SECTION 1C

DOHC ENGINE MECHANICAL

TABLE OF CONTENTS

SPECIFICATIONS

ENGINE SPECIFICATIONS

Application	Description (1.6L DOHC)
General Data:	
Engine Type	4 Cylinder (In-line)
Displacement	1 598 cm^3 (97.51 in^3)
Bore Stroke	79.0 X 81.5 mm (3.11 in. X 3.21 in.)
Compression Ratio	9.5$ 0.02:1
Firing Order	1-3-4-2
Cylinder Bore:	
Diameter	79.0 mm (3.11 in.)
Out of Round (Maximum)	0.0065 mm (0.00025 in.)
Taper (Maximum)	0.0065 mm (0.00025 in.)
Piston:	
Diameter	78.970 mm (3.1090 in.)
Clearance to Bore	0.030 mm (0.0012 in.)
Piston Rings:	
Ring, End Gap: Top Compression	0.3 mm (0.019 in.)
2nd Compression	0.3 mm (0.019 in.)
Groove Clearance: Top Impression	0.02 mm (0.0008 in.)
2nd Impression	0.02 mm (0.0008 in.)
Piston Pin:	
Diameter	18.00 mm (0.708 in.)
Pin Off-Set	0.6X 0.8 mm (0.02X 0.03 in.)
Camshaft:	
Lift Intake	8.75 mm (0.344 in.)
Lift Exhaust	8.75 mm (0.344 in.)
End Play	0.10X 0.25 mm (0.003X 0.009 in.)
Journal OD: No. 1	30 mm (1.18 in.)
No. 2	27 mm (1.06 in.)
No. 3	27 mm (1.06 in.)
No. 4	27 mm (1.06 in.)
No. 5	27 mm (1.06 in.)
Crankshaft:	
Main Journal: Diameter (All)	54.982X 54.994 mm (2.164X 2.165 in.)
Taper (Maximum)	0.005 mm (0.0001 in.)
Out of Round (Maximum)	0.004 mm (0.0001 in.)
Main Bearing Clearance (All)	0.005 mm (0.0001 in.)

ENGINE SPECIFICATIONS (Cont'd)

Application	Description (1.6L DOHC)
Crankshaft End Play	0.01 mm (0.003 in.)
Connecting Rod Journal: Diameter (All)	42.971X 42.987 mm (1.691X 1.692 in.)
Taper (Maximum)	0.005 mm (0.0001 in.)
Out of Round (Maximum)	0.004 mm (0.0001 in.)
Rod Bearing Clearance (All)	0.019X 0.070 mm (0.0007X 0.0027 in.)
Rod Side Clearance	0.070X 0.242 mm (0.0027X 0.009 in.)
Valve System:	
Valve Lash Compensators	Hydraulic
Face Angle (All)	46_
Seat Angle (All)	46_
Seat Runout (Maximum, All)	0.03 mm (0.019 in.)
Face Runout (Maximum, All)	0.03 mm (0.019 in.)
Seat Width: Intake	1.17X 1.57 mm (0.046X 0.062 in.)
Exhaust	1.07X 1.47 mm (0.042X 0.058 in.)
Valve Guide Inside Diameter (All)	6.00X 6.02 mm (0.236X 0.237 in.)
Valve Stem Diameter (All)	6 mm (0.236 in.)
Valve Diameter (All): Intake	30.3" 0.12 mm (1.19" 0.0047 in.)
Exhaust	26.0" 0.14 mm (1.02" 0.0055 in.)
Valve Spring Loads: Valve Open	580" 26 N (428" 19 lbs) @ 23.0 mm (0.90 in.)
Valve Closed	260" 13 N (192" 9 lbs) @ 32.0 mm (1.25 in.)
Valve Spring Free Length	-
Cylinder Head:	
Overall Height	138.18 mm (5.440 in.)
Minimum Height after machining	138.13 mm (5.438 in.)
Distortion	0.1 mm (0.002 in.)
Oil Pump:	
Gap Between Oil Pump Body and Out Rotor	0.4X 0.484 mm (0.016X 0.019 in.)
Out Rotor Side Clearance	0.45X 0.100 mm (0.017X 0.003 in.)
Inner Rotor Side Clearance	0.035X 0.085 mm (0.001X 0.003 in.)
Relief Valve Spring Free Length	81 mm (3.188 in.)
Sealants and Adhesives:	
Rear Main Bearing Cap	GE p/n RTV 159
Camshaft Carrier to Cylinder Head	HN 1581 (Loctite^{R} 515)
Oil Pan Bolts	HN 1256 (Loctite^{R} 242)
Oil Pump Bolts	HN 1256 (Loctite^{R} 242)
Oil Pan Pickup Tube Bolts	HN 1256 (Loctite^{R} 242)
Oil Gallery Plug	HN 1256 (Loctite^{R} 242)
Coolant Jacket Caps and Plugs (Freeze Plugs)	HN 1756 (Loctite^{R} 176)
Exhaust Manifold Studs/Nuts	Anti-seize Compound (HMC Spec HN1325)

FASTENER TIGHTENING SPECIFICATIONS

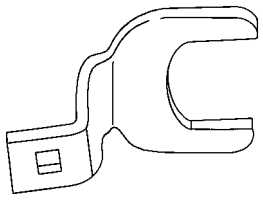
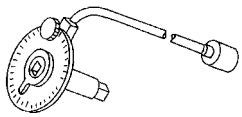
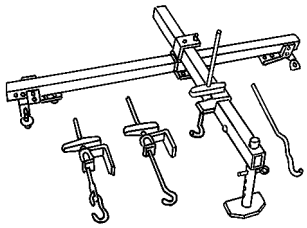
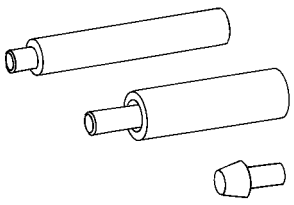
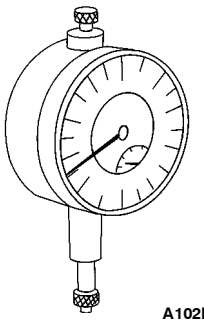
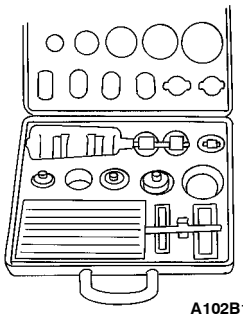
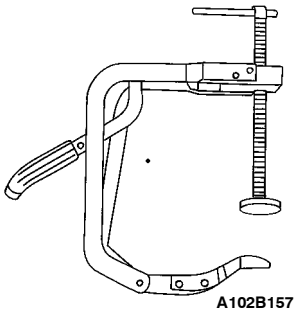
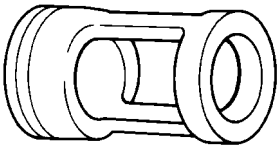
Application	NSm	Lb-Ft	Lb-In
A/C Compressor Hose Assembly Retaining Bolt	33	24	-
A/C Compressor Mounting Bolts	27	20	-
A/C Compressor Mounting Bracket Bolts	50	37	-
Air Filter Housing Bolts	12	-	106
Alternator Adjusting Bolt	20	15	-
Alternator Adjusting Bracket Retaining Bolt	20	15	-
Camshaft Cap Bolts	16	12	-
Camshaft Gear Bolt, Intake & Exhaust	67.5	49	-
Connecting Rod Cap Bolts	25 +30_+15_	18 +30_+15_	-
Coolant Pump Retaining Bolts	10	-	89
Coolant Temperature Sensor	20	15	-
Crankshaft Bearing Cap Bolts	50 +45_+15_	37 +45_+15_	-
Crankshaft Pulley Bolt	95 +30_+15_	70 +30_+15_	-
Crankshaft Position Sensor Retaining Bolt	10	-	89
Cylinder Head Bolts (Camshaft Support Housing & Cylinder Head Mounting Bolts)	25 +60_+60_ +60_+10_	18 +60_+60_ +60_+10_	-
DIS Ignition Coil Mounting Bracket Bolts	10	-	89
DIS Ignition Coil Mounting Bolts	10	-	89
Engine Mount Bracket Retaining Bolts	60	44	-
Engine Mount Retaining Nuts	40	30	-
Engine-Mount-to-Engine-Mount-Bracket Retaining Bolts	60	44	-
Exhaust Flexible Pipe Bracket Bolts	40	30	-
Exhaust Flex Pipe-to-Catalytic Converter or Connecting Pipe Retaining Nuts	30	22	-
Exhaust Flex Pipe-to-Exhaust Manifold Retaining Nuts	40	30	-
Exhaust Gas Recirculation Valve Adapter Bolts	25	18	-
Exhaust Manifold Heat Shield Bolts	15	11	-
Exhaust Manifold Retaining Nuts	25	18	-
Flexible Plate Bolts	60	44	-
Flexible Plate Inspection Cover Bolts	10	-	89
Flywheel Bolts	35 +30_+15_	25 +30_+15_	-
Flywheel Inspection Cover Bolts	12	-	106
Front Timing Belt Cover Bolts, Upper and Lower	10	-	89
Fuel Rail Retaining Bolts	25	18	-
Intake Manifold Retaining Nuts/Bolts	25	18	-
Intake Manifold Support Bracket Bolts, Upper	25	18	-

FASTENER TIGHTENING SPECIFICATIONS (Cont'd)

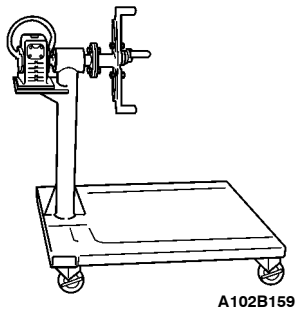
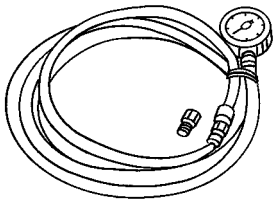
Application	NSm	Lb-Ft	Lb-In
Oil Pan Retaining Bolts	10	-	89
Oil Pressure Switch	40	30	-
Oil Pump Rear Cover Bolts	6	-	53
Oil Pump Retaining Bolts	10	-	89
Oil Pump Safety Relief Valve	30	22	-
Oil Pump/Pickup Tube Bolts	10	-	89
Power Steering Pump Mounting Bolts	25	18	-
Power Steering Pump Pulley Bolts	25	18	-
Rear Timing Belt Cover Bolts	10	-	89
Right Transaxle Brace Bolts	40	30	-
Spark Plug Cover Bolts	3	-	27
Spark Plugs	25	18	-
Support Bracket Bolt	10	-	89
Thermostat Housing Mounting Bolts	20	15	-
Throttle Cable Bracket Bolts	8	-	71
Timing Belt Automatic Tensioner Bolts	25	18	-
Timing Belt Idler Pulley Bolt	40	30	-
Transaxle Torque Converter Bolts	65	48	-
Transmission/Transaxle Bell Housing Bolts	75	55	-
Valve Cover Nuts	10	-	89

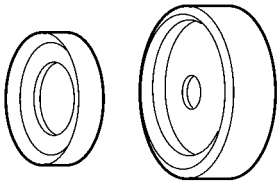
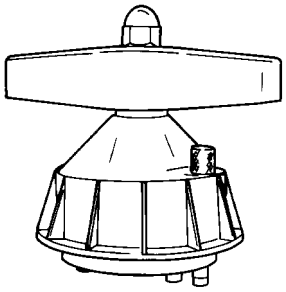
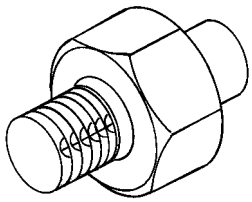
SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A102B151	**J-42492** **Timing Belt Adjuster**
 A102B161	**KM-470-B** **Angular Torque Gauge**
 A102B152	**J-28467-B** **Engine Assembly** **Support Fixture**
 A102B153	**KM-427** **Piston Pin Service Set**
 A102B154	**MKM-571-B** **Gauge**
 A102B156	**KM-340-0** **Cutter Set** **Includes: KM-340-7** **KM-340-13** **KM-340-26**
 A102B157	**KM-348** **Valve Spring** **Compressor**
 A102C153	**KM-653** **Adapter**

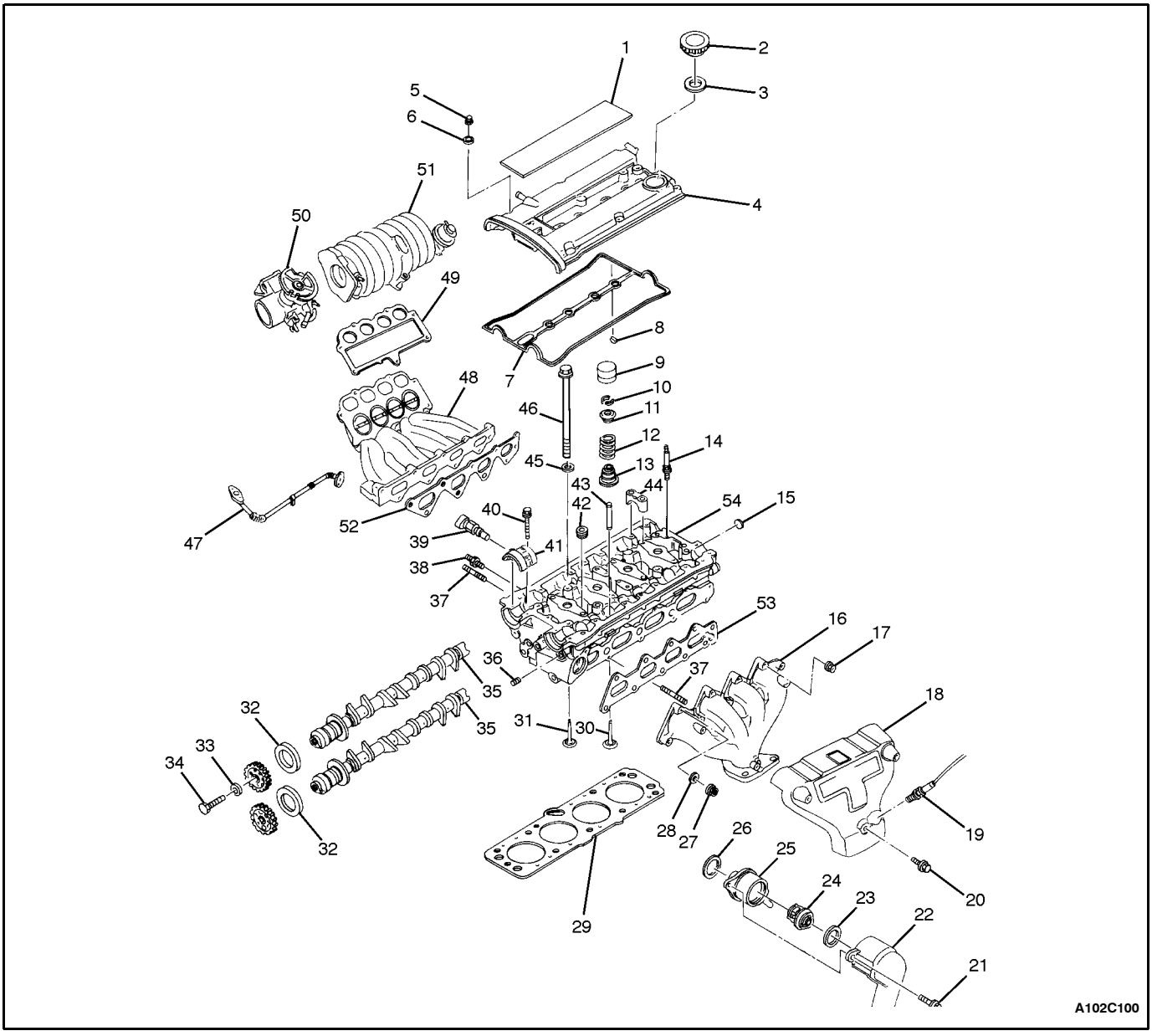
SPECIAL TOOLS TABLE (Cont'd)

 A102C154	**KM-805 Valve Guide Reamer**
 A102B159	**KM-412 Engine Overhaul Stand**
 A202B005	**KM-498-B Pressure Gauge**

 A102B160	**KM-635 Crankshaft Rear Oil Seal Installer**
 A102C155	**J-36972 Crankshaft Rear Oil Seal Installer**
 B102C044	**KM-135 Adapter**

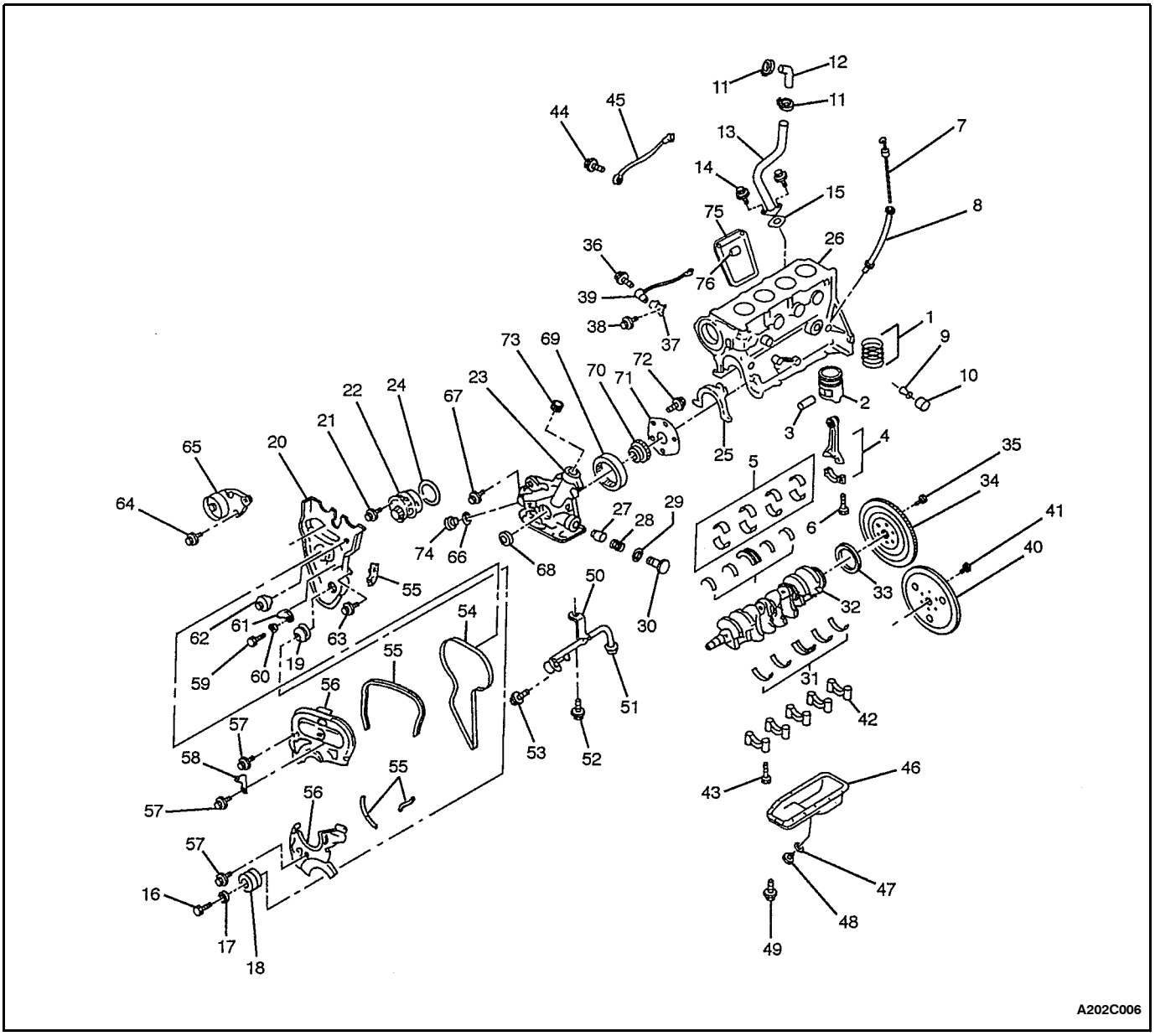
COMPONENT LOCATOR

UPPER END

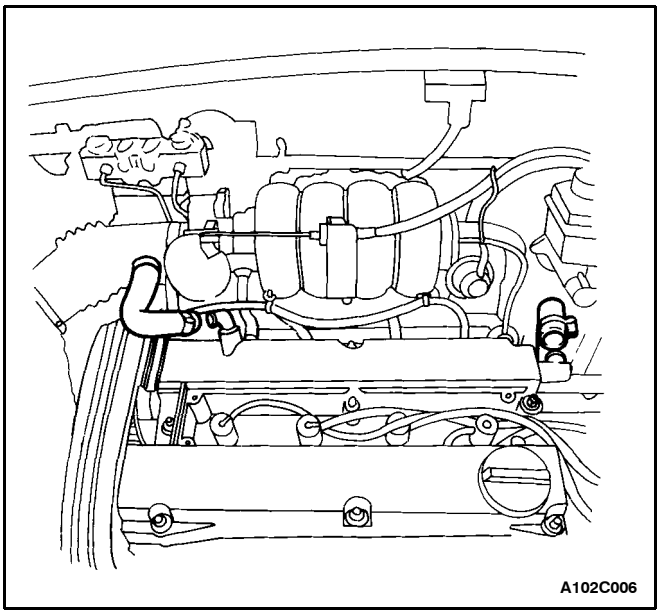


1 Spark Plug Cover
2 Oil Cap
3 Oil Cap Seal
4 Valve Cover
5 Valve Cover Nut
6 Valve Cover Washer
7 Valve Cover Gasket
8 Seal
9 Hydraulic Valve Lash Adjuster
10 Valve Key
11 Valve Spring Retainer
12 Valve Spring
13 Valve Stem Oil Seal
14 Valve Cover Stud
15 Freeze Plug
16 Exhaust Manifold
17 Nut
18 Exhaust Manifold Heat Shield
19 Oxygen Sensor
20 Bolt
21 Bolt
22 Thermostat Housing
23 Thermostat Housing Seal
24 Thermostat
25 Thermostat Adapter
26 Thermostat Adapter Seal
27 Nut
28 Washer
29 Cylinder Head Gasket
30 Exhaust Valve
31 Intake Valve
32 Camshaft Seal
33 Washer
34 Camshaft Gear Bolt
35 Camshaft
36 Plug
37 Stud
38 Engine Coolant Temperature Sensor
39 Coolant Temperature Sensor
40 Bolt
41 Front Camshaft Cap
42 Plug
43 Valve Guide
44 Intermediate Camshaft Cap
45 Washer
46 Head Bolt
47 Exhaust Gas Recirculation Pipe
48 Intake Manifold
49 Plenum Gasket
50 Throttle Body
51 Plenum
52 Intake Manifold Gasket
53 Exhaust Manifold Gasket
54 Cylinder Head

