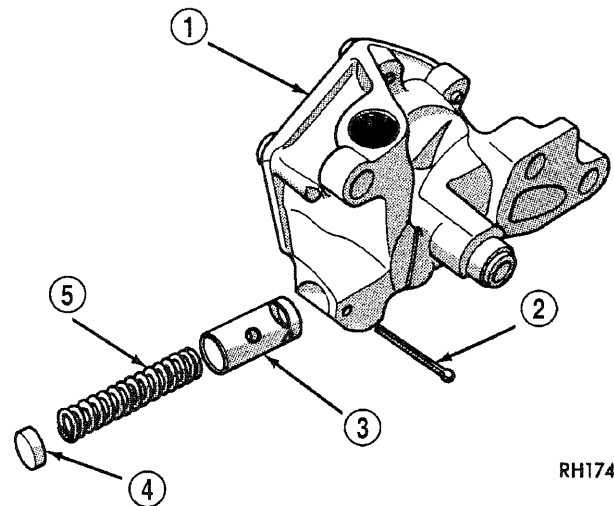
(12) Install exhaust pipe.

(13) Lower vehicle.

(14) Install dipstick.

(15) Connect the negative cable to the battery.

(16) Fill crankcase with oil to proper level.



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Fig. 66 Oil Pressure Relief Valve

- 1 - OIL PUMP ASSEMBLY
- 2 - COTTER PIN
- 3 - RELIEF VALVE
- 4 - RETAINER CAP
- 5 - SPRING

OIL PUMP

REMOVAL

(1) Remove the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - REMOVAL).

(2) Remove the oil pump from rear main bearing cap.

DISASSEMBLY

(1) Remove the relief valve as follows:

(a) Remove cotter pin. Drill a 3.175 mm (1/8 in.) 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, remove cap by tapping pump body using a soft hammer. Discard retainer cap and remove spring and relief valve (Fig. 66).

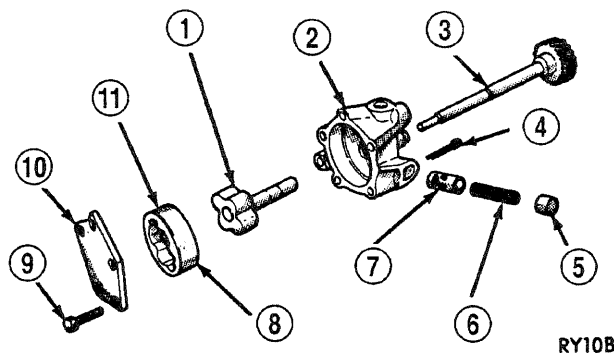
(2) Remove oil pump cover (Fig. 67).

(3) Remove pump outer rotor and inner rotor with shaft (Fig. 67).

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

CLEANING

Use only mild solvents to clean the oil pump. Do not use any abrasive material to clean the oil pump housing or rotors.



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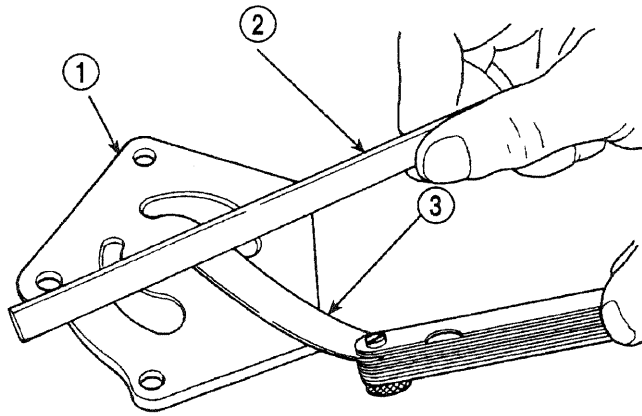
Fig. 67 Oil Pump

- 1 - INNER ROTOR AND SHAFT
- 2 - BODY
- 3 - DISTRIBUTOR DRIVESHAFT (REFERENCE)
- 4 - COTTER PIN
- 5 - RETAINER CAP
- 6 - SPRING
- 7 - RELIEF VALVE
- 8 - LARGE CHAMFERED EDGE
- 9 - BOLT
- 10 - COVER
- 11 - OUTER ROTOR

INSPECTION

Mating surface of the oil pump cover should be smooth. Replace pump assembly if cover is scratched or grooved.

Lay a straightedge across the pump cover surface (Fig. 68). If a 0.038 mm (0.0015 in.) feeler gauge can be inserted between cover and straightedge, pump assembly should be replaced.

