2008 ENGINE

Service Information - 3.7L - Raider

DESCRIPTION

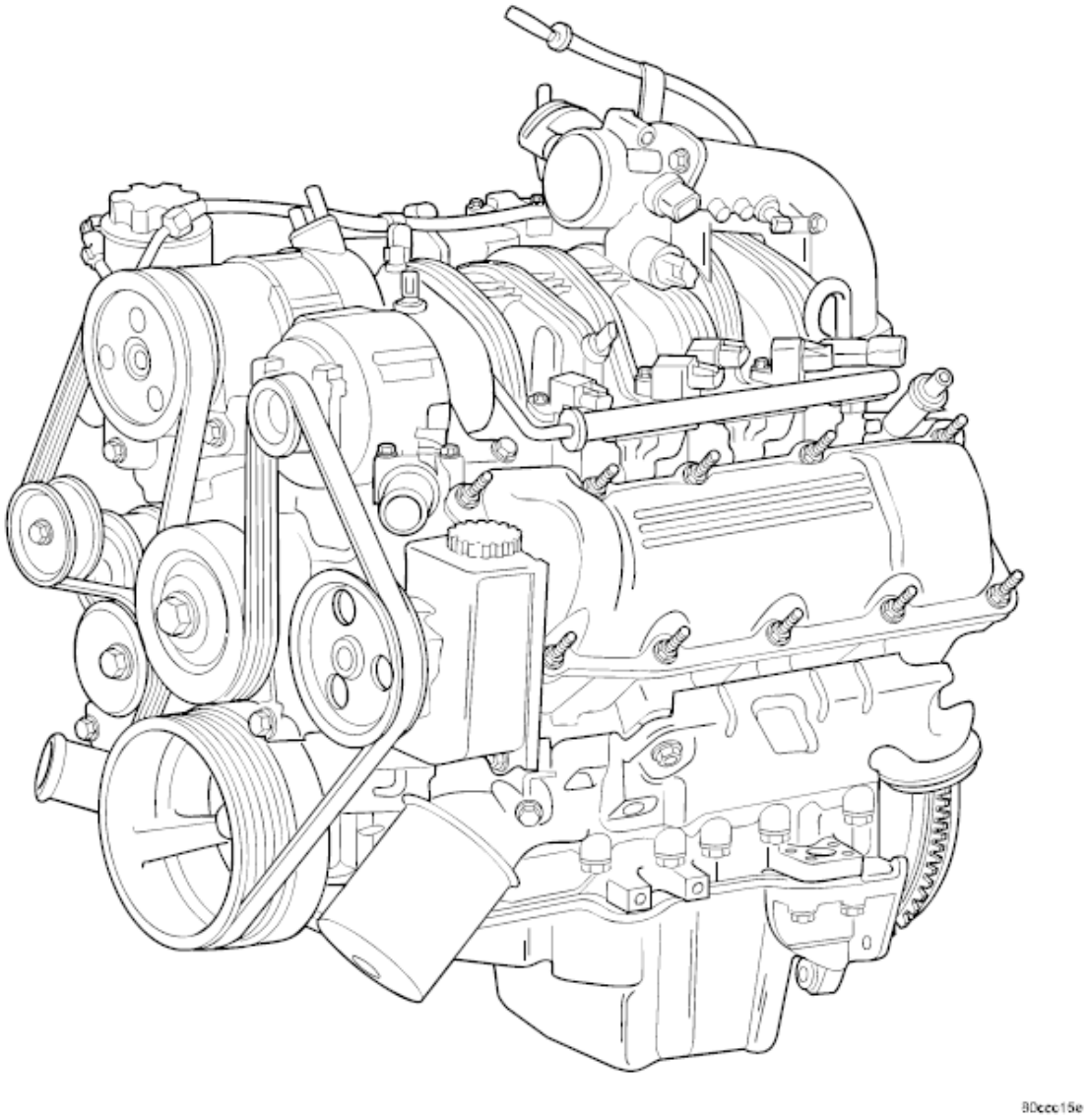


Fig. 1: Identifying 3.7L (226 CID) Engine
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The 3.7 liter (226 CID) six-cylinder engine is an 90° single overhead camshaft engine. The cast iron cylinder block is made up of two different components; the first component is the cylinder bore and upper block, the second component is the bedplate that comprises the lower portion of the cylinder block and houses the lower half of the crankshaft main bearings. The cylinders are numbered from front to rear with the left bank being numbered 1,3, and 5 and the right bank being numbered 2,4, and 6. The firing order is 1-6-5-4-3-2. The engine serial number is located at the right front side of the engine block .

DIAGNOSIS AND TESTING

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 performance (e.g., engine idles rough and stalls) or mechanical (e.g., a strange noise).

*Refer to **PERFORMANCE** and refer to **MECHANICAL** for possible causes and corrections of malfunctions. Refer to **FUEL DELIVERY** for the fuel system diagnosis.*

Additional tests and diagnostic procedures may be necessary for specific engine malfunctions that can not be isolated with the Service Diagnosis charts.

Information concerning additional tests and diagnosis is provided within the following diagnosis:

- **CYLINDER COMPRESSION PRESSURE TEST**
- **CYLINDER COMBUSTION PRESSURE LEAKAGE TEST**
- **ENGINE CYLINDER HEAD GASKET FAILURE DIAGNOSIS**
- **INTAKE MANIFOLD LEAKAGE DIAGNOSIS**

PERFORMANCE

ENGINE DIAGNOSTIC CHART (PERFORMANCE)

CONDITION	POSSIBLE CAUSE	CORRECTION
ENGINE WILL NOT START	1. Weak battery	1. Charge or replace as necessary.
	2. Corroded or loose battery connections.	2. Clean and tighten battery connections. Apply a coat of light mineral grease to the terminals.
	3. Faulty starter.	3. Refer to **DIAGNOSIS AND TESTING** .
	4. Faulty coil or control unit.	4. Refer to **COIL - IGNITION** .
	5. Incorrect spark plug gap.	5. Refer to **SPARK PLUGS** .
	6. Incorrect right bank cam timing.	6. Refer to **STANDARD PROCEDURE**.
	7. Dirt or water in fuel system.	7. Clean system and replace fuel filter.
	8. Faulty fuel pump, relay or wiring.	8. Repair or replace as necessary.
	9. Faulty cam or crank sensor	9. Refer to **IGNITION SYSTEM - ELECTRICAL DIAGNOSTICS** .
	1. Vacuum leak.	1. Inspect intake manifold and vacuum hoses,

		repair or replace as necessary.
ENGINE STALLS OR ROUGH IDLE	2. Faulty crank position sensor	2. Replace crank position sensor
	3. Faulty coil.	3. Refer to **COIL - IGNITION** .
	4. Incorrect cam timing.	4. Refer to **STANDARD PROCEDURE**.
ENGINE LOSS OF POWER	1. Dirty or incorrectly gapped spark plugs.	1. Refer to **SPARK PLUGS** .
	2. Dirt or water in fuel system.	2. Clean system and replace fuel filter.
	3. Faulty fuel pump.	3. Refer to **DESCRIPTION** .
	4. Blown cylinder head gasket.	4. Replace cylinder head gasket.
	5. Low compression.	5. Refer to **DIAGNOSIS AND TESTING**. Repair as necessary.
	6. Burned, warped or pitted valves.	6. Replace as necessary.
	7. Plugged or restricted exhaust system.	7. Inspect and replace as necessary.
	8. Faulty coil.	8. Refer to **COIL - IGNITION** .
	9. Incorrect cam timing.	9. Refer to **STANDARD PROCEDURE**.
ENGINE MISSES ON ACCELERATION	1. Spark plugs dirty or incorrectly gapped.	1. Refer to **SPARK PLUGS** .
	2. Dirt in fuel system.	2. Clean fuel system.
	3. Burned, warped or pitted valves.	3. Replace as necessary.
	4. Faulty coil.	4. Refer to **COIL - IGNITION** .
ENGINE MISSES AT HIGH SPEED	1. Spark plugs dirty or incorrectly gapped.	1. Refer to **SPARK PLUGS** .
	2. Faulty coil.	2. Refer to **COIL - IGNITION** .
	3. Dirt or water in fuel system.	3. Clean system and replace fuel filter.

MECHANICAL

ENGINE DIAGNOSTIC CHART (MECHANICAL)

CONDITION	POSSIBLE CAUSES	CORRECTIONS
NOISY VALVES	1. High or low oil level in crankcase.	1. Refer to **STANDARD PROCEDURE**.
	2. Thin or diluted oil.	2. Change oil and filter.
	3. Low oil pressure.	3. Check oil pump, if okay, check rod and main bearings for excessive wear.
	4. Dirt in lash adjusters.	4. Replace as necessary.
	5. Worn rocker arms.	5. Replace as necessary.
	6. Worn lash adjusters	6. Replace as necessary.

	7. Worn valve guides. 8. Excessive runout of valve seats on valve faces.	7. Refer to **STANDARD PROCEDURE**. 8. Refer to **STANDARD PROCEDURE**.
CONNECTING ROD NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Misaligned connecting rods.	1. Refer to **STANDARD PROCEDURE**. 2. Check oil pump, if okay, check rod and main bearings for excessive wear. 3. Change oil and filter. 4. Replace as necessary. 5. Service or replace crankshaft. 6. Replace bent connecting rods.
MAIN BEARING NOISE	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of round. 7. Loose flywheel or torque converter.	1. Refer to **STANDARD PROCEDURE**. 2. Check oil pump, if okay, check rod and main bearings for excessive wear. 3. Change oil and filter. 4. Replace as necessary. 5. Check thrust washers for wear. 6. Service or replace crankshaft. 7. Tighten to correct torque

LUBRICATION

ENGINE DIAGNOSTIC CHART (LUBRICATION)

CONDITION	POSSIBLE CAUSES	CORRECTION
OIL LEAKS	1. Gaskets and O-Rings. (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.	1. (a) Replace as necessary. (b) Tighten fasteners, Repair or replace metal parts. 2. Replace as necessary. Refer to **REMOVAL**. 3. Polish or replace crankshaft. 4. Replace oil pan. Refer to **REMOVAL**. 5. Replace seal. Refer to **REMOVAL**. 6. Polish or replace damper.
	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure.	1. Check and correct oil level. 2. Replace sending unit. Refer to **REMOVAL**. 3. Check oil pump and bearing clearance.

OIL PRESSURE DROP	4. Clogged oil filter.	4. Replace oil filter. Refer to **REMOVAL**.
	5. Worn oil pump.	5. Replace oil pump. Refer to **REMOVAL**.
	6. Thin or diluted oil.	6. Change oil and filter.
	7. Excessive bearing clearance.	7. Replace as necessary.
	8. Oil pump relief valve stuck.	8. Replace oil pump. Refer to **REMOVAL**.
	9. Oil pick up tube loose, damaged or clogged.	9. Replace as necessary.
OIL PUMPING AT RINGS; SPARK PLUGS FOULING	1. Worn or damaged rings.	1. Hone cylinder bores and replace rings.
	2. Carbon in oil ring slots.	2. Replace rings. Refer to **STANDARD PROCEDURE**.
	3. Incorrect ring size installed.	3. Replace rings. Refer to **STANDARD PROCEDURE**.
	4. Worn valve guides.	4. Ream guides and replace valves. Refer to **STANDARD PROCEDURE**.
	5. Leaking valve guide seals.	5. Replace valve guide seals.

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.
3. Secure the throttle in the wide-open position.
4. Disable the fuel system. Refer to **STANDARD PROCEDURE** .
5. Remove the Automatic Shutdown (ASD) relay. Refer to **RELAY - AUTO SHUT DOWN** .
6. Insert a compression pressure gauge and rotate the engine with the engine starter motor for three revolutions.
7. Record the compression pressure on the 3rd revolution. Continue the test for the remaining cylinders.
8. Refer to **SPECIFICATIONS** for the correct engine compression pressures.

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.*

1. Check the coolant level and fill as required. DO NOT install the radiator cap.
2. Start and operate the engine until it attains normal operating temperature, then turn the engine OFF.
3. Remove the spark plugs.
4. Remove the oil filler cap.
5. Remove the air cleaner hose.
6. 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.
7. Perform the test procedures on each cylinder according to the tester manufacturer's instructions. Set piston of cylinder to be tested at TDC compression, While testing, listen for pressurized air escaping through the throttle body, tailpipe and oil filler cap opening. Check for bubbles in the radiator coolant.

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

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

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. Inspect valve springs. 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. Inspect valve springs. 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

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.*

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. Engine RTV, ATF-RTV, and Gasket Maker gasket materials, each have different properties and can not be used in place of the other.

ENGINE RTV (MITSUBISHI APPROVED)

Engine RTV 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.

ATF RTV (MITSUBISHI APPROVED)

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.

GASKET MAKER (MITSUBISHI APPROVED)

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

GASKET SEALANT (MITSUBISHI APPROVED)

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.

FORM-IN-PLACE GASKET AND SEALER APPLICATION

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

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.

Engine RTV 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.

Gasket Sealant in an aerosol can should be applied using a thin, even coat sprayed completely over both surfaces to be joined, and both sides of a gasket.

Then proceed with assembly. Material in a can w/applicator can be brushed on evenly over the sealing surfaces. Material in an aerosol can should be used on engines with multi-layer steel gaskets.

ENGINE GASKET SURFACE PREPARATION

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

***Never** use the following to clean gasket surfaces:*

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

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

Only use the following for cleaning gasket surfaces:

- *Solvent or a commercially available gasket remover*
- *Plastic or wood scraper (3).*
- *Drill motor with 3M Roloc™ Bristle Disc (white or yellow) (2).*

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.

ENGINE - REMOVAL

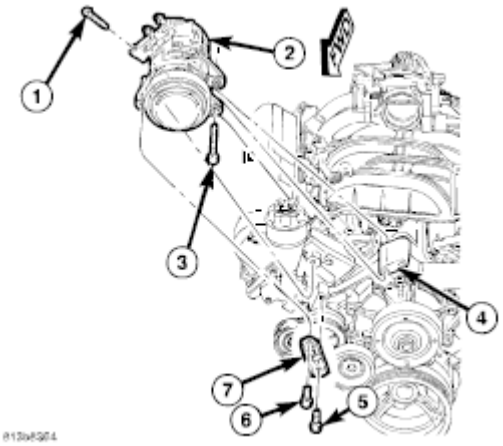


Fig. 2: Identifying A/C Compressor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Release fuel rail pressure. Refer to **STANDARD PROCEDURE** . Disconnect the fuel supply quick connect fitting at the fuel rail. Refer to **STANDARD PROCEDURE** .
2. Disconnect the battery negative cable.
3. Remove air cleaner assembly.
4. Remove fan shroud with viscous fan assembly.
5. Remove drive belt.
6. Remove A/C compressor (2) and secure away from engine.
7. Remove generator (3) and secure away from engine.

NOTE: Do NOT remove the phenolic pulley from the P/S pump. It is not required for P/S pump removal.

8. Remove power steering pump with lines attached and secure away from engine.
9. Drain cooling system.
10. Disconnect the heater hoses from the engine.
11. Disconnect heater hoses from heater core and remove hose assembly.
12. Disconnect throttle and speed control cables.
13. Remove upper radiator hose from engine.
14. Remove lower radiator hose from engine.
15. Remove radiator/cooling module assembly.
16. Disconnect the engine to body ground straps at the left side of cowl.
17. Disconnect the engine wiring harness at the following points:
    - *Intake air temperature (IAT) sensor (4)*
    - *Fuel Injectors*

- *Throttle Position (TPS) Switch (2)*
- *Idle Air Control (IAC) Motor (3)*
- *Engine Oil Pressure Switch*
- *Engine Coolant Temperature (ECT) Sensor*
- *Manifold Absolute Pressure MAP) Sensor*
- *Camshaft Position (CMP) Sensor*
- *Coil Over Plugs*
- *Crankshaft Position Sensor*

18. Remove coil over plugs.
19. Remove fuel rail and secure away from engine.

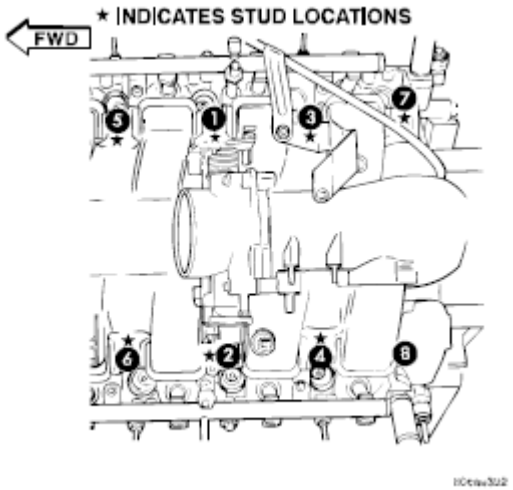


Fig. 3: Identifying Removal & Installation Sequence Of Intake Manifold Retaining Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: It is not necessary to release the quick connect fitting from the fuel supply line for engine removal.

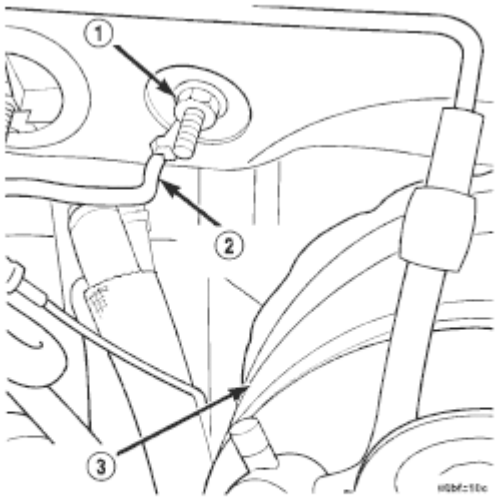
20. Remove the PCV hose.
21. Remove the breather hoses.
22. Remove the vacuum hose for the power brake booster.
23. Disconnect knock sensors.
24. Remove engine oil dipstick tube.
25. Remove intake manifold.
26. Install engine lifting fixture, special tool # 8247, using original fasteners from the removed intake manifold, and fuel rail. Torque to factory specifications.

NOTE: Recheck bolt torque for engine lift plate before removing engine.

27. Disconnect oxygen sensor wiring.
28. Disconnect crankshaft position sensor.
29. Disconnect the engine block heater power cable, if equipped.
30. Disconnect the front propshaft at the front differential and secure out of way.
31. Remove the pinion bracket.

NOTE: It is necessary to disconnect the front propshaft for access to the starter and left side exhaust flange.

32. Remove the starter (4).



1 - NUT
2 - GROUND STRAP
3 - BRAKE BOOSTER

Fig. 4: Identifying Ground Strap And Brake Booster
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

33. Remove the ground straps from the left (2) and right (3) side of the block.
34. Remove the structural cover.
35. Disconnect the right and left exhaust pipes at the manifolds and from the crossover, and remove from the vehicle.
36. Remove torque convertor bolts (3), and mark location for reassembly.
37. Remove transmission bellhousing to engine bolts (3).
38. Remove left and right engine mount thru bolts (3).
39. Lower the vehicle.
40. Support the transmission with a suitable jack.
41. Connect a suitable engine hoist to the engine lift plate.

42. Remove engine from vehicle.

ENGINE - INSTALLATION

1. Position the engine in the vehicle.
2. Install the transmission bellhousing to engine mounting bolts (3). Tighten the bolts to 41 N.m (30 ft. lbs.)
3. Install the engine mount thru bolts.
4. Install the torque convertor bolts (3).
5. Install the starter (4).
6. Connect the crankshaft position sensor.
7. Install the engine block heater power cable, if equipped.

CAUTION: The structural cover requires a specific torque sequence. Failure to follow this sequence may cause severe damage to the cover.

8. Install the structural cover.
9. Install the pinion bracket.
10. Install the left and right exhaust pipes.
11. Connect the left and right oxygen sensors.
12. Remove the engine lift plate.
13. Connect the knock sensors.
14. Connect the engine to body ground straps at the left side of the cowl.

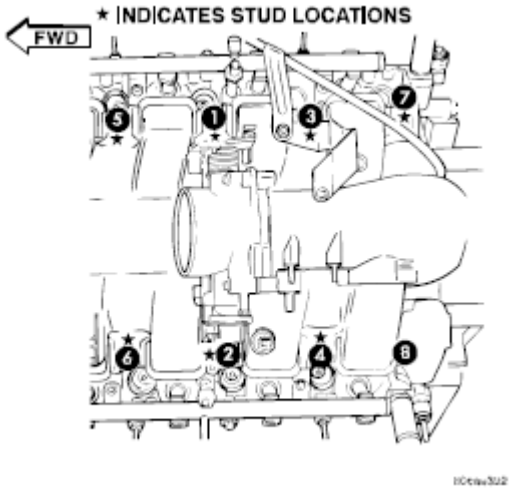


Fig. 5: Identifying Removal & Installation Sequence Of Intake Manifold Retaining Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

15. Install the intake manifold using the sequence provided.
16. Install the engine oil dipstick tube.

17. Install the power brake booster vacuum hose.
18. Install the breather hoses.
19. Install the PCV hose.
20. Install the fuel rail.
21. Install the coil over plugs.
22. Connect the engine wiring harness at the following points:
    - *Intake air temperature (IAT) sensor (4)*
    - *Fuel Injectors*
    - *Throttle Position (TPS) Switch (2)*
    - *Idle Air Control (IAC) Motor (3)*
    - *Engine Oil Pressure Switch*
    - *Engine Coolant Temperature (ECT) Sensor*
    - *Manifold Absolute Pressure MAP) Sensor*
    - *Camshaft Position (CMP) Sensor*
    - *Coil Over Plugs*
    - *Crankshaft Position Sensor*
23. Connect the ground straps on the right (3) side of the engine.
24. Connect the ground straps on the left (2) side of the engine.
25. Reinstall the radiator/cooling module assembly.
26. Connect lower radiator hose.
27. Connect upper radiator hose.
28. Connect throttle and speed control cables.
29. Install the heater hose assembly.
30. Install coolant recovery bottle.
31. Install the power steering pump.
32. Install the generator (3).
33. Install the A/C compressor (2).
34. Install the drive belt.
35. Install the fan shroud with the viscous fan assembly.
36. Install the radiator core support bracket.
37. Recharge the A/C system. Refer to **STANDARD PROCEDURE** .
38. Install the air cleaner assembly.
39. Refill the engine cooling system.
40. Check and fill engine oil.
41. Connect the battery negative cable.
42. Start the engine and check for leaks.

SPECIFICATIONS

SPECIFICATIONS - 3.7L ENGINE

GENERAL SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
Type	90° SOHC V6 12 Valve	
Number of Cylinders	6	
Firing Order	1-6-5-4-3-2	
Lead Cylinder	No. 1 Left Bank	
Compression Ratio	9.6:1	
Max. Variation Between Cylinders	25%	
	Metric	**Standard**
Displacement	3.7 Liters	226 Cubic Inches
Bore	93.0 mm	3.66 in.
Stroke	90.8 mm	3.40 in.
Horsepower	211 / 5200 RPM	
Torque	236 ft. lbs./4000 RPM	
Compression Pressure	1172-1551 kPa	170-225 psi

CYLINDER BLOCK SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	**Standard**
Bore Diameter	93.013 ± .0075 mm	3.6619 ± 0.0003 in.
Out of Round (MAX)	0.076 mm	0.003 in.
Taper (MAX)	0.051 mm	0.002 in.

PISTONS SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	**Standard**
Diameter	92.975 mm	3.6605 in.
Weight	365.0 grams	12.87 oz
Ring Groove Diameter		
No. 1	85.37 - 83.13 mm	3.282 - 3.273 in
No. 2	82.833 - 83.033 mm	3.261 - 3.310 in.
No. 3	83.88 - 84.08 mm	3.302 - 3.310 in.

PISTON PINS SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	**Standard**
Clearance In Piston	0.006 - 0.015 mm	0.0002 - 0.0005 in.
Diameter	24.017 - 24.020 mm	0.9455 - 0.9456 in.

PISTON RINGS SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Ring Gap		
Top Compression Ring	0.20 - 0.36 mm	0.0079 - 0.0142 in.
Second Compression Ring	0.37 - 0.63 mm	0.0146 - 0.0249 in.
Oil Control (Steel Rails)	0.25 - 0.76 mm	0.0099 - 0.30 in.
Side Clearance		
Top Compression Ring	.051 - .094 mm	0.0020 - 0.0037 in.
Second Compression Ring	0.040 - 0.080 mm	0.0016 - 0.0031 in.
Oil Ring (Steel Ring)	.019 - .229 mm	.0007 - .0091 in.
Ring Width		
Top Compression Ring	1.472 - 1.490 mm	0.057 - 0.058 in.
Second Compression Ring	1.472 - 1.490 mm	0.057 - 0.058 in.
Oil Ring (Steel Rails)	0.445 - 0.470 mm	0.017 - 0.018 in.

CONNECTING RODS SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Bearing Clearance	0.006 - 0.044 mm	0.0002 - 0.0017 in.
Side Clearance	0.10 - 0.35 mm	0.004 - 0.0138 in.
Piston Pin Clearance	.015 - .028 mm	0.0006 - 0.0011 in.
Bearing Bore Out of Round (MAX)	0.004 mm	0.0002 in.
Total Weight (Less Bearing)	612 grams	21.588 ounces

CRANKSHAFT SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Main Bearing Journal Diameter	63.488 - 63.512 mm	2.4996 - 2.5005 in.
Bearing Clearance	0.002 - 0.046 mm	0.00008 - 0.0018 in.
Out of Round (MAX)	0.005 mm	0.0002 in.
Taper (MAX)	0.006 mm	0.0004 in.
End Play	0.052 - 0.282 mm	0.0021 - 0.0112 in.
End Play (MAX)	0.282 mm	0.0112 in.
Connecting Rod Journal Diameter	57.908 - 57.892 mm	2.2798 - 2.2792 in.
Bearing Clearance	0.006 - 0.044	0.0002 - 0.0011 in.
Out of Round (MAX)	0.005 mm	0.0002 in.
Taper (MAX)	0.006 mm	0.0002 in.