LOWER END



1 Piston Ring Set
2 Piston
3 Piston Pin
4 Connecting Rod
5 Connecting Rod Bearing Set
6 Connecting Rod Bolt
7 Oil Level Gauge Stick
8 Gauge Stick Tube
9 Connecting Piece
10 Oil Filter
11 Hose Clamp
12 Engine Ventilation Hose
13 Engine Ventilation Pipe
14 Bolt
15 Oil Separator Gasket
16 Crankshaft Pulley Bolt
17 Washer
18 Crankshaft Pulley
19 Crankshaft Gear
20 Rear Timing Belt Cover
21 Bolt
22 Coolant Pump
23 Oil Pump
24 Engine Block Seal Ring
25 Oil Pump Body Gasket
26 Engine Block
27 Pressure Relief Valve Plunger
28 Spring
29 Oil Pump Seal Ring
30 Bolt Plug
31 Crankshaft Bearing Set
32 Crankshaft
33 Shaft Seal Ring
34 Flywheel (Manual Transmission)
35 Bolt (Manual Transmission)
36 Bolt
37 Bracket
38 Bolt
39 Crankshaft Position Sensor
40 Flexible Plate (Automatic Transmission)
41 Bolt (Automatic Transmission)
42 Crankshaft Main Bearing Cap
43 Bolt
44 Bolt
45 Knock Sensor
46 Oil Pan
47 Threaded Ring
48 Bolt
49 Bolt
50 Bracket
51 Oil Pickup Tube
52 Bolt
53 Bolt
54 Timing Belt
55 Cover Seal
56 Cover
57 Bolt
58 Clamp
59 Bolt
60 Washer
61 Cover Bracket
62 Idler Pulley
63 Rear Cover Bolt
64 Bolt
65 Auto Tensioner
66 Seal
67 Bolt
68 Seal
69 Gear
70 Gear
71 Cover
72 Bolt
73 Plug
74 Oil Pressure Sensor
75 Intake Manifold Support Bracket
76 EGR Solenoid


A102C006

MAINTENANCE AND REPAIR

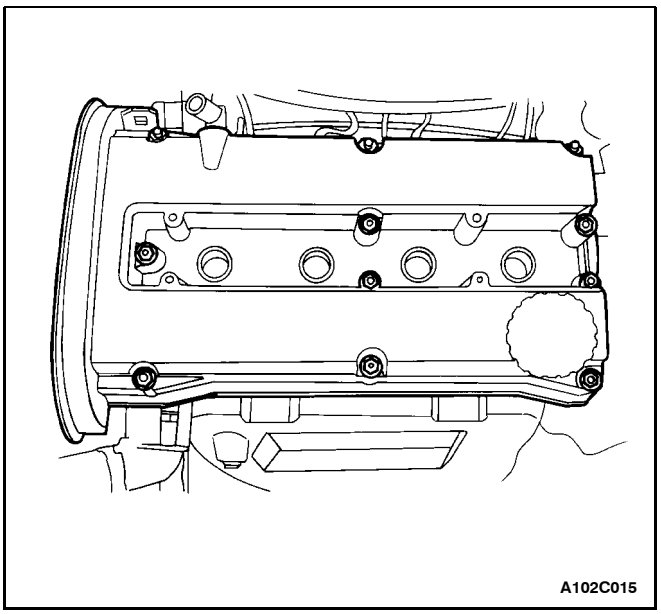
ON-VEHICLE SERVICE

VALVE COVER

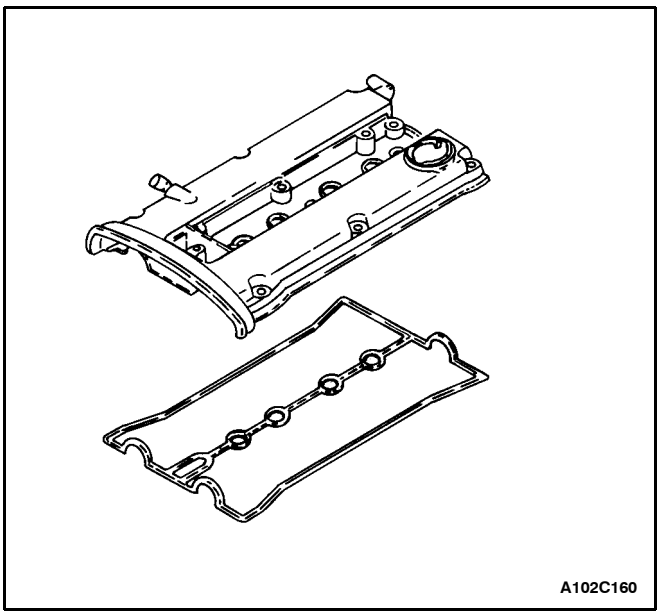
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

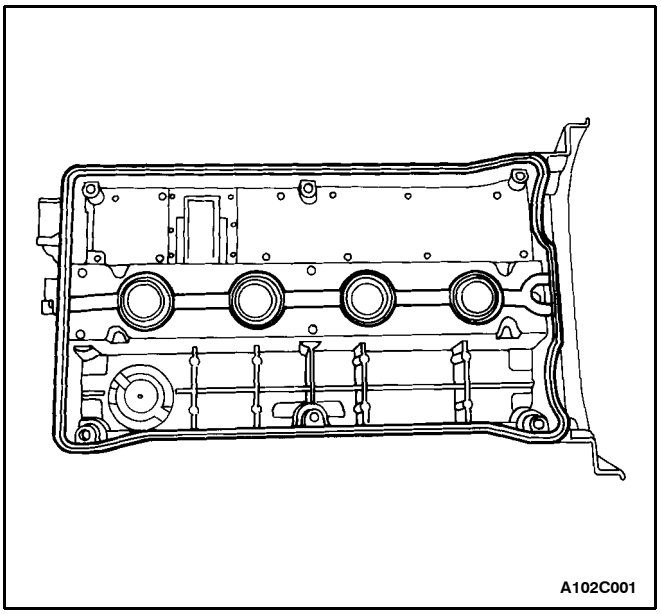
1. Disconnect the negative battery cable.
2. Remove the spark plug cover bolts and cover.
3. Disconnect the breather tube from the valve cover.
4. Disconnect the crankcase ventilation tube from the valve cover.


A102C015

5. Disconnect all of the necessary vacuum lines.
6. Disconnect the ignition wires from the spark plugs.
7. Remove the valve cover nuts.
8. Remove the valve cover washers.

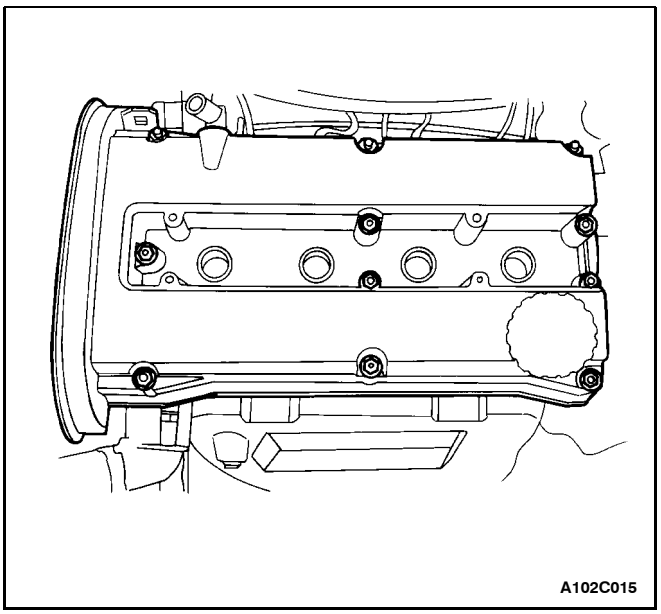

A102C160

9. Remove the valve cover.
10. Remove the valve cover gasket from the valve cover.


A102C001

Installation Procedure

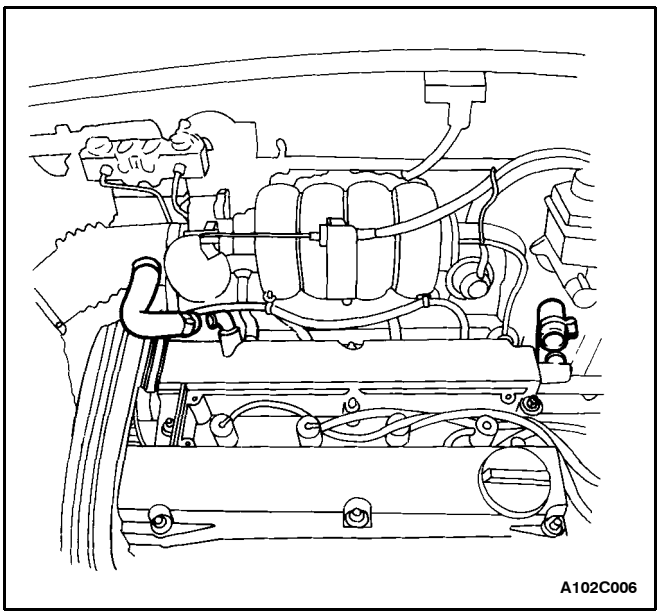
1. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover to cylinder head seal.
2. Install the new valve cover gasket to the valve cover.
3. Install the valve cover.


A102C015

4. Install the valve cover washers.
5. Install the valve cover nuts.

Tighten

Tighten the valve cover nuts to 10 NSm (89 lb-in).

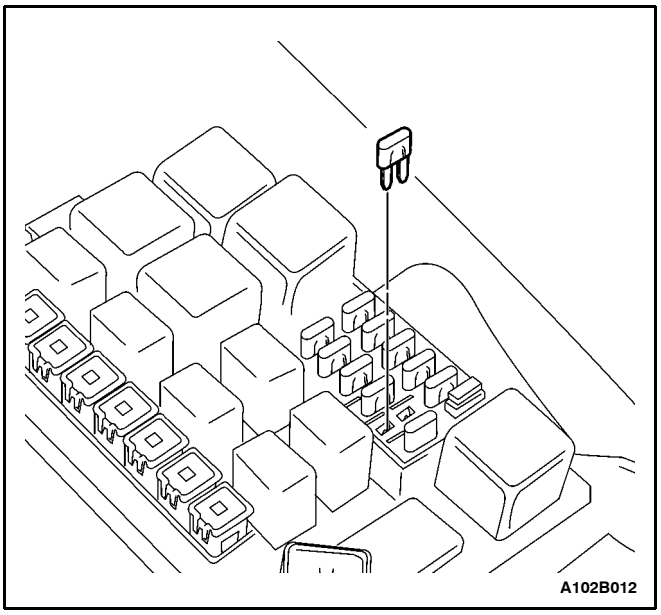

A102C006

6. Connect the ignition wires to the spark plugs.
7. Install the spark plug cover.
8. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 NSm (27 lb-in).

9. Connect all of the necessary vacuum lines.
10. Connect the crankcase ventilation tube to the valve cover.
11. Connect the breather tube to the valve cover.
12. Connect the negative battery cable.


A102B012

CYLINDER HEAD AND GASKET

(Left-Hand Drive Shown, Right-Hand Drive Similar)

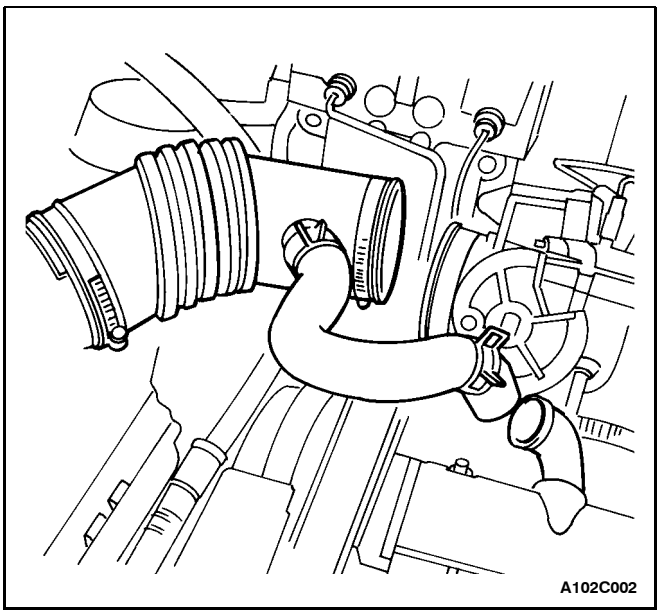
Tools Required

J-42472 Timing Belt Adjuster

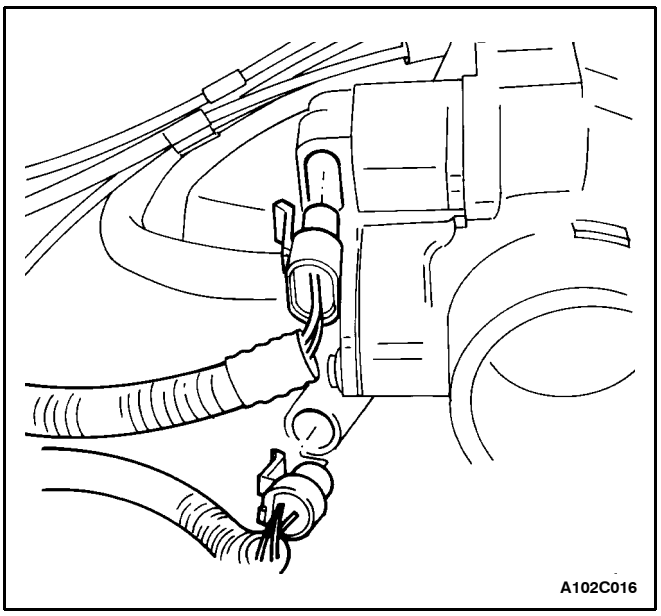
KM-470-B Angular Torque Gauge

Removal Procedure

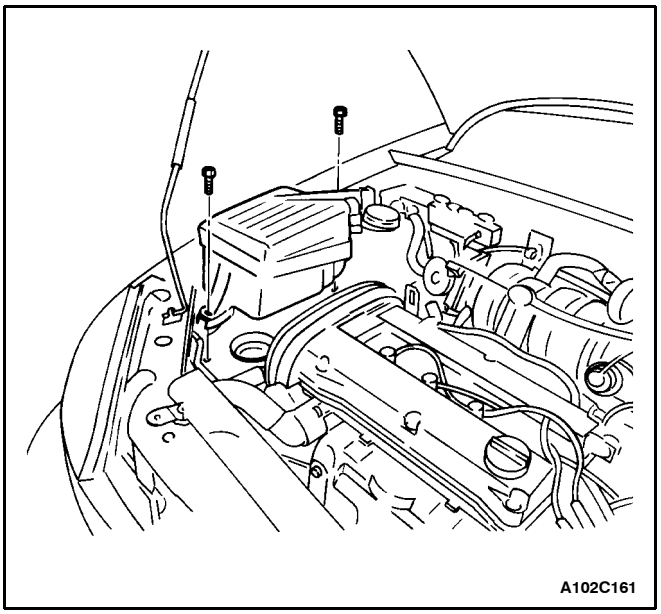
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine after it stalls for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the ECM ground terminal from the intake manifold.
5. Drain the engine coolant. Refer to Section 1D, Engine Cooling.


A102C002

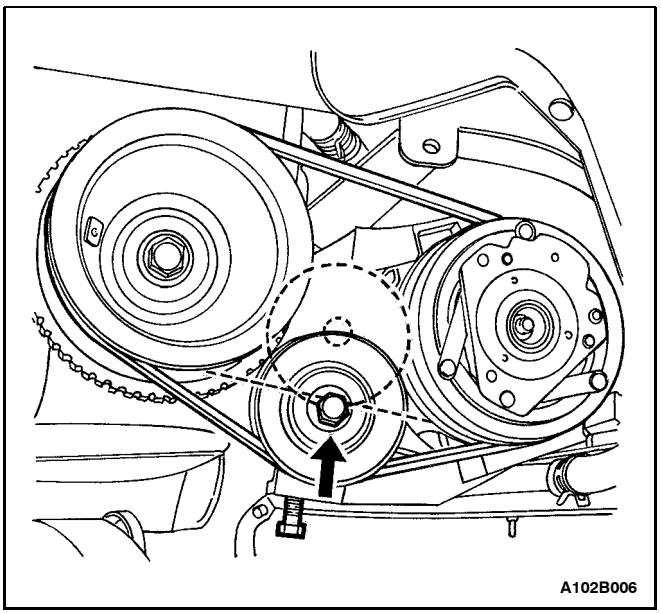
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the breather tube from the valve cover.
8. Disconnect the air intake tube from the throttle body.


A102C016

9. Disconnect the DIS ignition coil connector.
10. Disconnect the oxygen sensor connector.
11. Disconnect the fuel injector harness connectors.
12. Disconnect the idle air control valve connector.
13. Disconnect the throttle position sensor connector.
14. Disconnect the engine coolant temperature sensor connector.
15. Disconnect the coolant temperature sensor connector.


A102C161

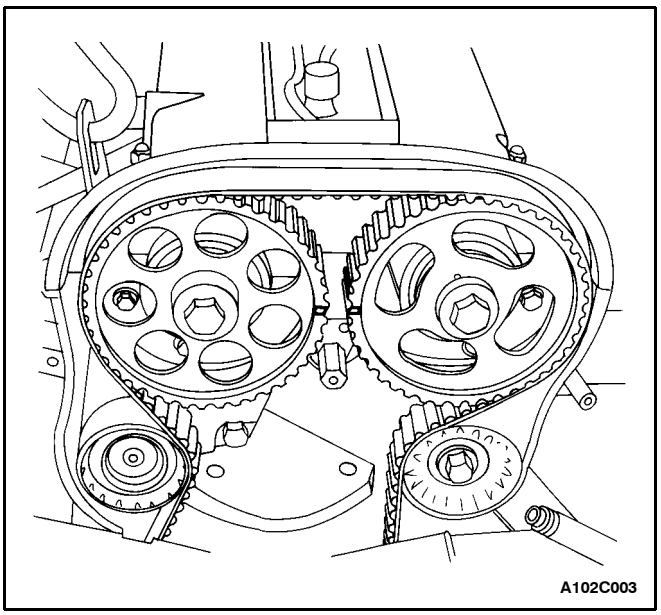
16. Remove the air filter housing bolts.
17. Remove the air filter housing.
18. Remove the right front wheel. Refer to Section 2E, Tires and Wheels.
19. Remove the right front splash shield.


A102B006

20. Disconnect the upper radiator hose at the thermostat housing.
21. Remove the A/C compressor drive belt, if equipped.
22. Remove the alternator adjusting bolt and the alternator drive belt.
23. Remove the power steering pump pulley bolts, if equipped.

Important: Push the engine assembly toward the battery to remove the power steering pump pulley.

24. Remove the power steering pump pulley, if equipped.
25. Remove the crankshaft pulley bolt.
26. Remove the crankshaft pulley.

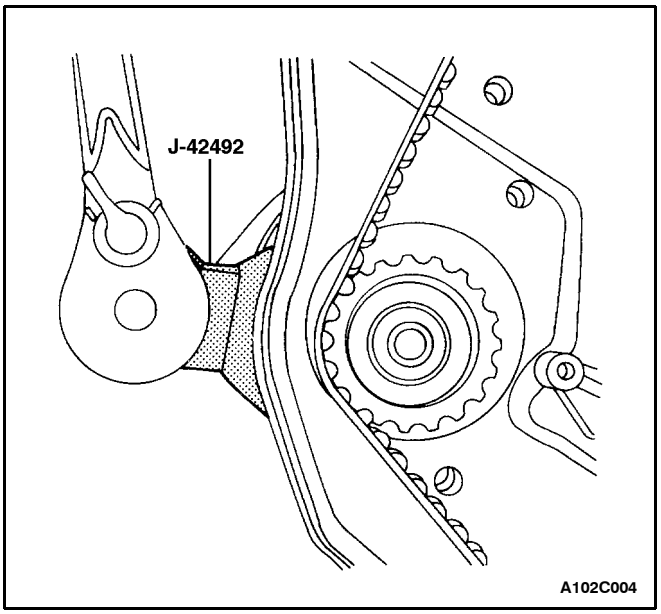

A102C003

27. Remove the upper front timing belt cover bolts.
28. Remove the upper front timing belt cover.
29. Remove the lower front timing belt cover bolts.
30. Remove the lower front timing belt cover.
31. Remove the power steering pump, if equipped. Refer to Section 6B, Power Steering Pump.
32. Install the engine-mount-to-engine-mount-bracket retaining bolts and tighten the bolts to secure the engine if the power steering was removed.

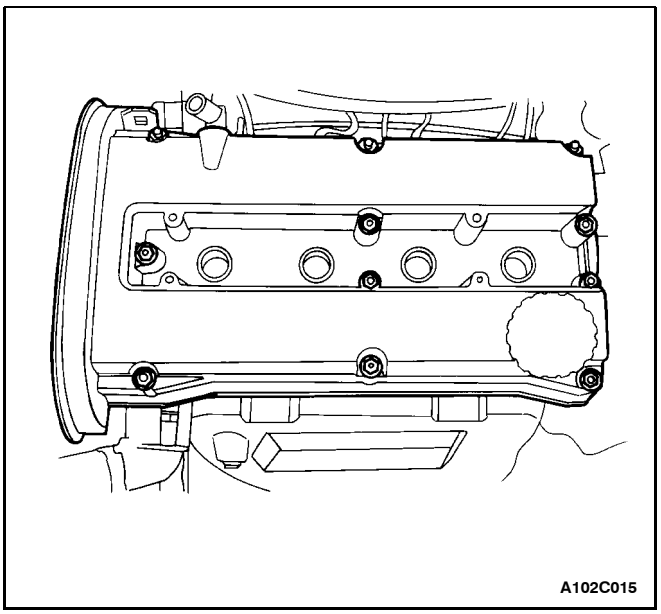
Tighten

Tighten the engine-mount-to-engine-mount-bracket retaining bolts to 60 NSm (44 lb-ft).

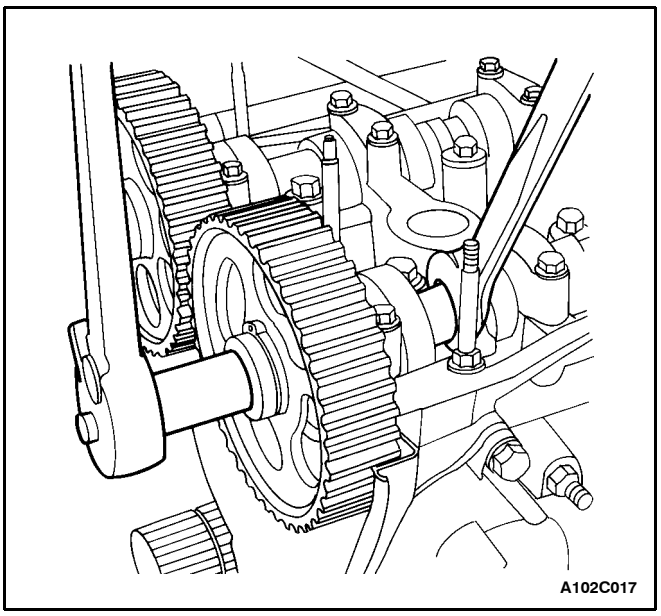
33. Align the camshaft gear timing marks.



34. Slightly loosen the coolant pump retaining bolts.
35. Rotate the coolant pump counterclockwise using the timing belt adjuster J-42492 to relieve the timing belt tension.
36. Remove the timing belt. Refer to "Timing Belt" in this section.

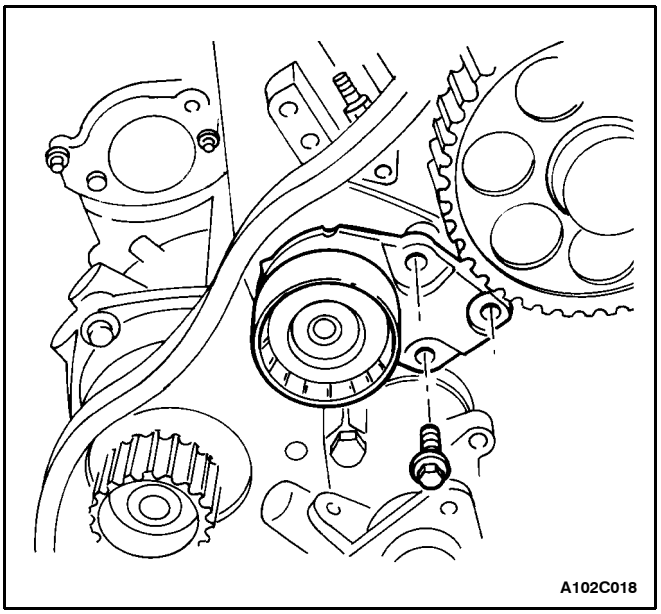


37. Disconnect the crankcase ventilation tube at the valve cover.
38. Remove the spark plug cover bolts.
39. Remove the spark plug cover.
40. Disconnect the ignition wires from the spark plugs.
41. Remove the valve cover nuts.
42. Remove the valve cover washers.
43. Remove the valve cover and the valve cover gasket.