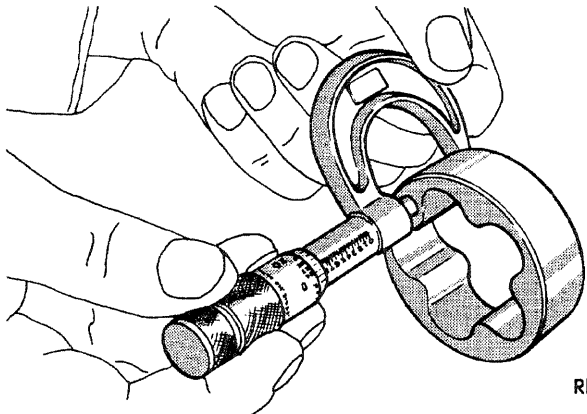
OIL PUMP (Continued)

8020cd6e

Fig. 68 Checking Oil Pump Cover Flatness

- 1 - COVER
- 2 - STRAIGHT EDGE
- 3 - FEELER GAUGE

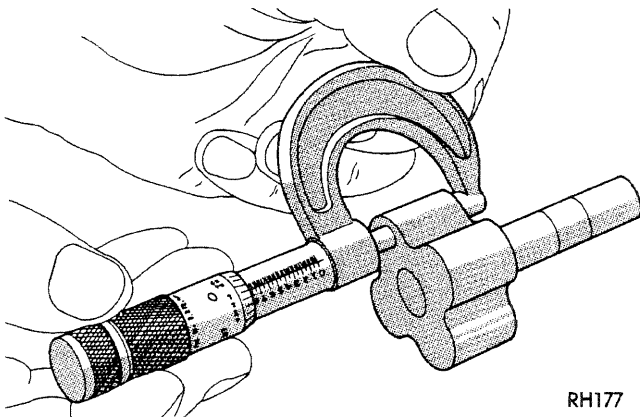
Measure thickness and diameter of outer rotor. If outer rotor thickness measures 20.9 mm (0.825 in.) or less, or if the diameter is 62.7 mm (2.469 in.) or less, replace outer rotor (Fig. 69).



RH176

Fig. 69 Measuring Outer Rotor Thickness

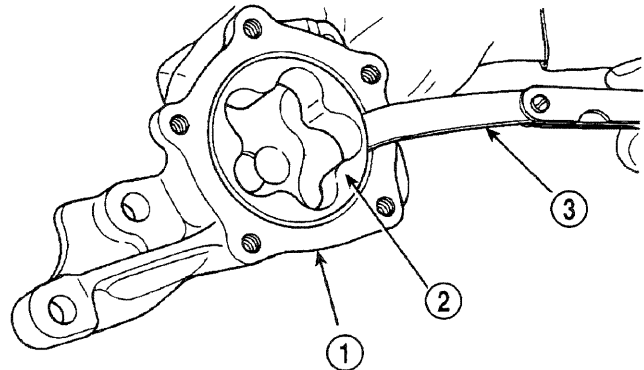
If inner rotor measures 20.9 mm (0.825 in.) or less, replace inner rotor and shaft assembly (Fig. 70).



RH177

Fig. 70 Measuring Inner Rotor Thickness

Slide outer rotor into pump body. Press rotor to the side with your fingers and measure clearance between rotor and pump body (Fig. 71). If clearance is 0.356 mm (0.014 in.) or more, replace oil pump assembly.

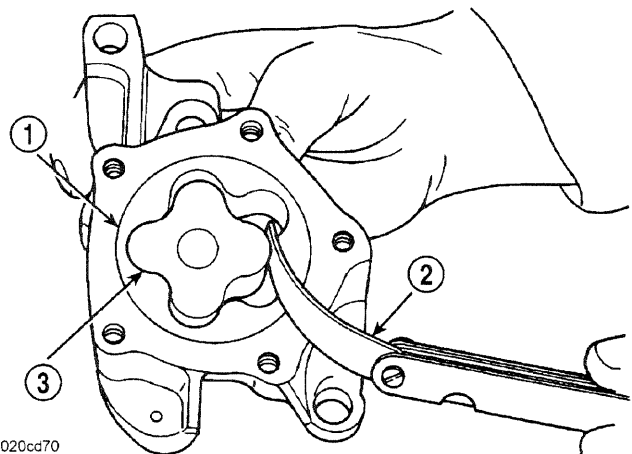


8020cd6f

Fig. 71 Measuring Outer Rotor Clearance in Housing

- 1 - PUMP BODY
- 2 - OUTER ROTOR
- 3 - FEELER GAUGE

Install inner rotor and shaft into pump body. If clearance between inner and outer rotors is 0.203 mm (0.008 in.) or more, replace shaft and both rotors (Fig. 72).



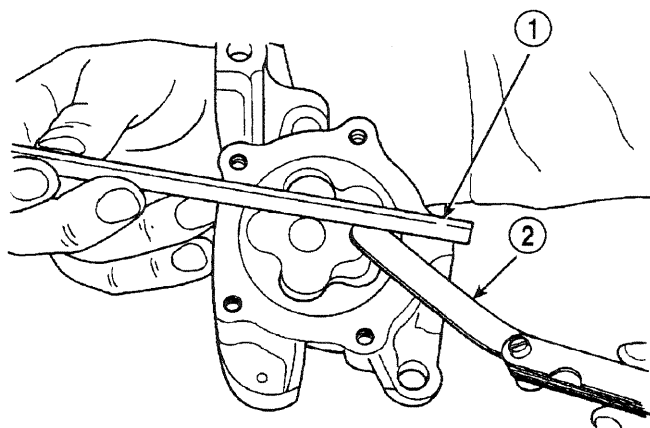
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Fig. 72 Measuring Clearance Between Rotors

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

Place a straightedge across the face of the pump, between bolt holes. If a feeler gauge of 0.102 mm (0.004 in.) or more can be inserted between rotors and the straightedge, replace pump assembly (Fig. 73).