CAMSHAFT SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Bore Diameter	26.02 - 26.04 mm	1.0245 - 1.0252 in.

Bearing Journal Diameter	25.975 - 25.995 mm	1.0227 - 1.0235 in.
Bearing Clearance	0.025 - 0.065 mm	0.001 - 0.0026 in.
Bearing Clearance (MAX)	0.065 mm	0.0026 in.
End Play	.075 - .200 mm	0.003 - 0.0079 in.
End Play (MAX)	.200 mm	0.0079 in.

VALVE TIMING SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION
Intake	
Opens (BTDC)	5.6°
Closes (ATDC)	240.1°
Duration	245.7°
Exhaust	
Opens (BTDC)	241.5°
Closes (ATDC)	20.1°
Duration	261.6°
Valve Overlap	25.7°

VALVES SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Face Angle	45° - 45.5°	
Head Diameter		
Intake	48.52 - 48.78 mm	1.9103 - 1.9205 in.
Exhaust	36.87 - 37.13 mm	1.4516 - 1.4618 in.
Length (Overall)		
Intake	113.45 - 114.21 mm	4.4666 - 4.4965 in.
Exhaust	114.92 - 115.68 mm	4.5244 - 4.5543 in.
Stem Diameter		
Intake	6.931 - 6.957 mm	0.2729 - 0.2739 in.
Exhaust	6.902 - 6.928 mm	0.2717 - 0.2728 in.
Stem-to-Guide Clearance		
Intake	0.018 - 0.069 mm	0.0008 - 0.0028 in.
Exhaust	0.047 - 0.098 mm	0.0019 - 0.0039 in.
Max. Allowable Stem-to-Guide Clearance (Rocking Method)		
Intake	0.069 mm	0.0028 in.
Exhaust	0.098 mm	0.0039 in.
Valve Lift (Zero Lash)		
Intake	12.00 mm	0.472 in.
Exhaust	12.00 mm	0.472 in.

VALVE SPRING SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Free Length (Approx)		
Intake	48.18 mm	1.896 in.
Exhaust - w/damper	48.2 mm	1.897 in.
Spring Force (Valve Closed)		
Intake	332.0 - 368.0 N / 40.12 mm	74.63 - 82.72 lbs. / 1.5795 in.
Exhaust - (without damper)	356 - 394 N / 39.12 mm	80.031 - 88.57 lbs. / 1.54 in.
Spring Force (Valve Open)		
Intake	948.0 - 1038.0 N / 28.12 mm	213.2 - 233.8 lbs. / 1.107 in.
Exhaust - without damper	974 - 956 N / 27.12 mm	218.8 - 215.1 lbs. / 1.067 in.
Number of Coils		
Intake	7.30	
Exhaust	7.15	
Wire Diameter		
Intake	4.77 x 3.80 mm	0.1878 x 0.1496 in.
Exhaust	4.66 x 3.72 mm	0.1843 x .1464 in.
Installed Height (Spring Seat to Bottom of Retainer)		
Nominal		
Intake	40.12 mm	1.579 in.
Exhaust - w/damper	40.12 mm	1.579 in.

CYLINDER HEAD SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard
Gasket Thickness (Compressed)	0.7 mm	(0.0276 in.)
Valve Seat Angle	44.5° - 45.0°	
Valve Seat Runout (MAX)	0.051 mm	0.002 in.
Valve Seat Width		
Intake	1.75 - 2.36 mm	0.0698 - 0.0928 in.
Exhaust	1.71 - 2.32 mm	0.0673 - 0.0911 in.
Guide Bore Diameter (Std.)	6.975 - 7.00 mm	0.2747 - 0.2756 in.
Cylinder Head Warpage (Flatness)	0.0508 mm	0.002 in.

OIL PUMP SPECIFICATIONS - 3.7L ENGINE

DESCRIPTION	SPECIFICATION	
	Metric	Standard

Clearance Over Rotors/End Face (MAX)	0.095 mm	0.0038 in.
Cover Out - of - Flat (MAX)	0.025 mm	0.001 in.
Inner and Outer Rotor Thickness	12.02 mm	0.4731 in.
Outer Rotor to pocket (Diametral) clearance (MAX)	.235 mm	.0093 in.
Outer Rotor Diameter (MIN)	85.925 mm	0.400 in.
Tip Clearance Between Rotors (MAX)	0.150 mm	0.006 in.

OIL PRESSURE SPECIFICATIONS - 3.7L ENGINE

SPECIFICATION	SPECIFICATION	
	Metric	Standard
At Curb Idle Speed (MIN)(1)	25 kPa	4 psi
at 3000 RPM	170 - 758 kPa	25 - 110 psi

CAUTION:

(1) If pressure is zero at curb idle, DO NOT run engine at 3000 RPM.

ENGINE TORQUE SPECIFICATIONS

ENGINE TORQUE SPECIFICATIONS

DESCRIPTION	N.m	Ft. Lbs.	In. Lbs.
Camshaft			
Non - Oiled Sprocket Bolt	122	90	-
Bearing Cap Bolts	11	-	100
Counterbalance Shaft Retaining Bolt	28	-	250
Timing Chain Cover Bolts	58	43	-
Connecting Rod Cap Bolts	27	20	-
	PLUS 90° TURN		
Bed Plate Bolts	Refer to **Fig. 33**.		
Crankshaft Damper Bolt	175	130	-
Cylinder Head Bolts			
M11 Bolts	Refer to appropriate INSTALLATION procedure under **CYLINDER HEAD**.		
M8 Bolts	Refer to appropriate INSTALLATION procedure under **CYLINDER HEAD**.		
Cylinder Head Cover Bolts	12	-	105
Exhaust Manifold Bolts	25	18	-
Exhaust Manifold Heat Shield Nuts	8	-	72
	Then loosen 45°		
Flexplate Bolts	95	70	-
Engine Mount Bracket to Block Bolts	61	45	-
Engine to Transmission Bellhousing	41	30	-

Bolts			
Rear Mount to Transmission Bolts	46	34	-
Generator Mounting Bolts			
M10 Bolts	54	40	-
M8 Bolts	28	-	250
Intake Manifold Bolts	12	-	105
	Refer to **INSTALLATION** for Tightening Sequence.		
Oil Pan Bolts	15	-	130
Oil Pan Drain Plug	34	25	-
Oil Pump Bolts	28	-	250
Oil Pump Cover Bolts	12	-	105
Oil Pickup Tube Bolt and Nut	28	-	250
Oil Dipstick Tube to Engine Block Bolt	15	-	130
Oil Fill Tube Bolts	12	-	105
Timing Chain Guide Bolts	28	-	250
Timing Chain Tensioner Arm	28	-	250
Hydraulic Tensioner Bolts	28	-	250
Timing Chain Primary Tensioner Bolts	28	-	250
Timing Drive Idler Sprocket Bolt	34	25	-
Thermostat Housing Bolts	12	-	105
Water Pump Bolts	58	43	-

SPECIAL TOOLS

CLEANER - AIR ELEMENT

REMOVAL

Filter Element Only

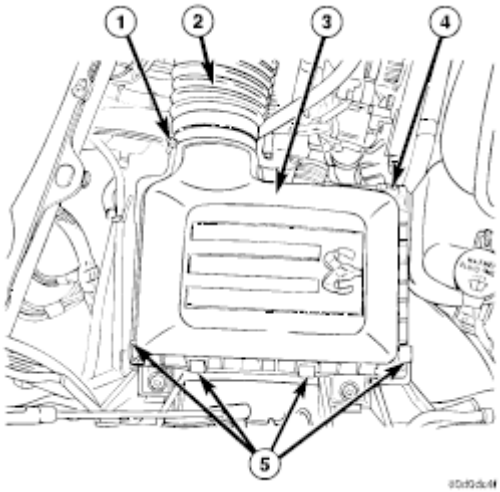


Fig. 6: Identifying Clamp And Air Duct At Air Cleaner Cover
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

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

1. Loosen clamp (1) and disconnect air duct at air cleaner cover (3).
2. Pry over 4 spring clips (5) from housing cover (spring clips retain cover to housing).
3. Release housing cover (3) from locating tabs on housing and remove cover (3).
4. Remove air cleaner element (filter) from housing.
5. Clean inside of housing before replacing element.

Housing Assembly

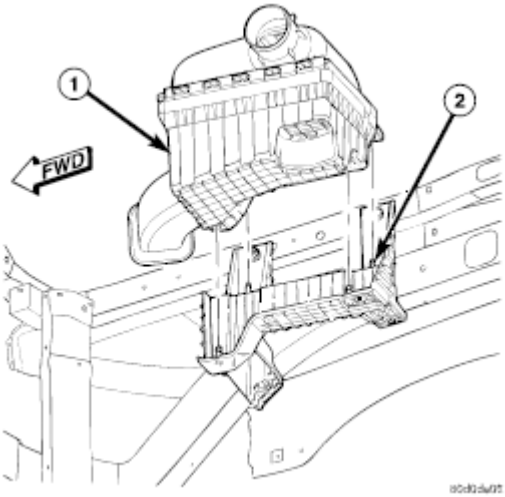


Fig. 7: Identifying Housing Assembly And Pins
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Loosen clamp and disconnect air duct at air cleaner cover.

2. Lift entire housing assembly (1) from 4 locating pins (2).

INSTALLATION

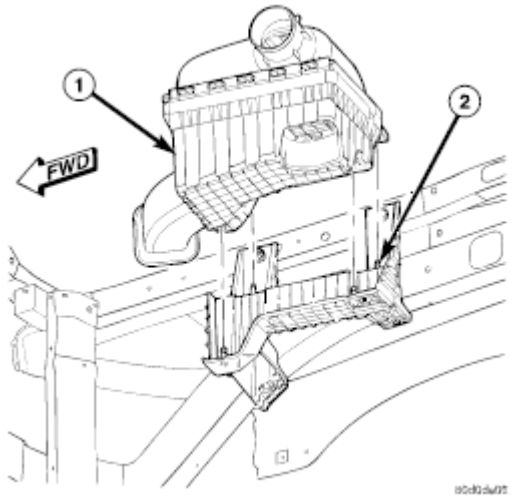


Fig. 8: Identifying Housing Assembly And Pins
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Install filter element into housing (1).
2. Position housing cover into housing locating tabs.
3. Pry up 4 spring clips and lock cover to housing.
4. Install air duct to air cleaner cover and tighten hose clamp to 3 N.m (30 in. lbs.) torque.
5. If any other hose clamps were removed from air intake system, tighten them to 3.4 N.m (30 in. lbs.) torque.
6. If any bolts were removed from air resonator housing or air intake tubing, tighten them to 4.5 N.m (40 in. lbs.) torque.

CYLINDER HEAD

DESCRIPTION

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

VALVE GUIDE SEALS

The valve guide seals are made of rubber and incorporate an integral steel valve spring seat. The integral garter spring maintains consistent lubrication control to the valve stems.

DIAGNOSIS AND TESTING

CYLINDER HEAD GASKET

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*

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****. 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 138 kPa (20 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.

HYDRAULIC LASH ADJUSTER

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

1. Engine oil level too high or too low. This may cause aerated oil to enter the adjusters and cause them to be spongy.
2. Insufficient running time after rebuilding cylinder head. Low speed running up to 1 hour may be required.
3. Turn engine off and let set for a few minutes before restarting. Repeat this several times after engine has reached normal operating temperature.
4. Low oil pressure.
5. The oil restrictor in cylinder head gasket or the oil passage to the cylinder head is plugged with debris.
6. Air ingested into oil due to broken or cracked oil pump pick up.
7. Worn valve guides.
8. Rocker arm ears contacting valve spring retainer.
9. Rocker arm loose, adjuster stuck or at maximum extension and still leaves lash in the system.
10. Oil leak or excessive cam bore wear in cylinder head.
11. Faulty lash adjuster.
    a. *Check lash adjusters for sponginess while installed in cylinder head and cam on camshaft at base circle. Depress part of rocker arm over adjuster. Normal adjusters should feel firm when pressed quickly. When pressed very slowly, lash adjusters should collapse.*
    b. *Remove suspected lash adjusters, and replace.*
    c. *Before installation, make sure adjusters are full of oil. This can be verified by little plunger travel when lash adjuster is depressed quickly.*

CYLINDER HEAD - LEFT

1. Disconnect the negative cable from the battery.
2. Raise the vehicle on a hoist.
3. Disconnect the exhaust pipe at the left side exhaust manifold.
4. Drain the engine coolant. Refer to **STANDARD PROCEDURE** .
5. Lower the vehicle.
6. Remove the intake manifold. Refer to **REMOVAL**.
7. Remove the master cylinder and booster assembly. Refer to **REMOVAL** .
8. Remove the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
9. Remove the fan shroud and fan blade assembly. Refer to **REMOVAL** .
10. Remove accessory drive belt. Refer to **REMOVAL** .
11. Remove the power steering pump and set aside.

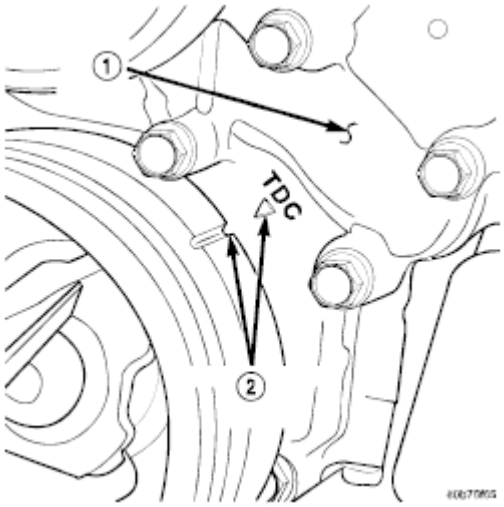


Fig. 9: Identifying TDC Indicator Mark
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

12. Rotate the crankshaft until the damper timing mark is aligned with TDC indicator mark (2).

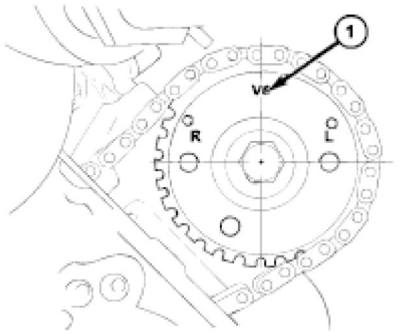


Fig. 10: Identifying V6 Mark On Camshaft Sprocket
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

13. Verify the V6 mark (1) on the camshaft sprocket is at the 12 o'clock position, with the No. 1 cylinder at TDC on the exhaust stroke. Rotate the crankshaft one turn if necessary.
14. Remove the crankshaft damper. Refer to **REMOVAL**.
15. Remove the timing chain cover. Refer to **REMOVAL**.

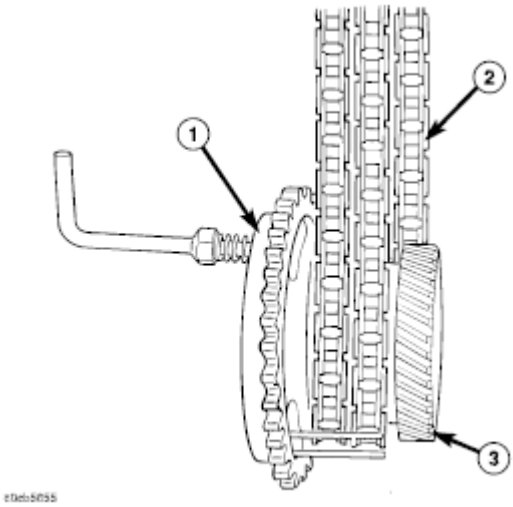


Fig. 11: Identifying Secondary Timing Chains And Special Tool 8429 Timing Chain Holding Fixture
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

16. Lock the secondary timing chains (2) to the idler sprocket using Special Tool 8429 Timing Chain Holding Fixture (1).

NOTE: Mark the secondary timing chain prior to removal to aid in installation.

17. Mark the secondary timing chain (2), one link on each side of the V6 mark on the camshaft drive gear.
18. Remove the left side secondary chain tensioner. Refer to **REMOVAL**.

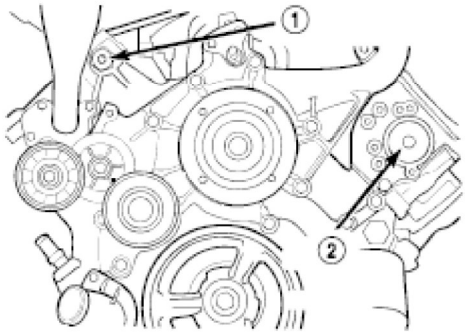


Fig. 12: Identifying Cylinder Head Access Plugs
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

19. Remove the cylinder head access plug (1) and (2).
20. Remove the left side secondary chain guide. Refer to **REMOVAL**.
21. Remove the retaining bolt and the camshaft drive gear.

CAUTION: Do not allow the engine to rotate. Severe damage to the valve train can occur.

CAUTION: Do not overlook the four smaller bolts at the front of the cylinder head. Do not attempt to remove the cylinder head without removing these four bolts.

NOTE: The cylinder head is attached to the cylinder block with twelve bolts.

22. Remove the cylinder head retaining bolts.
23. Remove the cylinder head and gasket. Discard the gasket.

CAUTION: Do not lay the cylinder head on its gasket sealing surface, due to the design of the cylinder head gasket any distortion to the cylinder head sealing surface may prevent the gasket from properly sealing resulting in leaks.

CYLINDER HEAD - RIGHT

1. Disconnect battery negative cable.
2. Raise the vehicle on a hoist.
3. Disconnect the exhaust pipe at the right side exhaust manifold.
4. Drain the engine coolant. Refer to **STANDARD PROCEDURE** .
5. Lower the vehicle.
6. Remove the intake manifold. Refer to **REMOVAL**.
7. Remove the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
8. Remove the radiator fan. Refer to **REMOVAL** .
9. Remove oil fill housing from cylinder head.
10. Remove accessory drive belt. Refer to **REMOVAL** .
11. Rotate the crankshaft until the damper timing mark is aligned with TDC indicator mark.
12. Verify the V6 mark on the camshaft sprocket is at the 12 o'clock position. Rotate the crankshaft one turn if necessary.
13. Remove the crankshaft damper. Refer to **REMOVAL**.
14. Remove the timing chain cover. Refer to **REMOVAL**.
15. Lock the secondary timing chains to the idler sprocket using Special Tool 8429 Timing Chain Holding Fixture.

NOTE: Mark the secondary timing chain prior to removal to aid in installation.

16. Mark the secondary timing chain, one link on each side of the V6 mark on the camshaft drive gear.
17. Remove the right side secondary chain tensioner. Refer to **REMOVAL**.
18. Remove the cylinder head access plug.
19. Remove the right side secondary chain guide. Refer to **REMOVAL**.

CAUTION: The nut on the right side camshaft sprocket should not be removed for any reason, as the sprocket and camshaft sensor target wheel is serviced as an assembly. If the nut was removed retorque nut to 5 N.m (44 in. lbs.).

20. Remove the retaining bolt and the camshaft drive gear.

CAUTION: Do not allow the engine to rotate. severe damage to the valve train can occur.

CAUTION: Do not overlook the four smaller bolts at the front of the cylinder head. Do not attempt to remove the cylinder head without removing these four bolts.

CAUTION: Do not hold or pry on the camshaft target wheel for any reason. A damaged target wheel can result in a vehicle no start condition.

NOTE: The cylinder head is attached to the cylinder block with twelve bolts.

21. Remove the cylinder head retaining bolts.
22. Remove the cylinder head and gasket. Discard the gasket.

CAUTION: Do not lay the cylinder head on its gasket sealing surface, do to the design of the cylinder head gasket any distortion to the cylinder head sealing surface may prevent the gasket from properly sealing resulting in leaks.

INSPECTION

1. Inspect the cylinder head for out-of-flatness, using a straightedge and a feeler gauge. If tolerances exceed 0.0508 mm (0.002 in.) replace the cylinder head.
2. Inspect the valve seats for damage. Service the valve seats as necessary.
3. Inspect the valve guides for wear, cracks or looseness. If either condition exist, replace the cylinder head.

CYLINDER HEAD - LEFT

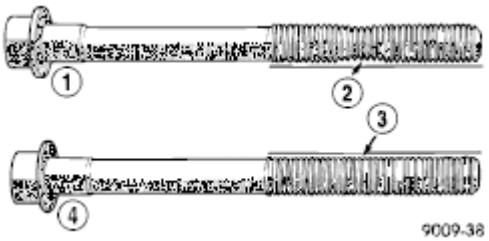


Fig. 13: Identifying Cylinder Head Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: The cylinder head bolts are tightened using a torque plus angle procedure. The bolts must be examined BEFORE reuse. If the threads are necked down the bolts should be replaced.
Necking can be checked by holding a straight edge against the threads (2). If all the threads do not contact the scale, the bolt should be replaced.

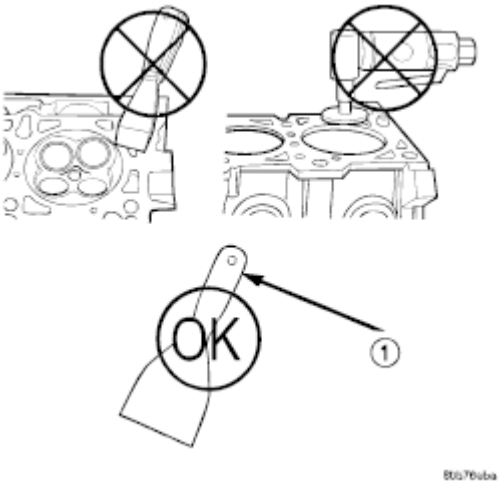


Fig. 14: Precaution For Cleaning Cylinder Head And Cylinder Block Surfaces
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: When cleaning cylinder head and cylinder block surfaces, DO NOT use a metal scraper because the surfaces could be cut or ground. Use only a wooden or plastic scraper (1).

1. Clean the cylinder head and cylinder block mating surfaces.
2. Position the new cylinder head gasket on the locating dowels.

CAUTION: When installing cylinder head, use care not damage the tensioner arm or the guide arm.

3. Position the cylinder head onto the cylinder block. Make sure the cylinder head seats fully over the locating dowels.

NOTE: The four smaller cylinder head mounting bolts require sealant to be added to them before installing. Failure to do so may cause leaks. The locations are identified with an *.

4. Lubricate the cylinder head bolt threads with clean engine oil and install the eight M11 bolts.
5. Coat the four M8 cylinder head bolts with Loctite 242 Lock and Seal Adhesive (or equivalent) then install

the bolts.

NOTE: The cylinder head bolts are tightened using an angle torque procedure, however, the bolts are not a torque-to-yield design.

6. Tighten the bolts in sequence using the following steps and torque values:
   - *Step 1: Tighten bolts 1-8, 27 N.m (20 ft. lbs.).*
   - *Step 2: Verify that bolts 1-8, all reached 27 N.m (20 ft. lbs.), by repeating step 1 without loosening the bolts. Tighten bolts 9 thru 12 to 14 N.m (10 ft. lbs.).*
   - *Step 3: Tighten bolts 1-8, 90 degrees.*
   - *Step 4: Tighten bolts 1-8, 90 degrees, again. Tighten bolts 9-12, 26 N.m (19 ft. lbs.)*
7. Position the secondary chain onto the camshaft drive gear, making sure one marked chain link is on either side of the V6 mark on the gear then using Special Tool 8428 Camshaft Wrench, position the gear onto the camshaft.

CAUTION: Remove excess oil from camshaft sprocket retaining bolt before reinstalling bolt. Failure to do so may cause over-torqueing of bolt resulting in bolt failure.

8. Install the camshaft drive gear retaining bolt.
9. Install the left side secondary chain guide. Refer to **INSTALLATION**.
10. Install the cylinder head access plug.
11. Reset and install the left side secondary chain tensioner. Refer to **INSTALLATION**.
12. Remove Special Tool 8429.
13. Install the timing chain cover. Refer to **INSTALLATION**.
14. Install the crankshaft damper. Refer to **INSTALLATION**. Tighten damper bolt 175 N.m (130 ft. lbs.).
15. Install the power steering pump.
16. Install the fan blade assembly and fan shroud. Refer to **INSTALLATION** .
17. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.
18. Install the master cylinder and booster assembly. Refer to **INSTALLATION** .
19. Install the intake manifold. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.
20. Refill the cooling system. Refer to **STANDARD PROCEDURE** .
21. Raise the vehicle.
22. Install the exhaust pipe onto the left exhaust manifold. Refer to **INSTALLATION**.
23. Lower the vehicle.
24. Connect the negative cable to the battery.
25. Start the engine and check for leaks.