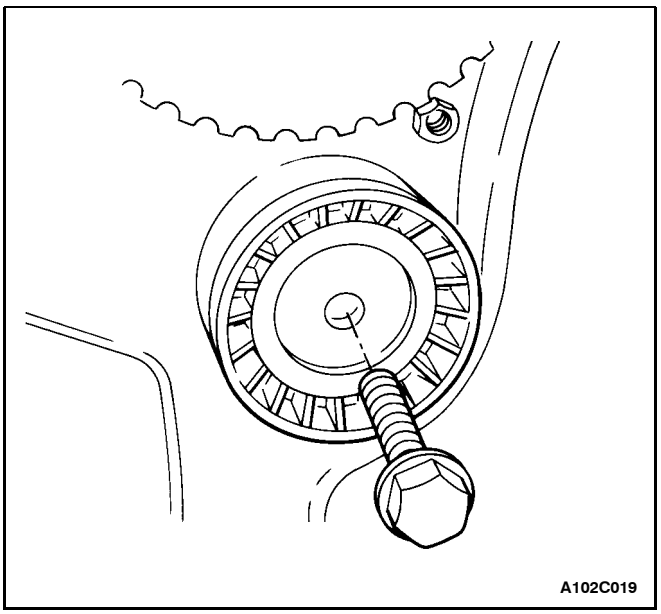


Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

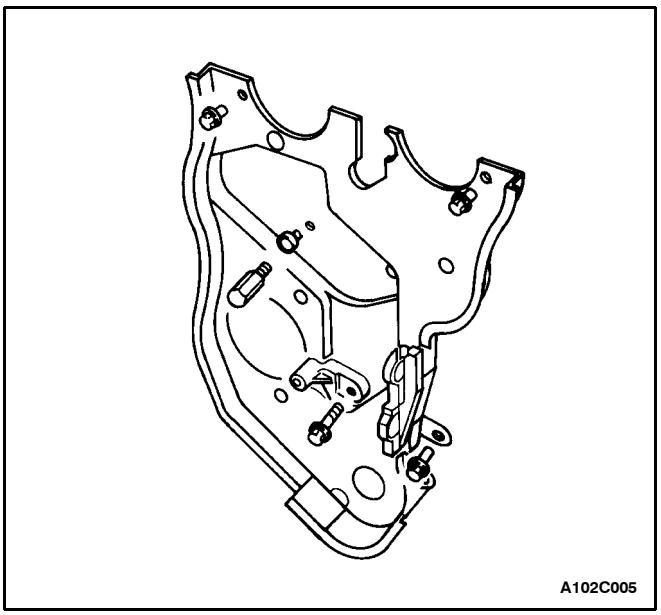
44. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
45. Remove the intake camshaft gear.
46. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
47. Remove the exhaust camshaft gear.



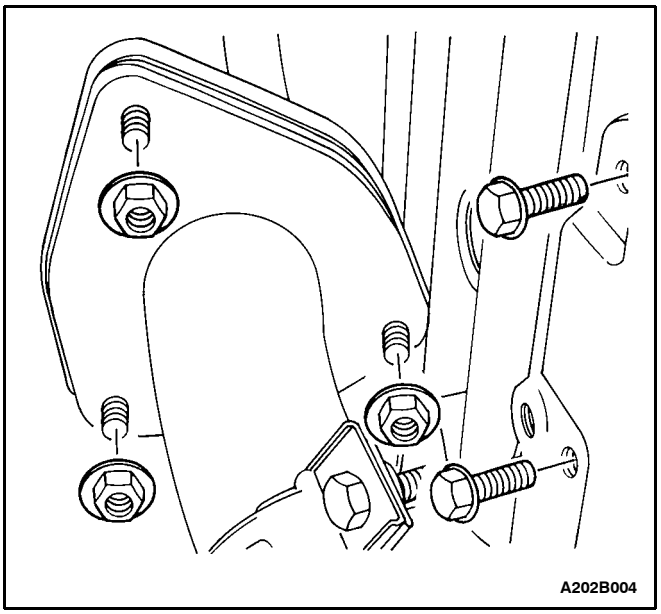
48. Remove the timing belt automatic tensioner bolts.
49. Remove the timing belt automatic tensioner.



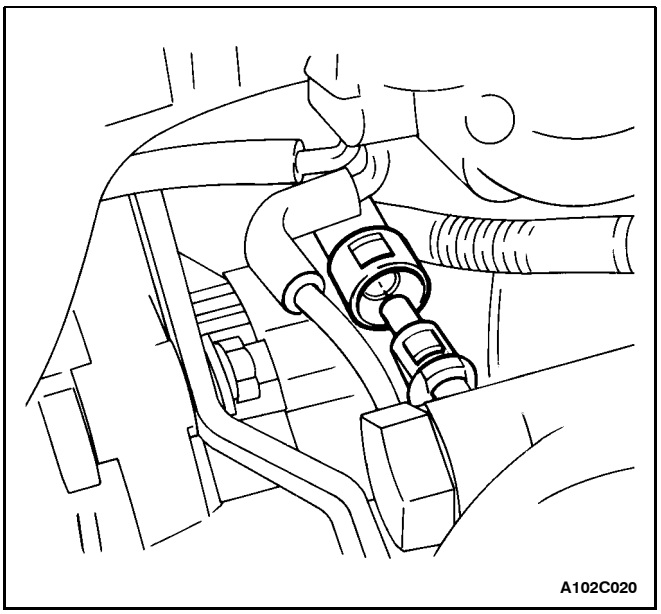
50. Remove the timing belt idler pulley bolt.
51. Remove the timing belt idler pulley.



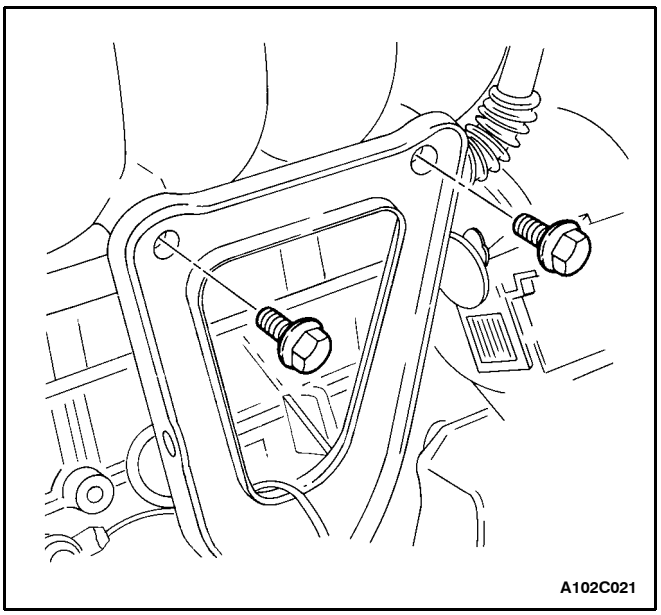
52. Remove the rear timing belt cover bolts.
53. Remove the rear timing belt cover.



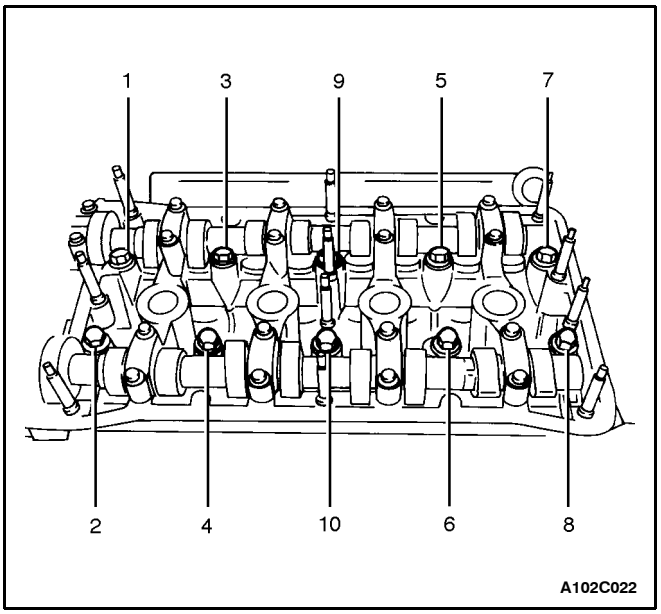
54. Remove the exhaust flex pipe retaining nuts at the exhaust manifold studs and the bolts at the bracket.
55. Disconnect all of the necessary vacuum hoses.



56. Disconnect the fuel return line at the fuel pressure regulator.
57. Disconnect the fuel feed line at the fuel rail.
58. Remove the alternator adjusting bracket retaining bolt and the bracket.
59. Disconnect the heater inlet hose at the cylinder head.
60. Disconnect the surge tank coolant hose at the throttle body.



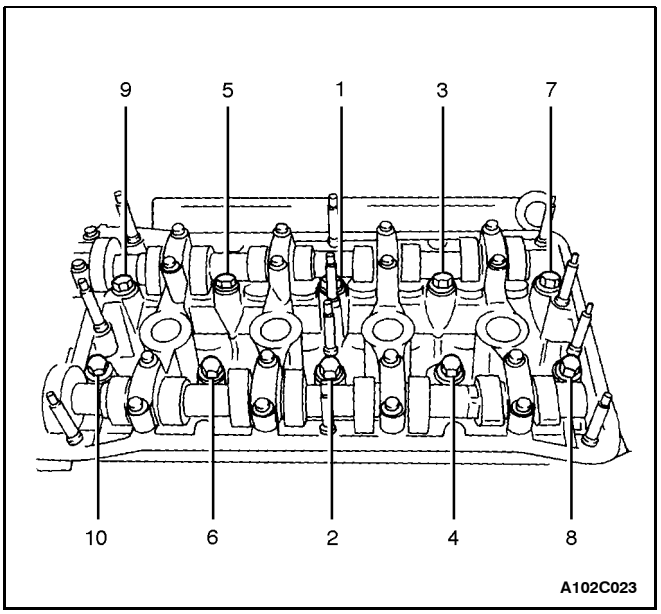
61. Remove the upper intake manifold support bracket bolts.



62. Disconnect the throttle cable at the throttle body and the intake manifold.
63. Loosen all of the cylinder head bolts gradually and in the sequence shown.
64. Remove the cylinder head bolts.
65. Remove the cylinder head with the intake manifold and the exhaust manifold attached.

Notice: Prevent any engine oil or coolant from entering the cylinders when removing the cylinder heads.

66. Remove the cylinder head gasket.



Cleaning Procedure

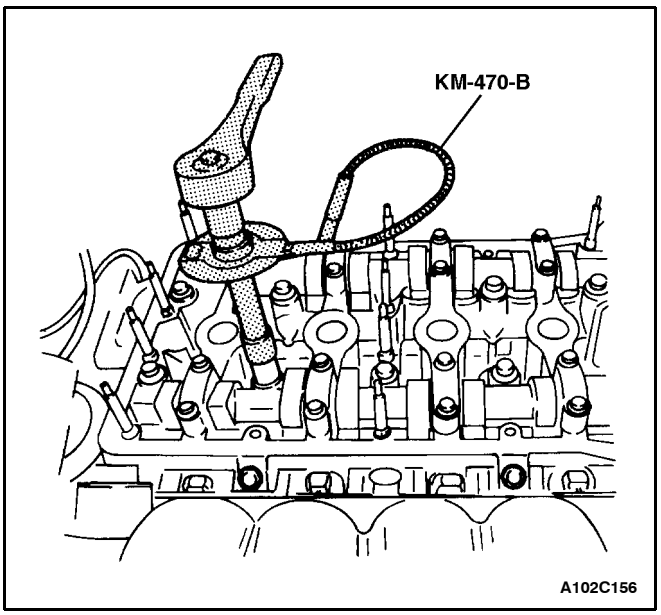
1. Clean the gasket surfaces of the cylinder head and the engine block.
2. Make sure the gasket surfaces of the cylinder head and the engine block are free of nicks and heavy scratches.
3. Clean the cylinder head bolts.
4. Inspect the cylinder head for warpage. Refer to "Cylinder Head and Valve Train Components" in this section.

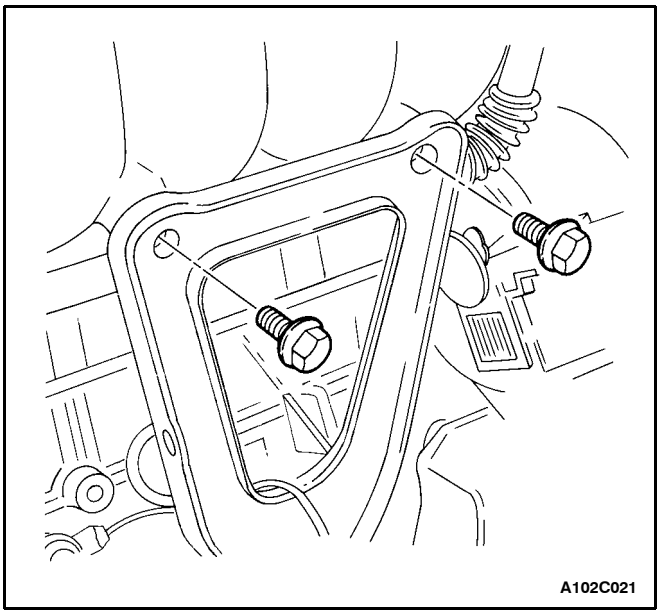
Installation Procedure

1. Install the cylinder head gasket.
2. Install the cylinder head with the intake manifold and the exhaust manifold attached.
3. Install the cylinder head bolts.
4. Tighten the cylinder head bolts gradually and in the sequence shown.

Tighten

Tighten the cylinder head bolts to 25 NSm (18 lb-ft). Adjust the bolts to 60 degrees + 60 degrees + 60 degrees + 10 degrees using the angular torque gauge KM-470-B.



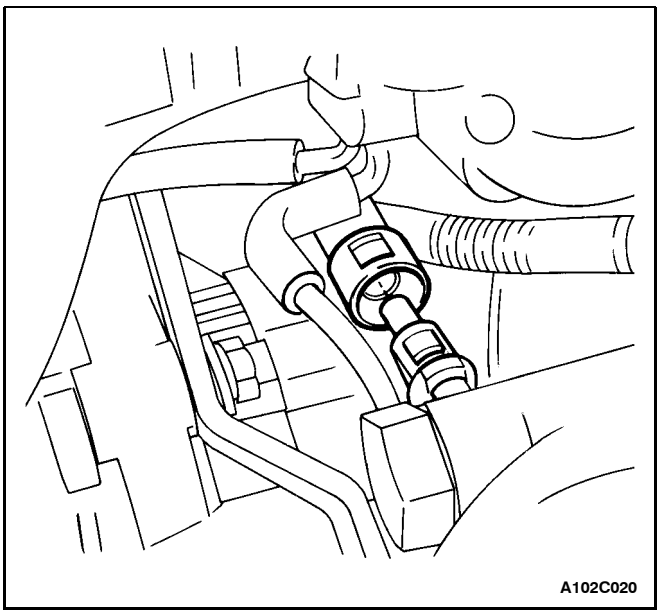

A102C021

5. Connect the throttle cable at the throttle body and the intake manifold.
6. Install the intake manifold support bracket upper bolts to the intake manifold.

Tighten

Tighten the intake manifold support bracket upper bolts to the intake manifold to 25 NSm (18 lb-ft).

7. Connect the surge tank coolant hose at the throttle body.
8. Connect the heater inlet hose to the cylinder head.

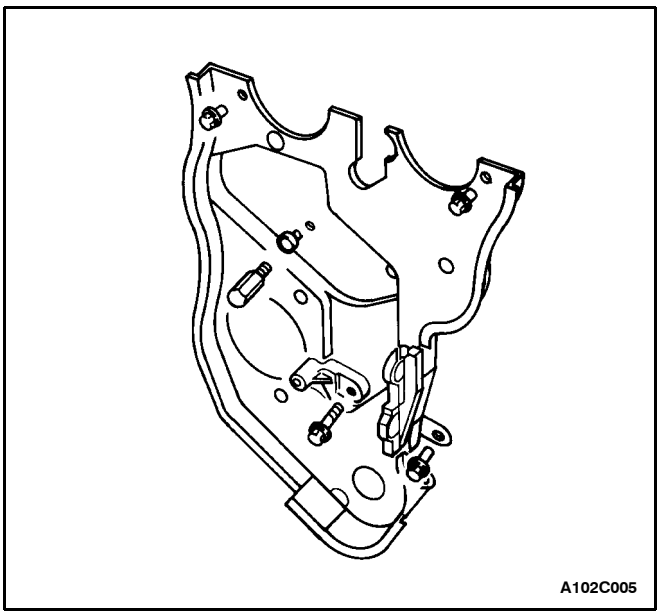

A102C020

9. Install the alternator adjusting bracket with the bolt.

Tighten

Tighten the alternator adjusting bracket retaining bolt to 20 NSm (15 lb-ft).

10. Connect the fuel feed line at the fuel rail.
11. Connect the fuel return line at the fuel rail.
12. Connect all of the necessary vacuum hoses.


A102C005

13. Install the exhaust flex pipe retaining nuts at the exhaust manifold flange and the bolts at the bracket.

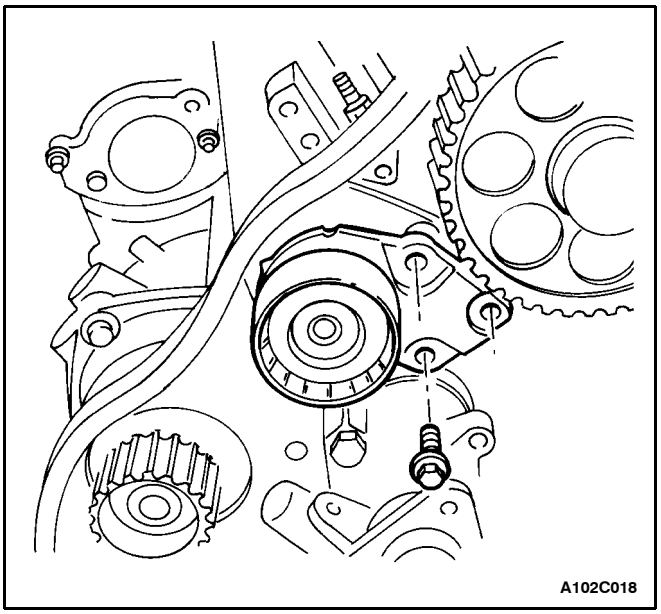
Tighten

Tighten the exhaust flex pipe retaining nuts and bracket bolts to 40 NSm (30 lb-ft).

14. Install the rear timing belt cover.
15. Install the rear timing belt cover bolts.

Tighten

Tighten the rear timing belt cover bolts to 10 NSm (89 lb-in).


A102C018

16. Install the timing belt automatic tensioner.
17. Install the timing belt automatic tensioner bolts.

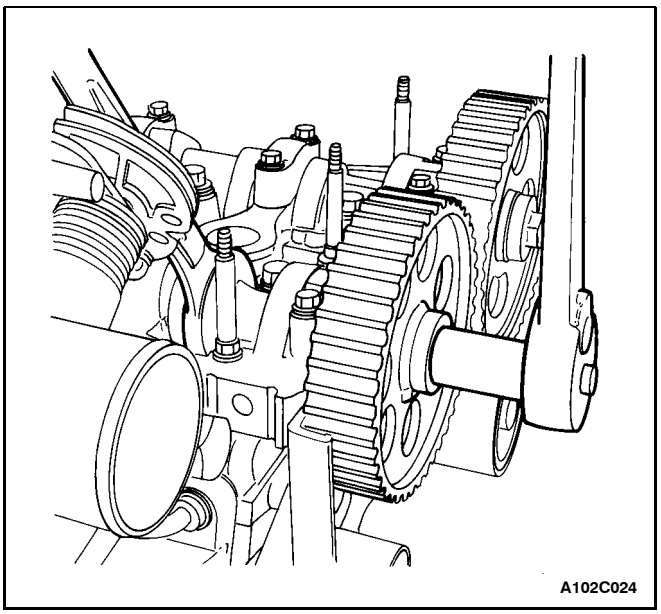
Tighten

Tighten the timing belt automatic tensioner bolts to 25 NSm (18 lb-ft).

18. Install the timing belt idler pulley.
19. Install the timing belt idler pulley bolt.

Tighten

Tighten the timing belt idler pulley bolt to 40 NSm (30 lb-ft).

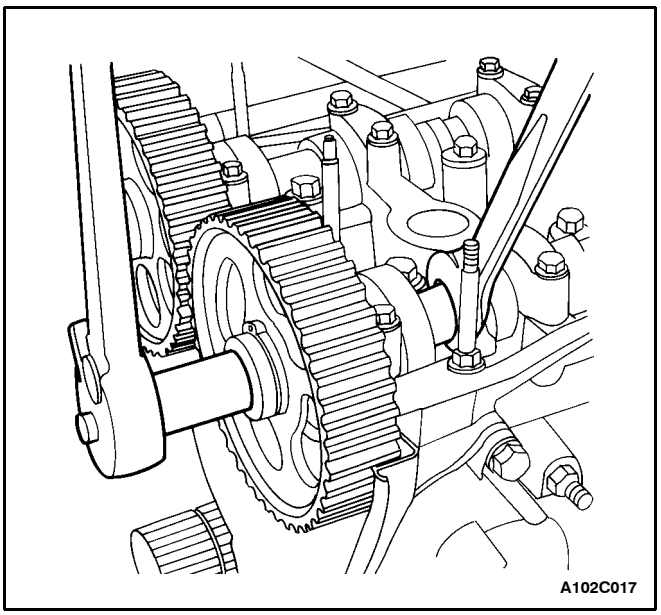

A102C024

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

20. Install the intake camshaft gear.
21. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten

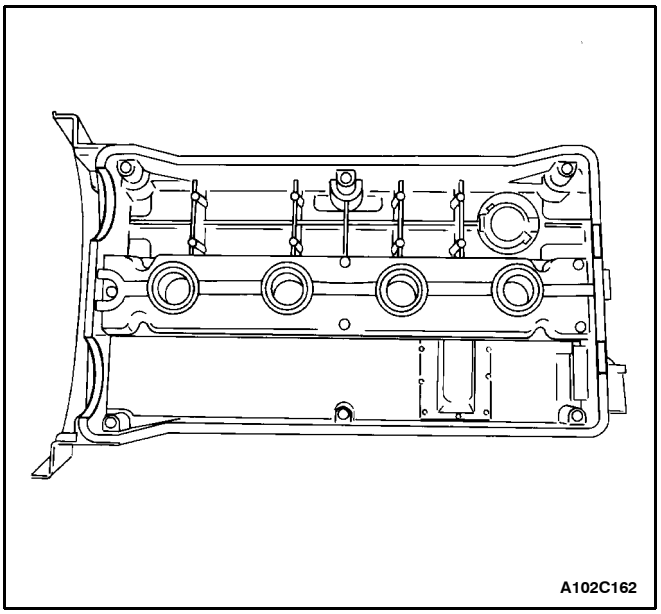
Tighten the intake camshaft gear bolt to 67.5 NSm (49 lb-ft).


A102C017

22. Install the exhaust camshaft gear.
23. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

Tighten the exhaust camshaft gear bolt to 67.5 NSm (49 lb-ft).