OIL PUMP (Continued)



8020cd71

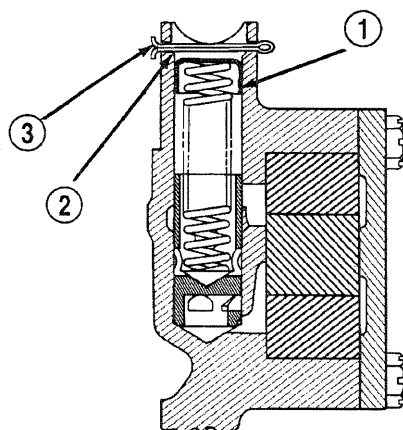
Fig. 73 Measuring Clearance Over Rotors

- 1 - STRAIGHT EDGE
2 - FEELER GAUGE

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.

The relief valve spring has a free length of approximately 49.5 mm (1.95 in.). The spring should test between 19.5 and 20.5 pounds when compressed to 34 mm (1-11/32 in.). Replace spring that fails to meet these specifications (Fig. 74).

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



RN98

Fig. 74 Proper Installation of Retainer Cap

- 1 - RETAINER CAP
2 - CHAMFER
3 - COTTER KEY

ASSEMBLY

(1) Install pump rotors and shaft, using new parts as required.

(2) Position the oil pump cover onto the pump body. Tighten cover bolts to 11 N·m (95 in. lbs.) torque.

(3) Install the relief valve and spring. Insert the cotter pin.

(4) Tap on a new retainer cap.

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

INSTALLATION

(1) Install oil pump. During installation, slowly rotate pump body to ensure driveshaft-to-pump rotor shaft engagement.

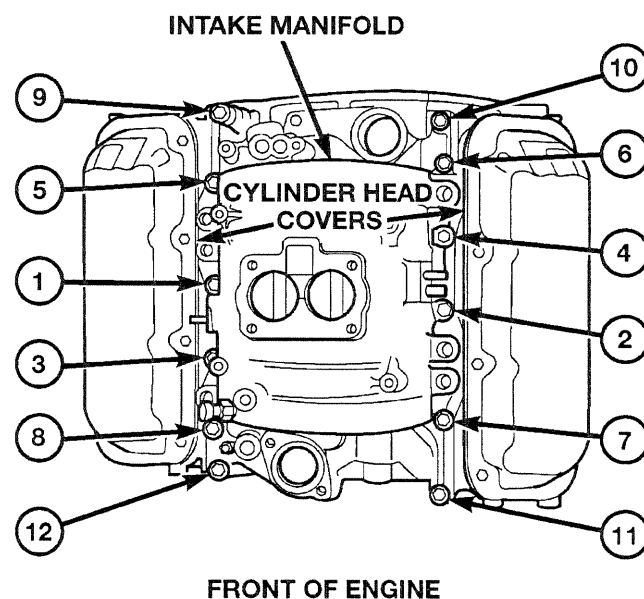
(2) Hold the oil pump base flush against mating surface on No. 4 main bearing cap. Finger-tighten pump attaching bolts. Tighten attaching bolts to 41 N·m (30 ft. lbs.) torque.

(3) Install the oil pan (Refer to 9 - ENGINE/LUBRICATION/OIL PAN - INSTALLATION).

INTAKE MANIFOLD

DESCRIPTION

The aluminum intake manifold (Fig. 75) is a single plane design with equal length runners. This manifold uses a separate plenum pan and gasket, therefore the plenum gasket is servicable. It also uses separate flange gaskets and front and rear cross-over gaskets. Extreme care must be used when sealing the gaskets to ensure that excess sealant does not enter the intake runners causing a restriction.



80c071ac

Fig. 75 Intake Manifold with Tightening Sequence—3.9L Engine

INTAKE MANIFOLD (Continued)

OPERATION

The intake manifold, meters and delivers air to the combustion chambers allowing the fuel delivered by the fuel injectors to ignite, thus producing power.

DIAGNOSIS AND TESTING—INTAKE MANIFOLD LEAKAGE

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

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

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

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Drain the cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
- (3) Remove the A/C compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - REMOVAL).
- (4) Remove the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - REMOVAL).
- (5) Remove the accessory drive bracket.
- (6) Remove the air cleaner.
- (7) Perform the Fuel System Pressure release procedure (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY - STANDARD PROCEDURE). Disconnect the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).
- (8) Disconnect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - REMOVAL) and if so equipped, the speed control and transmission kickdown cables.
- (9) Remove the return spring.
- (10) Remove the distributor cap and wires.
- (11) Disconnect the coil wires.
- (12) Disconnect the heat indicator sending unit wire.
- (13) Disconnect the heater hoses and bypass hose.
- (14) Remove the closed crankcase ventilation and evaporation control systems.
- (15) Remove intake manifold bolts.
- (16) Lift the intake manifold and throttle body out of the engine compartment as an assembly.

(17) Remove and discard the flange side gaskets and the front and rear cross-over gaskets.

(18) Remove the throttle body (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - REMOVAL).