CYLINDER HEAD - RIGHT

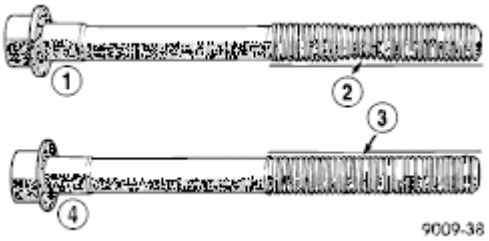


Fig. 15: Identifying Cylinder Head Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: The cylinder head bolts (4) are tightened using a torque plus angle procedure. The bolts must be examined BEFORE reuse. If the threads are necked down the bolts should be replaced.
Necking can be checked by holding a straight edge against the threads (2). If all the threads do not contact the scale, the bolt should be replaced.

CAUTION: When cleaning cylinder head and cylinder block surfaces, DO NOT use a metal scraper because the surfaces could be cut or ground. Use only a wooden or plastic scraper (1).

1. Clean the cylinder head and cylinder block mating surfaces.

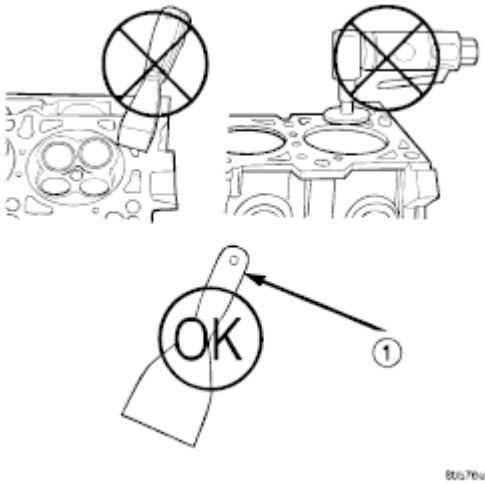


Fig. 16: Precaution For Cleaning Cylinder Head And Cylinder Block Surfaces
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

2. Position the new cylinder head gasket on the locating dowels.

CAUTION: When installing cylinder head, use care not damage the tensioner arm or the guide arm.

3. Position the cylinder head onto the cylinder block. Make sure the cylinder head seats fully over the

locating dowels.

NOTE: The four M8 cylinder head mounting bolts require sealant to be added to them before installing.

Failure to do so may cause leaks.

4. Lubricate the cylinder head bolt threads with clean engine oil and install the eight M10 bolts.
5. Coat the four M8 cylinder head bolts with Loctite 242 Lock and Seal Adhesive (or equivalent) then install the bolts.

NOTE: The cylinder head bolts are tightened using an angle torque procedure, however, the bolts are not a torque-to-yield design.

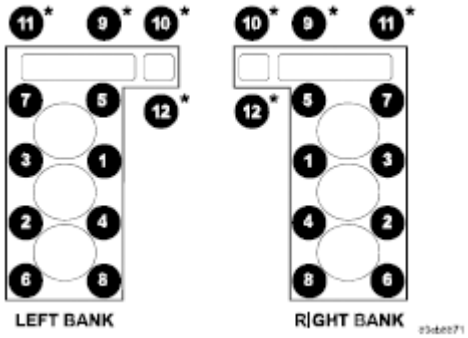


Fig. 17: Identifying Installation Sequence Of Cylinder Head Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

6. Tighten the bolts in sequence using the following steps and torque values:
   - *Step 1: Tighten bolts 1-8, 27 N.m (20 ft. lbs.).*
   - *Step 2: Verify that bolts 1-8, all reached 27 N.m (20 ft. lbs.), by repeating step 1 without loosening the bolts. Tighten bolts 9 thru 12 to 14 N.m (10 ft. lbs.).*
   - *Step 3: Tighten bolts 1-8, 90°.*
   - *Step 4: Tighten bolts 1-8, 90°, again. Tighten bolts 9-12, 26 N.m (19 ft. lbs.)*

CAUTION: The nut on the right side camshaft sprocket should not be removed for any reason, as the sprocket and camshaft sensor target wheel is serviced as an assembly. If the nut was removed retorque nut to 5 N.m (60 in. lbs.).

7. Position the secondary chain onto the camshaft drive gear, making sure one marked chain link is on either side of the V6 mark on the gear then using Tool 8428 Camshaft Wrench, position the gear onto the camshaft.

CAUTION: Remove excess oil from camshaft sprocket retaining bolt before

reinstalling bolt. Failure to do so may cause over-torquing of bolt resulting in bolt failure.

8. Install the camshaft drive gear retaining bolt.
9. Install the right side secondary chain guide. Refer to **INSTALLATION**.
10. Install the cylinder head access plug.
11. Reset and install the right side secondary chain tensioner. Refer to **INSTALLATION**.
12. Remove Special Tool 8429.
13. Install the timing chain cover. Refer to **INSTALLATION**.
14. Install the crankshaft damper. Refer to **INSTALLATION**. Tighten damper bolt 175 N.m (130 ft. lbs.).
15. Install accessory drive belt. Refer to **INSTALLATION** .
16. Install the radiator fan and shroud. Refer to **INSTALLATION** .
17. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.
18. Install the intake manifold. Refer to **INSTALLATION**.
19. Install oil fill housing onto cylinder head.
20. Refill the cooling system. Refer to **STANDARD PROCEDURE** .
21. Raise the vehicle.
22. Install the exhaust pipe onto the right exhaust manifold.
23. Lower the vehicle.
24. Reconnect battery negative cable.
25. Start the engine and check for leaks.

CAMSHAFT(S)

DESCRIPTION

The camshafts consist of powdered metal steel lobes which are sinter-bonded to a steel tube. Four bearing journals are machined into the camshaft. Camshaft end play is controlled by two thrust walls that border the nose piece journal.

REMOVAL - LEFT

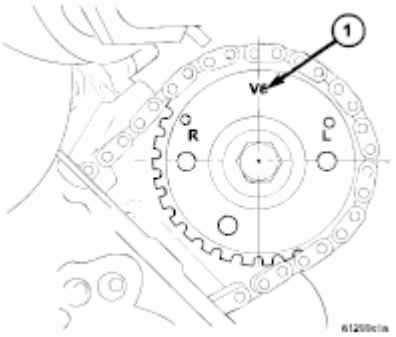


Fig. 18: Identifying V6 Mark On Camshaft Sprocket
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: When the timing chain is removed and the cylinder heads are still installed, DO NOT forcefully rotate the camshafts or crankshaft independently of each other. Severe valve and/or piston damage can occur.

CAUTION: When removing the cam sprocket, timing chains or camshaft, Failure to use Special Tool 8379 will result in hydraulic tensioner ratchet over extension, requiring timing chain cover removal to reset the tensioner ratchet.

1. Remove cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
2. Set engine to TDC cylinder No. 1, camshaft sprocket V6 marks (1) at the 12 o'clock position.
3. Mark one link on the secondary timing chain on both sides of the V6 mark on the camshaft sprocket to aid in installation.

CAUTION: Do not hold or pry on the camshaft target wheel (Located on the right side camshaft sprocket) for any reason, Severe damage will occur to the target wheel resulting in a vehicle no start condition.

4. Loosen but DO NOT remove the camshaft sprocket retaining bolt. Leave the bolt snug against the sprocket.

NOTE: The timing chain tensioners must be secured prior to removing the camshaft sprockets. Failure to secure tensioners will allow the tensioners to extend, requiring timing chain cover removal in order to reset tensioners.

CAUTION: Do not force wedge past the narrowest point between the chain strands. Damage to the tensioners may occur.

5. Position Special Tool 8379 timing chain wedge (1) between the timing chain strands, tap the tool to securely wedge the timing chain against the tensioner arm and guide.
6. Hold the camshaft with Special Tool 8428 Camshaft Wrench (2), while removing the camshaft sprocket bolt and sprocket.
7. Using Special Tool 8428 Camshaft Wrench (2), gently allow the camshaft to rotate 5° clockwise until the camshaft is in the neutral position (no valve load).
8. Starting at the outside working inward, loosen the camshaft bearing cap retaining bolts 1/2 turn at a time. Repeat until all load is off the bearing caps.

CAUTION: DO NOT STAMP OR STRIKE THE CAMSHAFT BEARING CAPS. SEVERE DAMAGE WILL OCCUR TO THE BEARING CAPS.

NOTE: When the camshaft is removed the rocker arms may slide downward, mark the rocker arms before removing camshaft.

9. Remove the camshaft bearing caps and the camshaft.

CAMSHAFT-RIGHT

CAUTION: When the timing chain is removed and the cylinder heads are still installed, DO NOT forcefully rotate the camshafts or crankshaft independently of each other. Severe valve and/or piston damage can occur.

CAUTION: When removing the cam sprocket, timing chains or camshaft, Failure to use special tool 8379 will result in hydraulic tensioner ratchet over extension, Requiring timing chain cover removal to reset the tensioner ratchet.

1. Remove the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
2. Set engine to TDC cylinder No. 1, camshaft sprocket V6 marks at the 12 o'clock position.
3. Mark one link on the secondary timing chain on both sides of the V6 mark on the camshaft sprocket to aid in installation.

CAUTION: Do not hold or pry on the camshaft target wheel for any reason, Severe damage will occur to the target wheel. A damaged target wheel could cause a vehicle no start condition.

4. Loosen but **DO NOT** remove the camshaft sprocket retaining bolt. Leave bolt snug against sprocket.

NOTE: The timing chain tensioners must be secured prior to removing the camshaft sprockets. Failure to secure tensioners will allow the tensioners to extend, requiring timing chain cover removal in order to reset tensioners.

CAUTION: Do not force wedge past the narrowest point between the chain strands. Damage to the tensioners may occur.

5. Position Tool 8379 timing chain wedge between the timing chain strands. Tap the tool to securely wedge the timing chain against the tensioner arm and guide.
6. Remove the camshaft position sensor.
7. Hold the camshaft with Tool 8428 Camshaft Wrench, while removing the camshaft sprocket bolt and sprocket.
8. Starting at the outside working inward, loosen the camshaft bearing cap retaining bolts 1/2 turn at a time.

Repeat until all load is off the bearing caps.

CAUTION: DO NOT STAMP OR STRIKE THE CAMSHAFT BEARING CAPS. SEVERE DAMAGE WILL OCCUR TO THE BEARING CAPS.

NOTE: When the camshaft is removed the rocker arms may slide downward, mark the rocker arms before removing camshaft.

9. Remove the camshaft bearing caps and the camshaft.

INSTALLATION - LEFT

1. Lubricate camshaft journals with clean engine oil.

NOTE: Position the left side camshaft so that the camshaft sprocket dowel is near the 1 o'clock position, This will place the camshaft at the neutral position easing the installation of the camshaft bearing caps.

2. Position the camshaft into the cylinder head.

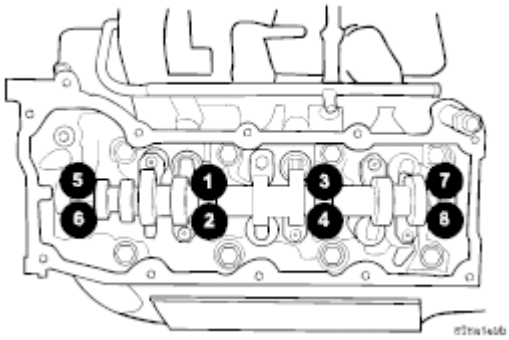


Fig. 19: Identifying Installation Sequence Of Camshaft Bearing Cap Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Install the camshaft bearing caps, hand tighten the retaining bolts.

NOTE: Caps should be installed so that the stamped numbers on the caps are in numerical order, (1 thru 4) from the front to the rear of the engine. All caps should be installed so that the stamped arrows on the caps point toward the front of the engine.

4. Working in 1/2 turn increments, tighten the bearing cap retaining bolts starting with the middle cap working outward.
5. Torque the camshaft bearing cap retaining bolts to 11 N.m (100 in. lbs.).
6. Position the camshaft drive gear into the timing chain aligning the V6 mark between the two marked chain links (Two links marked during removal).

7. Using Tool 8428 Camshaft Wrench, rotate the camshaft until the camshaft sprocket dowel is aligned with the slot in the camshaft sprocket. Install the sprocket onto the camshaft.

CAUTION: Remove excess oil from camshaft sprocket bolt. Failure to do so can cause bolt over-torque resulting in bolt failure.

8. Remove excess oil from bolt, then install the camshaft sprocket retaining bolt and hand tighten.
9. Remove Special Tool 8379 timing chain wedge.
10. Using Special Tool 6958 spanner wrench with adapter pins 8346, torque the camshaft sprocket retaining bolt to 122 N.m (90 ft. lbs.).
11. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

CAMSHAFT-RIGHT

1. Lubricate camshaft journals with clean engine oil.

NOTE: Position the right side camshaft so that the camshaft sprocket dowel is near the 10 o'clock position, This will place the camshaft at the neutral position easing the installation of the camshaft bearing caps.

2. Position the camshaft into the cylinder head.

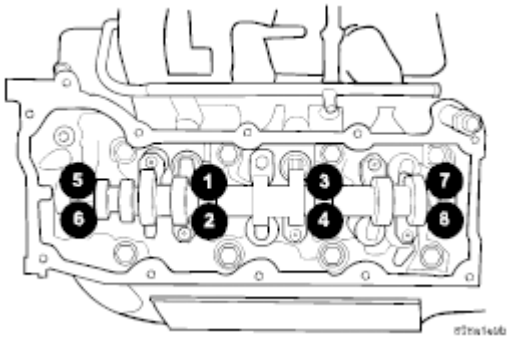


Fig. 20: Identifying Installation Sequence Of Camshaft Bearing Cap Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Install the camshaft bearing caps, hand tighten the retaining bolts.

NOTE: Caps should be installed so that the stamped numbers on the caps are in numerical order, (1 thru 4) from the front to the rear of the engine. All caps should be installed so that the stamped arrows on the caps point toward the front of the engine.

4. Working in 1/2 turn increments, tighten the bearing cap retaining bolts starting with the middle cap working outward as shown in illustration.

5. Torque the camshaft bearing cap retaining bolts to 11 N.m (100 in. lbs.).
6. Position the camshaft drive gear into the timing chain aligning the V6 mark between the two marked chain links (Two links marked during removal).
7. Using Special Tool 8428 Camshaft Wrench, rotate the camshaft until the camshaft sprocket dowel is aligned with the slot in the camshaft sprocket. Install the sprocket onto the camshaft.

CAUTION: Remove excess oil from camshaft sprocket bolt. Failure to do so can cause bolt over-torque resulting in bolt failure.

8. Remove excess oil from camshaft sprocket bolt, then install the camshaft sprocket retaining bolt and hand tighten.
9. Remove timing chain wedge Tool 8379.
10. Using Tool 6958 spanner wrench with adapter pins 8346, torque the camshaft sprocket retaining bolt to 122 N.m (90 ft. lbs.).
11. Install the camshaft position sensor.
12. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

COVER(S) - CYLINDER HEAD

DESCRIPTION

The cylinder head covers (1, 2) are made of glass reinforced thermoset plastic, and are not interchangeable from side-to-side.

REMOVAL

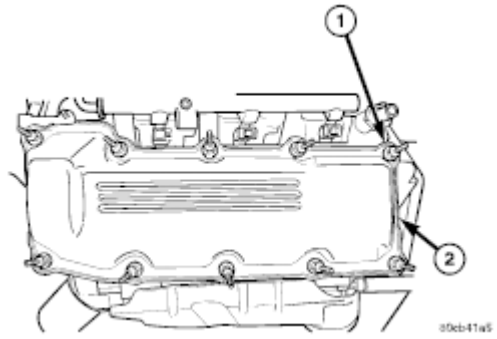


Fig. 21: Identifying Cylinder Head Cover And Cylinder Head Cover Mounting Bolt
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Disconnect negative cable from battery.
2. Remove the resonator assemble and air inlet hose.
3. Disconnect injector connectors and unclip the injector harness.
4. Route injector harness in front of cylinder head cover (2).

5. Disconnect the left side breather tube and remove the breather tube.
6. Remove the cylinder head cover mounting bolts (1).
7. Remove cylinder head cover and gasket.

NOTE: The gasket may be used again, providing no cuts, tears, or deformation has occurred.

INSTALLATION

CAUTION: Do not use harsh cleaners to clean the cylinder head covers. Severe damage to covers may occur.

NOTE: The gasket may be used again, provided no cuts, tears, or deformation has occurred.

1. Clean cylinder head cover and both sealing surfaces. Inspect and replace gasket as necessary.
2. Tighten cylinder head cover bolts and double ended studs to 12 N.m (105 in. lbs.).
3. Install left side breather and connect breather tube.
4. Connect injector electrical connectors and injector harness retaining clips
5. Install the resonator and air inlet hose.
6. Connect negative cable to battery.

VALVES & SEATS - INTAKE/EXHAUST

DESCRIPTION

The valves are made of heat resistant steel and have chrome plated stems to prevent scuffing. Each valve is actuated by a roller rocker arm which pivots on a stationary lash adjuster. All valves use three bead lock keepers to retain the springs and promote valve rotation.

STANDARD PROCEDURE

REFACING

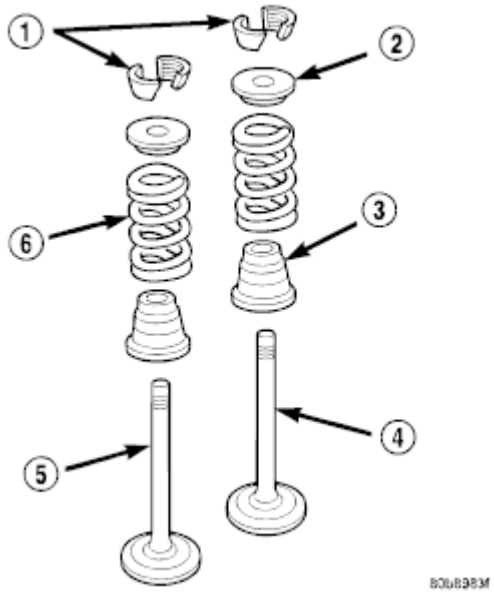


Fig. 22: Identifying Valve Components
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

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

NOTE: When refacing valves and 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.

1. Using a suitable dial indicator measure the center of the valve seat Total run out must not exceed 0.051 mm (0.002 in).
2. Apply a small amount of Prussian blue to the valve seat, insert the valve (4) or (5) into the cylinder head, while applying light pressure on the valve rotate the valve. Remove the valve and examine the valve face. If the blue is transferred below the top edge of the valve face, lower the valve seat using a 15 degree stone. If the blue is transferred to the bottom edge of the valve face, raise the valve seat using a 65 degree stone.
3. When the seat is properly positioned the width of the intake seat must be 1.75 - 2.36 mm (0.0689 - 0.0928 in.) and the exhaust seat must be 1.71 - 2.32 mm (0.0673 - 0.0911 in.).
4. Check the valve spring installed height after refacing the valve (4) and (5) and seat. The installed height for both intake and exhaust valve springs must not exceed 40.74 mm (1.6039 in.).
5. The valve seat and valve face must maintain a face angle of 44.5 - 45 degree angle.

REMOVAL

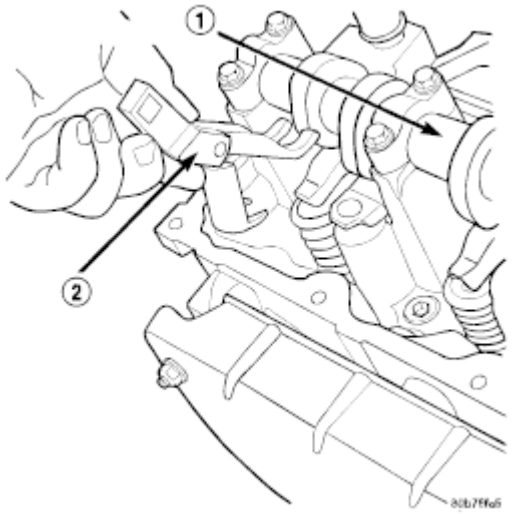


Fig. 23: Identifying Rocker Arm And Valve Spring Compressor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: The cylinder heads must be removed in order to perform this procedure.

1. Remove rocker arms and lash adjusters. Refer to **REMOVAL**.
2. Remove the camshaft bearing caps and the camshaft.

NOTE: All six valve springs and valves are removed in the same manner; this procedure only covers one valve and valve spring.

3. Using Tool C-3422-B or C-3422-C Valve Spring Compressor and Tool 8519 Adapter (2), compress the valve spring.

NOTE: It may be necessary to tap the top of the valve spring to loosen the spring retainers locks enough to be removed.

4. Remove the two spring retainer lock halves.

NOTE: the valve spring is under tension use care when releasing the valve spring compressor.

5. Remove the valve spring compressor (2).
6. Remove the spring retainer, and the spring.

NOTE: Check for sharp edges on the keeper grooves. Remove any burrs from the valve stem before removing the valve from the cylinder head.

7. Remove the valve from the cylinder head.

NOTE: The valve stem seals are common between intake and exhaust.

8. Remove the valve stem seal. Mark the valve for proper installation.

TESTING VALVE SPRINGS

NOTE: Whenever the valves are removed from the cylinder head it is recommended that the valve springs be inspected and tested for reuse.

Inspect the valve springs for physical signs of wear or damage. Turn table of Tool C-647 (1) until surface is in line with the 40.12 mm (1.579 in.) mark on the threaded stud and the zero mark on the front. Place spring over the stud on the table and lift compressing lever to set tone device. Pull on torque wrench until a Ping is heard. Take reading on torque wrench at this instant. Multiply this reading by two. This will give the spring load at test length. Fractional measurements are indicated on the table for finer adjustments. Refer to ***SPECIFICATIONS*** *to obtain specified height and allowable tensions. Replace any springs that do not meet specifications.*

INSTALLATION

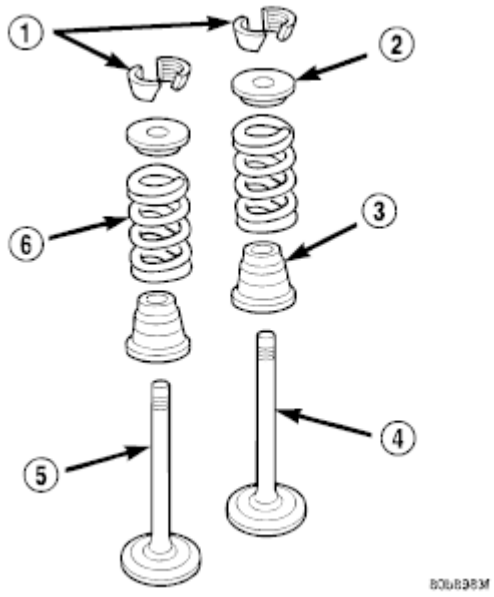


Fig. 24: Identifying Valve Components
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Coat the valve stem with clean engine oil and insert it into the cylinder head.
2. Install the valve stem seal (3). Make sure the seal is fully seated and that the garter spring at the top of the seal is intact.
3. Install the spring and the spring retainer (2).
4. Using the valve spring compressor, compress the spring (6) and install the two valve spring retainer halves (1).
5. Release the valve spring compressor and make sure the two spring retainer halves (1) and the spring

retainer (2) are fully seated.

6. Lubricate the camshaft journal with clean engine oil then position the camshaft, with the sprocket dowel on the left camshaft at 11 o'clock and the right camshaft at 12 o'clock, then position the camshaft bearing caps.

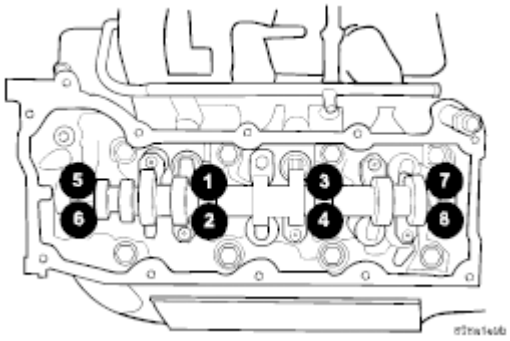


Fig. 25: Identifying Installation Sequence Of Camshaft Bearing Cap Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

7. Install the camshaft bearing cap retaining bolts. Tighten the bolts 11 N.m (100 in. lbs.) in 1/2 turn increments in the sequence shown in illustration.
8. Position the hydraulic lash adjusters and rocker arms. Refer to **INSTALLATION**.

ARM - ROCKER

DESCRIPTION

The rocker arms are steel stampings with an integral roller bearing. The rocker arms incorporate a 0.5 mm oil hole in the lash adjuster socket for roller and camshaft lubrication.

REMOVAL

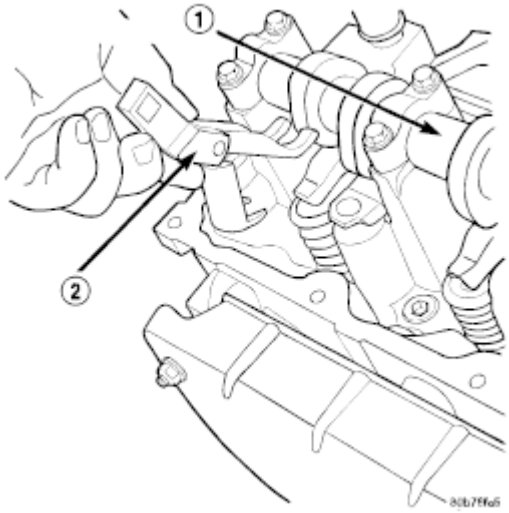


Fig. 26: Identifying Rocker Arm And Valve Spring Compressor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: Disconnect the battery negative cable to prevent accidental starter engagement.