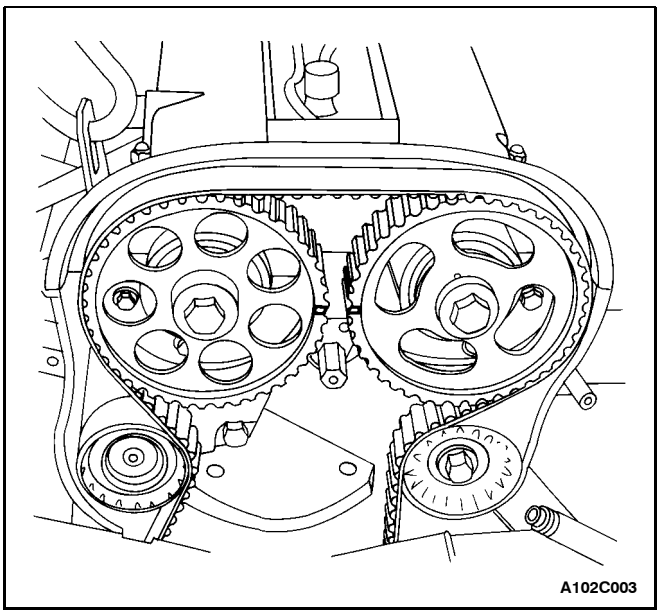


A102C162

24. Apply a small amount of gasket sealant to the corners of the front camshaft caps, and the top of the rear valve cover to cylinder head seal.
25. Install the valve cover and the valve cover gasket.
26. Install the valve cover washers.
27. Install the valve cover nuts.

Tighten

Tighten the valve cover nuts to 10 NSm (89 lb-in).



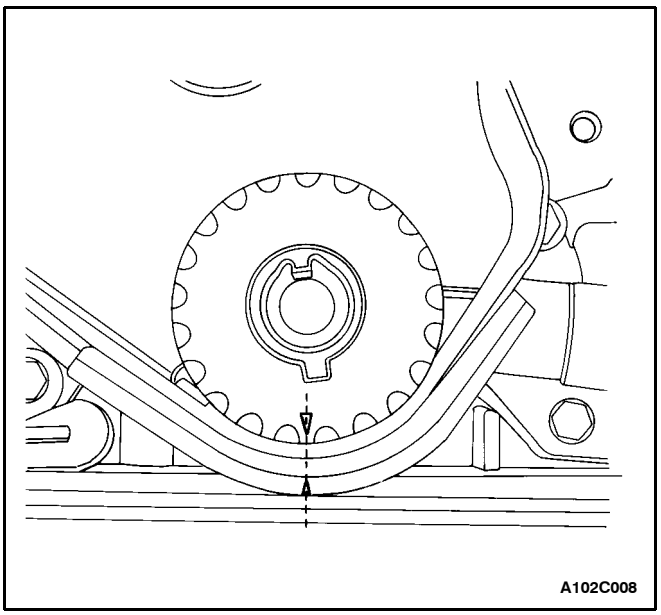
A102C003

28. Connect the ignition wires to the spark plugs.
29. Install the spark plug cover.
30. Install the spark plug cover bolts.

Tighten

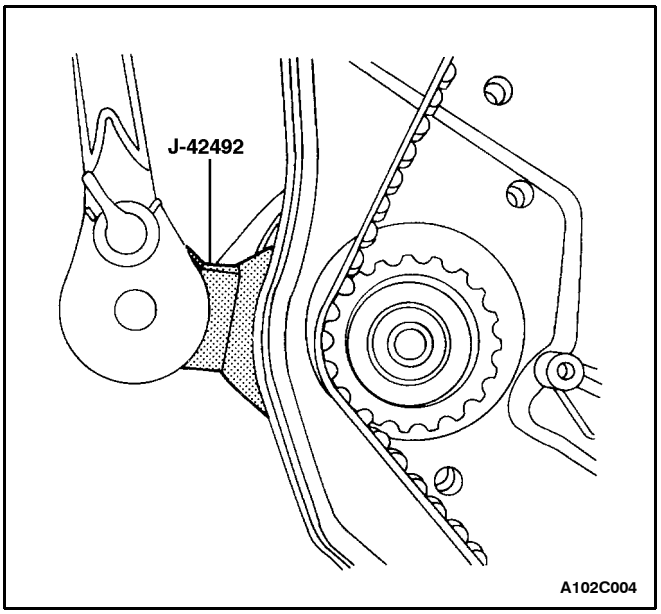
Tighten the spark plug cover bolts to 3 NSm (27 lb-in).

31. Connect the crankcase ventilation tube to the valve cover.
32. Align the timing marks on the camshaft gears.



A102C008

33. Align the mark on the crankshaft gear to the notch at the bottom of the rear timing belt cover.

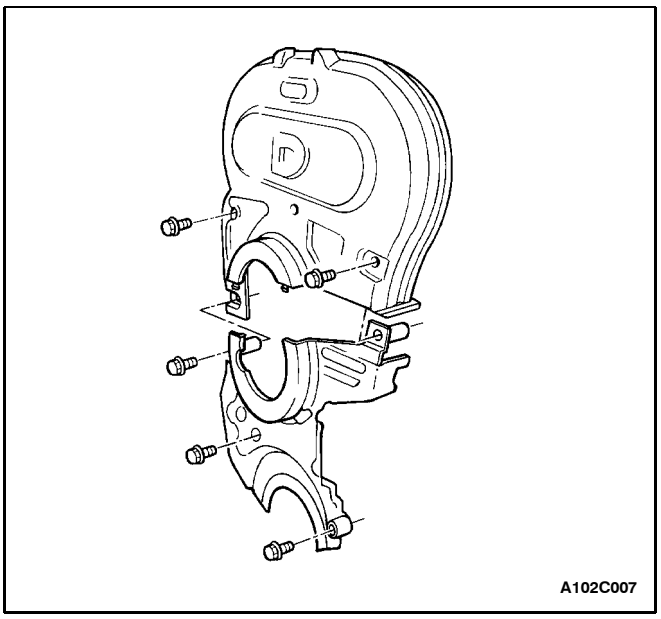


34. Install the timing belt.
35. Rotate the coolant pump clockwise using the timing belt adjuster J-42492 to apply tension to the timing belt.

Tighten

Tighten the coolant pump retaining bolts to 10 NSm (89 lb-in).

36. Check and adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.



37. Install the power steering pump, if equipped. Refer to Section 6B, Power Steering Pump.
38. Install the engine-mount-bracket-to-engine-mount retaining bolts if the power steering pump was installed.

Tighten

Tighten the engine-mount-bracket-to-engine-mount retaining bolts to 60 NSm (44 lb-ft).

39. Install the upper and lower front timing belt cover.
40. Install the upper and lower front timing belt cover bolts.

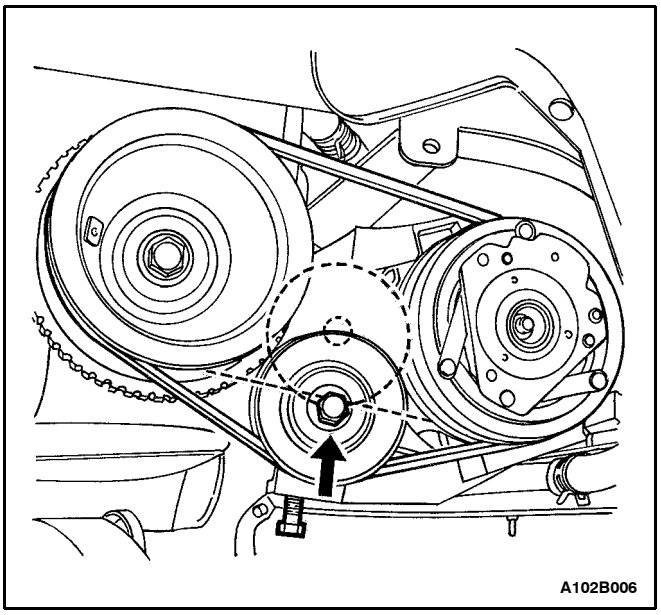
Tighten

Tighten the upper and lower front timing belt cover bolts to 10 NSm (89 lb-in).

41. Install the crankshaft pulley.
42. Install the crankshaft pulley bolt.

Tighten

Tighten the crankshaft pulley bolt to 95 NSm (70 lb-ft) using a torque wrench. Using the angular torque gauge KM-470-B, tighten the crankshaft pulley bolt to 30 degrees + 15 degrees.


A102B006

43. Install the power steering pump pulley, if equipped.
44. Install the power steering pump pulley bolts, if equipped.

Tighten

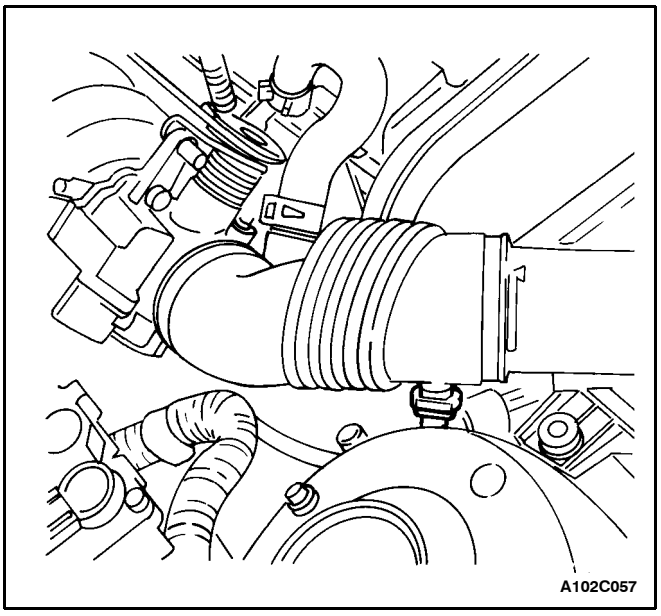
Tighten the power steering pump pulley bolts to 25 NSm (18 lb-ft).

45. Install the alternator drive belt.
46. Install the alternator adjusting bolt.

Tighten

Tighten the alternator adjusting bolt to 20 NSm (15 lb-ft).

47. Install the A/C compressor drive belt, if equipped.
48. Connect the upper radiator hose to the thermostat housing.
49. Install the right front splash shield.
50. Install the right front wheel. Refer to Section 2E, Tires and Wheels.

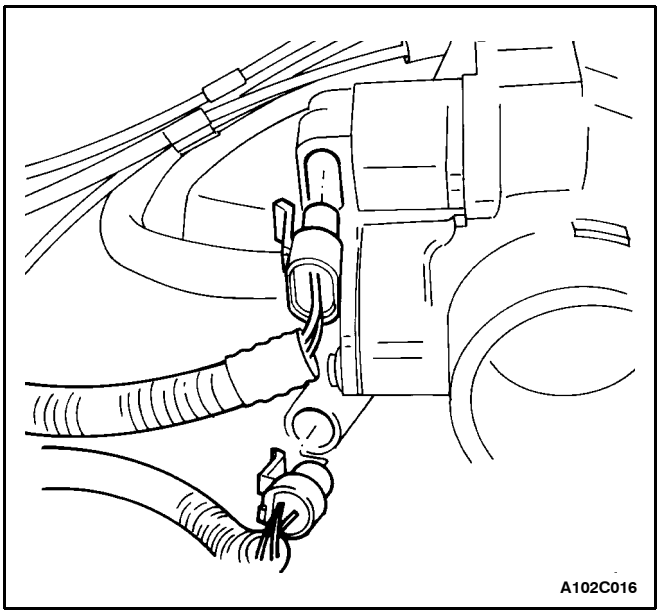

A102C057

51. Install the air filter housing.
52. Install the air filter housing bolts.

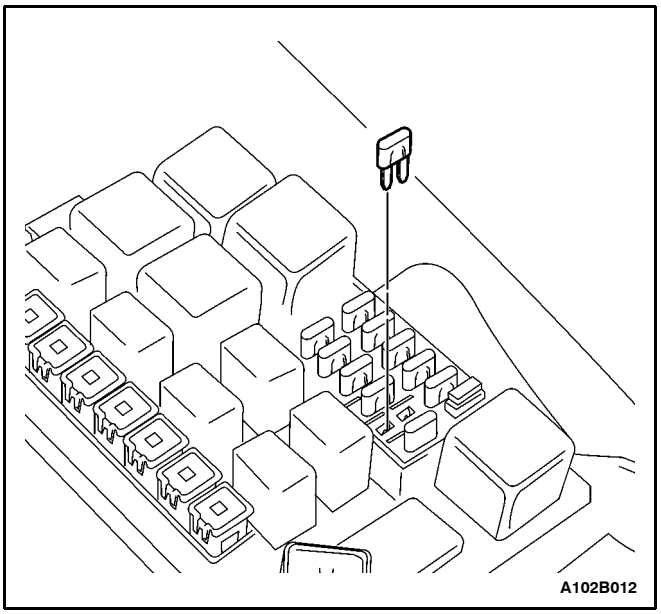
Tighten

Tighten the air filter housing bolts to 12 NSm (106 lb-in).

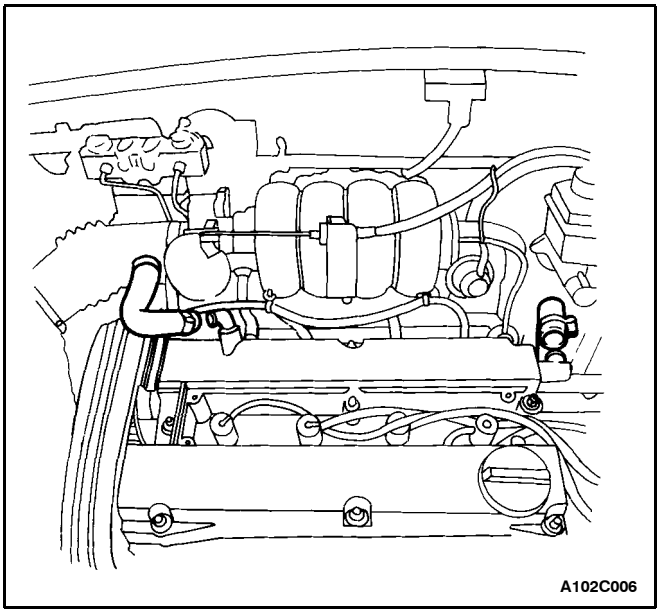
53. Connect the air intake tube to the throttle body.
54. Connect the breather tube to the valve cover.
55. Connect the manifold air temperature sensor connector.


A102C016

56. Connect the coolant temperature sensor connector.
57. Connect the engine coolant temperature sensor connector.
58. Connect the idle air control valve connector.
59. Connect the throttle position sensor connector.


A102B012

60. Connect the DIS ignition coil connector.
61. Connect the fuel injector harness connectors.
62. Connect the oxygen sensor connector.
63. Connect the ECM ground terminal at the intake manifold.
64. Install the fuel pump fuse.
65. Connect the negative battery ground cable.
66. Refill the engine cooling system. Refer to Section 1D, Engine Cooling.

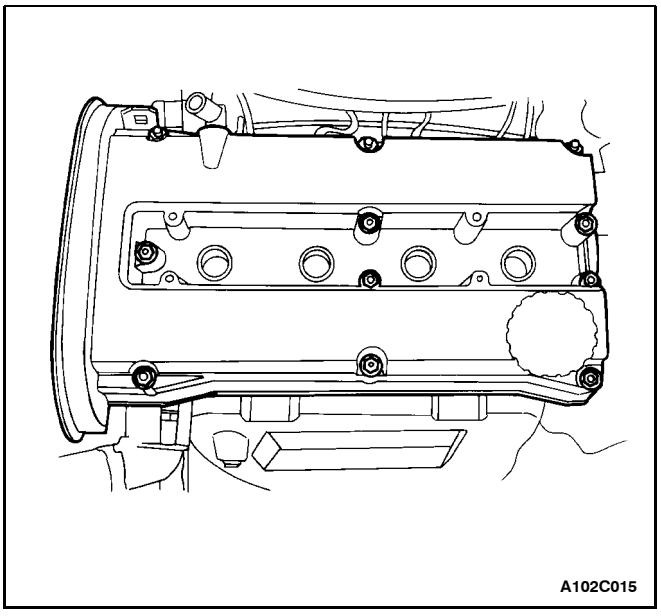

A102C006

CAMSHAFTS

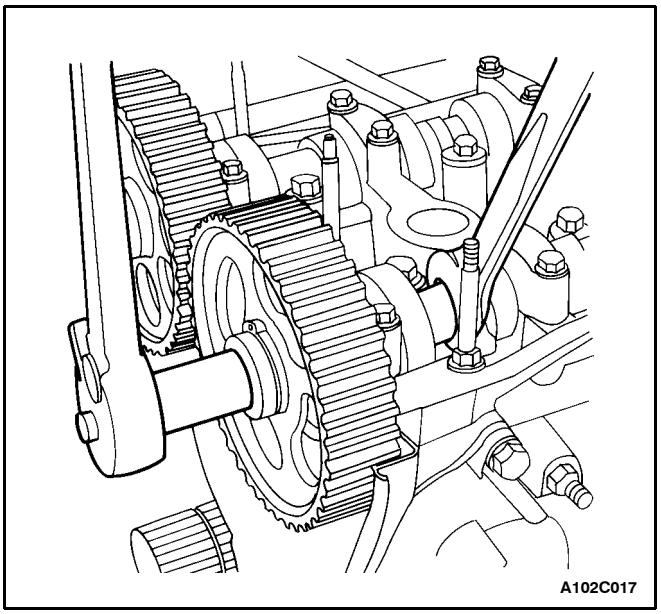
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Remove the timing belt. Refer to "Timing Belt" in this section.
2. Disconnect the air breather tube at the valve cover.
3. Disconnect the crankcase ventilation tube at the valve cover.
4. Remove the spark plug cover bolts.
5. Remove the spark plug cover.

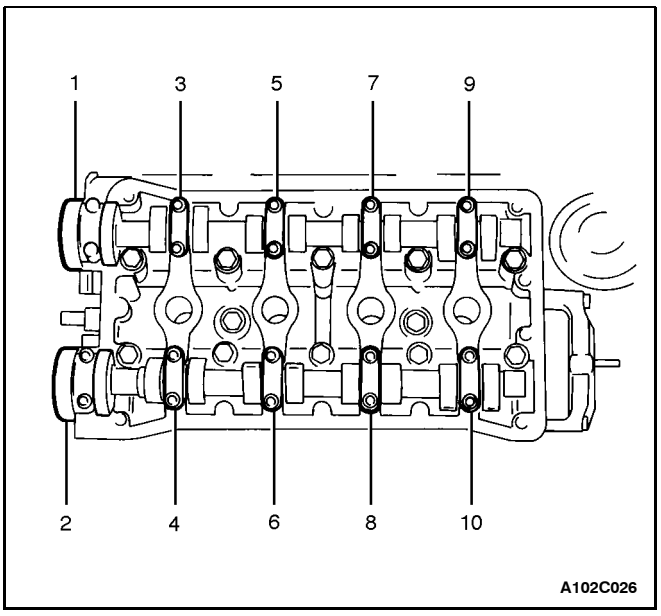

A102C015

6. Disconnect the ignition wires from the spark plugs.
7. Remove the valve cover nuts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.


A102C017

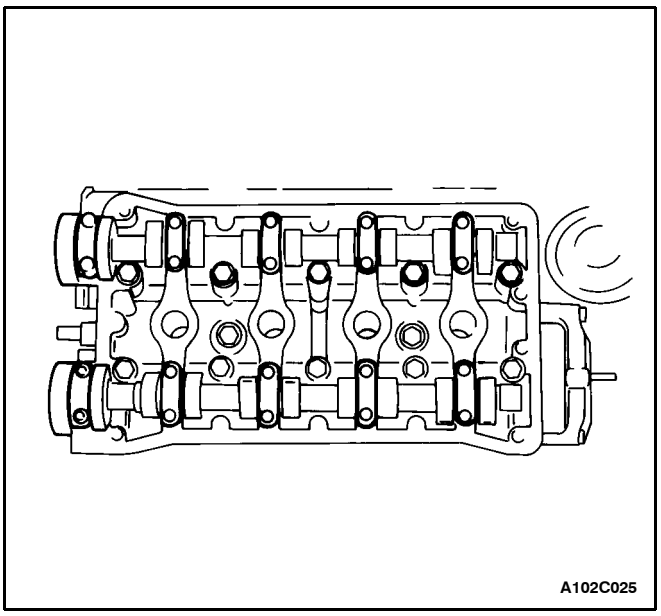
Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

10. **While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.**
11. **Remove the intake camshaft gear.**
12. **While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.**
13. **Remove the exhaust camshaft gear.**

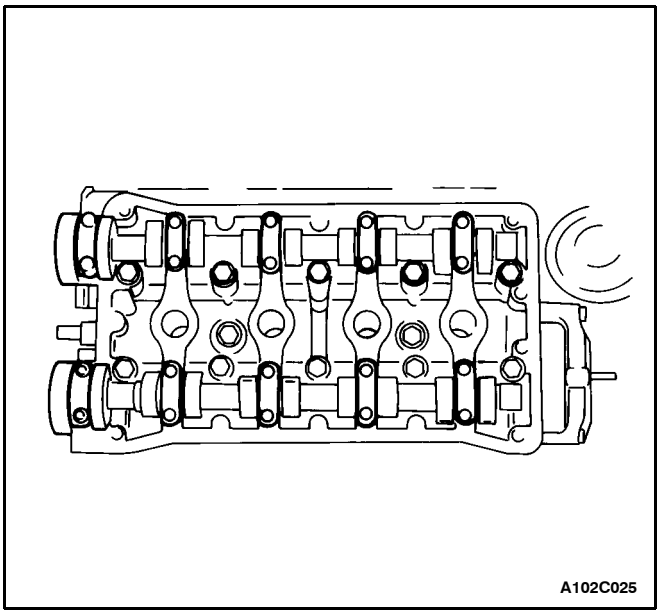


A102C026

14. **Remove the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.**


A102C025

15. **Remove the intake camshaft caps. Maintain the correct positions for installation.**
16. **Remove the intake camshaft.**
17. **Remove the exhaust camshaft caps. Maintain the correct positions for installation.**
18. **Remove the exhaust camshaft.**

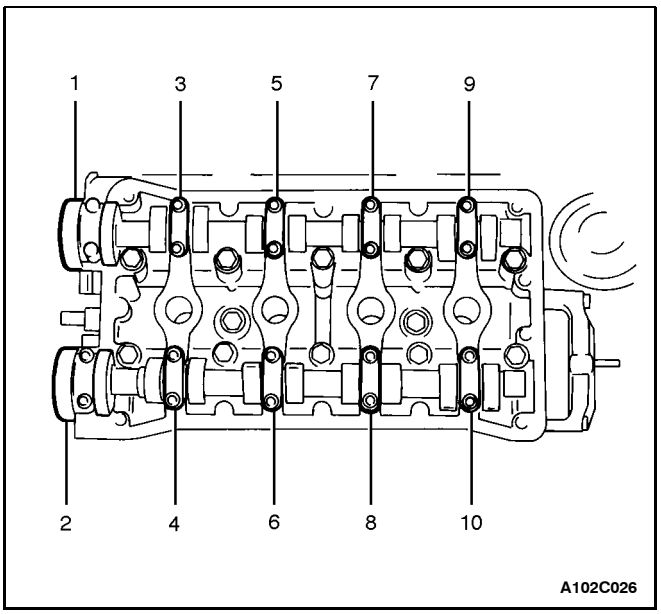


A102C025

Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Lubricate the camshaft journals and the camshaft caps with engine oil.
2. Install the intake camshaft.
3. Install the intake camshaft caps in their original positions.
4. Install the intake camshaft cap bolts.
5. Install the exhaust camshaft.
6. Install the exhaust camshaft caps in their original positions.
7. Install the exhaust camshaft cap bolts.