(19) If required, remove the plenum pan and gasket. Discard gasket.

CLEANING

Clean manifold in solvent and blow dry with compressed air.

Clean cylinder block front and rear gasket surfaces using a suitable solvent.

The plenum pan rail must be clean and dry (free of all foreign material).

INSPECTION

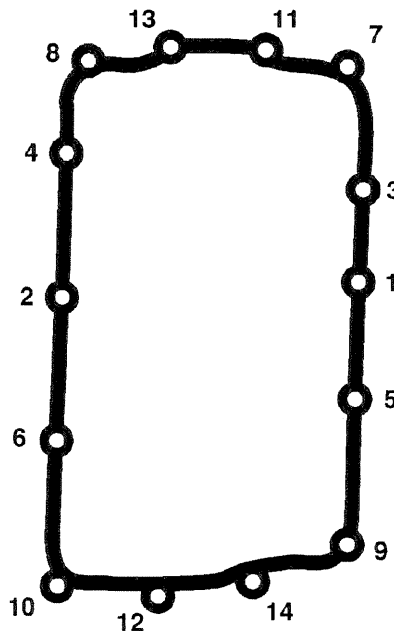
Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straightedge.

INSTALLATION

(1) If the plenum pan was removed, position a new gasket and install the plenum pan (Fig. 76). Tighten bolts in the following sequence:

- Step 1. Tighten bolts to 5.4 N·m (48 in. lbs.)
- Step 2. Tighten bolts to 9.5 N·m (84 in. lbs.)
- Step 3. Check bolts to 9.5 N·m (84 in. lbs.)



80c071ea

Fig. 76 Plenum Pan Bolt Tightening Sequence

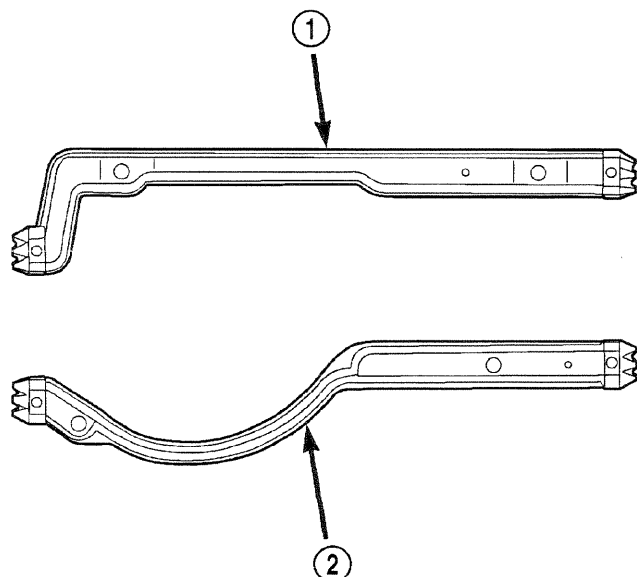
(2) Install the flange gaskets. Ensure that the vertical port alignment tab is resting on the deck face of the block. Also the horizontal alignment tabs must be in position with the mating cylinder head gasket tabs

INTAKE MANIFOLD (Continued)

(Fig. 78). The words MANIFOLD SIDE should be visible on the center of each flange gasket.

(3) Apply Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, to the four corner joints. An excessive amount of sealant is not required to ensure a leak proof seal. However, an excessive amount of sealant may reduce the effectiveness of the flange gasket. The sealant should be approximately 5 mm (0.2 in) in diameter.

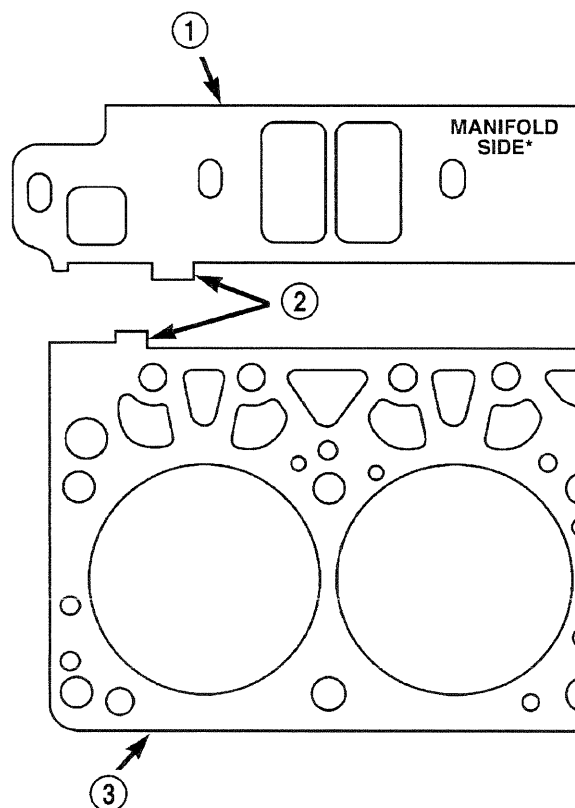
(4) Install the front and rear cross-over gaskets (Fig. 77).