1. Remove the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
2. For rocker arm removal on cylinder No. 4, Rotate the crankshaft until cylinder No. 1 is at BDC intake stroke.
3. For rocker arm removal on cylinder No. 1, Rotate the crankshaft until cylinder No. 1 is at BDC combustion stroke.
4. For rocker arm removal on cylinders No. 3 and No. 5, Rotate the crankshaft until cylinder No. 1 is at TDC exhaust stroke.
5. For rocker arm removal on cylinders No. 2 and No. 6, Rotate the crankshaft until cylinder No. 1 is at TDC ignition stroke.
6. Using special Tool 8516 Rocker Arm Remover (2), press downward on the valve spring, remove rocker arm.

INSTALLATION

1. Using Tool 8516 (2) press downward on the valve spring, install rocker arm.

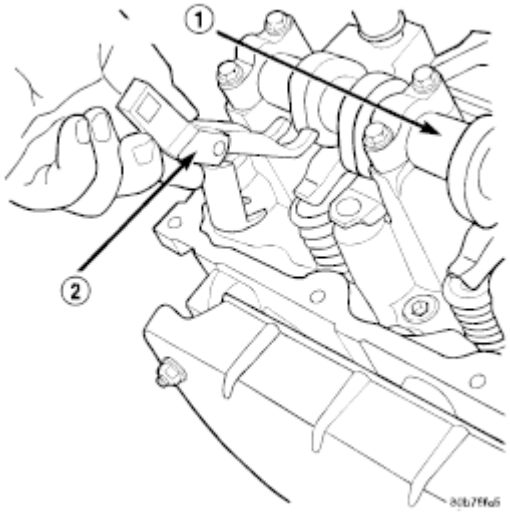


Fig. 27: Identifying Rocker Arm And Valve Spring Compressor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: Make sure the rocker arms are installed with the concave pocket over the lash adjusters. Failure to do so may cause severe damage to the rocker arms and/or lash adjusters.

NOTE: Coat the rocker arms with clean engine oil prior to installation.

2. For rocker arm installation on cylinders No. 4, Rotate the crankshaft until cylinder No. 1 is at BDC intake stroke.
3. For rocker arm installation on cylinder No. 1, Rotate the crankshaft until cylinder No. 1 is at BDC combustion stroke.
4. For rocker arm installation on cylinders No. 3 and No. 5, Rotate the crankshaft until cylinder No. 1 is at TDC exhaust stroke.
5. For rocker arm installation on cylinders No. 2 and No. 6, Rotate the crankshaft until cylinder No. 1 is at TDC ignition stroke.
6. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

SEALS - VALVE GUIDE

DESCRIPTION

The valve guide seals are made of rubber and incorporate an integral steel valve spring seat. The integral garter spring maintains consistent lubrication control to the valve stems.

SPRINGS - VALVE

DESCRIPTION

The valve springs are made from high strength chrome silicon steel. The springs are NOT common for intake and exhaust applications. The valve spring seat is integral with the valve stem seal, which is a positive type seal to control lubrication.

REMOVAL

1. Remove the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
2. Using Special Tool 8516 Valve Spring Compressor, remove the rocker arms and the hydraulic lash adjusters.
3. Remove the spark plug for the cylinder the valve spring and seal are to be removed from.
4. Apply shop air to the cylinder to hold the valves in place when the spring is removed.

NOTE: All six valve springs and seals are removed in the same manner; this procedure only covers one valve seal and valve spring.

5. Using Special Tool 8387 Valve Spring Compressor, compress the valve spring.

NOTE: It may be necessary to tap the top of the valve spring to loosen the spring retainers locks enough to be removed.

6. Remove the two spring retainer lock halves.

NOTE: The valve spring is under tension use care when releasing the valve spring

compressor.

7. Remove the valve spring compressor.

NOTE: The valve springs are NOT common between intake and exhaust.

8. Remove the spring retainer, and the spring.
9. Remove the valve stem seal.

NOTE: The valve stem seals are common between intake and exhaust.

INSTALLATION

NOTE: All six valve springs and seals are removed in the same manner; this procedure only covers one valve seal and valve spring.

1. Apply shop air to the cylinder to hold the valves in place while the spring is installed.

NOTE: The valve stem seals are common between intake and exhaust.

2. Install the valve stem seal.

NOTE: The valve springs are NOT common between intake and exhaust.

3. Install the spring retainer, and the spring.
4. Using Special Tool 8387 Valve Spring Compressor, compress the valve spring.
5. Install the two spring retainer lock halves.

NOTE: The valve spring is under tension use care when releasing the valve spring compressor.

6. Remove the valve spring compressor.
7. Disconnect the shop air to the cylinder.
8. Install the spark plug for the cylinder the valve spring and seal was installed on.
9. Using Special Tool 8516 Valve Spring Compressor, install the rocker arms and the hydraulic lash adjusters.
10. Install the cylinder head cover. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

ENGINE BLOCK

DESCRIPTION

The cylinder block is made of cast iron. The block is a closed deck design with the left bank forward. To provide

high rigidity and improved NVH an enhanced compacted graphite bedplate is bolted to the block. The block design allows coolant flow between the cylinders bores, and an internal coolant bypass to a single poppet inlet thermostat is included in the cast aluminum front cover.

STANDARD PROCEDURE

CYLINDER BORE HONING

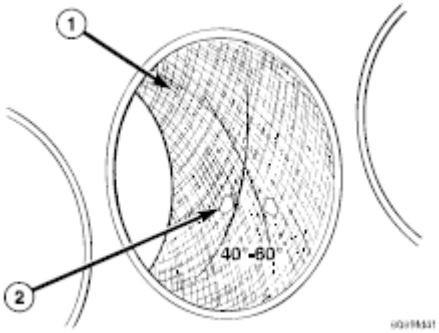


Fig. 28: Identifying Crosshatch Angle In Cylinder Bore
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

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.

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 50° to 60° for proper seating of rings.
4. A controlled hone motor speed between 200 and 300 RPM is necessary to obtain the proper crosshatch angle (1). The number of up and down strokes per minute can be regulated to get the desired 50° to 60° angle (2). Faster up and down strokes increase the crosshatch 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.

CLEANING

Thoroughly clean the oil pan and engine block gasket surfaces.

Use compressed air to clean out:

- *The galley at the oil filter adaptor hole.*
- *The front and rear oil galley holes.*
- *The feed holes for the crankshaft main bearings.*

Once the block has been completely cleaned, apply Loctite PST pipe sealant with Teflon 592 to the threads of the front and rear oil galley plugs. Tighten the 1/4 inch NPT plugs to 20 N.m (177 in. lbs.) torque. Tighten the 3/8 inch NPT plugs to 27 N.m (240 in. lbs.) torque.

INSPECTION

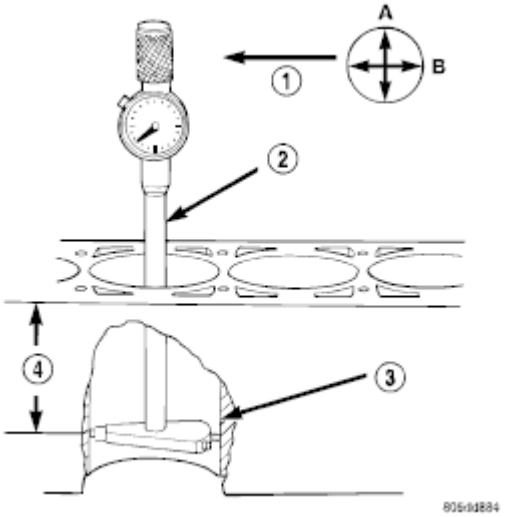


Fig. 29: Measuring Cylinder Bore Diameter
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. It is mandatory to use a dial bore gauge (2) to measure each cylinder bore diameter. To correctly select the proper size piston, a cylinder bore gauge, capable of reading in 0.003 mm (.0001 in.) INCREMENTS is required. If a bore gauge is not available, do not use an inside micrometer.
2. Measure the inside diameter of the cylinder bore at three levels below top of bore. Start perpendicular (across or at 90 degrees) to the axis of the crankshaft and then take two additional reading.
3. Measure the cylinder bore diameter crosswise to the cylinder block near the top of the bore. Repeat the measurement near the middle of the bore, then repeat the measurement near the bottom of the bore.
4. Determine taper by subtracting the smaller diameter from the larger diameter.
5. Rotate measuring device 90° and repeat steps above.

6. Determine out-of-roundness by comparing the difference between each measurement.
7. If cylinder bore taper does not exceed 0.025 mm (0.001 inch) and out-of-roundness does not exceed 0.025 mm (0.001 inch), the cylinder bore can be honed. If the cylinder bore taper or out- of-round condition exceeds these maximum limits, the cylinder block must be replaced. A slight amount of taper always exists in the cylinder bore after the engine has been in use for a period of time.

CRANKSHAFT

DESCRIPTION

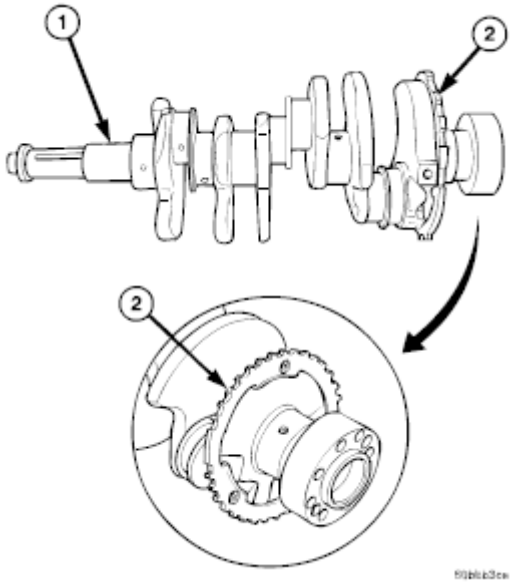


Fig. 30: Identifying Crankshaft And Target Wheel
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The crankshaft (1) is constructed of nodular cast iron. The crankshaft is a three throw split pin design with six counterweights for balancing purposes. The crankshaft is supported by four select fit main bearings with the No. 2 serving as the thrust washer location. The main journals of the crankshaft are cross drilled to improve rod bearing lubrication. The No. 6 counterweight has provisions for crankshaft position sensor target wheel mounting. The select fit main bearing markings are located on the rear side of the target wheel (2). The crankshaft oil seals are one piece design. The front oil seal is retained in the timing chain cover, and the rear seal is pressed in to a bore formed by the cylinder block and the bedplate assembly.

REMOVAL

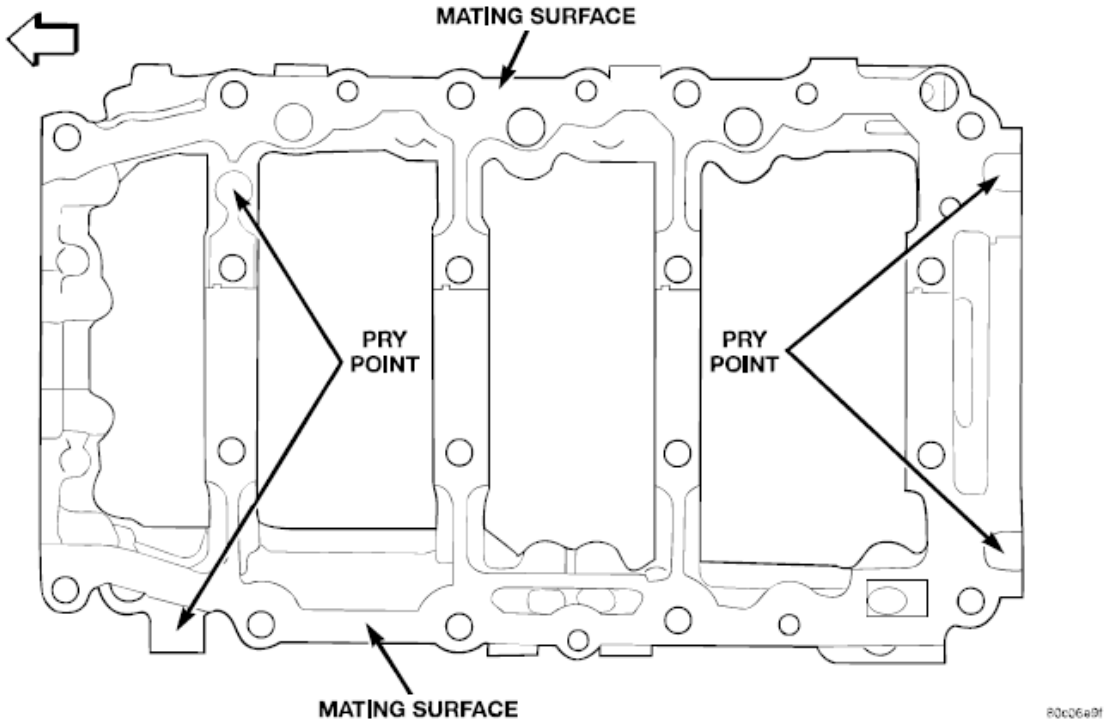


Fig. 31: Identifying Pry Points On Bedplate
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: To remove the crankshaft from the engine, the engine must be removed from the vehicle.

1. Remove the engine. Refer to **ENGINE - REMOVAL**.
2. Remove the engine oil pump. Refer to **REMOVAL**.

CAUTION: DO NOT pry on the oil pan gasket when removing the oil pan, The oil pan gasket is mounted to the cylinder block in three locations and will remain attached to block when removing oil pan. Gasket can not be removed with oil pan.

3. Remove the bedplate mounting bolts. Note the location of the two stud bolts for installation.
4. Remove the connecting rods from the crankshaft.

CAUTION: The bedplate to cylinder block mating surface is a critical sealing surface. Do not pry on or damage this surface in anyway.

NOTE: The bedplate contains the lower main bearing halves. Use care when handling bedplate as not to drop or damage bearing halves. Installing main bearing halves in the wrong position will cause severe damage to the crankshaft.

NOTE: The bedplate has pry points (1) cast into it. Use these points only.

5. Carefully pry on the pry points (1) to loosen the bedplate then remove the bedplate.

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

6. Remove the crankshaft.
7. Remove the crankshaft tone wheel.

INSPECTION

NOTE: Thoroughly inspect the connecting rod bearing bores and main bearing bores for scoring, blueing or severe scratches. Further disassembly may be required.

If connecting rod bearing bores show damage, the cylinder heads must be removed to service the piston and rod assemblies. If the bedplate or the cylinder block main bearing bores show damage the engine must be replaced.

1. If required, remove the main bearing halves from the cylinder block and bedplate.
2. Thoroughly clean the bedplate to cylinder block sealing surfaces and main bearing bores. Remove all oil and sealant residue.
3. Inspect the bedplate main bearing bores for cracks, scoring or severe blueing. If either condition exists the engine must be replaced.
4. Inspect the crankshaft thrust washers for scoring, scratches, wear or blueing. If either condition exist replace the thrust washers.
5. Inspect the oil pan gasket/windage tray for splits, tears or cracks in the gasket sealing surfaces. Replace gasket as necessary.

INSTALLATION

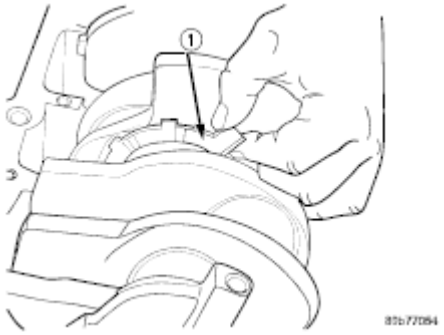


Fig. 32: Installing Thrust Washer
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: Main bearings are select fit. Refer to CRANKSHAFT MAIN BEARINGS for

proper bearing selections.

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

NOTE: Apply sealant to the tone wheel retaining screws prior to installation.

1. Lubricate upper main bearing halves with clean engine oil.
2. Install the crankshaft tone wheel. Torque the mounting screws to 15 N.m (11 ft. lbs.).
3. Position crankshaft in cylinder block.
4. Install the thrust washers (1).

CAUTION: The bedplate to cylinder block mating surface must be coated with Engine RTV sealant prior to installation. Failure to do so will cause severe oil leaks.

NOTE: Make sure that the bedplate and cylinder block sealing surfaces are clean and free of oil or other contaminants. Contaminants on the sealing surfaces may cause main bearing distortion and/or oil leaks.

5. Apply a 2.5 mm (0.100 inch) bead of Engine RTV sealant to the cylinder block-to-bedplate mating surface (1) and (2).
6. Coat the crankshaft main bearing journals with clean engine oil and position the bedplate onto the cylinder block.

NOTE: Lubricate the bedplate retaining bolts with clean engine oil prior to installation.

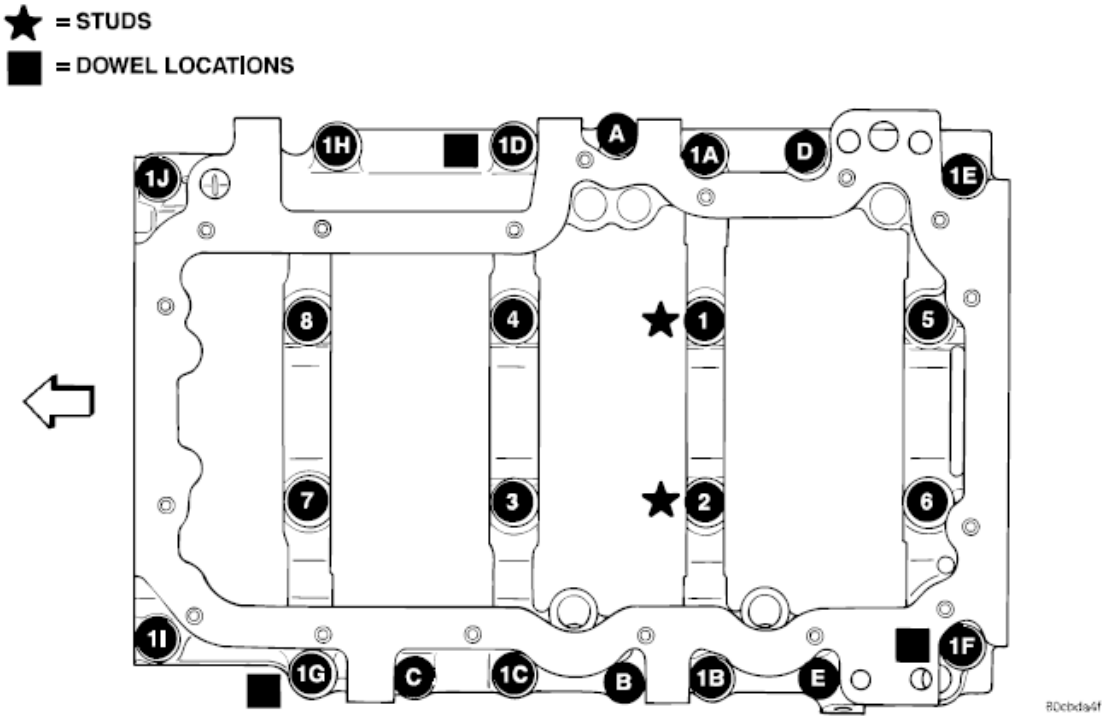


Fig. 33: Identifying Installation Sequence Of Bedplate Retaining Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

7. Install the bedplate retaining bolts, making sure to place the stud bolts in the correct location, Torque the bolts in the sequence shown in illustration.
   - *Hand tighten bolts **1D, 1G and 1F** until the bed plate contacts the block.*
   - *Tighten bolts **1A - 1J** to 54 N.m (40 ft. lbs.)*
   - *Tighten bolts **1 - 8** to 7 N.m (5 ft. lbs.)*
   - *Turn bolts **1 - 8** an additional 90°.*
   - *Tighten bolts **A - E** 27 N.m (20 ft. lbs.).*
8. Measure crankshaft end play.
9. Install the connecting rods and measure side clearance. Refer to **STANDARD PROCEDURE**.
10. Install oil pump. Refer to **INSTALLATION**.
11. Install the engine. Refer to **ENGINE - INSTALLATION**.

BEARINGS - CRANKSHAFT MAIN

STANDARD PROCEDURE

MAIN BEARING FITTING

SELECT FIT IDENTIFICATION

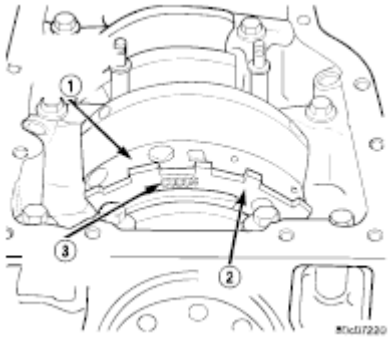


Fig. 34: Identifying Crankshaft Position Sensor Target Wheel And Counter Weight
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The main bearings are "select fit" to achieve proper oil clearances. For main bearing selection, the crankshaft position sensor target wheel (2) has grade identification marks (3) stamped into it. These marks are read from left to right, corresponding with journal number 1, 2, 3, 4. The crankshaft position sensor target wheel (2) is mounted to the number 6 counter weight (1) on the crankshaft.

INSPECTION

Wipe the inserts clean and inspect for abnormal wear patterns and for metal or other foreign material imbedded in the lining. Normal main bearing insert wear patterns are illustrated.

Inspect the back of the inserts for fractures, scrapings or irregular wear patterns.

Inspect the upper insert locking tabs for damage.

Replace all damaged or worn bearing inserts.

MAIN BEARING JOURNAL DIAMETER (CRANKSHAFT REMOVED)

Remove the crankshaft from the cylinder block. Refer to ***REMOVAL*** .

Clean the oil off the main bearing journal.

Determine the maximum diameter of the journal with a micrometer. Measure at two locations 90° apart at each end of the journal.

The maximum allowable taper is 0.008 mm (0.0004 inch.) and maximum out of round is 0.005 mm (0.002 inch). Compare the measured diameter with the journal diameter specification (Main Bearing Fitting Chart). Select inserts required to obtain the specified bearing-to-journal clearance.

Install the crankshaft into the cylinder block. Refer to ***INSTALLATION*** .

Check crankshaft end play.

CRANKSHAFT MAIN BEARING SELECTION

1. Service main bearings are available in four grades. The chart below identifies the four service grades available.

CRANKSHAFT MAIN BEARING SELECTION CHART

Crankshaft Marking	JOURNAL SIZE mm (in.)	
"R" Size	63.488 - 63.496 mm (2.4995 - 2.4998 in.)	
"S" Size	63.496 - 63.500 mm (2.4998 - 2.4999 in.)	
"T" Size	63.500 - 63.504 mm (2.4999 - 2.501 in.)	
"U" Size	63.504 - 63.512 mm (2.5001 - 2.5004 in.)	
Bearing size		
Bearing Code	Size	Application
Upper Bearing		
A	.2.443 - 2.447 mm (.0961 - .0963 in.)	Use with crankshaft size "R"
B	2.439 - 2.443 mm (0.960 - .0961 in.)	Use with crankshaft "S, T"
C	2.435 - 2.439 mm (.0958 - .0960 in.)	Use with crankshaft "U"
Lower Bearing Main "1" and "4"		
"1"	2.441 - 2.447 mm (.0961 -.0963 in.)	Use with crankshaft "R, S"
"2"	2.435 - 2.441 mm (.0958 - .0962 in.)	Use with crankshaft "T, U"
Lower Main Bearing "2" and "3"		
"3"	2.429 - 2.435 mm (.0956 - .0958 in.)	Use with crankshaft "R, S"
"4"	2.423 - 2.429 mm (.0953 - .0956 in.)	Use with crankshaft "T, U"
Bearing Clearances		
Main "1, 4"		
Crankshaft "R"	.004 - .034 mm (.00015 - .0013 in.)	
Crankshaft "S"	.004 - .030 mm (.00015 - .0011 in.)	
Crankshaft "T"	.006 - .032 mm (.0002 - .0012 in.)	
Crankshaft "U"	.002 - .032 mm (.00007 - . 0012 in.)	
Main "2, 3"		
Crankshaft "R"	.016 - .046 mm (.0006 - .0018 in.)	
Crankshaft "S"	.016 - .042 mm (.00062 - .016 in.)	
Crankshaft "T"	.018 - .044 mm (.0007 - .0017 in.)	
Crankshaft "U"	.014 - .044 mm (.0005 - .0017 in.)	

SEAL - CRANKSHAFT OIL - FRONT

REMOVAL

1. Disconnect negative cable from battery.
2. Remove accessory drive belt. Refer to **REMOVAL** .
3. Remove A/C compressor mounting fasteners and set aside.
4. Drain cooling system. Refer to **STANDARD PROCEDURE** .

5. Remove upper radiator hose.
6. Disconnect electrical connector for fan mounted inside radiator shroud.
7. Remove radiator cooling fan. Refer to **REMOVAL** .
8. Remove crankshaft damper bolt.