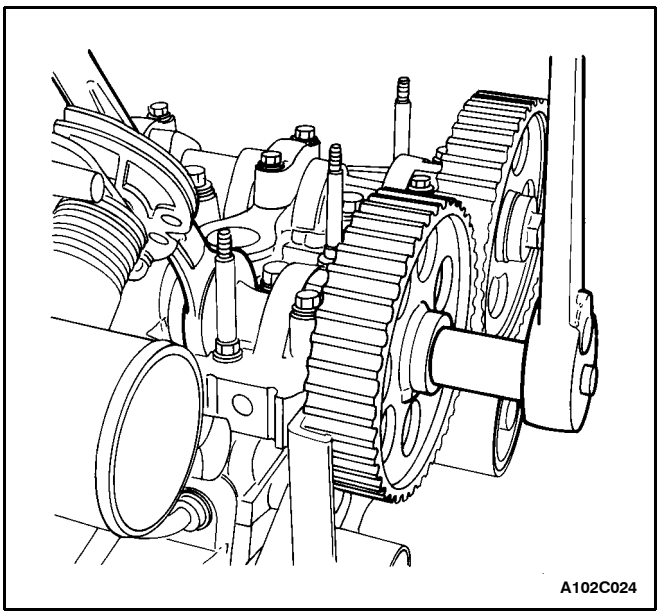


A102C026

8. Tighten the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten

Tighten the camshaft cap bolts to 16 NSm (12 lb-ft).

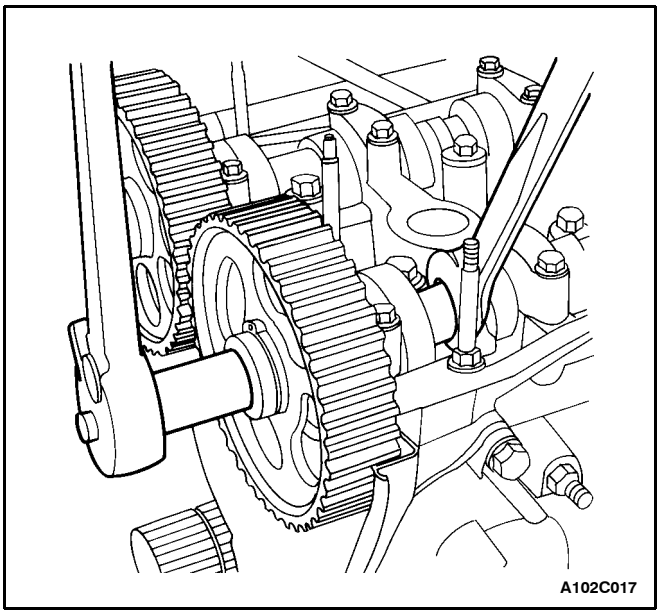


A102C024

9. Measure the intake camshaft end play and the exhaust camshaft end play. Refer to "Engine Specifications" in this section.
10. Install the intake camshaft gear.
11. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten

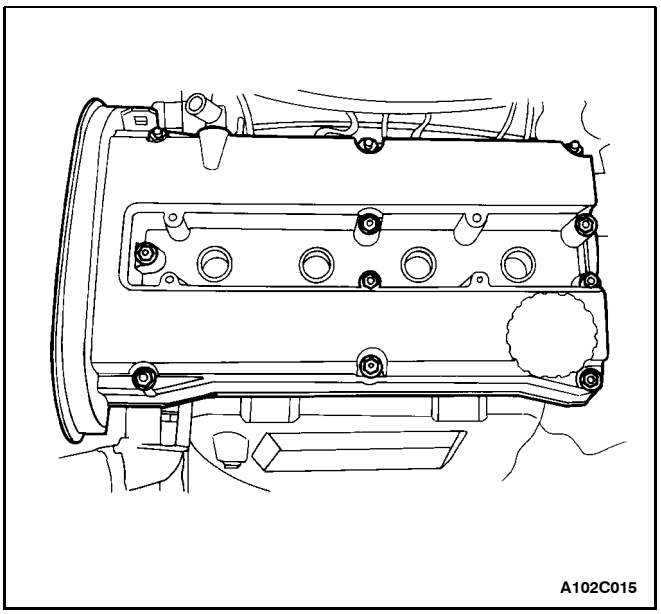
Tighten the intake camshaft gear bolt to 67.5 NSm (49 lb-ft).


A102C017

12. Install the exhaust camshaft gear.
13. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

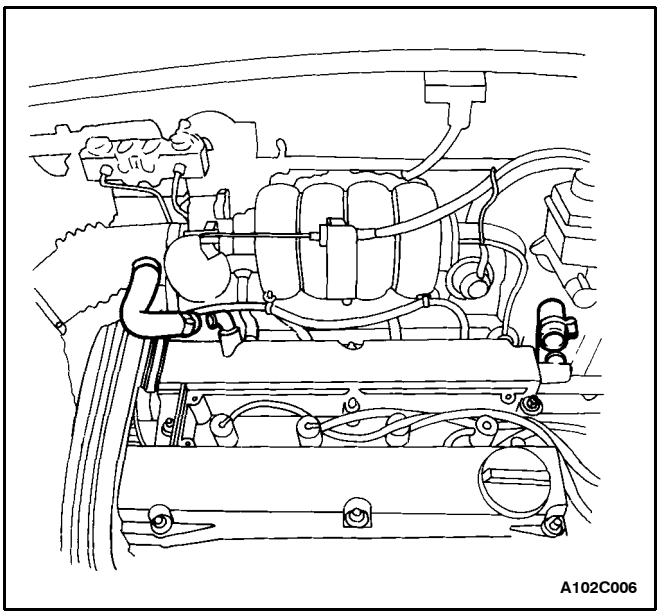
Tighten the exhaust camshaft gear bolt to 67.5 NSm (49 lb-ft).


A102C015

14. Install the valve cover and the valve cover gasket.
15. Install the valve cover washers.
16. Install the valve cover nuts.

Tighten

Tighten the valve cover nuts to 10 NSm (89 lb-in).

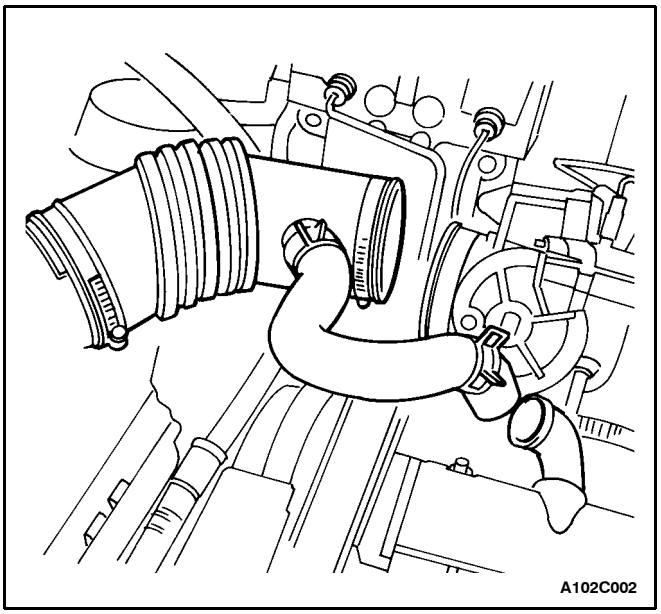

A102C006

17. Connect the ignition wires to the spark plugs.
18. Install the spark plug cover.
19. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 NSm (27 lb-in).

20. Connect the air breather tube to the valve cover.
21. Connect the crankcase ventilation tube to the valve cover.
22. Install the timing belt. Refer to “Timing Belt” in this section.


A102C002

TIMING BELT CHECK AND ADJUST

(Left-Hand Drive Shown, Right-Hand Drive Similar)

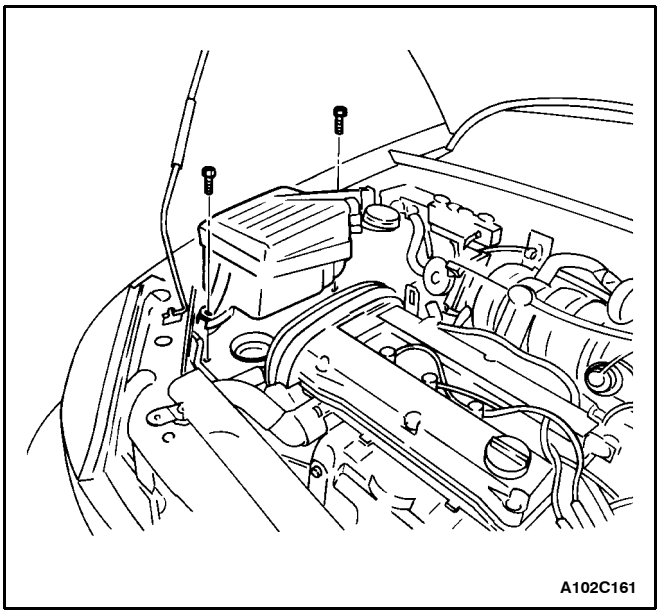
Tools Required

J-42492 Timing Belt Adjuster

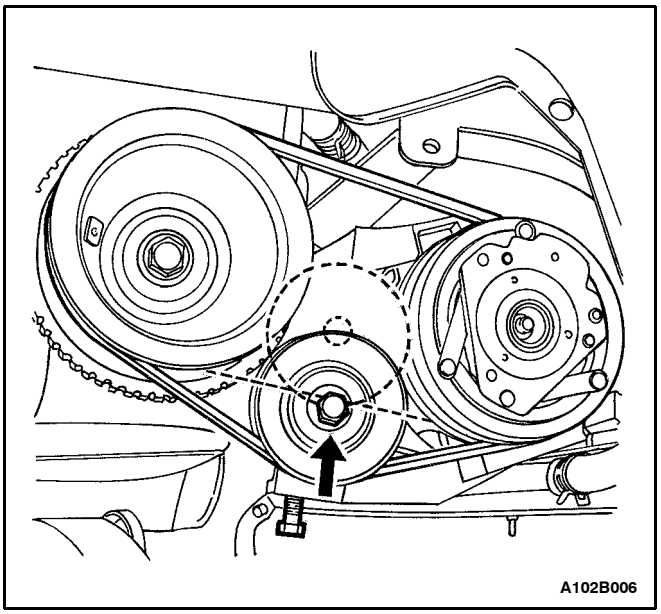
KM-470-B Angular Torque Gauge

Adjustment Procedure

1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Remove the air intake tube from the throttle body.
4. Remove the breather tube from the valve cover.


A102C161

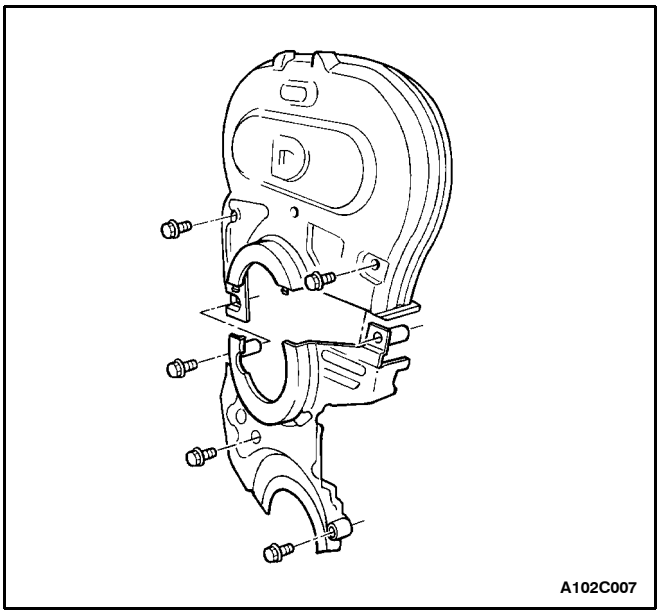
5. Remove the air filter housing bolts.
6. Remove the air filter housing.
7. Remove the right front wheel. Refer to Section 2E, Tires and Wheels.
8. Remove the right front splash shield.


A102B006

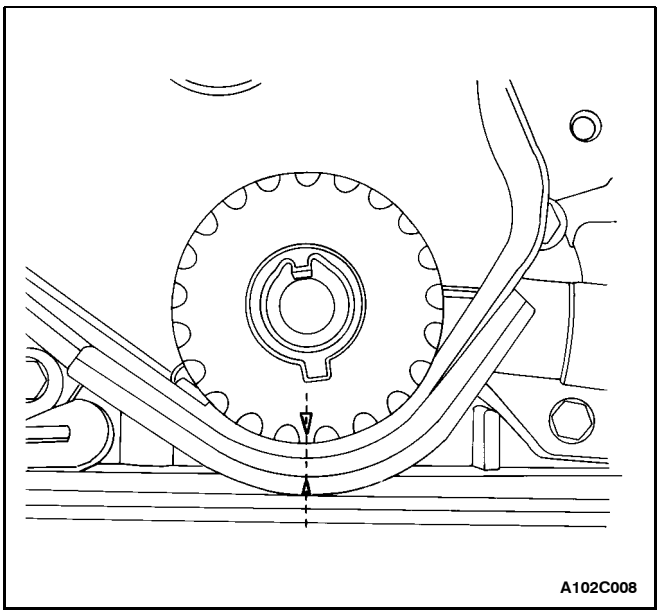
9. Remove the A/C compressor drive belt, if equipped.
10. Remove the alternator drive belt.
11. Remove the power steering pump pulley bolts, if equipped.

Important: Push the engine assembly toward the battery to remove the power steering pump pulley.

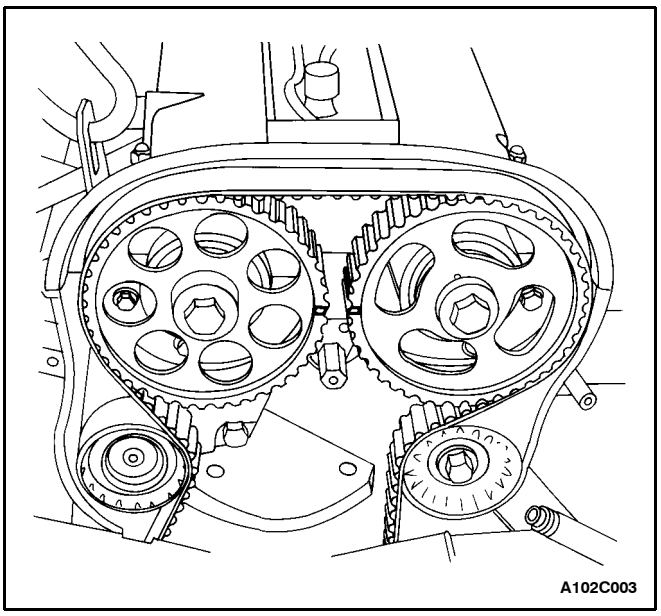
12. Remove the power steering pump pulley, if equipped.
13. Remove the crankshaft pulley bolt.
14. Remove the crankshaft pulley.


A102C007

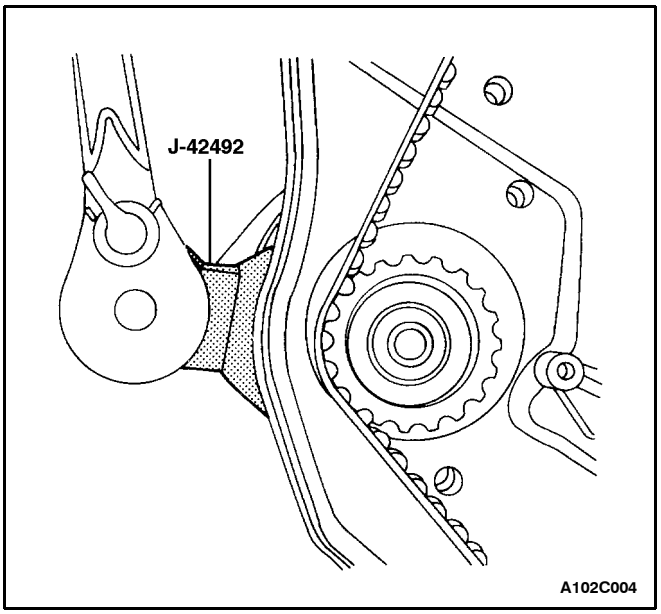
15. Remove the upper front timing belt cover bolts.
16. Remove the upper front timing belt cover.
17. Remove the lower front timing belt cover bolts.
18. Remove the lower front timing belt cover.
19. Remove the power steering pump mounting bolts, if equipped.
20. Install the crankshaft pulley bolt.


A102C008

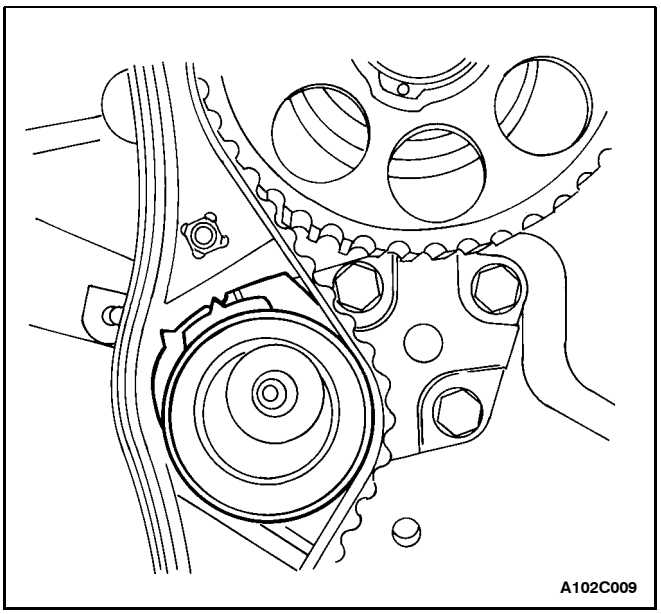
21. Rotate the crankshaft at least one full turn clockwise using the crankshaft pulley bolt.
22. Align the mark on the crankshaft gear to the notch at the bottom of the rear timing belt cover.


A102C003

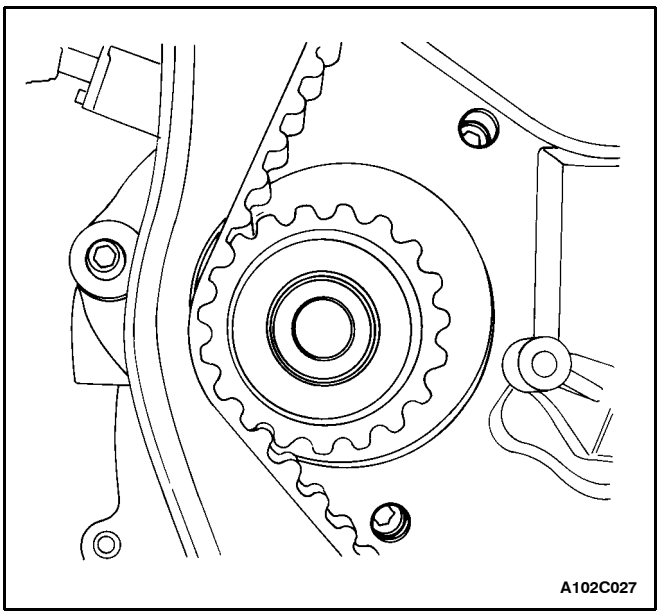
23. Align the camshaft gear timing marks.



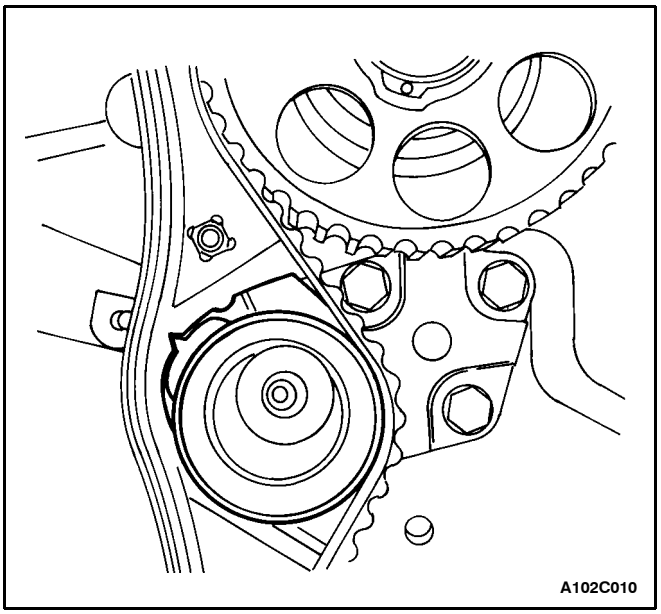
24. Slightly loosen the coolant pump retaining bolts.
25. Rotate the coolant pump clockwise using the timing belt adjuster J-42492.



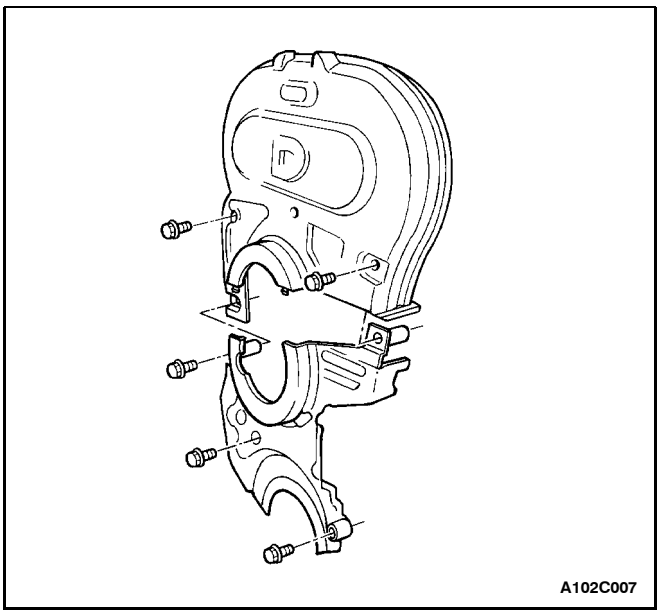
26. Rotate the coolant pump clockwise until the adjust arm pointer of the timing belt automatic tensioner is aligned to the notch in the timing belt automatic tensioner bracket.



27. Tighten the coolant pump retaining bolts.
28. Rotate the crankshaft two full turns clockwise using the crankshaft pulley.
29. Loosen the coolant pump retaining bolts.


A102C010

30. Using the timing belt adjuster J-42492, rotate the coolant pump until the adjust arm pointer of the timing belt automatic tensioner is aligned with the pointer on the timing belt automatic tensioner bracket.


A102C007

31. Tighten the coolant pump retaining bolts.

    Tighten

    Tighten the coolant pump retaining bolts to 10 NSm (89 lb-in).

32. Remove the crankshaft pulley bolt.
33. Install the power steering pump mounting bolts, if equipped.

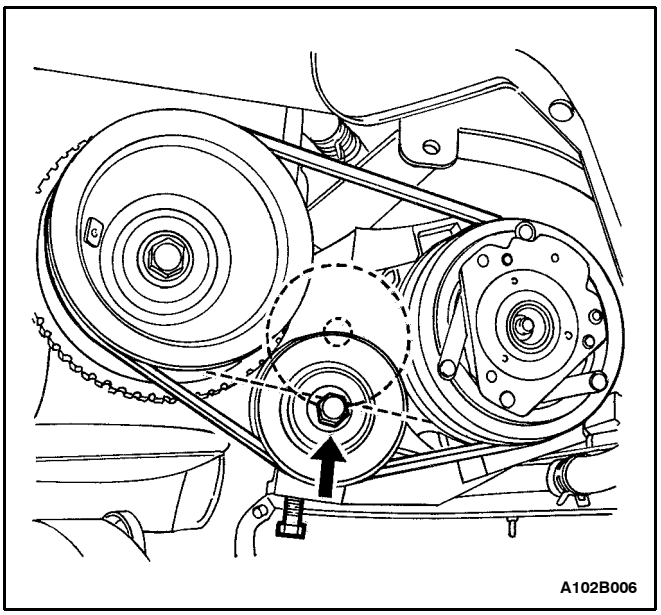
    Tighten

    Tighten the power steering pump mounting bolts to 25 NSm (18 lb-ft).