80c071ad

Fig. 77 Cross-Over Gaskets

- 1 - FRONT END SEALS
- 2 - REAR END SEALS



80c071ae

Fig. 78 Intake Manifold Flange Gasket Alignment

- 1 - FLANGE GASKET
- 2 - ALIGNMENT TABS
- 3 - CYLINDER HEAD GASKET

(5) Using a new gasket, install the throttle body onto the intake manifold (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE BODY - INSTALLATION).

(6) Carefully lower intake manifold into position on the cylinder block and cylinder heads. After intake manifold is in place, inspect to make sure seals are in place.

(7) Install the intake manifold bolts and tighten as follows (Fig. 79):

- Step 1. Tighten bolts 1 and 2 to 8 N·m (72 in. lbs.) Tighten in alternating steps 1.4 N·m (12 in. lbs.) at a time
- Step 2. Tighten bolts 3 through 12 to 8 N·m (72 in. lbs.)
- Step 3. Check all bolts are torqued to 8 N·m (72 in. lbs.)
- Step 4. Tighten all bolts in sequence to 16 N·m (12 ft. lbs.)

- Step 5. Check all bolts are torqued to 16 N·m (12 ft. lbs.)

(8) Install closed crankcase ventilation and evaporation control systems.

(9) Connect the coil wires.

(10) Connect the heat indicator sending unit wire.

(11) Connect the heater hoses and bypass hose.

(12) Install distributor cap and wires.

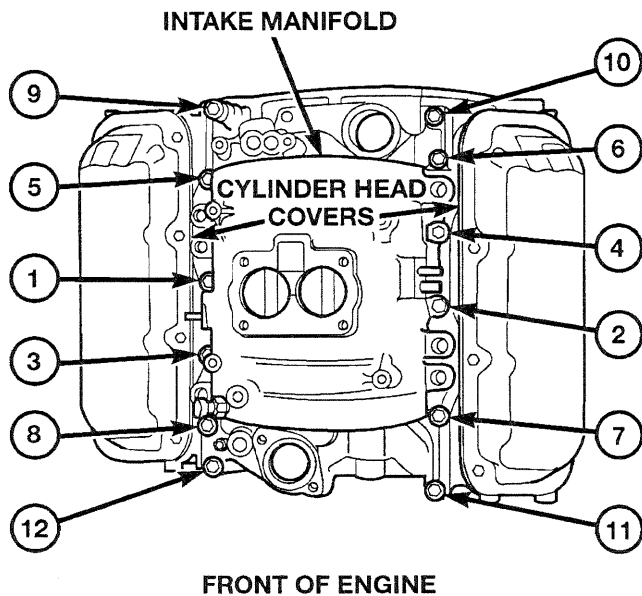
(13) Hook up the return spring.

(14) Connect the accelerator linkage (Refer to 14 - FUEL SYSTEM/FUEL INJECTION/THROTTLE CONTROL CABLE - INSTALLATION) and if so equipped, the speed control and transmission kickdown cables.

(15) Install the fuel lines (Refer to 14 - FUEL SYSTEM/FUEL DELIVERY/QUICK CONNECT FITTING - STANDARD PROCEDURE).

(16) Install the accessory drive bracket and A/C Compressor (Refer to 24 - HEATING & AIR CONDITIONING/PLUMBING/A/C COMPRESSOR - INSTALLATION).

(17) Install the generator (Refer to 8 - ELECTRICAL/CHARGING/GENERATOR - INSTALLATION) and drive belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

INTAKE MANIFOLD (Continued)

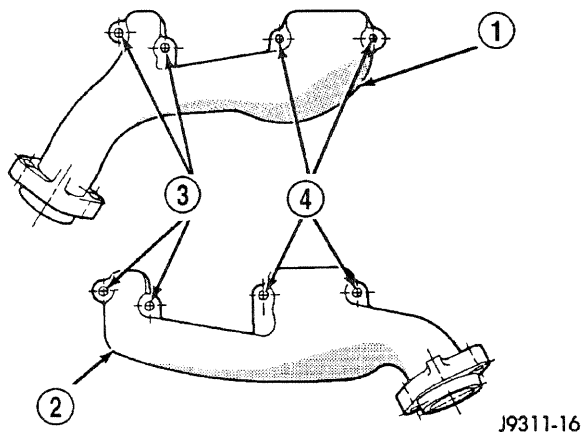
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Fig. 79 Intake Manifold Bolt Tightening Sequence

- (18) Install the air cleaner.
- (19) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
- (20) Connect the negative cable to the battery.

EXHAUST MANIFOLD**DESCRIPTION**

The exhaust manifolds (Fig. 80) are constructed of cast iron and are LOG type with balanced flow. One exhaust manifold is attached to each cylinder head.



J9311-16

Fig. 80 Exhaust Manifolds—3.9L Engine

- 1 - EXHAUST MANIFOLD (RIGHT)
- 2 - EXHAUST MANIFOLD (LEFT)
- 3 - BOLTS & WASHERS
- 4 - NUTS & WASHERS

OPERATION

The exhaust manifolds collect the engine exhaust exiting the combustion chambers, then channels the exhaust gases to the exhaust pipes attached to the manifolds.