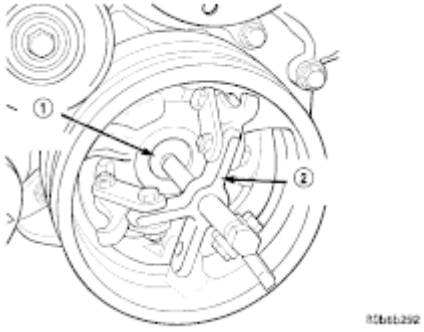


Fig. 35: Removing Damper Using Special Tools 8513 Insert And Tool 1026 Three Jaw Puller
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

9. Remove damper using Special Tools 8513 Insert (1) and Tool 1026 Three Jaw Puller (2).

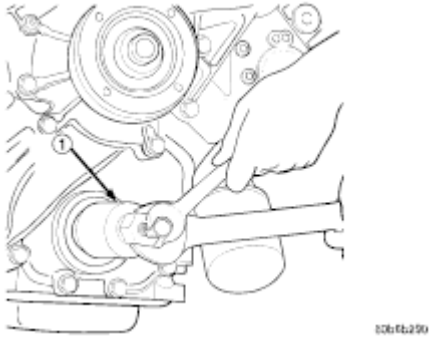


Fig. 36: Removing Crankshaft Front Seal Using Special Tool 8511
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

10. Using Special Tool 8511 (1), remove crankshaft front seal.

INSTALLATION

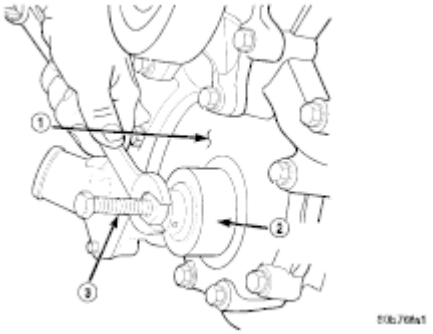


Fig. 37: Installing Crankshaft Front Seal Using Special Tool 8348 And 8512
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: To prevent severe damage to the Crankshaft, Damper or Special Tool 8512, thoroughly clean the damper bore and the crankshaft nose before installing Damper.

1. Using Special Tool 8348 (2) and 8512 (3), install crankshaft front seal.
2. Install vibration damper. Refer to **INSTALLATION**.
3. Install radiator cooling fan and shroud. Refer to **INSTALLATION** .
4. Install upper radiator hose.
5. Install A/C compressor and tighten fasteners to 54 N.m (40 ft. lbs.).
6. Install accessory drive belt. Refer to **INSTALLATION** .
7. Refill cooling system. Refer to **STANDARD PROCEDURE** .
8. Connect negative cable to battery.

CRANKSHAFT OIL SEAL - REAR

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.
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:
    1. Circular spray pattern generally indicates seal leakage or crankshaft damage.
    2. 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. See appropriate service information for proper repair procedures of these items.

4. If no leaks are detected, pressurize the crankcase as outlined in **AIR LEAK DETECTION TEST METHOD**.

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 **ENGINE DIAGNOSTIC CHART (LUBRICATION)** 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 **REMOVAL**.

REMOVAL

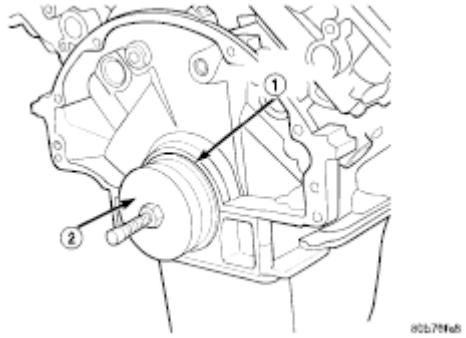


Fig. 38: Removing Crankshaft Rear Oil Seal Using Special Tool 8506
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: This procedure can be performed in vehicle.

1. If being performed in vehicle, remove the transmission.
2. Remove the flexplate. Refer to **REMOVAL**.

NOTE: The crankshaft oil seal (1) CANNOT be reused after removal.

NOTE: The crankshaft rear oil seal remover Special Tool 8506 (2) must be installed deeply into the seal. Continue to tighten the removal tool into the seal until the tool can not be turned farther. Failure to install tool correctly the first time will cause tool to pull free of seal without removing seal from engine.

3. Using Special Tool 8506 (2), remove the crankshaft rear oil seal (1).

INSTALLATION

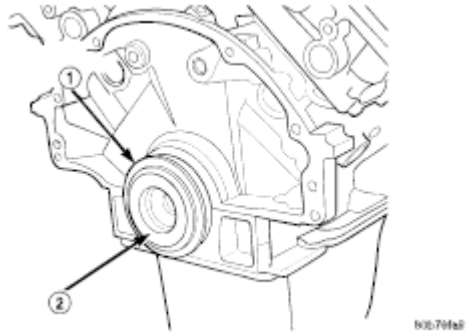


Fig. 39: Identifying Magnetic Seal Guide Special Tool 8349-2 And Crankshaft Rear Oil Seal
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Lubricate the crankshaft flange with engine oil.
2. Position the magnetic seal guide Special Tool 8349-2 (2) onto the crankshaft rear face. Then position the crankshaft rear oil seal (1) onto the guide.

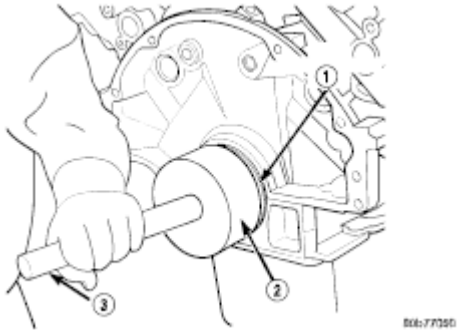


Fig. 40: Installing Crankshaft Rear Oil Seal
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Using Special Tools 8349 Crankshaft Rear Oil Seal Installer (2) and C-4171 Driver Handle (3), with a hammer, tap the seal (1) into place.

   Continue to tap on the driver handle until the seal installer seats against the cylinder block crankshaft bore.

4. Install the flexplate. Refer to **INSTALLATION**.
5. Install the transmission.

FLEX PLATE

REMOVAL

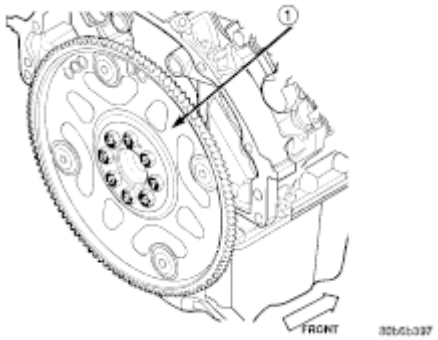


Fig. 41: Identifying Flex Plate
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Remove the transmission. Refer to **AUTOMATIC TRANSMISSION - REMOVAL** .
2. Remove the bolts using the sequence provided
3. Remove the flexplate.

INSTALLATION

1. Position the flexplate onto the crankshaft and install the bolts hand tight.
2. Tighten the flexplate retaining bolts to 95 N.m (70 ft. lbs.) in the sequence shown in illustration.
3. Install the transmission. Refer to **AUTOMATIC TRANSMISSION - INSTALLATION** .

ROD - PISTON & CONNECTING

DESCRIPTION

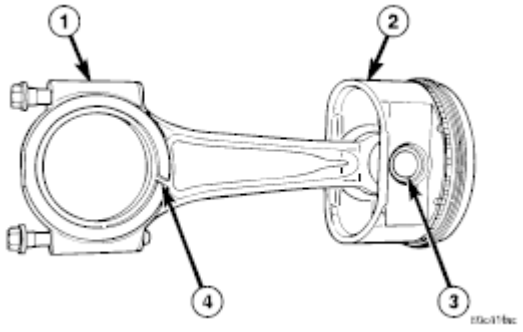


Fig. 42: Identifying Piston And Piston Pin

Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: Do not use a metal stamp to mark connecting rods as damage may result, instead use ink or a scratch awl.

The pistons (2) are made of a high strength aluminum alloy. The connecting rods are made of forged powdered metal, with a "fractured cap" design (1). A full floating piston pin (3) is used to attach the piston to the connecting rod.

STANDARD PROCEDURE

CONNECTING ROD BEARING FITTING

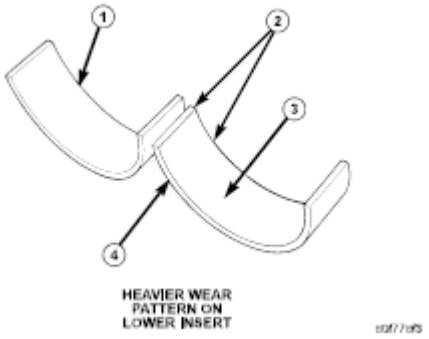


Fig. 43: Identifying Connecting Rod Bearings
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

Inspect the connecting rod bearings for scoring (10 and (3). Check the bearings for normal wear patterns, scoring, grooving, fatigue and pitting. Replace any bearing that shows abnormal wear.

Inspect the connecting rod journals for signs of scoring, nicks and burrs.

Misaligned or bent connecting rods can cause abnormal wear on pistons, piston rings, cylinder walls, connecting rod bearings and crankshaft connecting rod journals. If wear patterns or damage to any of these components indicate the probability of a misaligned connecting rod, inspect it for correct rod alignment. Replace misaligned, bent or twisted connecting rods.

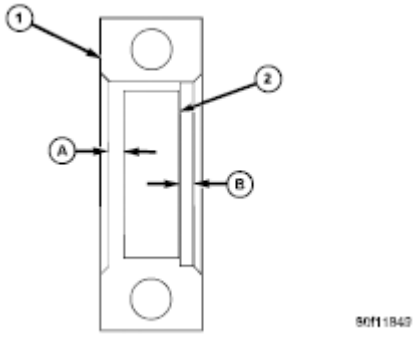


Fig. 44: Identifying Upper Bearing Insert
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Wipe the oil from the connecting rod journal.
2. Lubricate the upper bearing insert (2) and position in connecting rod (1). Center bearing insert in connecting rod
3. Measure at point A and point B. Measurement should be less then .50 mm (.0196 in.).

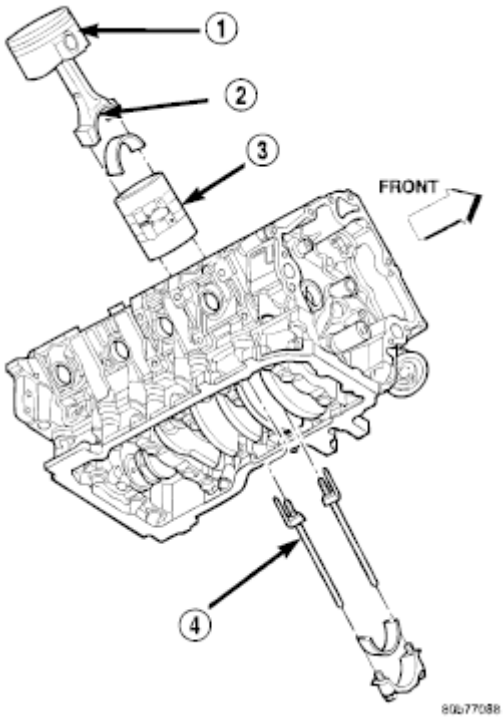


Fig. 45: Identifying Piston Ring Compressor And Guide Pins Special Tool 8507
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

4. Use piston ring compressor (3) and Guide Pins Special Tool 8507 (4) to install the rod and piston assemblies. The oil slinger slots in the rods must face front of the engine. The "F"'s (1) near the piston wrist pin bore should point to the front of the engine.

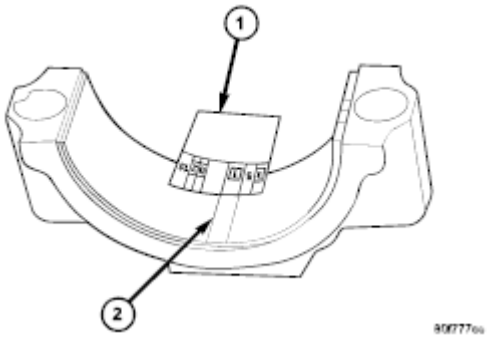


Fig. 46: Identifying Plastigage

Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

5. Install the lower bearing insert in the bearing cap. Center bearing insert in connecting rod. The lower insert must be dry. Place strip of Plastigage (1) across full width of the lower insert at the center of bearing cap. Plastigage must not crumble in use. If brittle, obtain fresh stock.
6. Install bearing cap and connecting rod on the journal and tighten bolts to 27 N.m (20 ft. lbs.) plus a 90° turn. DO NOT rotate crankshaft. Plastigage will smear, resulting in inaccurate indication.
7. Remove the bearing cap and determine amount of bearing-to-journal clearance by measuring the width of compressed Plastigage (2). Refer to **SPECIFICATIONS** for the proper clearance.

   Plastigage should indicate the same clearance across the entire width of the insert. If the clearance varies, it may be caused by either a tapered journal, bent connecting rod or foreign material trapped between the insert and cap or rod.

8. If the correct clearance is indicated, replacement of the bearing inserts is not necessary. Remove the Plastigage from crankshaft journal and bearing insert. Proceed with installation.
9. If bearing-to-journal clearance exceeds the specification, determine which services bearing set to use the bearing sizes are as follows:

BEARING-TO-JOURNAL CLEARANCE SPECIFICATION

Bearing Mark	SIZE	USED WITH JOURNAL SIZE
.025 US	.025 mm (.001 in.)	57.883-57.867 mm (2.2788-2.2783 in.)
Std.	STANDARD	57.908-57.892 mm (2.2798-2.2792 in.)
.250 US	.250 mm (.010 in.)	57.658-57.646 mm (2.2700-2.2695 in.)

CAUTION: Connecting Rod Bolts are Torque to Yield Bolts and must not be reused. Always replace the Rod Bolts whenever they are loosened or removed.

10. Repeat the Plastigage measurement to verify your bearing selection prior to final assembly.
11. Once you have selected the proper insert, install the insert and cap. Tighten the connecting rod bolts to 27 N.m (20 ft. lbs.) plus a 90° turn.

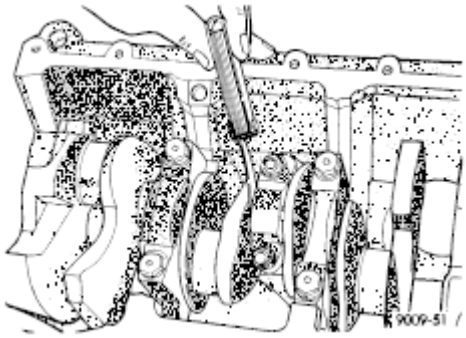


Fig. 47: Measuring Gap Between Connecting Rod And Crankshaft Journal Flange
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

Slide a snug-fitting feeler gauge between the connecting rod and crankshaft journal flange. Refer to ***SPECIFICATIONS*** *for the proper clearance.*

Replace the connecting rod if the side clearance is not within specification.

PISTON FITTING

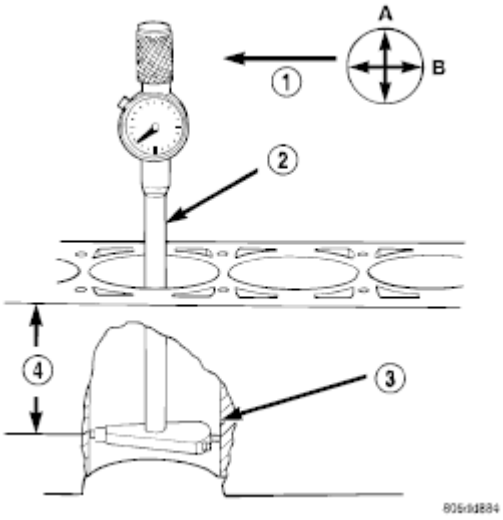


Fig. 48: Measuring Cylinder Bore Diameter
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. To correctly select the proper size piston, a cylinder bore gauge (2), capable of reading in 0.003 mm (.0001 in.) increments is required. If a bore gauge is not available, do not use an inside micrometer.
2. Measure the inside diameter of the cylinder bore at a point 38.0 mm (1.5 inches) below top of bore (4). Start perpendicular (across or at 90 degrees) to the axis of the crankshaft at point A and then take an additional bore reading 90 degrees to that at point B.

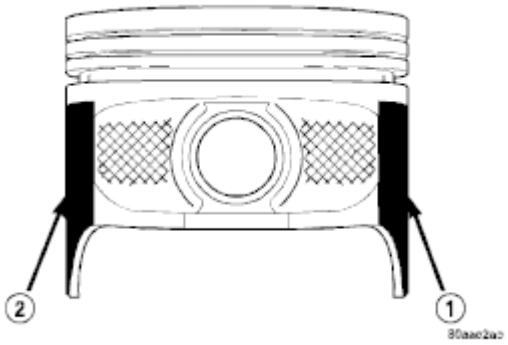


Fig. 49: Identifying Coating Material On Piston
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. The coated pistons will be serviced with the piston pin and connecting rod pre-assembled.
4. The coating material (1) and (2) is applied to the piston after the final piston machining process. Measuring the outside diameter of a coated piston will not provide accurate results. Therefore measuring the inside diameter of the cylinder bore with a dial Bore Gauge is **MANDATORY.** To correctly select the proper size piston, a cylinder bore gauge capable of reading in 0.003 mm (.0001 in.) increments is required.
5. Piston installation into the cylinder bore requires slightly more pressure than that required for non- coated pistons. The bonded coating on the piston will give the appearance of a line-to-line fit with the cylinder bore.

REMOVAL

1. Disconnect negative cable from battery.
2. Remove the following components:
   - *Oil pan and gasket/windage tray. Refer to* ***REMOVAL****.*
   - *Cylinder head(s). Refer to* ***REMOVAL****.*
3. If necessary, remove top ridge of cylinder bores with a reliable ridge reamer before removing pistons from cylinder block. **Be sure to keep tops of pistons covered during this operation.**

   Pistons and connecting rods must be removed from top of cylinder block. When removing piston and connecting rod assemblies from the engine, rotate crankshaft so that each connecting rod is centered in the cylinder bore.

CAUTION: DO NOT use a number stamp or a punch to mark connecting rods or caps, as damage to connecting rods could occur.

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

4. Mark connecting rod and bearing cap positions using a permanent ink marker or scribe tool.

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

5. Remove connecting rod cap. Install Special Tool 8507 Connecting Rod Guides into the connecting rod being removed. Remove piston from cylinder bore. Repeat this procedure for each piston being removed.

CAUTION: Care must be taken not to nick crankshaft journals, as engine damage may occur

6. Immediately after piston and connecting rod removal, install bearing cap on the mating connecting rod to prevent damage to the fractured cap and rod surfaces.

CLEANING

CAUTION: DO NOT use a wire wheel or other abrasive cleaning devise to clean the pistons or connecting rods. The pistons have a Moly coating, this coating must not be damaged.

1. Using a suitable cleaning solvent clean the pistons in warm water and towel dry.
2. Use a wood or plastic scraper to clean the ring land grooves.

CAUTION: DO NOT remove the piston pin from the piston and connecting rod assembly.

INSPECTION

Check the connecting rod journal for excessive wear, taper and scoring. Refer to ***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 ***STANDARD PROCEDURE****.*

Check the piston for scoring, or scraping marks in the piston skirts. Check the ring lands for cracks and/or deterioration.

INSTALLATION

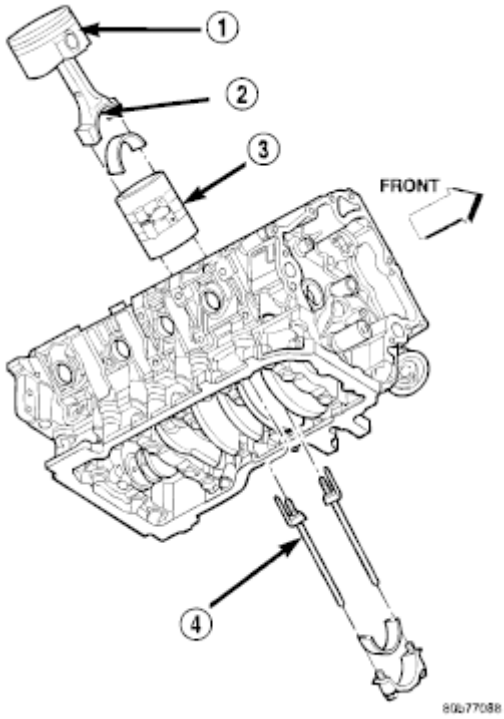


Fig. 50: Identifying Piston Ring Compressor And Guide Pins Special Tool 8507
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Before installing piston and connecting rod assemblies into the bore, install the piston rings.
2. Immerse the piston head and rings in clean engine oil. Position a ring compressor (3) over the piston and rings. Tighten ring compressor (3).
3. **Ensure position of rings do not change during this operation.**
4. Position bearing onto connecting rod. Ensure that hole in bearing shell aligns with hole in connecting rod. Lubricate bearing surface with clean engine oil.
5. Install Special Tool 8507 Connecting Rod Guides (4) into connecting rod bolt threads.

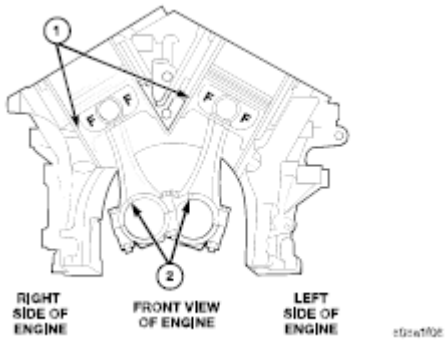


Fig. 51: Identifying Installation Position Of Piston
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

6. The pistons are marked on the piston pin bore surface with a raised "F" (1) indicating installation

position. This mark must be pointing toward the front of engine on both cylinder banks. The connecting rod oil slinger slot faces the front of the engine.

7. Wipe cylinder bore clean and lubricate with engine oil.
8. Rotate crankshaft until connecting rod journal is on the center of cylinder bore. Insert rod and piston into cylinder bore and carefully position connecting rod guides over crankshaft journal.
9. Tap piston down in cylinder bore using a hammer handle. While at the same time, guide connecting rod into position on rod journal.

CAUTION: Connecting Rod Bolts are Torque to Yield Bolts and Must Not Be Reused. Always replace the Rod Bolts whenever they are loosened or removed.

10. Lubricate rod bolts and bearing surfaces with engine oil. Install connecting rod cap and bearing. Tighten bolts to 27 N.m (20 ft. lbs.) plus 90°.
11. Install the following components:
    - *Cylinder head(s). Refer to* ***INSTALLATION****.*
    - *Timing chain and cover. Refer to* ***INSTALLATION****.*
    - *Cylinder head covers. Refer to* ***COVER(S) - CYLINDER HEAD/INSTALLATION****.*
    - *Oil pan and gasket/windage tray. Refer to* ***INSTALLATION****.*
12. Fill crankcase with proper engine oil to correct level.
13. Connect negative cable to battery.

RINGS - PISTON

STANDARD PROCEDURE

PISTON RING FITTING

Before reinstalling used rings or installing new rings, the ring clearances must be checked.

1. Wipe the cylinder bore clean.
2. Insert the ring in the cylinder bore.

NOTE: The ring gap measurement must be made with the ring positioned at least 12 mm (0.50 inch.) from bottom of cylinder bore.

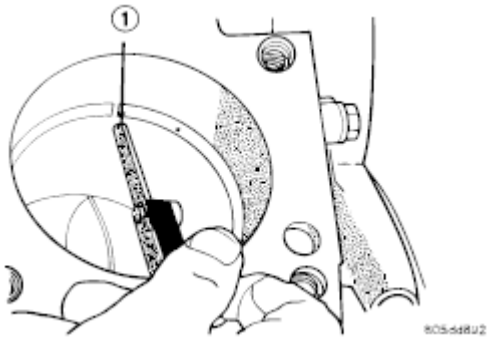


Fig. 52: Measuring Ring End Gap
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Using a piston, to ensure that the ring is squared in the cylinder bore, slide the ring downward into the cylinder.
4. Using a feeler gauge (1), check the ring end gap. Replace any rings not within specification.

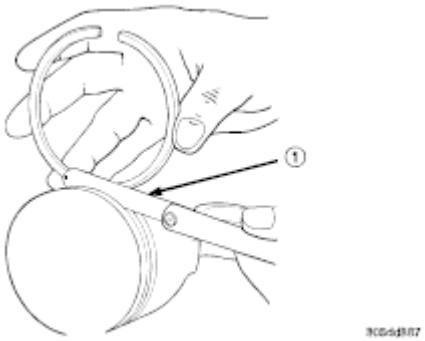


Fig. 53: Measuring Ring Side Clearance
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

5. Measure the ring side clearance as shown in illustration. Make sure the feeler gauge (1) fits snugly between the ring land and the ring. Replace any ring not within specification.

Fig. 54: Rotating Ring Around Piston
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

6. Rotate the ring around the piston, the ring must rotate in the groove with out binding.
7. The No. 1 and No. 2 piston rings have a different cross section. Ensure No. 2 ring is installed with manufacturers I.D. mark (Dot) facing up, towards top of the piston.

NOTE: Piston rings are installed in the following order:

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

8. Install the oil ring expander.
9. Install upper side rail by placing one end between the piston ring groove and the expander ring. Hold end firmly and press down the portion to be installed until side rail is in position. Repeat this step for the lower side rail.

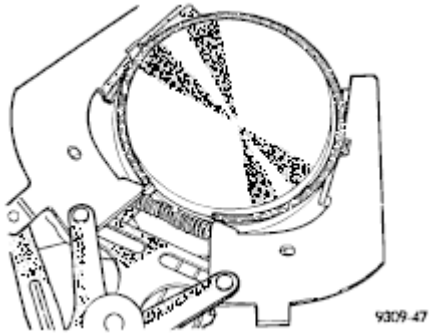


Fig. 55: Installing Piston Rings
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

10. Install No. 2 intermediate piston ring using a piston ring installer.
11. Install No. 1 upper piston ring using a piston ring installer.

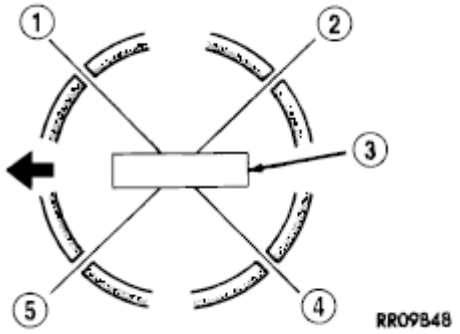


Fig. 56: Identifying Piston Ring End Gaps
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

12. Position piston ring end gaps as shown in illustration. It is important that expander ring gap is at least 45° from the side rail gaps, but not on the piston pin center or on the thrust direction.