34. Install the upper and lower front timing belt cover.
35. Install the upper and lower front timing belt cover bolts.

    Tighten

    Tighten the upper and lower front timing belt cover bolts to 10 NSm (89 lb-in).


A102B006

36. Install the crankshaft pulley.
37. Install the crankshaft pulley bolt.

    Tighten

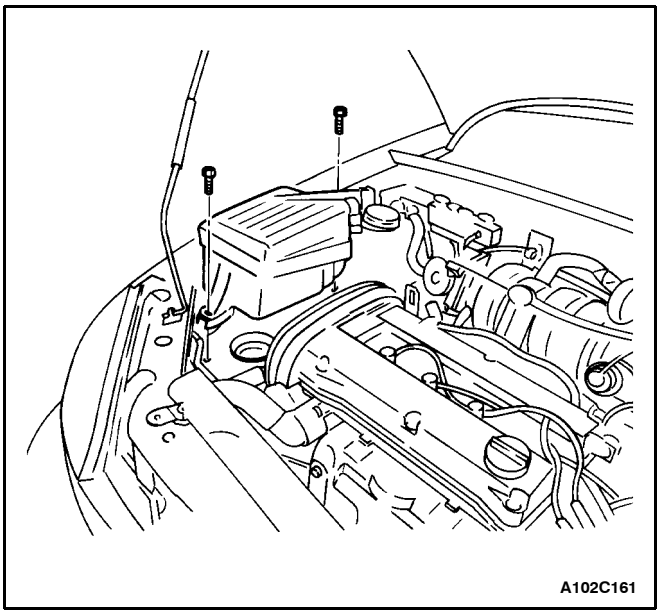
    Tighten the crankshaft pulley bolt to 95 NSm (70 lb-ft) using a torque wrench. Using the angular torque gauge KM-470-B, tighten the crankshaft pulley bolt to 30 degrees + 15 degrees.

38. Install the power steering pump pulley, if equipped.
39. Install the power steering pump pulley bolts, if equipped.

    Tighten

    Tighten the power steering pump pulley bolts to 25 NSm (18 lb-ft).

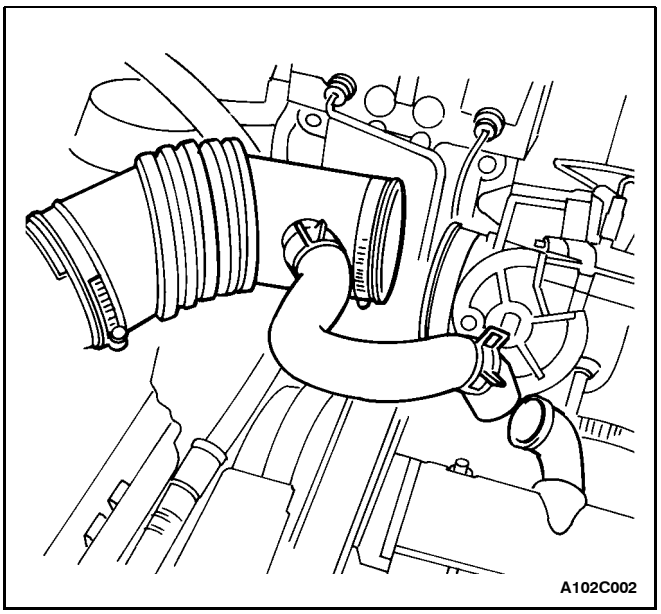
40. Install the alternator drive belt.
41. Install the A/C compressor drive belt, if equipped.


A102C161

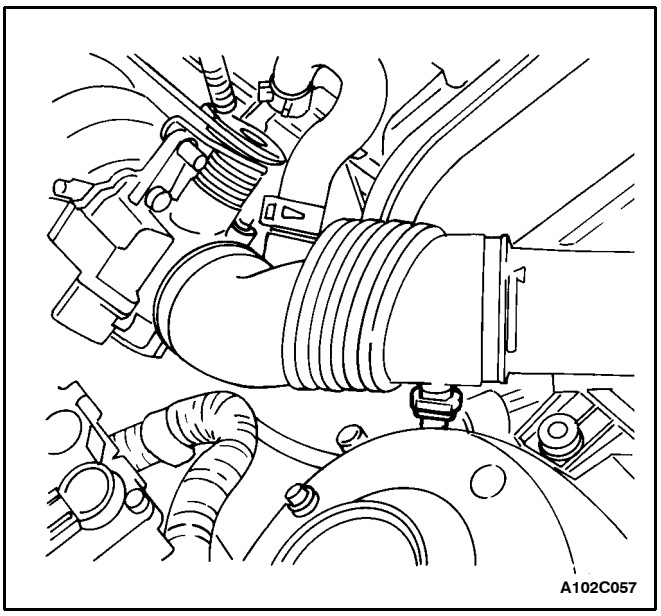
42. Install the right front splash shield.
43. Install the right front wheel. Refer to Section 2E, Tires and Wheels.
44. Install the air filter housing.
45. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 12 NSm (106 lb-in).


A102C002

46. Connect the air intake tube to the throttle body.
47. Connect the breather tube to the valve cover.
48. Connect the manifold air temperature sensor connector.
49. Connect the negative battery cable.


A102C057

TIMING BELT

(Left-Hand Drive Shown, Right-Hand Drive Similar)

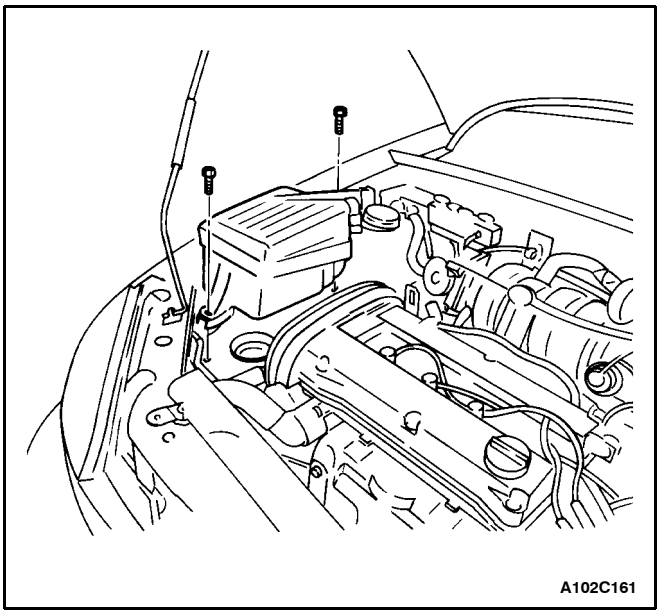
Tools Required

J-42492 Timing Belt Adjuster

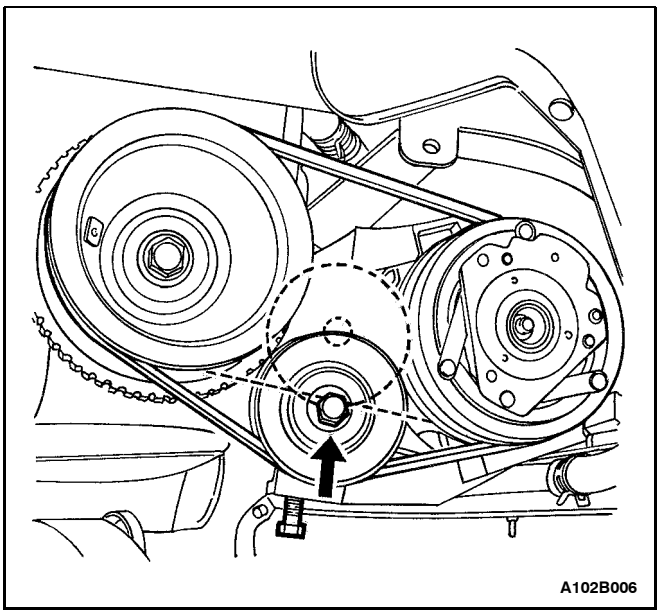
KM-470-B Angular Torque Gauge

Removal Procedure

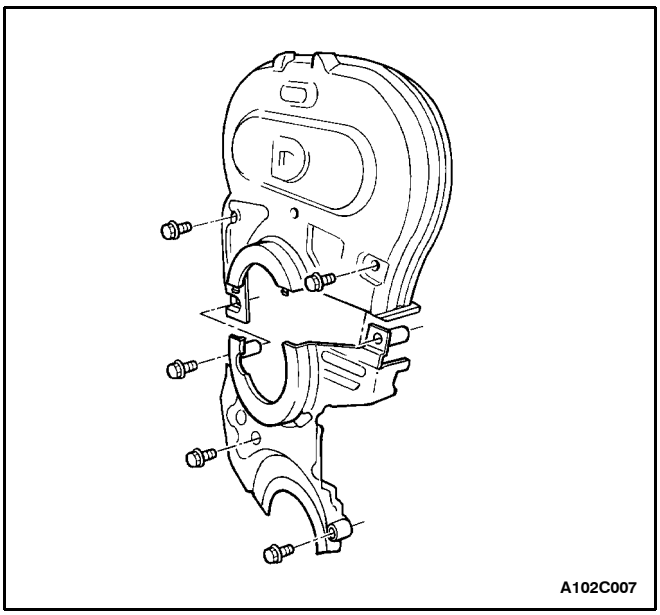
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Disconnect the air intake tube from the throttle body.
4. Disconnect the breather tube from the valve cover.


A102C161

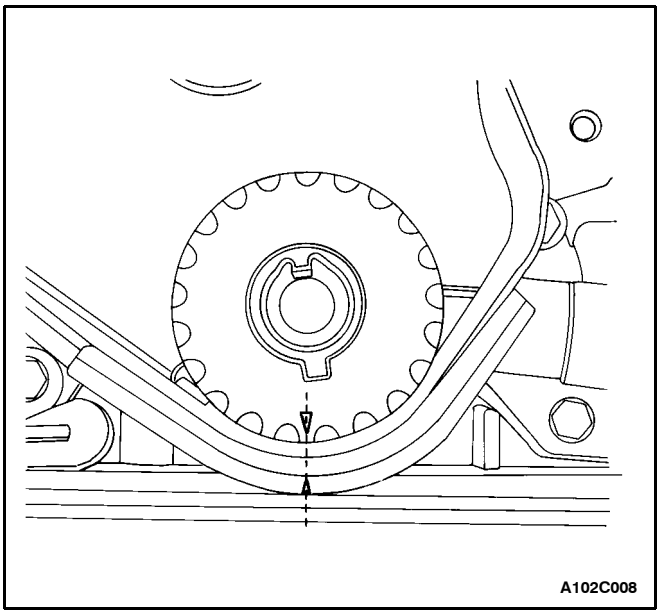
5. Remove the air filter housing bolts.
6. Remove the air filter housing.
7. Remove the right front wheel. Refer to Section 2E, Tires and Wheels.
8. Remove the right front splash shield.


A102B006

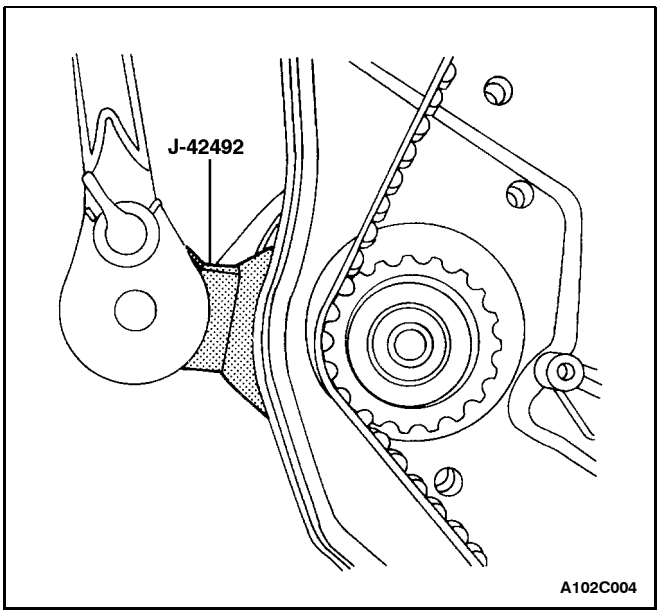
9. Remove the A/C compressor drive belt, if equipped.
10. Remove the alternator drive belt.
11. Remove the power steering pump pulley bolts, if equipped.
12. Remove the power steering pump pulley, if equipped.
13. Remove the crankshaft pulley bolt.
14. Remove the crankshaft pulley.


A102C007

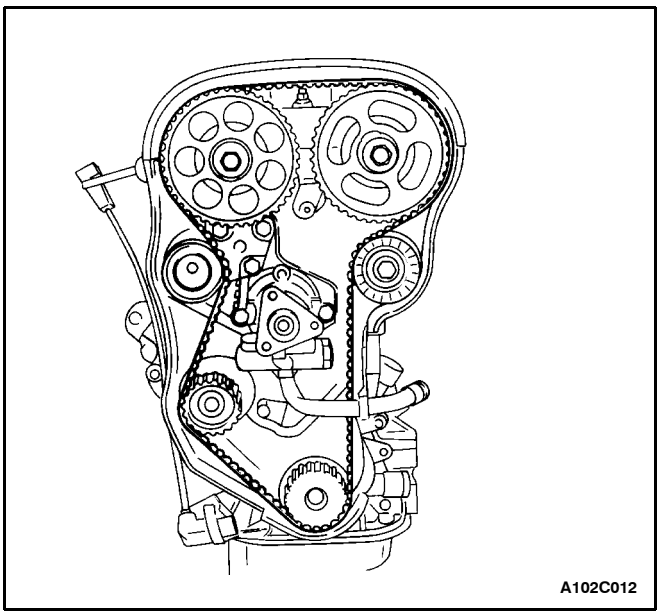
15. Remove the upper front timing belt cover bolts.
16. Remove the upper front timing belt cover.
17. Remove the lower front timing belt cover bolts.
18. Remove the lower front timing belt cover.
19. Remove the power steering pump mounting bolts, if equipped.
20. Install the crankshaft pulley bolt.



21. Using the crankshaft pulley bolt, rotate the crankshaft clockwise until the timing mark on the crankshaft gear is aligned with the notch at the bottom of the rear timing belt cover.

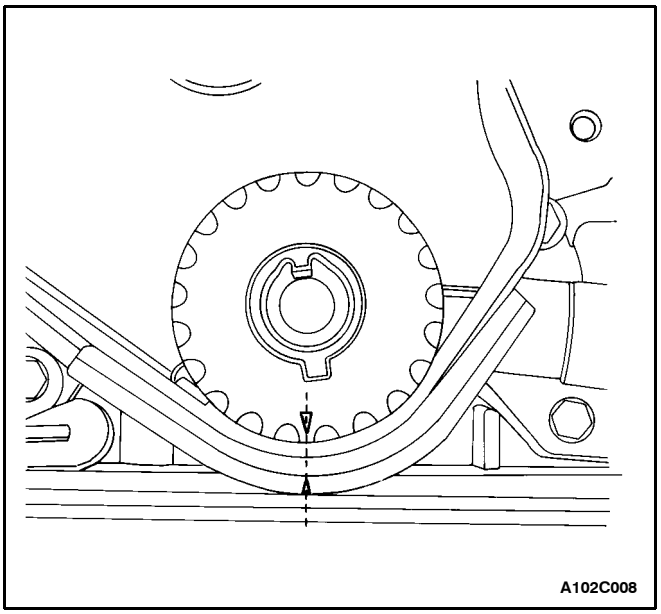


22. Slightly loosen the coolant pump retaining bolts.
23. Using the timing belt adjuster J-42492, rotate the coolant pump counterclockwise to release the tension on the timing belt.



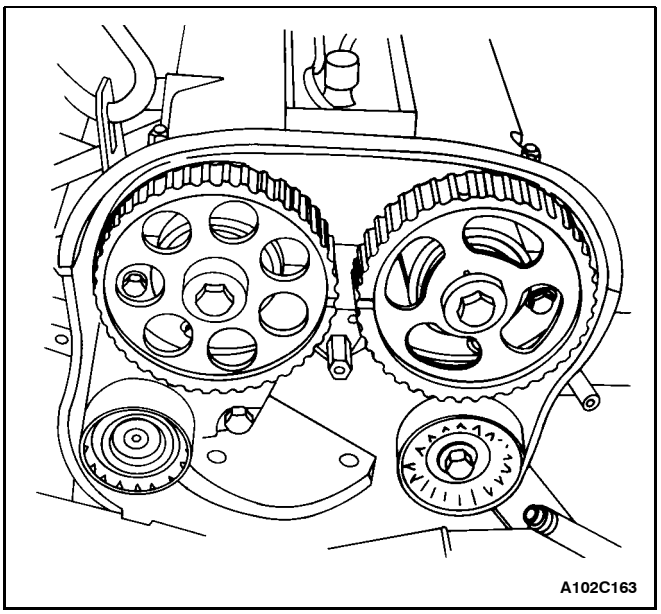
Important: Remove the timing belt behind the power steering pump.

24. Remove the timing belt.

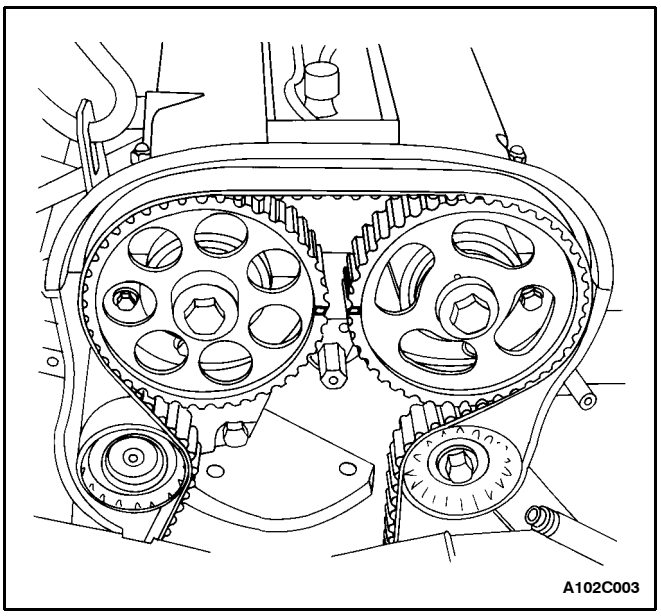


Installation Procedure

1. **Align the timing mark on the crankshaft gear to the notch on the bottom of the rear timing belt cover.**

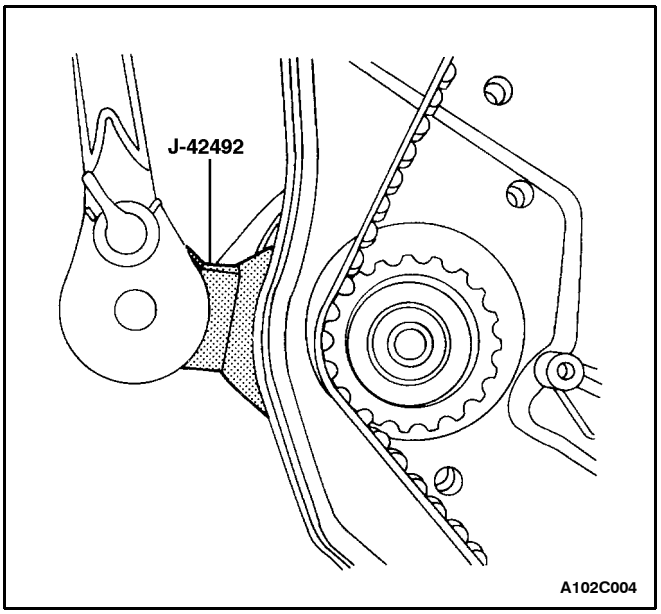


2. **Align the timing marks on the camshaft gears.**

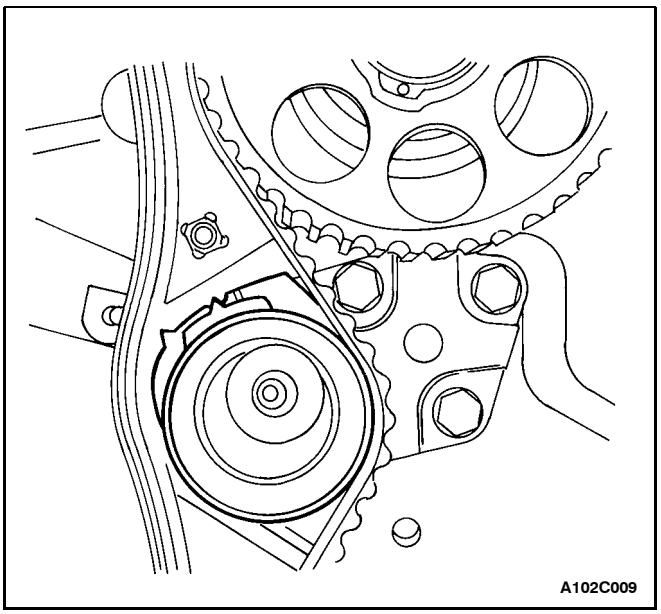


Important: Insert the timing belt behind the power steering pump.

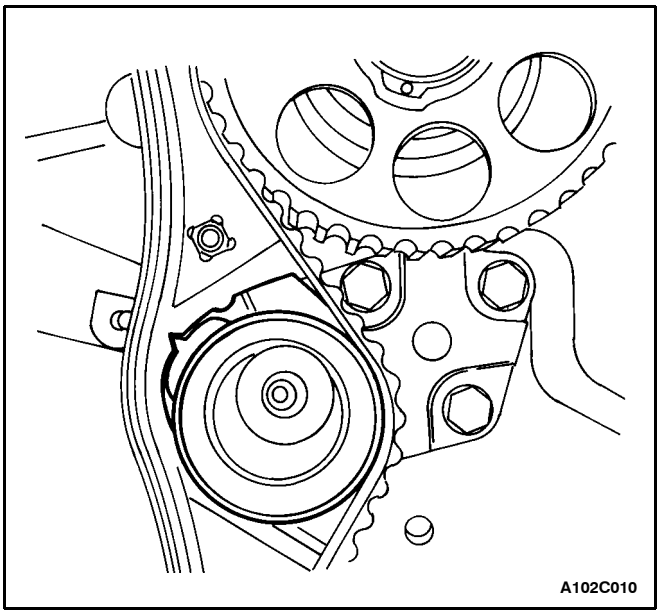
3. **Install the timing belt.**



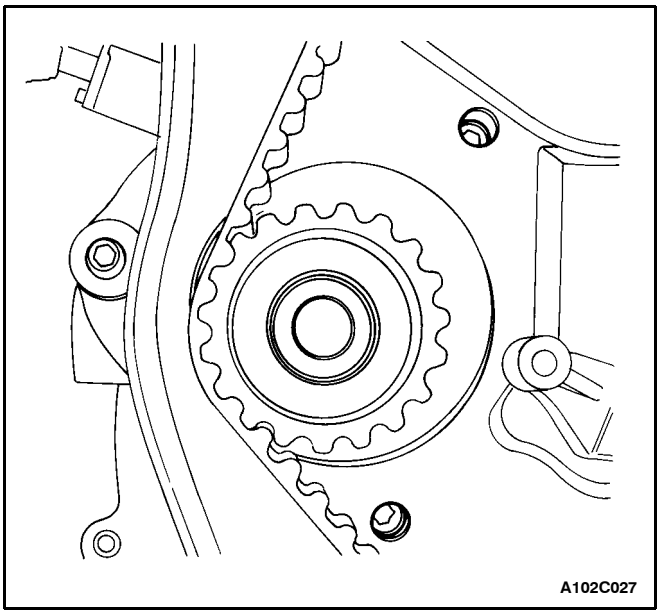
4. Rotate the coolant pump clockwise using the timing belt adjuster J-42492.