REMOVAL

- (1) Disconnect the negative cable from the battery.
- (2) Raise and support the vehicle.
- (3) Disconnect the exhaust pipe from the exhaust manifold (Refer to 11 - EXHAUST SYSTEM/EXHAUST PIPE - REMOVAL).
- (4) Lower the vehicle.
- (5) Remove the exhaust heat shields.
- (6) Remove bolts, nuts and washers attaching manifold to cylinder head.
- (7) Remove manifold from the cylinder head.

CLEANING

Clean mating surfaces on cylinder head and manifold. Wash with solvent and blow dry with compressed air.

INSPECTION

Inspect manifold for cracks.

Inspect mating surfaces of manifold for flatness with a straight edge. Gasket surfaces must be flat within 0.2 mm per 300 mm (0.008 inch per foot).

INSTALLATION

CAUTION: If the studs came out with the nuts when removing the engine exhaust manifold, install new studs. Apply sealer on the coarse thread ends. Water leaks may develop at the studs if this precaution is not taken.

- (1) Position the engine exhaust manifolds on the two studs located on the cylinder head. Install conical washers and nuts on these studs (Fig. 81).
- (2) Install two bolts and conical washers at the inner ends of the engine exhaust manifold outboard arms. Install two bolts **WITHOUT** washers on the center arm of engine exhaust manifold (Fig. 81). Starting at the center arm and working outward, tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.
- (3) Install the exhaust heat shields.
- (4) Raise and support the vehicle.
- (5) Assemble exhaust pipe to manifold and secure with bolts, nuts and retainers. Tighten the bolts and nuts to 34 N·m (25 ft. lbs.) torque.
- (6) Lower the vehicle.
- (7) Connect the negative cable to the battery.

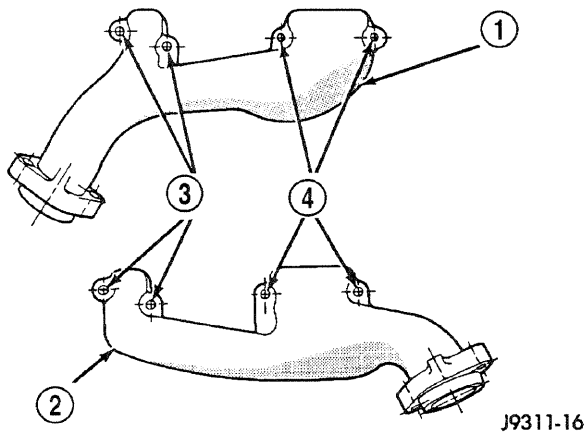
EXHAUST MANIFOLD (Continued)

Fig. 81 Engine Exhaust Manifold Installation—3.9L Engine

- 1 - EXHAUST MANIFOLD (RIGHT)
- 2 - EXHAUST MANIFOLD (LEFT)
- 3 - BOLTS & WASHERS
- 4 - NUTS & WASHERS

TIMING BELT / CHAIN COVER(S)**REMOVAL**

- (1) Disconnect the battery negative cable.
- (2) Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).
- (3) Remove the serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - REMOVAL).
- (4) Remove water pump (Refer to 7 - COOLING/ENGINE/WATER PUMP - REMOVAL).
- (5) Remove power steering pump (Refer to 19 - STEERING/PUMP - REMOVAL).
- (6) Remove vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - REMOVAL).
- (7) Loosen oil pan bolts and remove the front bolt at each side.
- (8) Remove the cover bolts.
- (9) Remove chain case cover and gasket using extreme caution to avoid damaging oil pan gasket.
- (10) From the inside of the cover tap the front crankshaft oil seal outward. Be careful not to damage the timing cover sealing surface.

INSTALLATION

- (1) Be sure mating surfaces of chain case cover and cylinder block are clean and free from burrs.
- (2) Using a new cover gasket, carefully install chain case cover to avoid damaging oil pan gasket. Use a small amount of Mopar® GEN II Silicone Rubber Adhesive Sealant, or equivalent, at the joint between timing chain cover gasket and the oil pan

gasket. Finger tighten the timing chain cover bolts at this time.

CAUTION: If chain cover is replaced for any reason, be sure the oil hole (passenger side of cover) is plugged.

NOTE: Special Tool 6635 must be used to align cover and seal with crankshaft.

- (3) Position the special tool 6635 onto the crankshaft (Fig. 82).