PISTON RING SIDE CLEARANCE

NOTE: Make sure the piston ring grooves are clean and free of nicks and burrs.

PISTON RING SPECIFICATION CHART

Ring Position	Groove Clearance	Maximum Clearance
Upper Ring	.051-.094 mm (0.0020-.0037 in.)	0.11 mm (0.004 in.)
Intermediate Ring	0.04-0.08 mm (0.0016-0.0031 in.)	0.10 mm (0.004 in.)
Oil Control Ring (Steel Rails)	.019-.229 mm (.0007-.0090 in.)	.25 mm (0.010 in.)
Ring Position	**Ring Gap**	**Wear Limit**
Upper Ring	0.20-0.36 mm (0.0079-0.0142 in.)	0.43 mm (0.0017 in.)
Intermediate Ring	0.37-0.63 mm (0.0146-0.0249 in.)	0.74 mm (0.029 in.)
Oil Control Ring (Steel Rail)	0.025-0.76 mm (0.0099 - 0.03 in.)	1.55 mm (0.061 in.)

DAMPER - CRANKSHAFT

REMOVAL

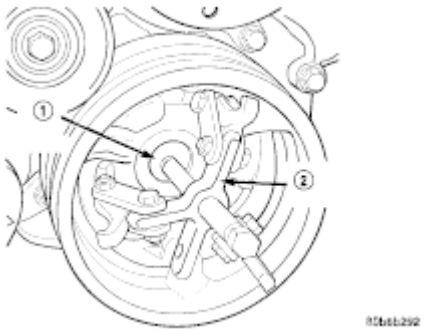


Fig. 57: Removing Damper Using Special Tools 8513 Insert And Tool 1026 Three Jaw Puller
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Disconnect negative cable from battery.
2. Remove radiator fan. Refer to **REMOVAL** .
3. Remove accessory drive belt. Refer to **REMOVAL** .
4. Remove crankshaft damper bolt.

5. Remove damper using Special Tools 8513 Insert (1) and 1026 Three Jaw Puller (2).

INSTALLATION

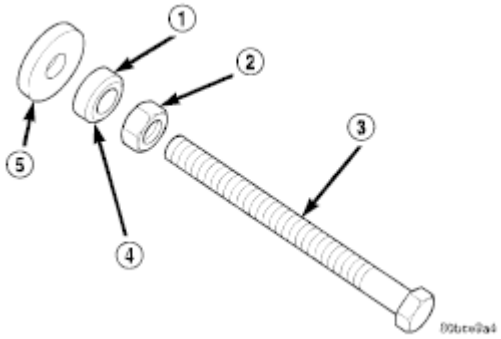


Fig. 58: Identifying Special Tool 8512-A
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: To prevent severe damage to the Crankshaft, Damper or Special Tool 8512-A, thoroughly clean the damper bore and the crankshaft nose before installing Damper.

1. Align crankshaft damper slot with key in crankshaft. Slide damper onto crankshaft slightly.

CAUTION: Special Tool 8512-A, is assembled in a specific sequence. Failure to assemble this tool in this sequence can result in tool failure and severe damage to either the tool or the crankshaft.

2. Assemble Special Tool 8512-A as follows, The nut (2) is threaded onto the threaded rod (3) first. Then the roller bearing (1) is placed onto the threaded rod (The hardened bearing surface of the bearing **MUST** face the nut (4)). Then the hardened washer (5) slides onto the threaded rod. Once assembled coat the threaded rod's threads with Nickel Anti-Seize or equivalent.

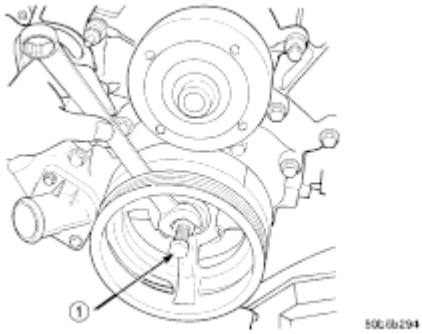


Fig. 59: Pressing Damper Onto Crankshaft Using Special Tool 8512-A
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Using Special Tool 8512-A, press damper onto crankshaft.

4. Install then tighten crankshaft damper bolt to 175 N.m (130 ft. lbs.).
5. Install radiator fan. Refer to **INSTALLATION** .
6. Install accessory drive belt. Refer to **INSTALLATION** .
7. Connect negative cable to battery.

COVER - STRUCTURAL

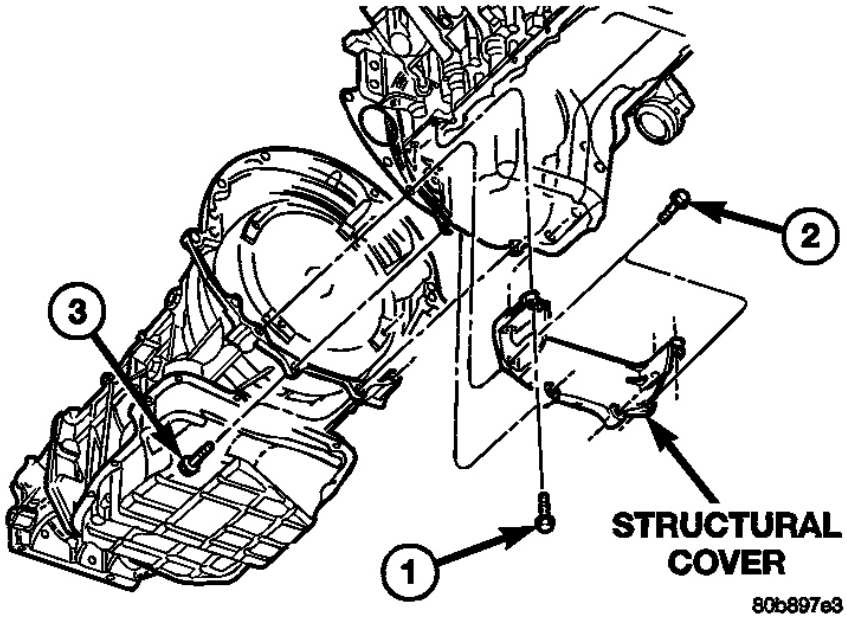
DESCRIPTION

The structural dust cover is made of die cast aluminum and joins the lower half of the transmission bell housing to the engine bedplate.

OPERATION

The structural cover provides additional powertrain stiffness and reduces noise and vibration.

REMOVAL



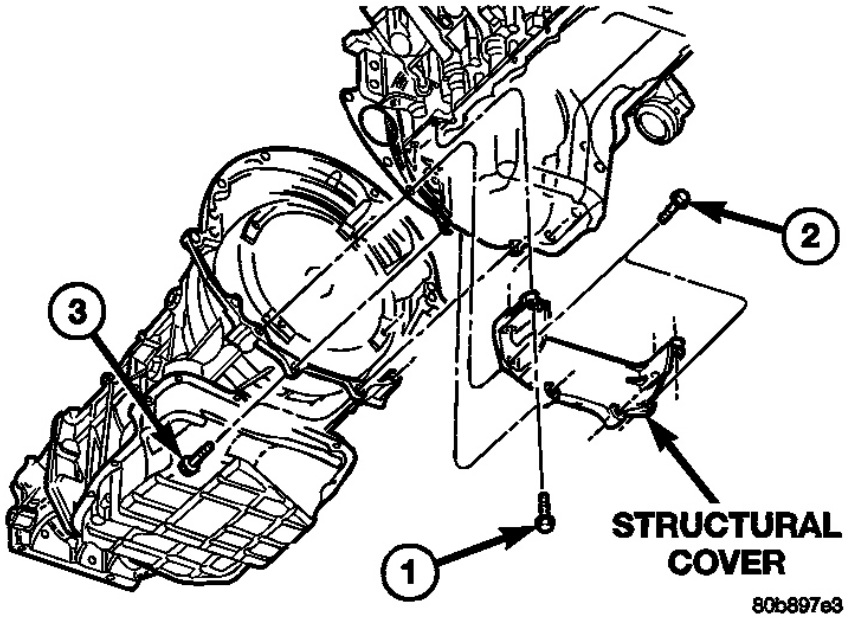
1 - BOLT
2 - BOLT
3 - BOLT

Fig. 60: Identifying Structural Cover

Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Raise vehicle on hoist.
2. Remove the left hand exhaust pipe from exhaust manifold.
3. Loosen the right hand exhaust manifold-to-exhaust pipe retaining bolts.
4. Remove the eight bolts (1,2,3) retaining structural cover in the sequence shown in illustration.
5. Pivot the exhaust pipe downward and remove the structural cover.

INSTALLATION



1 - BOLT
2 - BOLT
3 - BOLT

Fig. 61: Identifying Structural Cover
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: The structural cover must be installed as described in the following steps. Failure to do so will cause severe damage to the cover.

1. Position the structural cover in the vehicle.
2. Install all bolts (1,2,3) retaining the cover-to-engine. DO NOT tighten the bolts at this time.

3. Install the four cover-to-transmission bolts. Do NOT tighten at this time.

CAUTION: The structural cover must be held tightly against both the engine and the transmission bell housing during tightening sequence. Failure to do so may cause damage to the cover.

4. Starting with the two rear cover-to-engine bolts, tighten bolts (1) to 54 N.m (40 ft. lbs.), then tighten bolts (2) and (3) to 54 N.m (40 ft. lbs.) in the sequence shown in illustration.
5. Install the exhaust pipe on left hand exhaust manifold.
6. Tighten exhaust manifold-to-exhaust pipe retaining bolts to 20 - 26 N.m (15-20 ft. lbs.).

MOUNT - FRONT

REMOVAL

2WD

1. Disconnect the negative cable from the battery.

CAUTION: Remove the viscous fan before raising engine. Failure to do so may cause damage to the fan blade, fan clutch and fan shroud.

2. Remove the viscous fan. Refer to **REMOVAL** .
3. Raise the vehicle.
4. Remove the engine oil filter.
5. Remove the oil drain trough.
6. Support the engine with a suitable jack and a block of wood across the full width of the engine oil pan.
7. Support the front axle with a suitable jack.
8. Remove the bolts that attach the engine mounts to the front axle.
9. Remove the bolts that attach the front axle to the left engine bracket.
10. Lower the front axle.
11. Remove the through bolts
12. Raise the engine far enough to be able to remove the left and right engine mounts.
13. Remove the mount to engine attaching bolts
14. Remove the engine mounts.

4WD

1. Disconnect the negative cable from the battery.
2. Remove the viscous fan.
3. Raise the vehicle.
4. Remove the skid plate.

5. Remove the front crossmember.
6. Remove the engine oil filter.
7. Remove the oil drain trough.
8. Support the engine with a suitable jack and a block of wood across the full width of the engine oil pan.
9. Support the front axle with a suitable jack.
10. Remove the bolts that attach the engine mounts to the front axle.
11. Remove the bolts that attach the front axle to the left engine bracket.
12. Lower the front axle.
13. Remove the through bolts

CAUTION: Remove the viscous fan before raising engine. Failure to do so may cause damage to the fan blade, fan clutch and fan shroud.

14. Remove the viscous fan. Refer to **REMOVAL** .
15. Raise the engine far enough to be able to remove the left and right engine mounts (2).
16. Remove the engine mount bolts (1), and the mounts (2).

INSTALLATION

2WD

NOTE: For mount to engine block and left engine bracket to front axle bolts, apply Loctite 242 Lock and Seal Adhesive, Medium Strength Threadlocker or equivalent.

1. Install the right and left side engine mounts to the engine block bolts. Torque bolts to 54 N.m (40 ft. lbs.).
2. Insert the through bolts into the right and left side engine mounts and loosely assemble the two nuts onto the through bolts.
3. Lower the engine until the through bolts rest onto the slots in the frame brackets.
4. Tighten the through bolt nuts to 94 N.m (70 ft. lbs.).
5. Install the oil drain trough.
6. Install the engine oil filter.
7. Lower the vehicle.
8. Install the viscous fan. Refer to **INSTALLATION** .
9. Reconnect the negative battery cable.

4WD

NOTE: For mount to engine block and left engine bracket to front axle bolts, apply Loctite 242 Lock and Seal Adhesive, Medium Strength Threadlocker or equivalent.

1. Install the right and left side engine mount brackets (2) to the engine.
2. Install the right and left side engine mounts to the front axle. Torque nuts to 94 N.m (70 ft. lbs.).
3. Raise the front axle into the frame and install the left and right side through bolts. Torque nuts to 94 N.m (70 ft. lbs.).
4. Insert the two upper through bolts into the right and left side engine mounts and loosely assemble the two nuts onto the through bolts.
5. Lower the engine until the left and right side engine brackets rest on the through bolts, and the lower engine bracket through holes align with the engine mounts, and the left engine bracket holes align with the front axle slots.
6. Loosely assemble the bolts that attach the front axle to the left engine bracket.
7. Loosely assemble the lower through bolts.
8. Torque the nuts for the through bolts to 101 N.m (75 ft. lbs.).
9. Torque the bolts that attach the front axle to the left engine bracket to 101 N.m (75 ft. lbs.).
10. Install the oil drain trough.
11. Install the engine oil filter.
12. Lower the vehicle.
13. Install the viscous fan. Refer to **INSTALLATION** .
14. Reconnect the negative battery cable.

MOUNT - REAR

REMOVAL

1. Raise the vehicle on a hoist.
2. Using a suitable jack, support transmission.
3. Remove the nuts from the transmission mount (1).
4. Remove the two bolts that attach the transmission mount to the engine bracket.
5. Raise the transmission enough to remove the mount from the crossmember (2).
6. Remove the mount (1).

INSTALLATION

NOTE: Threadlocking compound must be applied to the bolts before installation.

1. Install the two bolts that attach the transmission mount to the transmission bracket.
2. Torque the bolts to 61 N.m (45 ft. lbs.) torque.
3. Lower the transmission so the transmission mount rests on the crossmember, and the studs of the transmission mount are aligned in the slots in the crossmember.
4. Install the nuts onto the transmission mount studs through the crossmember access slot.
5. Torque the nuts to 54 N.m (40 ft. lbs.).

LUBRICATION

DESCRIPTION

The lubrication system is a full flow filtration pressure feed type.

OPERATION

Oil from the oil pan is pumped by a gerotor type oil pump directly mounted to the crankshaft nose. Oil pressure is controlled by a relief valve mounted inside the oil pump housing.

The camshaft exhaust valve lobes and rocker arms are lubricated through a small hole in the rocker arm; oil flows through the lash adjuster then through the rocker arm and onto the camshaft lobe. Due to the orientation of the rocker arm, the camshaft intake lobes are not lubed in the same manner as the exhaust lobes. The intake lobes are lubed through internal passages in the camshaft. Oil flows through a bore in the No. 3 camshaft bearing bore, and as the camshaft turns, a hole in the camshaft aligns with the hole in the camshaft bore allowing engine oil to enter the camshaft tube. The oil then exits through 1.6 mm (0.063 in.) holes drilled into the intake lobes, lubricating the lobes and the rocker arms.

ENGINE LUBRICATION FLOW CHART - BLOCK

FROM	TO
Oil Pickup Tube	Oil Pump
Oil Pump	Oil Filter
Oil Filter	Block Main Oil Gallery
Block Main Oil Gallery	1. Crankshaft Main Journal 2. Left Cylinder Head (1) 3. Right Cylinder Head (1) 4. Counterbalance Shaft Rear Journal
Crankshaft Main Journals	Crankshaft Rod Journals
Crankshaft Number One Main Journal	1. Front Timing Chain Idler Shaft 2. Counterbalance Shaft - Front Journal 3. Both Secondary Chain Tensioners
Left Cylinder Head	Refer to **ENGINE LUBRICATION FLOW CHART - CYLINDER HEADS**
Right Cylinder Head	Refer to **ENGINE LUBRICATION FLOW CHART - CYLINDER HEADS**
(1) The cylinder head gaskets have an oil restrictor to control oil flow to the cylinder heads	

ENGINE LUBRICATION FLOW CHART - CYLINDER HEADS

FROM	TO
Cylinder Head Oil Port (in bolt hole)	Diagonal Cross Drilling to Main Oil Gallery
Main Oil Gallery (drilled through head from rear	1. Base of Camshaft Towers

to front)	2. Lash Adjuster Towers
Base of Camshaft Towers	Vertical Drilling Through Tower to Camshaft Bearings(1)
Lash Adjuster Towers	Diagonal Drillings to Hydraulic Lash Adjuster Pockets
(1) The number three camshaft bearing journal feeds oil into the hollow camshaft tubes. Oil is routed to the intake lobes, which have oil passages drilled into them to lubricate the rocker arms.	

DIAGNOSIS AND TESTING

ENGINE OIL LEAK

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

1. Do not clean or degrease the engine at this time because some solvents may cause rubber to swell, temporarily stopping the leak.
2. Add an oil soluble dye (use as recommended by manufacturer). Start the engine and let idle for approximately 15 minutes. Check the oil dipstick to make sure the dye is thoroughly mixed as indicated with a bright yellow color under a black light.
3. Using a black light, inspect the entire engine for fluorescent dye, particularly at the suspected area of oil leak. If the oil leak is found and identified, repair per service information instructions.
4. If dye is not observed, drive the vehicle at various speeds for approximately 24 km (15 miles), and repeat inspection.

If the oil leak source is not positively identified at this time, proceed with the air leak detection test method.

Air Leak Detection Test Method

1. Disconnect the breather cap to air cleaner hose at the breather cap end. Cap or plug breather cap nipple.
2. Remove the PCV valve from the cylinder head cover. Cap or plug the PCV valve grommet.
3. 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.

4. 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 information procedures.
5. If the leakage occurs at the rear oil seal area, refer to **INSPECTION FOR REAR SEAL AREA LEAK**.
6. If no leaks are detected, turn off the air supply and remove the air hose and all plugs and caps. Install the PCV valve and breather cap hose.
7. Clean the oil off the suspect oil leak area using a suitable solvent. Drive the vehicle at various speeds

approximately 24 km (15 miles). Inspect the engine for signs of an oil leak by using a black light.

INSPECTION FOR REAR SEAL AREA LEAKS

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

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

1. Disconnect the battery.
2. Raise the vehicle.
3. Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:
    1. Circular spray pattern generally indicates seal leakage or crankshaft damage.
    2. 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, pressurize the crankcase as outlined in **AIR LEAK DETECTION TEST METHOD**.

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

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

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

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

CHECKING ENGINE OIL PRESSURE

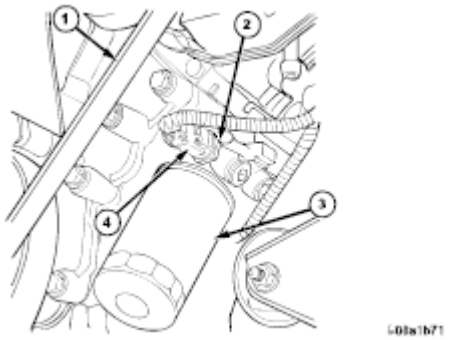


Fig. 62: Identifying Oil Pressure Sender Connector And Pressure Sender
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Remove oil pressure sending unit (2) and install gauge assembly C-3292.
2. Run engine until thermostat opens.
3. Oil Pressure:
   - *Curb Idle - 25 kPa (4 psi) minimum*
   - *3000 RPM - 170 - 758 kPa (25 - 110 psi)*
4. If oil pressure is 0 at idle, shut off engine. Check for a clogged oil pick-up screen or a pressure relief valve stuck open.

REAR SEAL AREA LEAKS

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

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

1. Disconnect the battery.
2. Raise the vehicle.
3. Remove torque converter or clutch housing cover and inspect rear of block for evidence of oil. Use a black light to check for the oil leak:
   1. Circular spray pattern generally indicates seal leakage or crankshaft damage.
   2. Where leakage tends to run straight down, possible causes are a porous block, 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, pressurize the crankcase as outlined in **AIR LEAK DETECTION TEST METHOD**.

   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 **ENGINE DIAGNOSTIC CHART (LUBRICATION)** under the Oil Leak, for components inspections on possible causes and corrections.
7. After the oil leak root cause and appropriate corrective action have been identified, refer to **REMOVAL**.

PAN - ENGINE OIL

DESCRIPTION

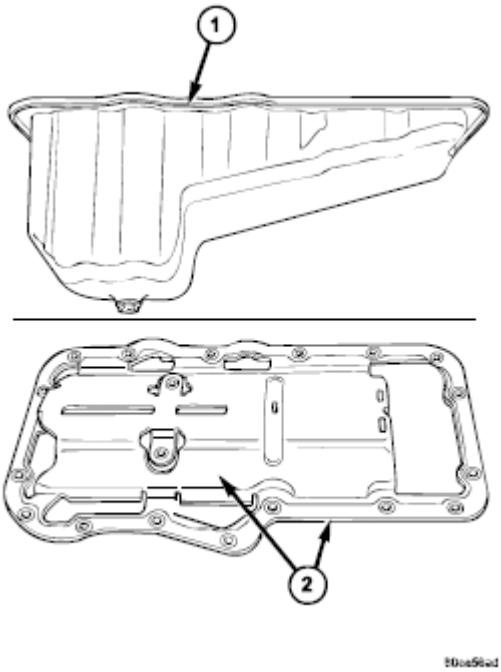


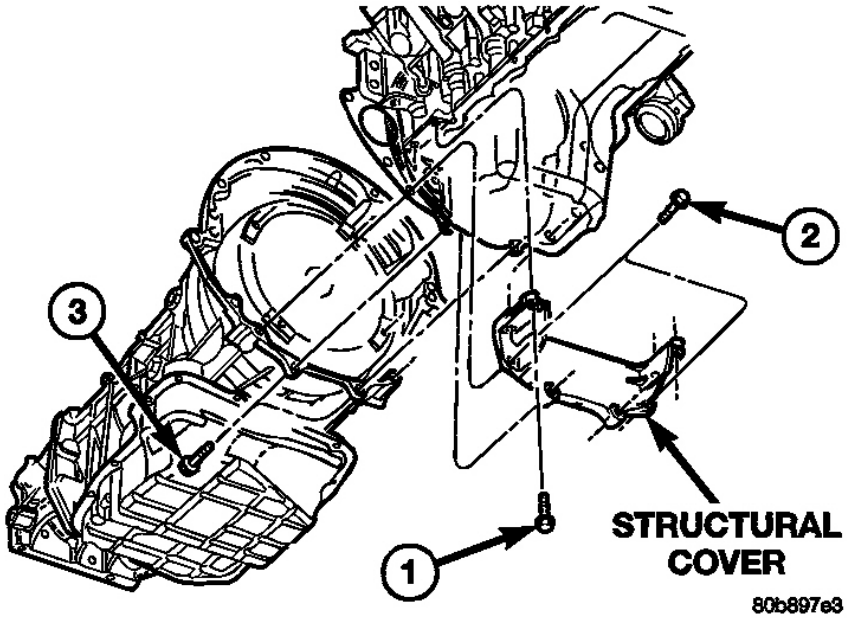
Fig. 63: Identifying Engine Oil Pan And Windage Tray
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The engine oil pan (1) is made of laminated steel and has a single plane sealing surface. The sandwich style oil pan gasket has an integrated windage tray (2) and steel carrier. The sealing area of the gasket is molded with rubber and is designed to be reused as long as the gasket is not cut, torn or ripped.

REMOVAL

1. Disconnect the negative battery cable.
2. Install engine support fixture (1) special tool # 8534. **Do not raise engine at this time.**

3. Remove both left and right side engine mount through bolts.



1 - BOLT
2 - BOLT
3 - BOLT

Fig. 64: Identifying Structural Cover
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

4. Remove the structural dust cover.
5. Drain engine oil.

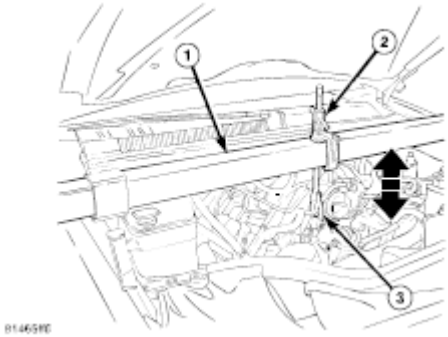


Fig. 65: Raising Engine Using Special Tool

Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: Only raise the engine enough to provide clearance for oil pan removal. Check for proper clearance at fan shroud to fan and cowl to intake manifold.

6. Raise engine using special tool (1) # 8534 to provide clearance to remove oil pan.

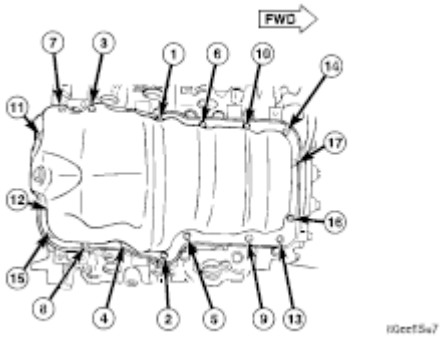


Fig. 66: Identifying Removal & Installation Sequence Of Oil Pan Mounting Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

NOTE: On 4WD vehicles, the front axle must be lowered, to provide clearance for oil pan removal. It is not necessary to remove the front axle from the vehicle, or remove the axle shafts.