5. Rotate the coolant pump clockwise until the adjust arm pointer of the timing belt automatic tensioner is aligned to the notch in the timing belt automatic tensioner bracket.



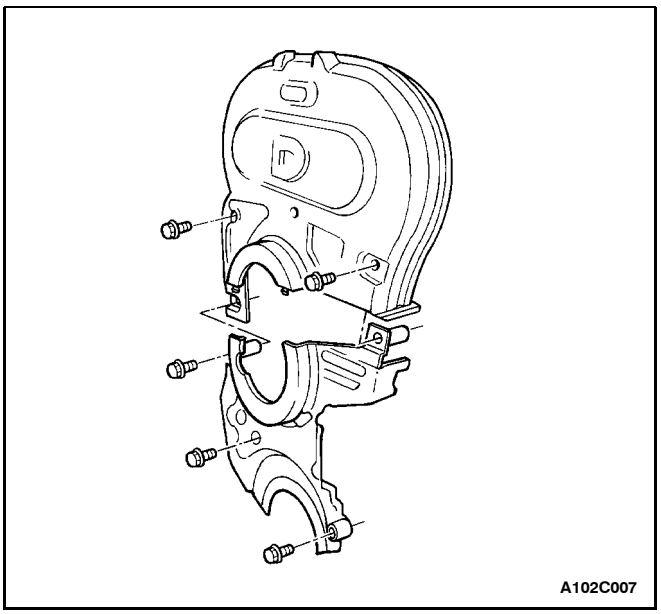
6. Tighten the coolant pump retaining bolts.
7. Rotate the crankshaft two full turns clockwise using the crankshaft pulley bolt.
8. Loosen the coolant pump retaining bolts.
9. Rotate the coolant pump until the adjust arm pointer of the timing belt automatic tensioner is aligned with the pointer on the timing belt automatic tensioner bracket.


A102C027

10. Tighten the coolant pump retaining bolts.

Tighten

Tighten the coolant pump retaining bolts to 10 NSm (89 lb-in).


A102C007

11. Remove the crankshaft pulley bolt.
12. Install the power steering pump mounting bolts, if equipped.

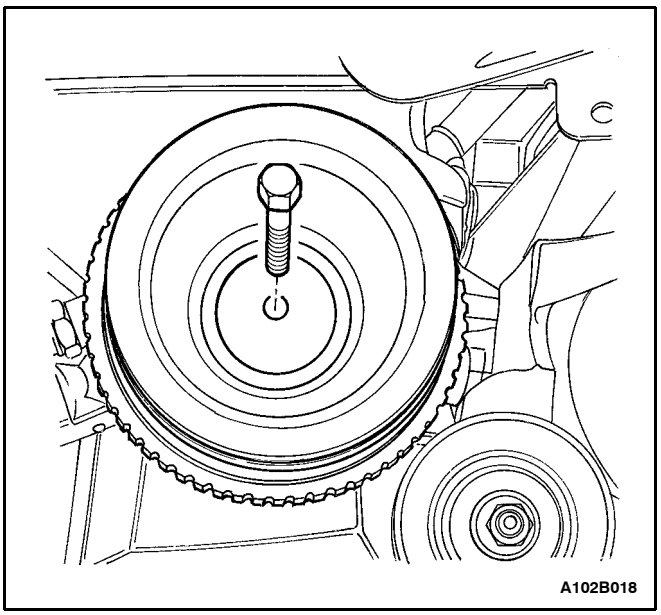
Tighten

Tighten the power steering mounting bolts to 25 NSm (18 lb-ft).

13. Install the upper and lower front timing belt cover.
14. Install the upper and lower front timing belt cover bolts.

Tighten

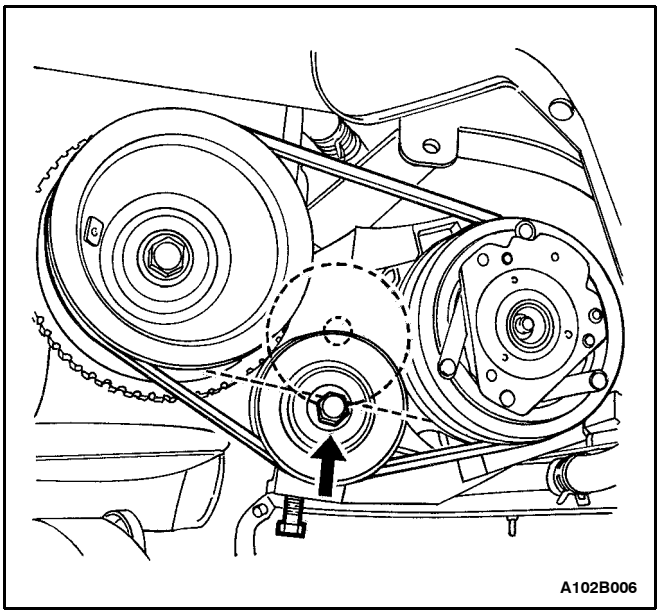
Tighten the upper and lower front timing belt cover bolts to 10 NSm (89 lb-in).


A102B018

15. Install the crankshaft pulley.
16. Install the crankshaft pulley bolt.

Tighten

Tighten the crankshaft pulley bolt to 95 NSm (70 lb-ft) using a torque wrench. Using the angular torque gauge KM-470-B, tighten the crankshaft pulley bolt to 30 degrees + 15 degrees.

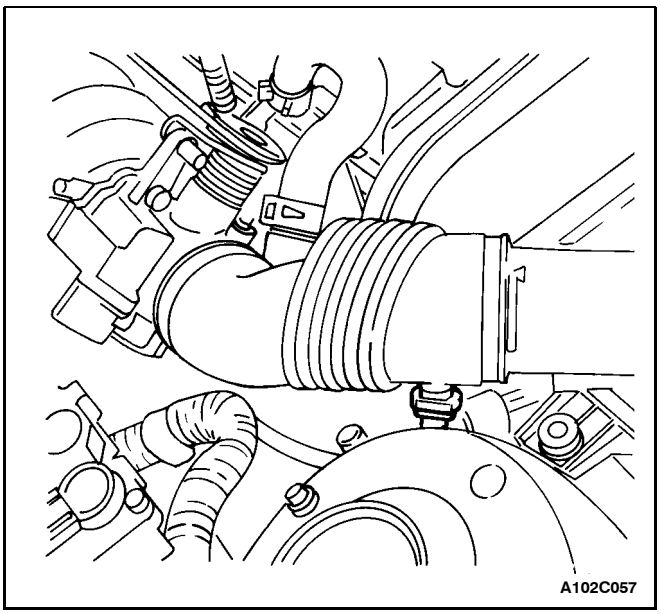

A102B006

17. Install the power steering pump pulley, if equipped.
18. Install the power steering pump pulley bolts, if equipped.

Tighten

Tighten the power steering pump pulley bolts to 25 NSm (18 lb-ft).

19. Install the alternator drive belt.
20. Install the A/C compressor drive belt, if equipped.
21. Install the right front splash shield.
22. Install the right front wheel. Refer to Section 2E, Tires and Wheels.

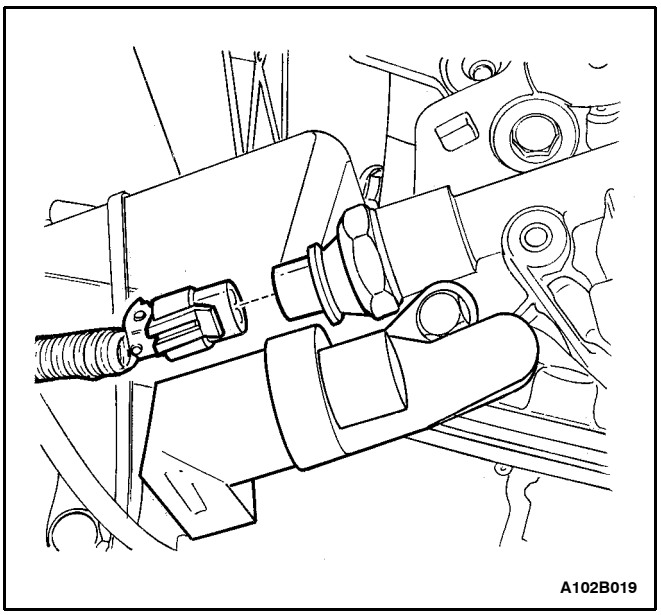

A102C057

24. Install the air filter housing.
25. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 12 NSm (106 lb-in).

26. Connect the air intake tube to the throttle body.
27. Connect the breather tube to the valve cover.
28. Connect the manifold air temperature sensor connector.
29. Connect the negative battery cable.


A102B019

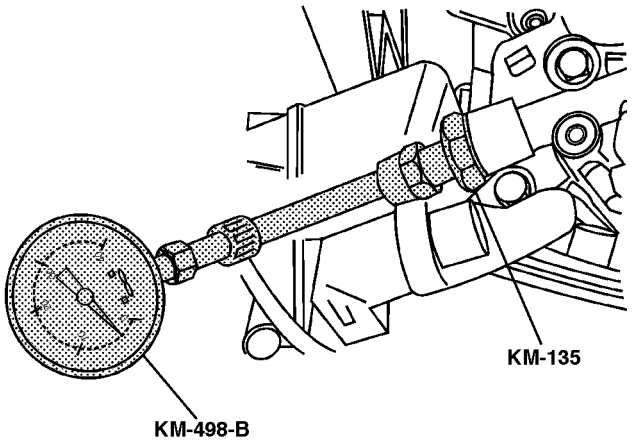
ENGINE OIL PRESSURE INSPECTION PROCEDURE

Tools Required

KM-498-B Pressure Gauge

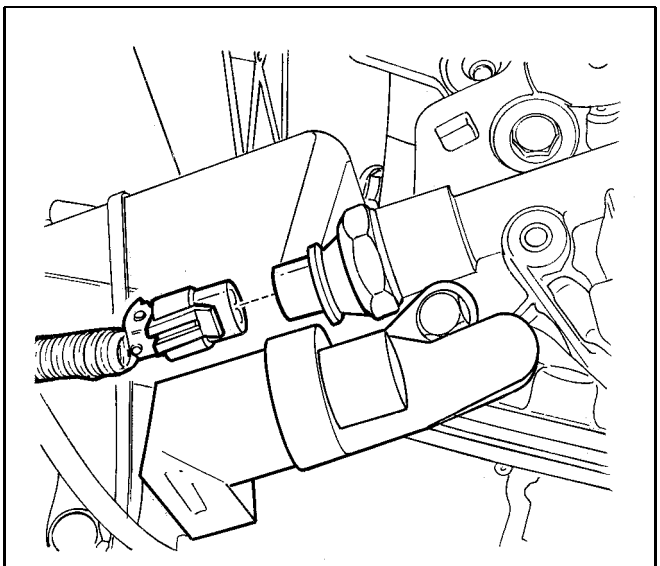
KM-135 Adapter

1. Remove the front, right-hand wheel well splash shield.
2. Disconnect the oil pressure switch connector.



A202B003

3. Install the adapter KM-135 in place of the oil pressure switch.
4. Connect the pressure gauge KM-498-B to the adapter.
5. Start the engine and check the oil pressure at idle speed and engine temperature of 80_C (176_F). The minimum oil pressure should be 30 kPa (8.88 psi).
6. Turn the engine OFF and remove the oil pressure gauge and adapter.

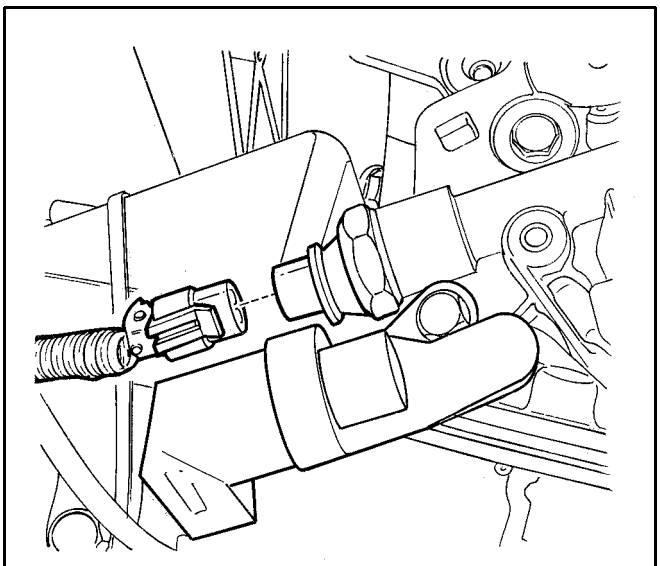

A102B019

7. Install the oil pressure switch.

Tighten

Tighten the oil pressure switch to 40 NSm (30 lb-ft).

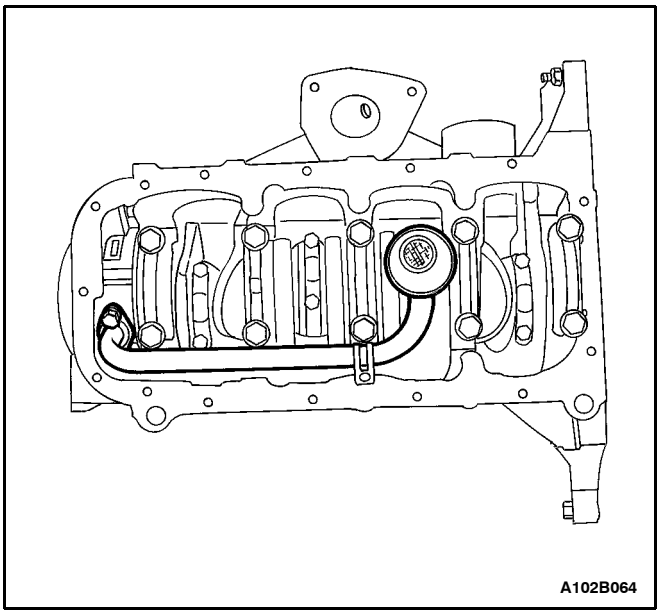
8. Connect the oil pressure switch connector.
9. Install the lower front, right-hand wheel well splash shield.
10. Check the oil level and fill to the full mark.


A102B019

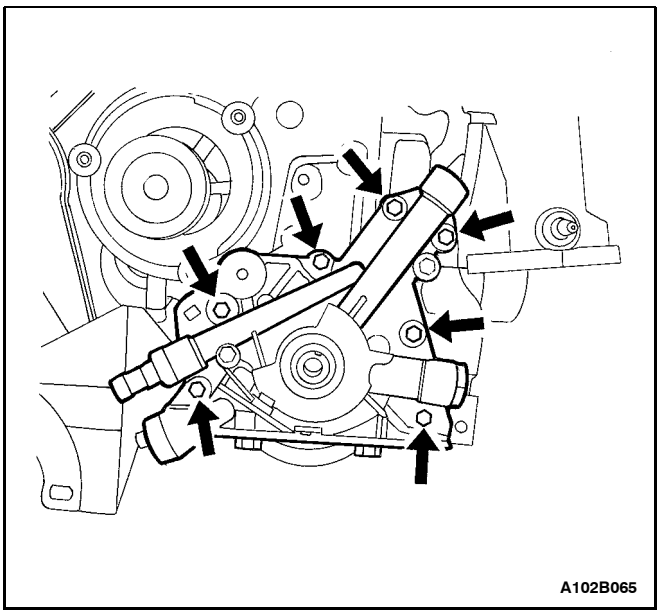
OIL PUMP

Removal Procedure

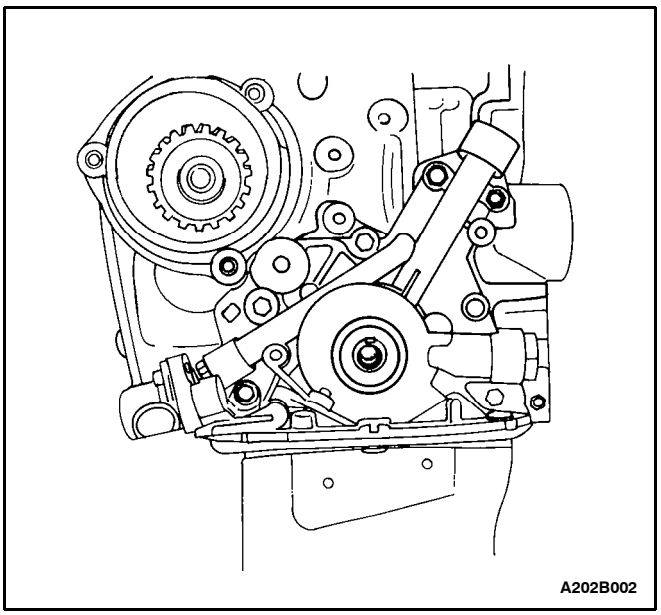
1. Disconnect the negative battery cable.
2. Remove the power steering pump, if equipped. Refer to Section 6B, Power Steering Pump.
3. Remove the timing belt. Refer to "Timing Belt" in this section.
4. Remove the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
5. Disconnect the oil pressure switch connector.


A102B064

6. Remove the crankshaft position sensor bolt.
7. Remove the crankshaft position sensor.
8. Remove the oil pan. Refer to "Oil Pan" in this section.
9. Remove the oil pump pickup tube and the support bracket bolts.
10. Remove the oil pump pickup tube.

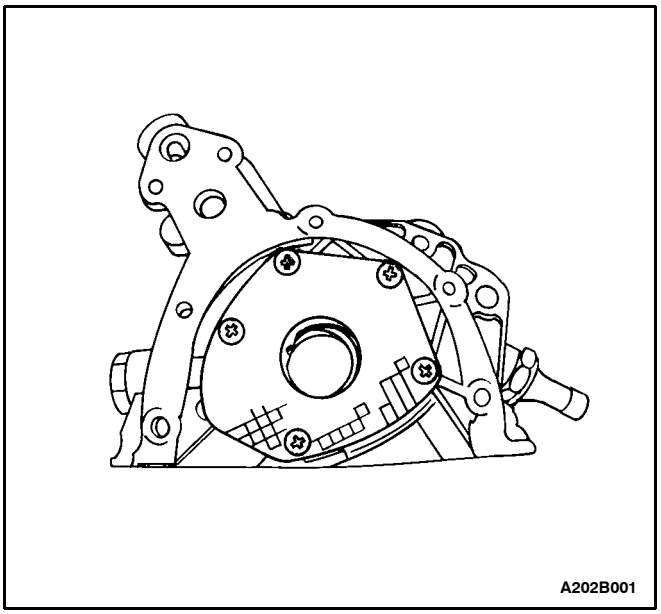

A102B065

11. Remove the oil pump retaining bolts.
12. Carefully separate the oil pump and the gasket from the engine block and the oil pan.
13. Remove the oil pump.

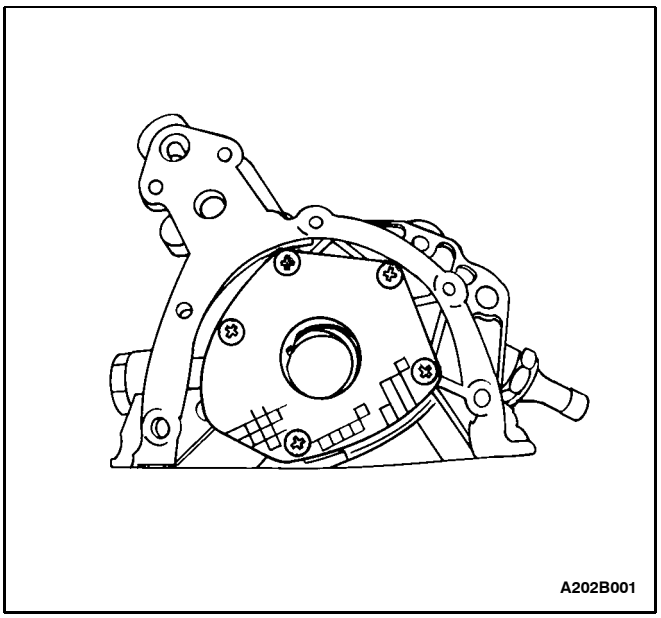

A202B002

Inspection Procedure

1. Clean the oil pump and the engine block gasket mating surfaces.
2. Remove the safety relief valve bolt.
3. Remove the safety relief valve and the spring.
4. Remove the oil pump-to-crankshaft seal.


A202B001

5. Remove the oil pump rear cover bolts.
6. Remove the rear cover.


A202B001

7. Clean the oil pump housing and all of the parts of the oil pump housing.
8. Inspect all of the parts for signs of wear. Refer to "Engine Specifications" in this section.
9. Coat all of the oil pump parts with clean engine oil and reinstall them.

Notice: Pack the oil pump gear cavity with petroleum jelly to ensure an oil pump prime, or engine damage could result.

10. Apply Loctite® 242 to the rear cover bolts and install the rear oil pump cover with the bolts.

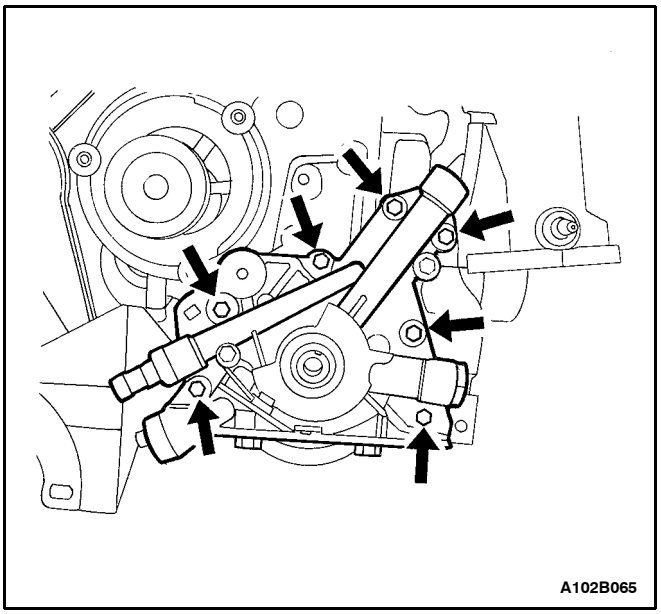
Tighten

Tighten the rear cover bolts to 6 NSm (53 lb-in).

11. Install the safety relief valve, the spring, the washer, and the bolt.

Tighten

Tighten the safety relief valve bolt to 30 NSm (22 lb-ft).