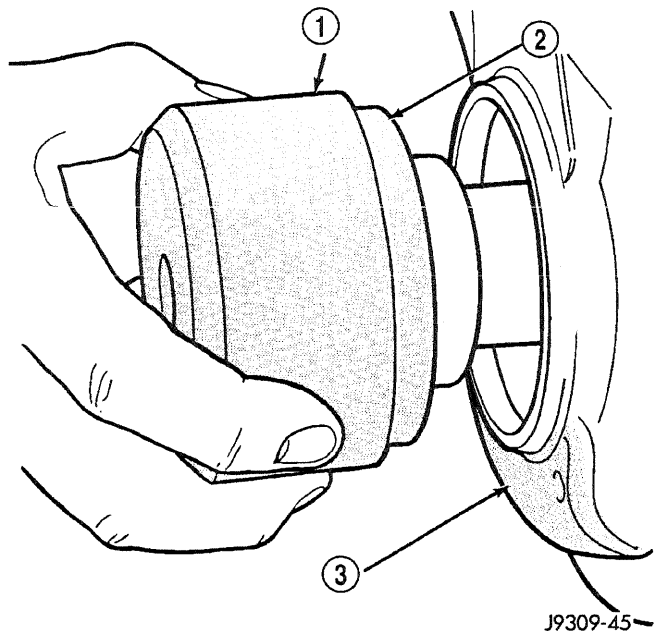


Fig. 82 Position Special Tool 6635 onto Crankshaft

- 1 - SPECIAL TOOL 6635
- 2 - OIL SEAL
- 3 - TIMING CHAIN COVER

- (4) Tighten chain case cover bolts to 41 N·m (30 ft. lbs.) torque. Tighten oil pan bolts to 24 N·m (215 in. lbs.) torque.

- (5) Remove special tool 6635.
- (6) Inspect the seal flange on the vibration damper.
- (7) Install vibration damper (Refer to 9 - ENGINE/ENGINE BLOCK/VIBRATION DAMPER - INSTALLATION).
- (8) Install water pump (Refer to 7 - COOLING/ENGINE/WATER PUMP - INSTALLATION).
- (9) Install power steering pump (Refer to 19 - STEERING/PUMP - INSTALLATION).
- (10) Install the serpentine belt (Refer to 7 - COOLING/ACCESSORY DRIVE/DRIVE BELTS - INSTALLATION).

TIMING BELT / CHAIN COVER(S) (Continued)

(11) Install the cooling system fan (Refer to 7 - COOLING/ENGINE/FAN DRIVE VISCOUS CLUTCH - INSTALLATION).

(12) Position the fan shroud and install the bolts. Tighten the bolts to 11 N·m (95 in. lbs.) torque.

(13) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(14) Connect the negative cable to the battery.

TIMING BELT/CHAIN TENSIONER AND PULLEY**DESCRIPTION**

The timing chain tensioner is a stamped steel constant tension mechanical design. It is mounted to the front of the engine, behind the timing chain drive.

OPERATION

The timing chain tension is maintained by routing the timing chain through the tensioner assembly. A nylon covered spring steel arm presses on the timing chain maintaining the correct chain tension.

TIMING BELT/CHAIN AND SPROCKETS**REMOVAL**

(1) Disconnect battery negative cable.

(2) Drain cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

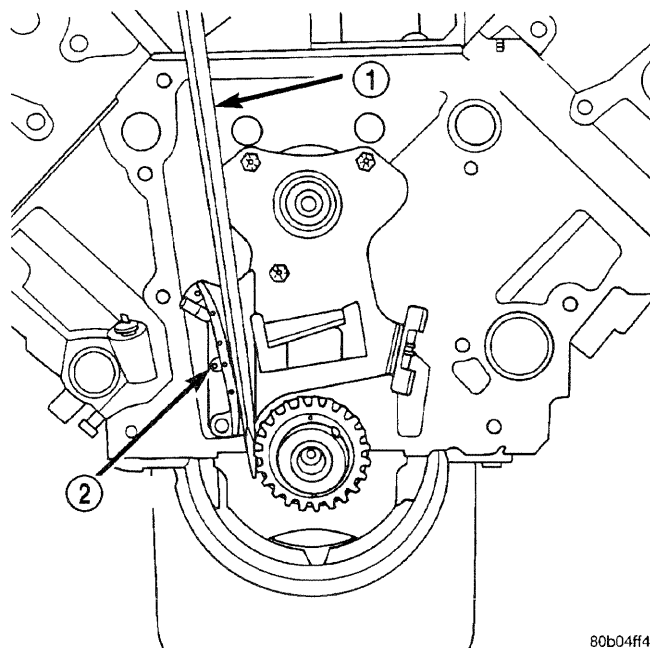
(3) Remove timing chain cover (Refer to 9 - ENGINE/VALVE TIMING/TIMING BELT / CHAIN COVER(S) - REMOVAL).

(4) Rotate crankshaft to align timing marks (Fig. 84) to #1 TDC.

(5) Remove camshaft sprocket attaching bolt and remove timing chain with crankshaft and camshaft sprockets.

(6) Slip crankshaft sprocket onto crankshaft and compress tensioner shoe by placing a large screwdriver between crankshaft sprocket and tensioner shoe (Fig. 83). Compress shoe until hole in shoe lines up with hole in bracket. Slide a suitable pin into the holes (Fig. 83) and remove screwdriver.