7. **For 4WD Vehicles** Remove the pinion bracket.
8. **For 4WD Vehicles** Disconnect the front driveshaft at the front axle.
9. **For 4WD Vehicles** Remove the front axle mounting bolts.
10. **For 4WD Vehicles** Lower axle using suitable jack enough to provide clearance to remove oil pan.

NOTE: Do not pry on oil pan or oil pan gasket. Gasket is integral to engine windage tray and does not come out with oil pan.

11. Remove the oil pan mounting bolts and oil pan.
12. Unbolt oil pump pickup tube and remove tube.
13. Inspect the integral windage tray and gasket and replace as needed.

CLEANING

1. Clean oil pan in solvent and wipe dry with a clean cloth.
2. Clean the oil pan gasket surface. **DO NOT** use a grinder wheel or other abrasive tool to clean sealing surface.
3. Clean oil screen and tube thoroughly in clean solvent.

INSPECTION

1. Inspect oil drain plug and plug hole for stripped or damaged threads. Repair as necessary.
2. Inspect the oil pan mounting flange for bends or distortion. Straighten flange, if necessary.

INSTALLATION

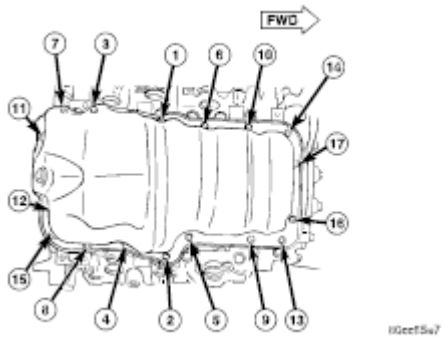


Fig. 67: Identifying Removal & Installation Sequence Of Oil Pan Mounting Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Clean the oil pan gasket mating surface of the bedplate and oil pan.
2. Position the oil pan gasket and pickup tube with new o-ring. Install the mounting bolt and nuts. Tighten bolt and nuts to 28 N.m (20 ft. lbs.).
3. Position the oil pan and install the mounting bolts. Tighten the mounting bolts to 15 N.m (11 ft. lbs.) in the sequence shown in illustration.

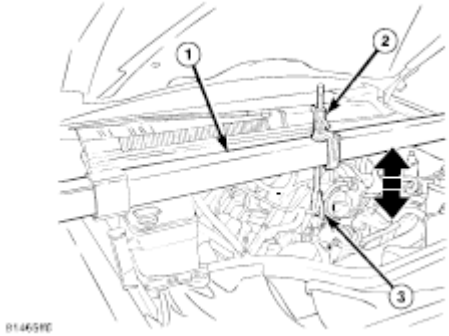
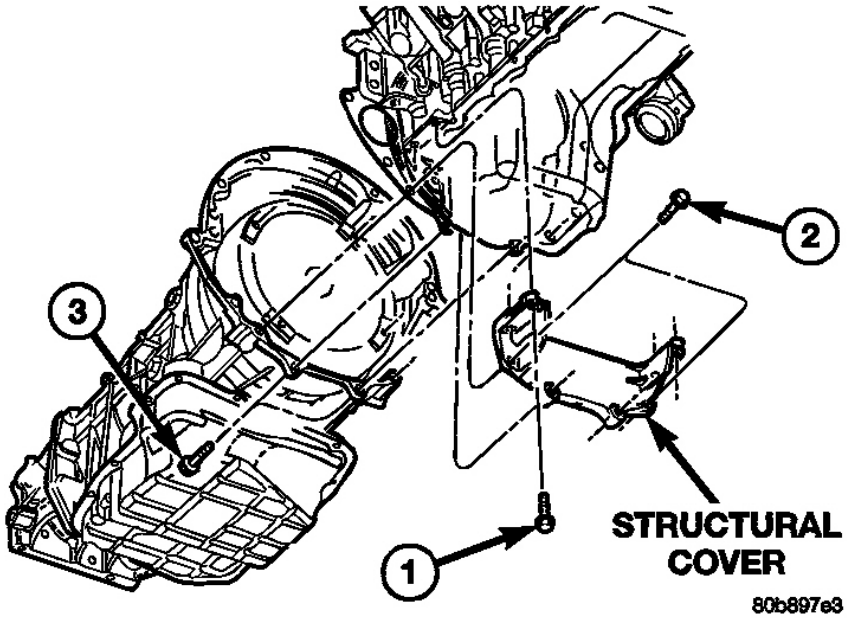


Fig. 68: Raising Engine Using Special Tool
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

4. Lower the engine into mounts using special tool (1) # 8534.
5. Install both the left and right side engine mount through bolts. Tighten the bolts to 68 N.m (50 ft. lbs.).
6. Remove special tool # 8534.



1 - BOLT
2 - BOLT
3 - BOLT

Fig. 69: Identifying Structural Cover
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

7. Install structural dust cover.

NOTE: On 4WD vehicles, the front axle must be lowered, to provide clearance for oil pan removal. It is not necessary to remove the front axle from the vehicle, or remove the axle shafts.

8. **For 4WD Vehicles** Raise axle using suitable jack.
9. **For 4WD Vehicles** Install the front axle mounting bolts.
10. **For 4WD Vehicles** Install the pinion bracket.
11. **For 4WD Vehicles** Install the front driveshaft to the front axle.
12. Fill engine oil.
13. Reconnect the negative battery cable.
14. Start engine and check for leaks.

SENSOR/SWITCH - OIL PRESSURE

DESCRIPTION

The 3 wire, solid-state engine oil pressure sensor (sending unit) is located in an engine oil pressure gallery.

OPERATION

The oil pressure sensor uses three circuits. They are:

- *A 5 volt power supply from the Powertrain Control Module (PCM)*
- *A sensor ground through the PCM's sensor return*
- *A signal to the PCM relating to engine oil pressure*

The oil pressure sensor has a 3 wire electrical function very much like the Manifold Absolute Pressure (MAP) sensor. Meaning different pressures relate to different output voltages.

A 5 volt supply is sent to the sensor from the PCM to power up the sensor. The sensor returns a voltage signal back to the PCM relating to engine oil pressure. This signal is then transferred (bussed) to the instrument panel on either a CCD or PCI bus circuit (depending on vehicle line) to operate the oil pressure gauge and the check gauges lamp. Ground for the sensor is provided by the PCM through a low-noise sensor return.

REMOVAL

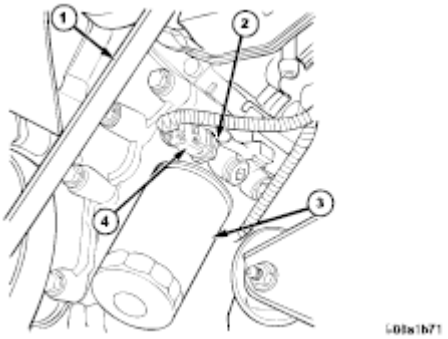


Fig. 70: Identifying Oil Pressure Sender Connector And Pressure Sender
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Disconnect the negative cable from the battery.
2. Raise vehicle on hoist.
3. Remove front splash shield.
4. Disconnect oil pressure sender connector (4).
5. Remove the pressure sender (2).

INSTALLATION

1. Install oil pressure sender.
2. Connect oil pressure sender wire.

3. Install front splash shield.
4. Lower vehicle.
5. Connect the negative battery cable.

PUMP - ENGINE OIL

REMOVAL

1. Remove the oil pan and pick-up tube. Refer to **REMOVAL**.
2. Remove the timing chain cover. Refer to **COVER(S) - TIMING/CHAIN/REMOVAL**.
3. Remove the timing chains and tensioners. Refer to **REMOVAL**.
4. Remove the four bolts, primary timing chain tensioner and the oil pump.

DISASSEMBLY

1. Remove oil pump cover screws and lift off cover plate.
2. Remove pump inner and outer rotors.

NOTE: Once the oil pressure relief valve, cup plug, and pin are removed, the pump assembly must be replaced.

3. If it is necessary to remove the pressure relief valve, drive the roll pin from pump housing and remove cup plug, spring and valve.

INSPECTION

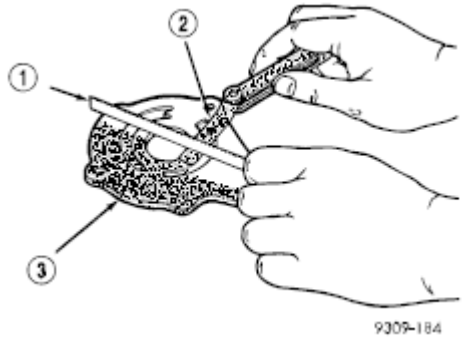


Fig. 71: Inserting Feeler Gauge Between Cover Surface And Straight Edge
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: Oil pump pressure relief valve and spring should not be removed from the oil pump. If these components are disassembled and or removed from the pump the entire oil pump assembly must be replaced.

1. Clean all parts thoroughly. Mating surface of the oil pump housing should be smooth. If the pump cover

is scratched or grooved the oil pump assembly should be replaced.

2. Lay a straight edge (1) across the pump cover surface. If a 0.025 mm (0.001 in.) feeler gauge (2) can be inserted between the cover and the straight edge the oil pump assembly should be replaced.

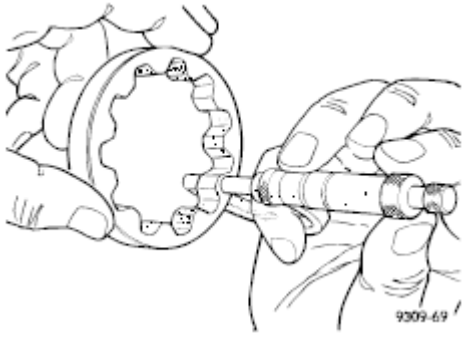


Fig. 72: Measuring Thickness Of Outer Rotor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Measure the thickness of the outer rotor. If the outer rotor thickness measures at 12.005 mm (0.472 in.) or less the oil pump assembly must be replaced.

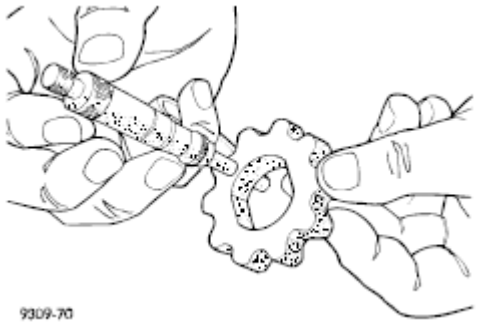


Fig. 73: Measuring Thickness Of Inner Rotor
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

4. Measure the diameter of the outer rotor. If the outer rotor diameter measures at 85.925 mm (3.382 in.) or less the oil pump assembly must be replaced.
5. Measure the thickness of the inner rotor. If the inner rotor thickness measures at 12.005 mm (0.472 in.) or less then the oil pump assembly must be replaced.
6. Slide outer rotor (1) into the body of the oil pump. Press the outer rotor to one side of the oil pump body and measure clearance between the outer rotor and the body. If the measurement is 0.235 mm (0.009 in.) or more, the oil pump assembly must be replaced.

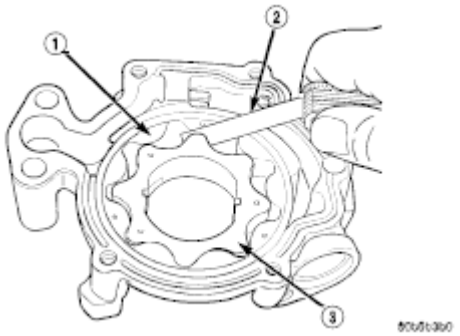


Fig. 74: Measuring Clearance Between Inner And Outer Rotors
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

7. Install the inner rotor in the into the oil pump body. Measure the clearance between the inner and outer rotors. If the clearance between the rotors is .150 mm (0.006 in.) or more, the oil pump assembly must be replaced.

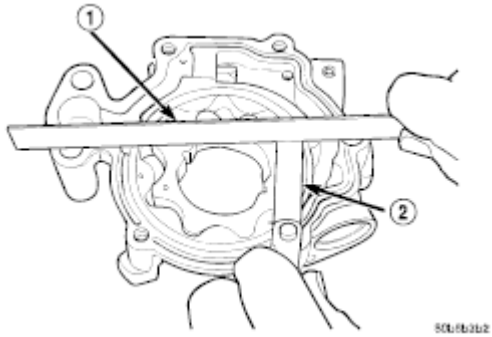


Fig. 75: Measuring Clearance Between Rotor And Oil Pump Body
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

8. Place a straight edge across the body of the oil pump (between the bolt holes), if a feeler gauge (2) of .095 mm (0.0038 in.) or greater can be inserted between the straightedge and the rotors, the pump must be replaced.

NOTE: The 3.7L oil pump is released as an assembly. There are no Mitsubishi part numbers for Sub-Assembly components. In the event the oil pump is not functioning or out of specification it must be replaced as an assembly.

ASSEMBLY

1. Wash all parts in a suitable solvent and inspect carefully for damage or wear.
2. Install inner and outer rotors
3. Install oil pump cover plate and install cover bolts and tighten them to 12 N.m (105 in. lbs.).
4. Prime oil pump before installation by filling rotor cavity with engine oil.
5. If oil pressure is low and pump is within specifications, inspect for worn engine bearings or other causes for oil pressure loss.

INSTALLATION

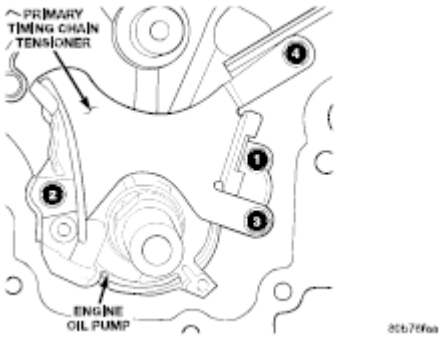


Fig. 76: Identifying Oil Pump And Primary Timing Chain Tensioner
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Position the oil pump onto the crankshaft and install one oil pump retaining bolt.
2. Position the primary timing chain tensioner and install three retaining bolts.
3. Tighten the oil pump and primary timing chain tensioner retaining bolts to 28 N.m (250 in. lbs.) in the sequence shown in illustration.
4. Install the secondary timing chain tensioners and timing chains. Refer to **INSTALLATION**.
5. Install the timing chain cover. Refer to **COVER(S) - TIMING/CHAIN/INSTALLATION**.
6. Install the pick-up tube and oil pan. Refer to **INSTALLATION**.

FILTER - ENGINE OIL

REMOVAL

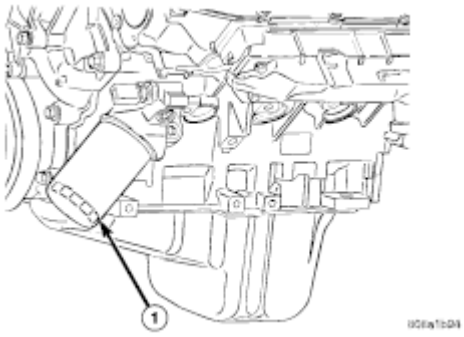


Fig. 77: Identifying Oil Filter
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

All engines are equipped with a high quality full-flow, disposable type oil filter (1). Mitsubishi Motors recommends a Mitsubishi 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 (1) counterclockwise to remove it from the cylinder block oil filter boss.
4. When filter separates from cylinder block oil filter boss, tip gasket end upward to minimize oil spill. Remove filter from vehicle.

NOTE: Make sure filter gasket was removed with filter.

5. With a wiping cloth, clean the gasket sealing surface of oil and grime.

INSTALLATION

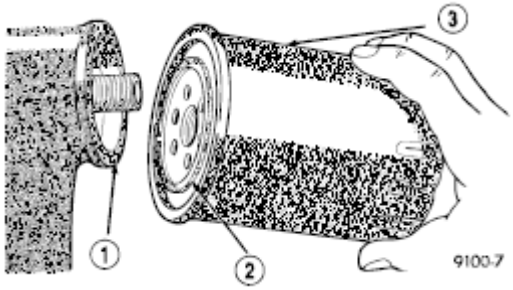


Fig. 78: Installing Oil Filter
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Lightly lubricate oil filter gasket (2) with engine oil.
2. Thread filter onto adapter nipple. When gasket makes contact with sealing surface (1), hand tighten filter (2) one full turn, do not over tighten.
3. Add oil, verify crankcase oil level and start engine. Inspect for oil leaks.

OIL

STANDARD PROCEDURE

ENGINE OIL SERVICE

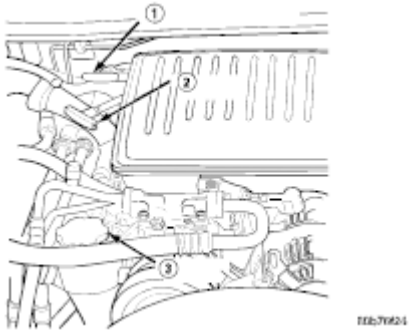


Fig. 79: Identifying Engine Oil Level Indicator
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The engine oil level indicator (2) is located at the right rear of the engine on the 3.7L engines.

CRANKCASE OIL LEVEL INSPECTION

CAUTION: Do not overfill crankcase with engine oil, pressure loss or oil foaming can result.

Inspect engine oil level approximately every 800 kilometers (500 miles). Unless the engine has exhibited loss of oil pressure, run the engine for about five minutes before checking oil level. Checking engine oil level on a cold engine is not accurate.

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 Maintenance Schedules.

Run engine until achieving normal operating temperature.

1. Position the vehicle on a level surface and turn engine off.
2. Hoist and support vehicle on safety stands.
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 if damaged.
6. Install drain plug in crankcase.
7. Lower vehicle and fill crankcase with specified type and amount of engine oil.
8. Install oil fill cap.
9. Start engine and inspect for leaks.
10. Stop engine and inspect oil level.

USED ENGINE OIL DISPOSAL

Care should be exercised when disposing used engine oil after it has been drained from a vehicle engine.

MANIFOLD - INTAKE

DESCRIPTION

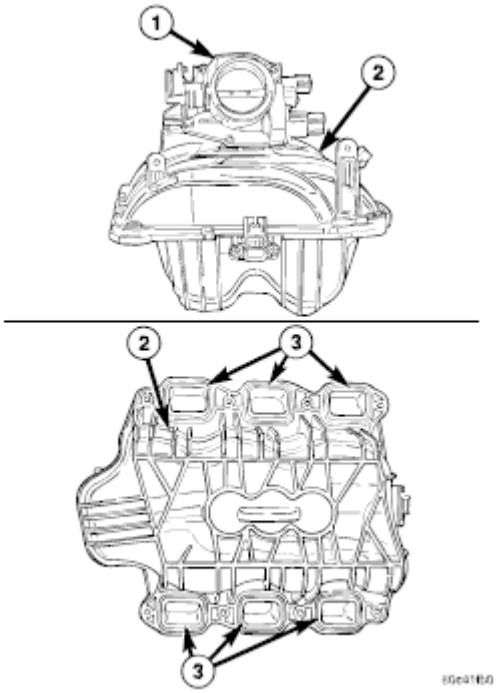


Fig. 80: Identifying Intake Manifold And Throttle Body
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The intake manifold (2) is made of a composite material and features 300 mm (11.811 in.) long runners which maximizes low end torque. The intake manifold (2) uses single plane sealing which consist of six individual press in place port gaskets to prevent leaks. The throttle body (1) attaches directly to the intake manifold (2). Eight studs and two bolts are used to fasten the intake to the head.

DIAGNOSIS AND TESTING

INTAKE MANIFOLD LEAKS

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

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

1. Start the engine.
2. Spray a small stream of water (spray bottle) at the suspected leak area.

3. If engine RPM'S change, the area of the suspected leak has been found.
4. Repair as required.

REMOVAL

1. Disconnect negative cable from battery.
2. Remove resonator assembly and air inlet hose.
3. Disconnect throttle and speed control cables.
4. Disconnect electrical connectors for the following components: Refer to **FUEL INJECTION** for component locations.
   - *Manifold Absolute Pressure (MAP) Sensor*
   - *Intake Air Temperature (IAT) Sensor*
   - *Throttle Position (TPS) Sensor*
   - *Coolant Temperature (CTS) Sensor*
   - *Idle Air Control (IAC) Motor*
5. Disconnect vapor purge hose, brake booster hose, speed control servo hose, positive crankcase ventilation (PCV) hose.
6. Disconnect generator electrical connections.
7. Disconnect air conditioning compressor electrical connections.
8. Disconnect left and right radio suppressor straps.
9. Disconnect and remove ignition coil towers.
10. Remove top oil dipstick tube retaining bolt and ground strap.
11. Bleed fuel system. Refer to **STANDARD PROCEDURE** .
12. Remove fuel rail.
13. Remove throttle body assembly and mounting bracket.
14. Drain cooling system below coolant temperature level. Refer to **STANDARD PROCEDURE** .
15. Remove the heater hoses from the engine front cover and the heater core.
16. Unclip and remove heater hoses and tubes from intake manifold.
17. Remove coolant temperature sensor. Refer to **REMOVAL** .
18. Remove intake manifold retaining fasteners in reverse order of tightening sequence.
19. Remove intake manifold.

INSTALLATION

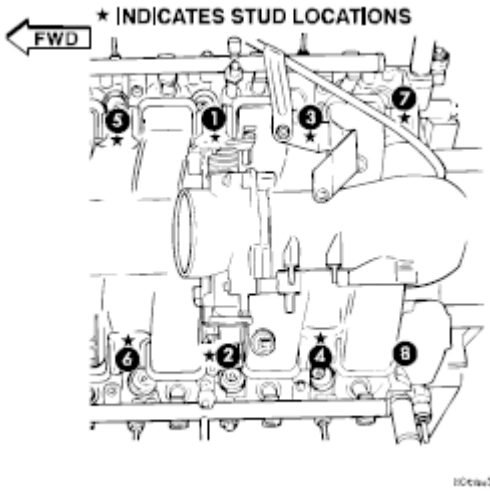


Fig. 81: Identifying Removal & Installation Sequence Of Intake Manifold Retaining Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Install intake manifold gaskets.
2. Install intake manifold.
3. Install intake manifold retaining bolts and tighten in sequence shown in illustration to 12 N.m (105 in. lbs.).
4. Install left and right radio suppressor straps.
5. Install throttle body assembly.
6. Connect throttle cable and speed control cable to throttle body.
7. Install fuel rail.
8. Install ignition coil towers.
9. Position and install heater hoses and tubes onto intake manifold.
10. Install the heater hoses to the heater core and engine front cover.
11. Connect electrical connectors for the following components:
    - *Manifold Absolute Pressure (MAP) Sensor*
    - *Intake Air Temperature (IAT) Sensor*
    - *Throttle Position (TPS) Sensor*
    - *Coolant Temperature (CTS) Sensor*
    - *Idle Air Control (IAC) Motor*
    - *Ignition coil towers*
    - *Fuel injectors*
12. Install top oil dipstick tube retaining bolt and ground strap.
13. Connect generator electrical connections.
14. Connect Vapor purge hose, Brake booster hose, Speed control servo hose, Positive crankcase ventilation (PCV) hose.
15. Fill cooling system. Refer to **STANDARD PROCEDURE** .

16. Install resonator assembly and air inlet hose.
17. Connect negative cable to battery.

MANIFOLD - EXHAUST

DESCRIPTION

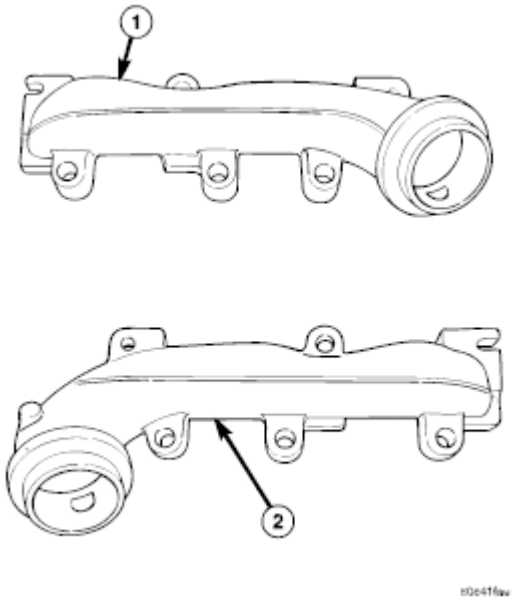


Fig. 82: Identifying Exhaust Manifolds
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The exhaust manifolds (1 and 2) are log style with a patented flow enhancing design to maximize performance. The exhaust manifolds are made of high silicon molybdenum cast iron. A perforated core graphite exhaust manifold gasket is used to improve sealing to the cylinder head.

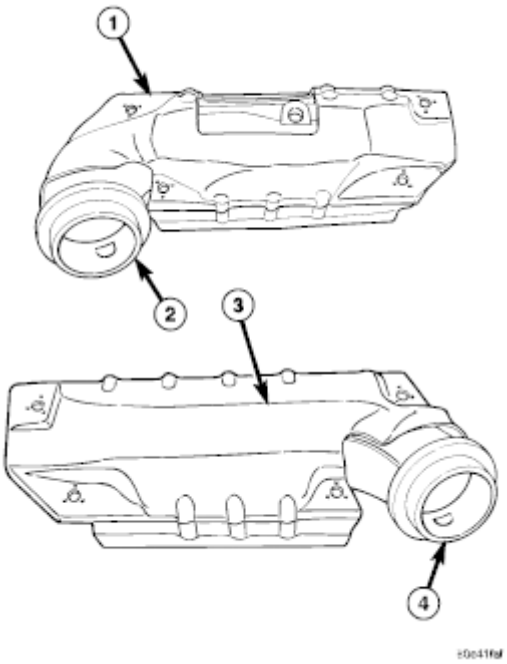


Fig. 83: Identifying Heat Shield
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

The exhaust manifolds are covered by a three layer laminated heat shield (1 and 3) for thermal protection and noise reduction. The heat shields (1 and 3) are fastened with a torque prevailing nut that is backed off slightly to allow for the thermal expansion of the exhaust manifold.