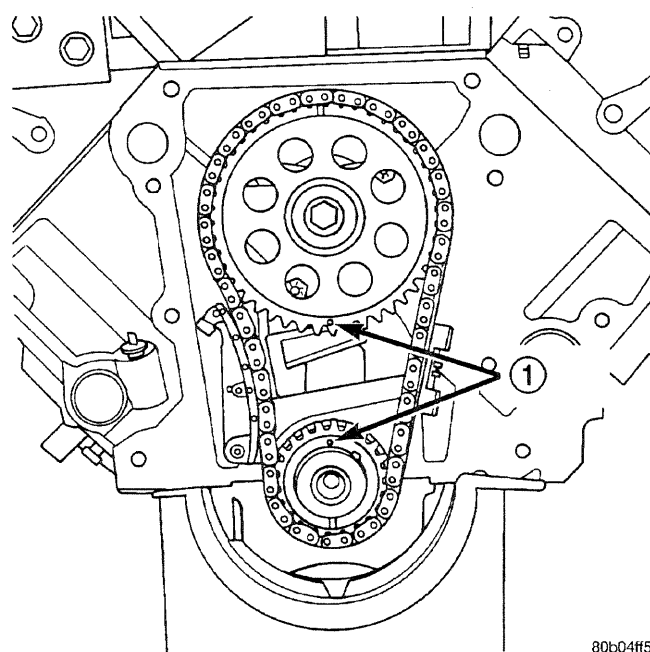
(7) If tensioner assembly is to be replaced, remove the three tensioner to block bolts and remove tensioner assembly.



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Fig. 83 Compressing Tensioner For Chain Installation

- 1 - SCREWDRIVER
2 - INSERT PIN HERE



80b04ff5

Fig. 84 Alignment of Timing Marks

- 1 - TIMING MARKS

TIMING BELT/CHAIN AND SPROCKETS (Continued)

INSPECTION—MEASURING TIMING CHAIN STRETCH

NOTE: Timing chain tensioner must be removed for this operation.

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

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

(3) Hold a scale with dimensional reading even with the edge of a chain link. With cylinder heads installed, apply 14 N·m (30 ft. lbs.) torque in the reverse direction. With the cylinder heads removed, apply 20 N·m (15 ft. lbs.) torque in the reverse direction. Note the amount of chain movement (Fig. 85).

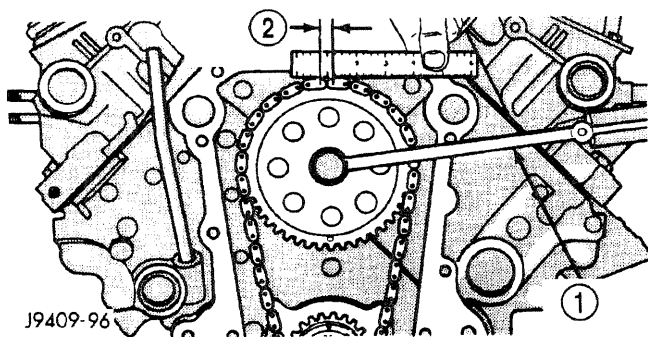


Fig. 85 Measuring Timing Chain Wear and Stretch

1 - TORQUE WRENCH
2 - 3.175 MM
(0.125 IN.)

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

INSTALLATION

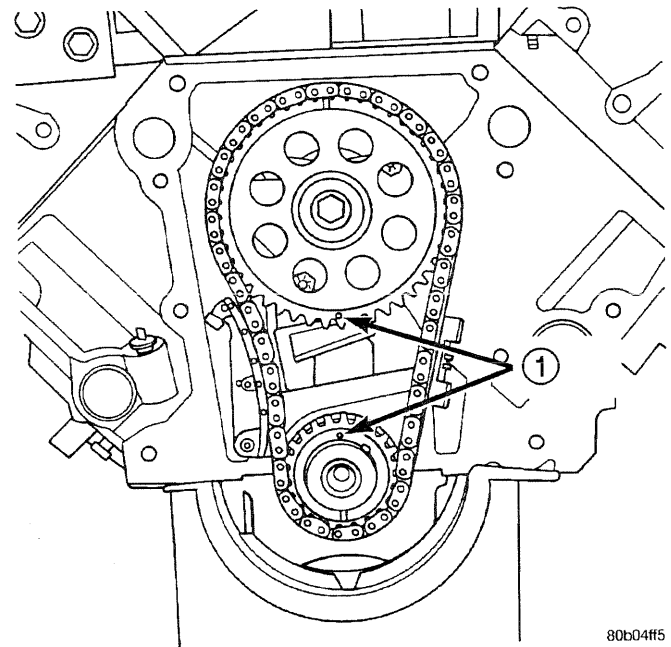
(1) If tensioner assembly is being replaced, install tensioner and mounting bolts. Torque bolts to 24 N·m (210 in. lbs.).

(2) Place both camshaft sprocket and crankshaft sprocket on the bench with timing marks on an exact imaginary center line through both camshaft and crankshaft bores.

(3) Place timing chain around both sprockets.

(4) Lift sprockets and chain (keep sprockets tight against the chain in position as described).

(5) Slide both sprockets evenly over their respective shafts and verify alignment of timing marks (Fig. 86) with a straight-edge if necessary.



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Fig. 86 Alignment of Timing Marks

1 - TIMING MARKS

(6) Install the camshaft bolt. Tighten the bolt to 68 N·m (50 ft. lbs.) torque.

(7) **Remove tensioner pin.** Again, verify alignment of timing marks.

(8) Install timing cover (Refer to 9 - ENGINE/ VALVE TIMING/TIMING BELT / CHAIN COVER(S) - INSTALLATION).

(9) Fill cooling system (Refer to 7 - COOLING - STANDARD PROCEDURE).

(10) Connect battery negative cable.

(11) Start engine and check for oil and coolant leaks.

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