REMOVAL

RIGHT EXHAUST MANIFOLD

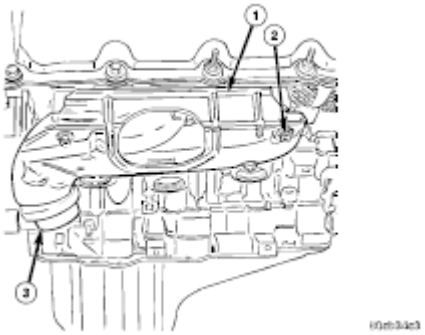


Fig. 84: Identifying Exhaust Heat Shield (Right Side)
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Disconnect the negative cable from the battery.
2. Raise and support the vehicle.
3. Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold.

4. Lower the vehicle.
5. Remove the exhaust heat shield (1).
6. Remove bolts, nuts (2) and washers attaching manifold to cylinder head.
7. Remove manifold and gasket from the cylinder head.

LEFT EXHAUST MANIFOLD

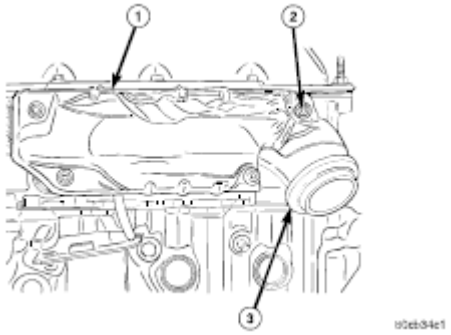


Fig. 85: Identifying Exhaust Heat Shield (Left Side)
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Disconnect the negative cable from the battery.
2. Raise and support the vehicle.
3. Remove the bolts and nuts attaching the exhaust pipe to the engine exhaust manifold.
4. Lower the vehicle.
5. Remove the exhaust heat shields (1).
6. Remove bolts, nuts (2) and washers attaching manifold to cylinder head.
7. Remove manifold and gasket from the cylinder head.

INSTALLATION

RIGHT EXHAUST MANIFOLD

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 manifold and gasket on the two studs located on the cylinder head. Install conical washers and nuts on these studs.
2. Install remaining conical washers. Starting at the center arm and working outward, tighten the bolts and nuts to 25 N.m (18 ft. lbs.) torque.
3. Install the exhaust heat shields.
4. Raise and support the vehicle.

CAUTION: Over tightening heat shield fasteners, may cause shield to distort and/or crack.

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.

LEFT EXHAUST MANIFOLD

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 manifold and gasket on the two studs located on the cylinder head. Install conical washers and nuts on these studs.
2. Install remaining conical washers. Starting at the center arm and working outward, tighten the bolts and nuts to 25 N.m (18 ft. lbs.) torque.
3. Install the exhaust heat shields.
4. Raise and support the vehicle.

CAUTION: Over tightening heat shield fasteners, may cause shield to distort and/or crack.

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.

VALVE TIMING

DESCRIPTION

The timing drive system has been designed to provide quiet performance and reliability to support a non-free wheeling engine. Specifically the intake valves are non-free wheeling and can be easily damaged with forceful engine rotation if camshaft-to-crankshaft timing is incorrect. The timing drive system consists of a primary chain, two secondary timing chain drives and a counterbalance shaft drive.

OPERATION

The primary timing chain is a single inverted tooth chain type. The primary chain drives the large 50 tooth idler sprocket directly from a 25 tooth crankshaft sprocket. Primary chain motion is controlled by a pivoting leaf spring tensioner arm and a fixed guide. The arm and the guide both use nylon plastic wear faces for low friction and long wear. The primary chain receives oil splash lubrication from the secondary chain drive and designed oil pump leakage. The idler sprocket assembly connects the primary chain drive, secondary chain drives, and the counterbalance shaft. The idler sprocket assembly consists of two integral 26 tooth sprockets a 50 tooth sprocket and a helical gear that is press-fit to the assembly. The spline joint for the 50 tooth sprocket is a non serviceable press fit anti rattle type. A spiral ring is installed on the outboard side of the 50 tooth sprocket to prevent spline disengagement. The idler sprocket assembly spins on a stationary idler shaft. The idler shaft is a

light press-fit into the cylinder block. A large washer on the idler shaft bolt and the rear flange of the idler shaft are used to control sprocket thrust movement. Pressurized oil is routed through the center of the idler shaft to provide lubrication for the two bushings used in the idler sprocket assembly.

There are two secondary drive chains, both are roller type, one to drive the camshaft in each SOHC cylinder head. There are no shaft speed changes in the secondary chain drive system. Each secondary chain drives a 26 tooth cam sprocket directly from the 26 tooth sprocket on the idler sprocket assembly. A fixed chain guide and a hydraulic oil damped tensioner are used to maintain tension in each secondary chain system. The hydraulic tensioners for the secondary chain systems are fed pressurized oil from oil reservoir pockets in the block. Each tensioner incorporates a controlled leak path through a device known as a vent disc located in the nose of the piston to manage chain loads. Each tensioner also has a mechanical ratchet system that limits chain slack if the tensioner piston bleeds down after engine shut down. The tensioner arms and guides also utilize nylon wear faces for low friction and long wear. The secondary timing chains receive lubrication from a small orifice in the tensioners. This orifice is protected from clogging by a fine mesh screen which is located on the back of the hydraulic tensioners.

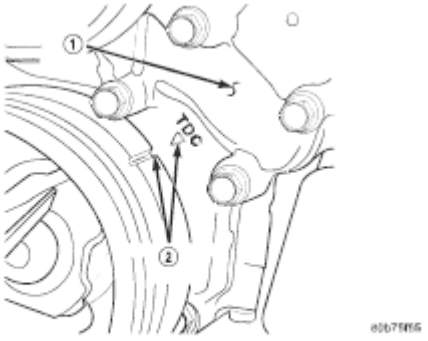
STANDARD PROCEDURE

MEASURING TIMING CHAIN WEAR

NOTE: This procedure must be performed with the timing chain cover removed.

1. Remove the timing chain cover. Refer to **REMOVAL**.
2. To determine if the secondary timing chains are worn, rotate the engine clockwise until maximum tensioner piston extension is obtained. Measure the distance between the secondary timing chain tensioner housing and the step ledge on the piston. This measurement must be less than 15 mm (.5906 inches).
3. If the measurement exceeds the specification, the secondary timing chains are worn and require replacement. Refer to **REMOVAL**.

SERVICE PROCEDURE - TIMING VERIFICATION



1 - TIMING CHAIN COVER
2 - CRANKSHAFT TIMING MARKS

Fig. 86: Identifying TDC Arrow On Front Cover
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

CAUTION: The 3.7L is a non free-wheeling design engine. Therefore, correct engine timing is critical.

NOTE: Components referred to as left hand or right hand are as viewed from the driver's position inside the vehicle.

NOTE: The blue link plates on the chains and the dots on the camshaft drive sprockets may not line up during the timing verification procedure. The blue link plates are lined up with the sprocket dots only when re-timing the complete timing drive. Once the timing drive is rotated, blue link-to-dot alignment is no longer valid.

Engine base timing can be verified by the following procedure:

1. Remove the cylinder head covers. Refer to **REMOVAL**.
2. Using a mirror, locate the TDC arrow (2) on the front cover (1). Rotate the crankshaft until the mark on the crankshaft damper is aligned with the TDC arrow on the front cover. The engine is now at TDC.

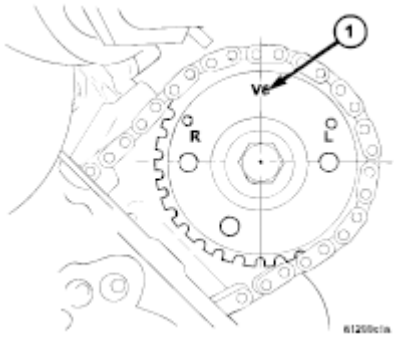


Fig. 87: Identifying V6 Mark On Camshaft Sprocket
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

3. Note the location of the V6 mark (1) stamped into the camshaft drive gears. If the V6 mark on each camshaft drive gear is at the twelve o'clock position, the engine is at TDC on the exhaust stroke. If the V6 mark on each gear is at the six o'clock position, the engine is at TDC on the compression stroke.
4. If both of the camshaft drive gears are off in the same or opposite directions, the primary chain or both secondary chains are at fault. Refer to **TIMING CHAIN AND SPROCKETS** procedure.
5. If only one of the camshaft drive gears is off and the other is correct, the problem is confined to one secondary chain. Refer to **TIMING - SINGLE CAMSHAFT** in this procedure.
6. If both camshaft drive gear V6 marks are at the twelve o'clock or the six o'clock position the engine base timing is correct. Reinstall the cylinder head covers.

COUNTERBALANCE SHAFT TIMING

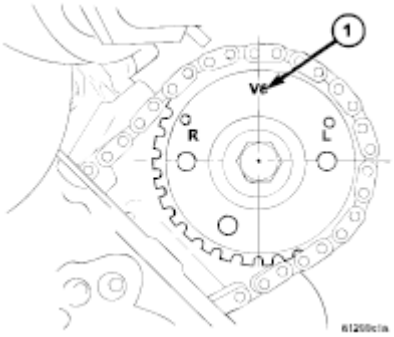


Fig. 88: Identifying V6 Mark On Camshaft Sprocket
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

1. Ensure that the engine is at TDC with both camshaft sprocket V6 marks (1) in the 12 o'clock position.
2. Look down the left cylinder head chain cavity. The timing dot on the counterbalance shaft drive gear should be in the 6 o'clock position (2).

TIMING - SINGLE CAMSHAFT

NOTE: To adjust the timing on one camshaft, preform the following procedure.

1. Using Chain Tensioner Wedge, Special Tool 8379 (2), stabilize the secondary chain drive (3). For reference purposes, mark the chain-to-sprocket position.
2. Remove the camshaft drive gear retaining bolt.
3. Carefully remove the camshaft drive gear (2) from the camshaft.
4. Reindex the camshaft drive gear in the chain until the V6 mark is at the same position as the V6 mark on the opposite camshaft drive gear.
5. Using Special Tool 8428 Camshaft Wrench (2), rotate the camshaft until the alignment dowel on the camshaft is aligned with the slot in the camshaft drive gear.

CAUTION: Remove excess oil from camshaft sprocket retaining bolt before reinstalling bolt. Failure to do so may cause over-torqueing of bolt resulting in bolt failure.

6. Position the camshaft drive gear onto the camshaft, remove oil from bolt then install the retaining bolt. Using Special Tools, Spanner Wrench 6958 with Adapter Pins 8346 (4) and a suitable torque wrench (1), tighten retaining bolt to 122 N.m (90 ft. lbs.).
7. Remove Special Tool 8379.
8. Rotate the crankshaft two full revolutions, then verify that the camshaft drive gear V6 marks are in fact aligned.
9. Install the cylinder head covers. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

SHAFT - BALANCE

REMOVAL

1. Remove the primary and secondary timing chains. Refer to **REMOVAL**.

NOTE: The balance shaft and gear are serviced as an assembly. Do not attempt to remove the gear from the balance shaft. Remove the retaining bolt (4) from the counterbalance shaft thrust plate (2).

2. Using Special Tool 8641 Counterbalance shaft remover/installer tool (1), remove the counterbalance shaft from the engine.

INSTALLATION

NOTE: The balance shaft and gear are serviced as an assembly. Do not attempt to remove the gear from the balance shaft.

1. Coat counterbalance shaft bearing journals with clean engine oil.

NOTE: The balance shaft is heavy, and care should be used when installing shaft, so bearings are not damaged.

2. Using Special Tool 8641 Counterbalance shaft remover/installer tool, carefully install counterbalance shaft into engine.
3. Install Counterbalance shaft thrust plate retaining bolt finger tight. Do not tighten bolt at this time.
4. Position the right side of the thrust plate with the right chain guide bolt, install bolt finger tight.
5. Torque the thrust plate retaining bolt to 28 N.m (250 in. lbs.).
6. Remove the chain guide bolt so that guide can be installed.

SHAFT - IDLER

REMOVAL

1. Remove the primary and secondary timing chains and sprockets. Refer to **REMOVAL**.

NOTE: To remove the idler shaft, it is necessary to tap threads into the shaft, to install the removal tool.

2. Using a 12 mm X 1.75 tap, cut threads in the idler shaft center bore.
3. Cover the radiator core with a suitable cover.

CAUTION: Use care when removing the idler shaft, Do not strike the radiator cooling fins with the slide hammer.

4. Using Special Tool 8517 Slide Hammer, remove the idler shaft.

INSTALLATION

1. Thoroughly clean the idler shaft bore.
2. Position the idler shaft in the bore.

NOTE: The two lubrication holes in the idler shaft do not require any special alignment.

NOTE: Before using the retaining bolt to install the idler shaft, coat the threads and the pilot on the idler shaft, with clean engine oil.

3. Using the primary idler sprocket retaining bolt and washer, carefully draw the idler shaft into the bore until fully seated.
4. Coat the idler shaft with clean engine oil.
5. Install the timing chains and sprockets. Refer to **INSTALLATION**.

COVER - TIMING / CHAIN

REMOVAL

1. Disconnect the battery negative cable.
2. Drain cooling system. Refer to **STANDARD PROCEDURE** .
3. Remove electric cooling fan and fan shroud assembly.
4. Remove radiator fan. Refer to **REMOVAL** .
5. Disconnect both heater hoses at timing cover.
6. Disconnect lower radiator hose at engine.
7. Remove accessory drive belt tensioner assembly (1).
8. Remove crankshaft damper. Refer to **REMOVAL**.
9. Remove the generator. Refer to **REMOVAL** .
10. Remove A/C compressor. Refer to **REMOVAL** .

CAUTION: The 3.7L engine uses an anaerobic sealer instead of a gasket to seal the front cover to the engine block, from the factory. For service, Grey Engine RTV sealant must be substituted.

NOTE: It is not necessary to remove the water pump for timing cover removal.

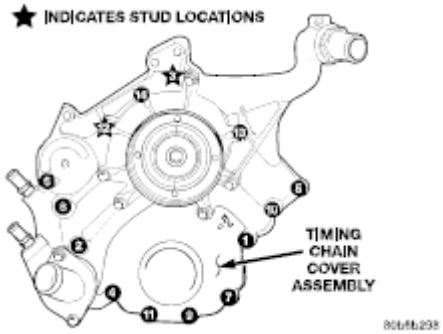


Fig. 89: Identifying Removal & Installation Sequence Of Timing Cover Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

11. Remove the bolts holding the timing cover to engine block.
12. Remove the timing cover.

INSTALLATION

CAUTION: Do not use oil based liquids to clean timing cover or block surfaces. Use only rubbing alcohol, along with plastic or wooden scrapers. Use no wire brushes or abrasive wheels or metal scrapers, or damage to surfaces could result.

1. Clean timing chain cover and block surface using rubbing alcohol.

CAUTION: The 3.7L uses a special anaerobic sealer instead of a gasket to seal the timing cover to the engine block, from the factory. For service repairs, Engine RTV must be used as a substitute.

2. Inspect the water passage O-rings (2) for any damage, and replace as necessary.
3. Apply Engine RTV sealer to front cover as shown in illustration (3) using a 3 to 4 mm thick bead.

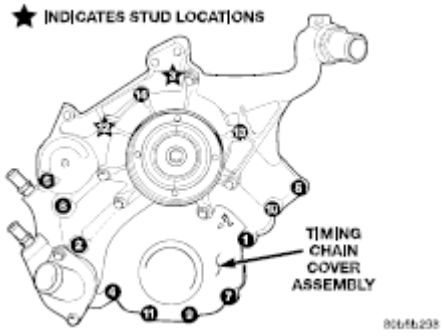


Fig. 90: Identifying Removal & Installation Sequence Of Timing Cover Bolts
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

4. Install cover. Tighten fasteners in sequence as shown in illustration to 58 N.m (43 ft. lbs.).

5. Install crankshaft damper. Refer to **INSTALLATION**.
6. Install A/C compressor. Refer to **INSTALLATION** .
7. Install the generator. Refer to **INSTALLATION** .
8. Install accessory drive belt tensioner. Refer to **INSTALLATION** .
9. Install radiator upper and lower hoses.
10. Install both heater hoses.
11. Install radiator fan. Refer to **INSTALLATION** .
12. Fill cooling system. Refer to **STANDARD PROCEDURE** .
13. Connect the battery negative cable.

TIMING CHAIN & SPROCKETS

REMOVAL

1. Disconnect negative cable from battery.
2. Drain cooling system. Refer to **STANDARD PROCEDURE** .
3. Remove right and left cylinder head covers. Refer to **COVER(S) - CYLINDER HEAD/REMOVAL**.
4. Remove radiator fan. Refer to **REMOVAL** .
5. Rotate engine until timing mark (2) on crankshaft damper aligns with TDC mark on timing chain cover (1).

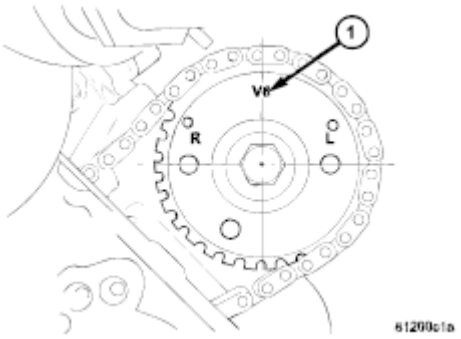


Fig. 91: Identifying V6 Mark On Camshaft Sprocket
Courtesy of MITSUBISHI MOTOR SALES OF AMERICA.

6. Make sure the camshaft sprocket "V6" marks (1) are at the 12 o'clock position (No. 1 TDC exhaust stroke).
7. Remove power steering pump. Refer to **REMOVAL** .
8. Remove access plugs (1 and 2) from left and right cylinder heads for access to chain guide fasteners.
9. Remove the oil fill housing to gain access to the right side tensioner arm fastener.
10. Remove crankshaft damper. Refer to **REMOVAL**. Remove timing chain cover. Refer to **REMOVAL**.
11. Collapse and pin primary chain tensioner.

CAUTION: Plate behind left secondary chain tensioner could fall into oil pan. Therefore, cover pan opening.

12. Remove secondary chain tensioners.
13. Remove camshaft position sensor (2).

CAUTION: Care should be taken not to damage camshaft target wheel. Do not hold target wheel while loosening or tightening camshaft sprocket. Do not place the target wheel near a magnetic source of any kind. A damaged or magnetized target wheel could cause a vehicle no start condition.

CAUTION: Do not forcefully rotate the camshafts or crankshaft independently of each other. Damaging intake valve to piston contact will occur. Ensure negative battery cable is disconnected to guard against accidental starter engagement.

14. Remove left and right camshaft sprocket bolts.
15. While holding the left camshaft steel tube with Special Tool 8428 Camshaft Wrench (2), remove the left camshaft sprocket. Slowly rotate the camshaft approximately 5 degrees clockwise to a neutral position.
16. While holding the right camshaft steel tube with Special Tool 8428 Camshaft Wrench (2), remove the right camshaft sprocket.
17. Remove idler sprocket assembly bolt.
18. Slide the idler sprocket assembly and crank sprocket forward simultaneously to remove the primary and secondary chains.
19. Remove both pivoting tensioner arms and chain guides.
20. Remove primary chain tensioner.

INSPECTION

Inspect the following components:

- *Sprockets for excessive tooth wear. Some tooth markings are normal and not a cause for sprocket replacement.*
- *Idler sprocket assembly bushing and shaft for excessive wear.*
- *Idler sprocket assembly spline joint. The joint should be tight with no backlash or axial movement.*
- *Chain guides and tensioner arms. Replace these parts if grooving in plastic face is more than 1 mm (0.039 in.) deep. If plastic face is severely grooved or melted, the tensioner lube jet may be clogged. The tensioner should be replaced.*
- *Secondary chain tensioner piston and ratcheting device. Inspect for evidence of heavy contact between tensioner piston and tensioner arm. If this condition exists, the tensioner arm and chain should be replaced.*
- *Primary chain tensioner plastic faces. Replace as required.*

INSTALLATION

1. Using a vise, lightly compress the secondary chain tensioner piston until the piston step (5) is flush with the tensioner body. Using a pin or suitable tool, release ratchet pawl (4) by pulling pawl back against spring force through access hole on side of tensioner. While continuing to hold pawl back, push ratchet device to approximately 2 mm from the tensioner body. Install Special Tool 8514 lock pin (2) into hole on front of tensioner. Slowly open vise to transfer piston spring force to lock pin.
2. Position primary chain tensioner over oil pump and insert bolts into lower two holes on tensioner bracket. Tighten bolts to 28 N.m (250 in. lbs.).
3. Install right side chain tensioner arm. Install Torx® bolt. Tighten Torx® bolt to 28 N.m (250 in. lbs.).

CAUTION: The silver bolts retain the guides to the cylinder heads. The black bolts retain the guides to the engine block.

4. Install the left side chain guide. Tighten the bolts to 28 N.m (250 in. lbs.).
5. Install left side chain tensioner arm, and Torx® bolt. Tighten Torx® bolt to 28 N.m (250 in. lbs.).
6. Install the right side chain guide. Tighten the bolts to 28 N.m (250 in. lbs.).
7. Install both secondary chains onto the idler sprocket (2). Align two plated links on the secondary chains to be visible through the two lower openings on the idler sprocket (4 o'clock and 8 o'clock). Once the secondary timing chains are installed, position special tool 8429 (1) to hold chains in place for installation.
8. Align primary chain double plated links with the timing mark at 12 o'clock on the idler sprocket. Align the primary chain single plated link with the timing mark at 6 o'clock on the crankshaft sprocket.
9. Lubricate idler shaft and bushings with clean engine oil.

NOTE: The idler sprocket must be timed to the counterbalance shaft drive gear before the idler sprocket is fully seated.

10. Install all chains, crankshaft sprocket, and idler sprocket as an assembly. After guiding both secondary chains through the block and cylinder head openings, affix chains with a elastic strap or equivalent. This will maintain tension on chains to aid in installation. Align the timing mark (2) on the idler sprocket gear (3) to the timing mark on the counterbalance shaft drive gear (1), then seat idler sprocket fully. Before installing idler sprocket bolt, lubricate washer with oil, and tighten idler sprocket assembly retaining bolt to 34 N.m (25 ft. lbs.).

NOTE: It will be necessary to slightly rotate camshafts for sprocket installation.

11. Align left camshaft sprocket "L" dot to plated link on chain.
12. Align right camshaft sprocket "R" dot to plated link on chain.

CAUTION: Remove excess oil from the camshaft sprocket bolt. Failure to do so can result in over-torque of bolt resulting in bolt failure.

13. Remove Special Tool 8429, then attach both sprockets to camshafts. Remove excess oil from bolts, then Install sprocket bolts, but do not tighten at this time.
14. Verify that all plated links are aligned with the marks on all sprockets and the "V6" marks on camshaft sprockets are at the 12 o'clock position.

CAUTION: Ensure the plate between the left secondary chain tensioner and block is correctly installed.

15. Install both secondary chain tensioners. Tighten bolts to 28 N.m (250 in. lbs.).

NOTE: Left and right secondary chain tensioners are not common.

16. Remove all locking pins (3) from tensioners.

CAUTION: After pulling locking pins out of each tensioner, DO NOT manually extend the tensioner(s) ratchet. Doing so will over tension the chains, resulting in noise and/or high timing chain loads.

17. Using Special Tool 6958, Spanner with Adaptor Pins 8346 (4), tighten left. camshaft sprocket bolts to 122 N.m (90 ft. lbs.).
18. Using Special Tool 6958, Spanner with Adaptor Pins 8346 (2), tighten right camshaft sprocket bolts to 122 N.m (90 ft. lbs.).
19. Rotate engine two full revolutions. Verify timing marks are at the follow locations:
    - *primary chain idler sprocket dot is at 12 o'clock*
    - *primary chain crankshaft sprocket dot is at 6 o'clock*
    - *secondary chain camshaft sprockets "V6" marks are at 12 o'clock*
    - *counterbalance shaft drive gear dot is aligned to the idler sprocket gear dot*
20. Lubricate all three chains with engine oil.
21. After installing all chains, it is recommended that the idler gear end play be checked. The end play must be within 0.10 -0.25 mm (0.004 - 0.010 in.). If not within specification, the idler gear (1) must be replaced.
22. Install timing chain cover. Refer to **INSTALLATION**. Install crankshaft damper. Refer to **INSTALLATION**.
23. Install cylinder head covers. Refer to **COVER(S) - CYLINDER HEAD/INSTALLATION**.

NOTE: Before installing threaded plug in right cylinder head, the plug must be coated with sealant to prevent leaks.

24. Coat the large threaded access plug (2) with **3M™ AAD Part No. 8731 or equivalent Thread Sealant** , then install into the right cylinder head and tighten to 81 N.m (60 ft. lbs.).
25. Install the oil fill housing.
26. Install access plug (1) in left cylinder head.

27. Install power steering pump. Refer to **INSTALLATION** .
28. Fill cooling system. Refer to **STANDARD PROCEDURE** .
29. Connect negative cable to battery.