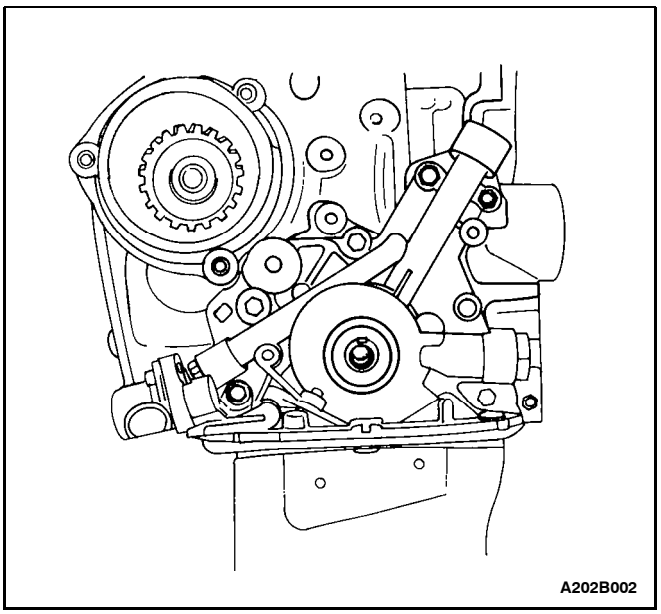

A102B065

Installation Procedure

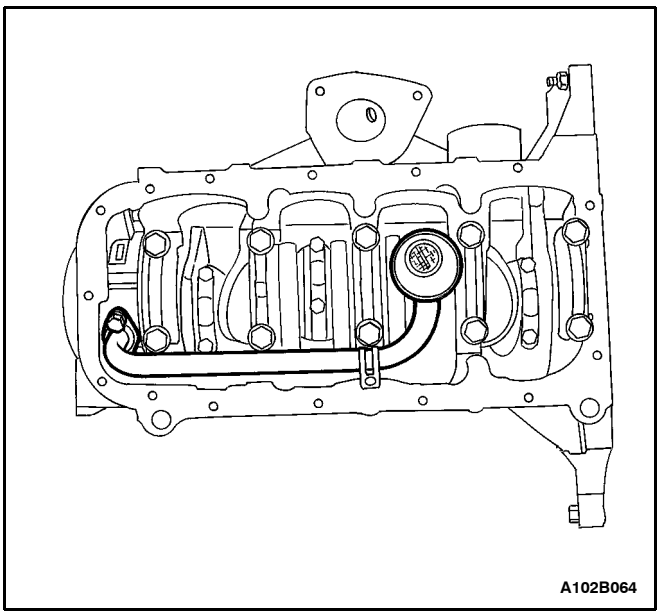
1. Apply Loctite[242 to the oil pump bolts and room temperature vulcanizing (RTV) (sealer) sealant to the new oil pump gasket.
2. Install the gasket to the oil pump and install the oil pump to the engine block with the retaining bolts.

Tighten

Tighten the oil pump retaining bolts to 10 NSm (89 lb-in).


A202B002

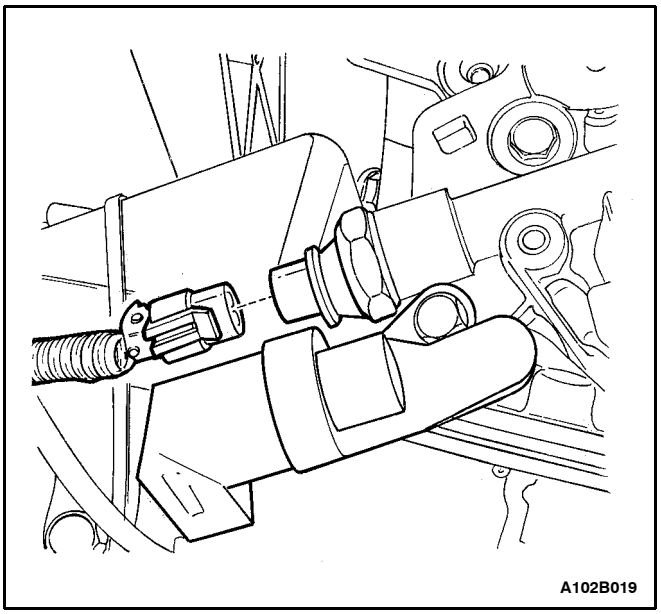
3. Install a new oil pump-to-crankshaft seal. Coat the lip of the seal with a thin coat of grease.


A102B064

4. Coat the threads of the oil pump pickup tube and support bracket bolts with Loctite^{R} 242.
5. Install the oil pump pickup tube and bolts.

Tighten

Tighten the oil pump pickup tube and the support bracket bolts to 10 NSm (89 lb-in).

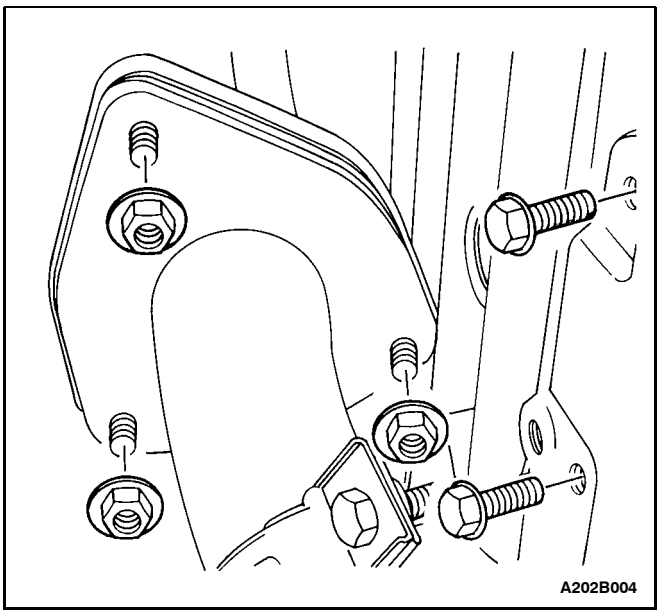

A102B019

6. Install the oil pan. Refer to "Oil Pan" in this section.
7. Install the crankshaft position sensor and the bolt.

Tighten

Tighten the crankshaft position sensor retaining bolt to 10 NSm (89 lb-in).

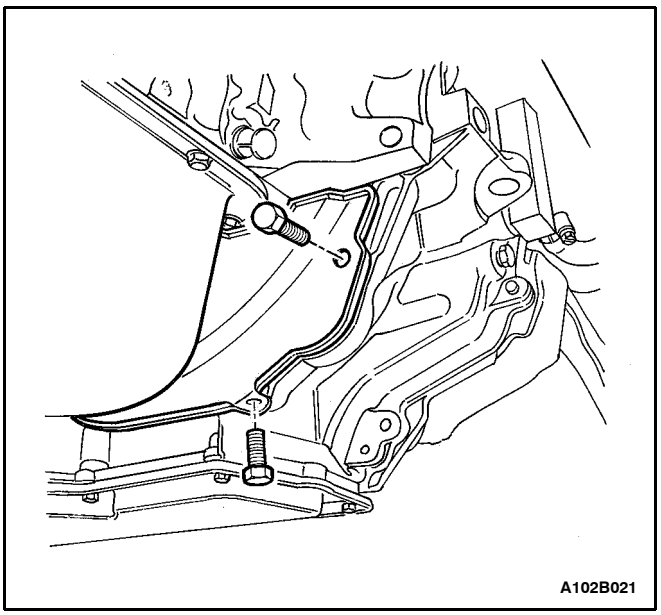
8. Connect the oil pressure switch connector.
9. Install the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
10. Install the power steering pump, if equipped. Refer to Section 6B, Power Steering Pump.
11. Install the timing belt. Refer to "Timing Belt" In this section.
12. Connect the negative battery cable.


A202B004

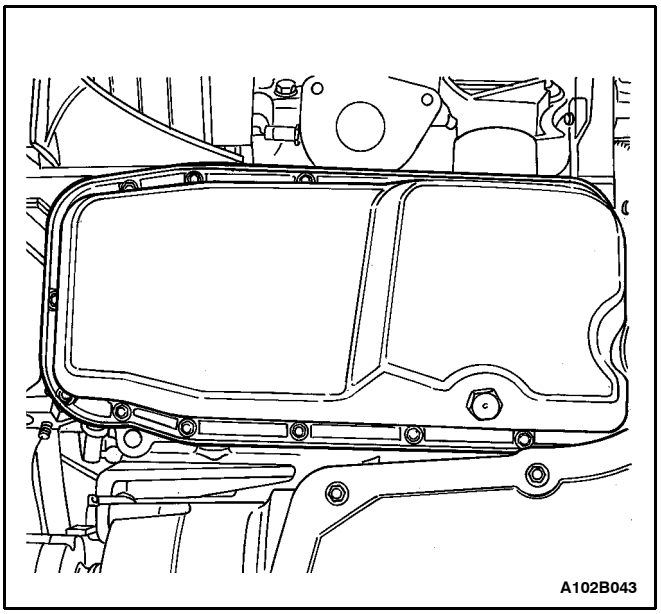
OIL PAN

Removal Procedure

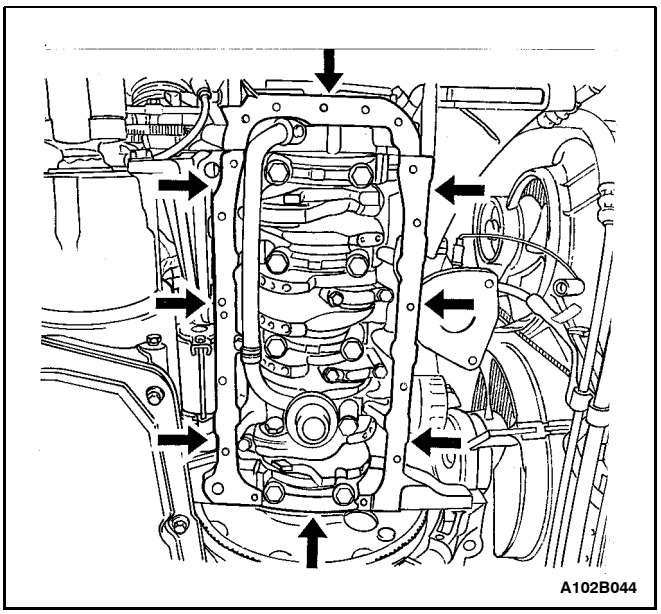
1. Disconnect the negative battery cable.
2. Remove the right front wheel. Refer to Section 2E, Tires and Wheels.
3. Remove the right front splash shield.
4. Drain the engine oil from the engine crankcase.
5. Remove the exhaust flex pipe retaining nuts from the exhaust manifold and the bolts at the bracket.
6. Remove the exhaust flex pipe retaining nuts from the catalytic converter or the connecting pipe.
7. Remove the exhaust flex pipe.


A102B021

8. Remove the flywheel or flexible plate inspection cover bolts.
9. Remove the flywheel or flexible plate inspection cover.

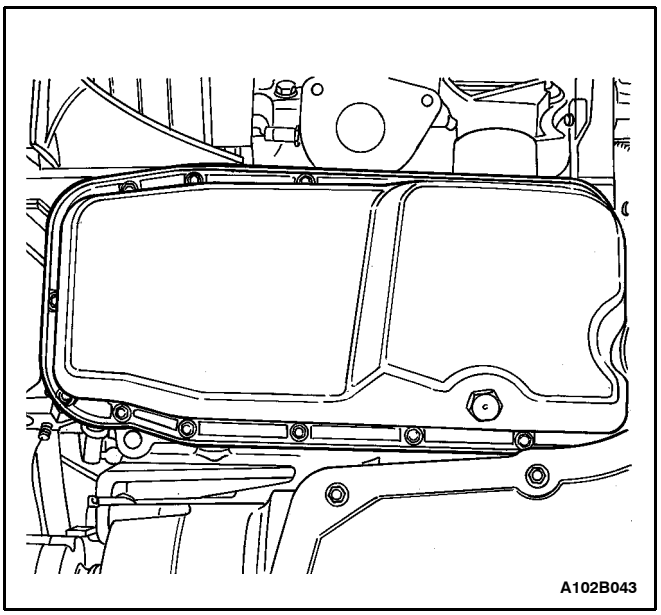


10. Remove the oil pan retaining bolts.
11. Remove the oil pan from the engine block.
12. Remove the oil pan gasket from the oil pan.



Cleaning Procedure

1. Clean the oil pan sealing surface.
2. Clean the engine block sealing surface.
3. Clean the oil pan retaining bolts.
4. Clean the oil pan attaching bolt holes in the engine block.



Installation Procedure

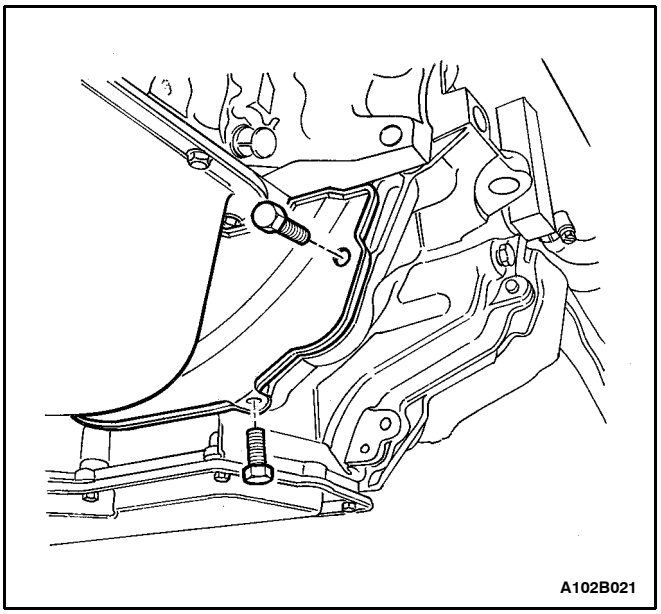
1. Install the oil pan gasket to the oil pan.
2. Install the oil pan to the engine block.

Important: Install the oil pan within 5 minutes after applying the liquid gasket to the oil pan.

3. Install the oil pan retaining bolts.

Tighten

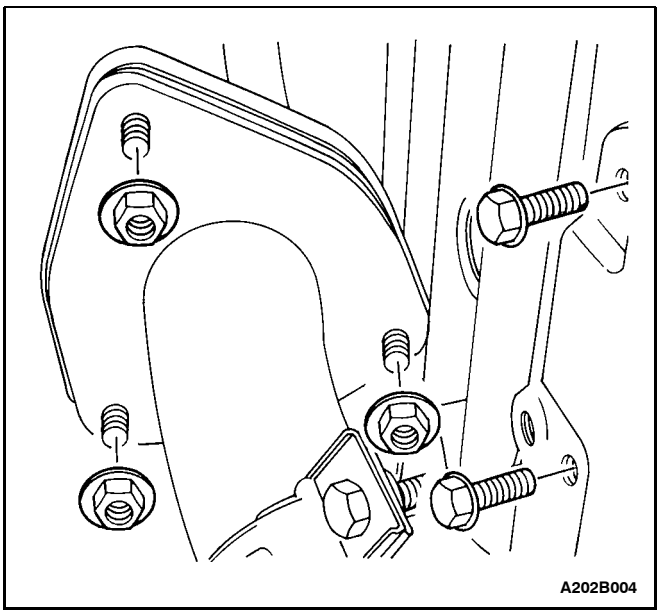
Tighten the oil pan retaining bolts to 10 NSm (89 lb-in).


A102B021

4. Install the flywheel or flexible plate inspection cover.
5. Install the flywheel or flexible plate inspection cover bolts.

Tighten

Tighten the flywheel inspection cover bolts to 12 NSm (106 lb-in) or the flexible plate inspection cover bolts to 10 NSm (89 lb-in).


A202B004

6. Install the exhaust flex pipe.
7. Install the exhaust flex pipe retaining nuts to the exhaust manifold and the exhaust pipe bracket bolts.

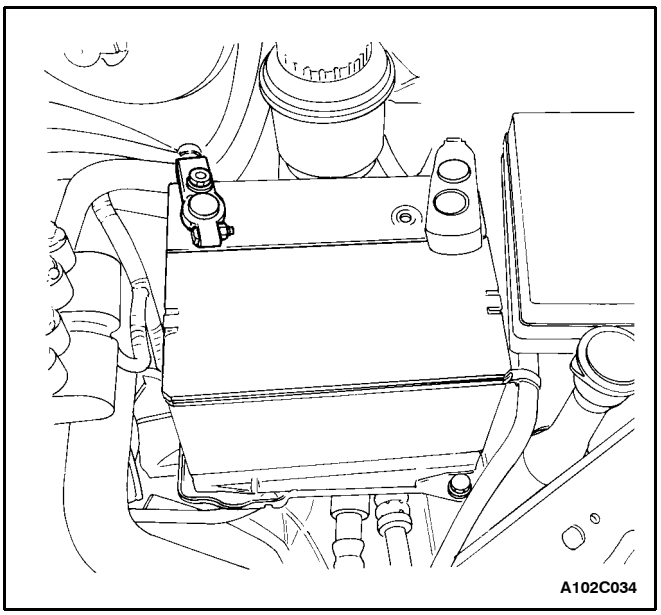
Tighten

Tighten the exhaust flex pipe retaining nuts to the exhaust manifold and the exhaust pipe bracket bolts to 40 NSm (30 lb-ft).

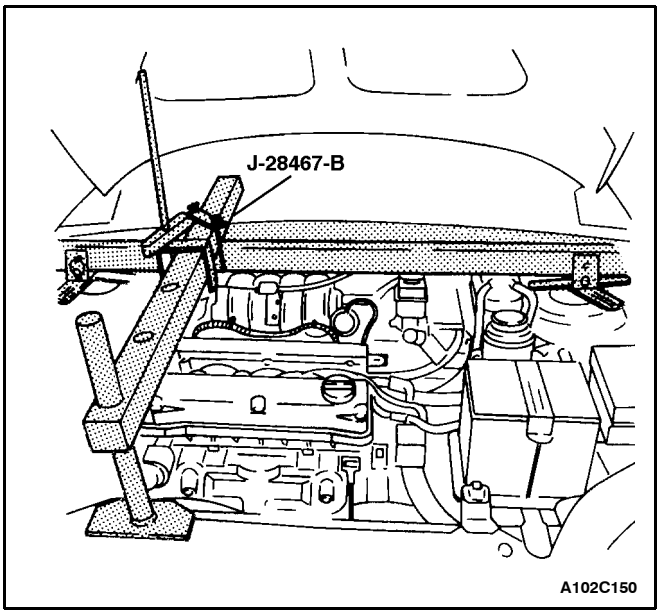
8. Install the exhaust flex pipe retaining nuts to the catalytic converter or the connecting pipe.

Tighten

Tighten the exhaust flex pipe retaining nuts to the catalytic converter or the connecting pipe to 30 NSm (22 lb-ft).


A102C034

9. Install the right front splash shield.
10. Install the right front wheel. Refer to Section 2E, Tires and Wheels.
11. Connect the negative battery cable.
12. Refill the engine crankcase with engine oil.



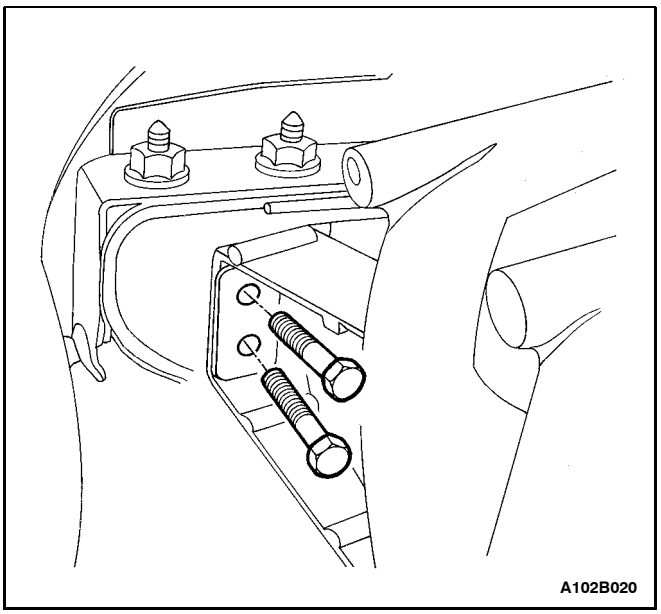
ENGINE MOUNT

Tools Required

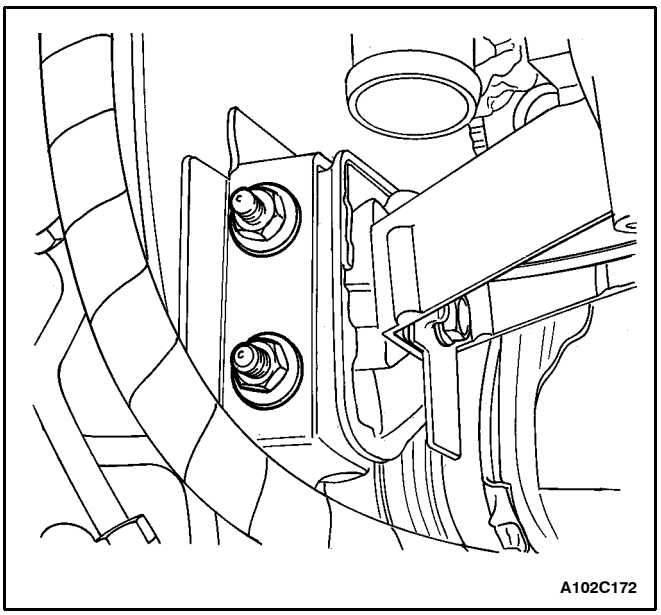
J-28467-B Engine Assembly Lift Support

Removal Procedure

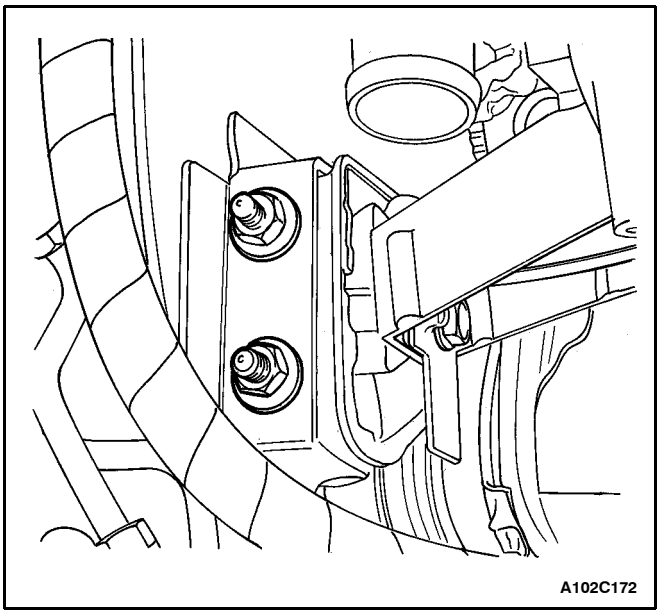
1. **Disconnect the negative battery cable.**
2. **Remove the upper radiator cover.**
3. **Remove the right front splash shield.**
4. **Support the engine assembly using the engine assembly lift support J-28467-B.**



5. **Remove the engine mount bracket retaining bolts.**



6. **Remove the engine mount retaining nuts.**
7. **Lower the engine.**
8. **Remove the engine mount.**

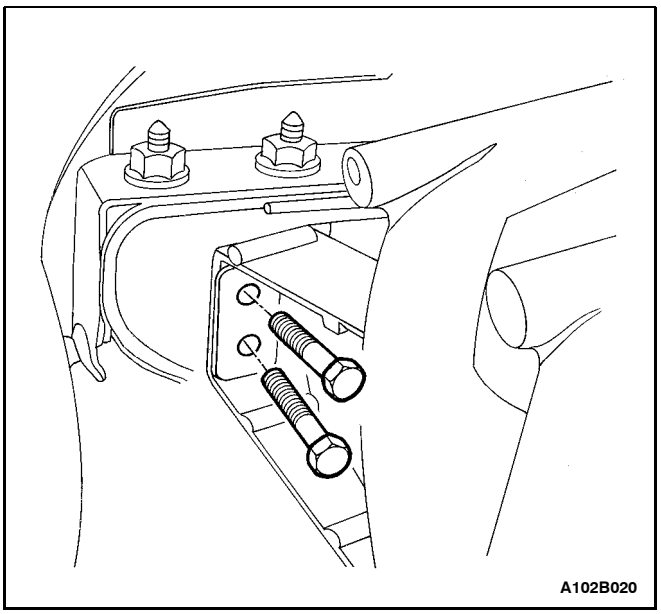

A102C172

Installation Procedure

1. Install the engine mount.
2. Raise the engine.
3. Install the engine mount retaining nuts.

Tighten

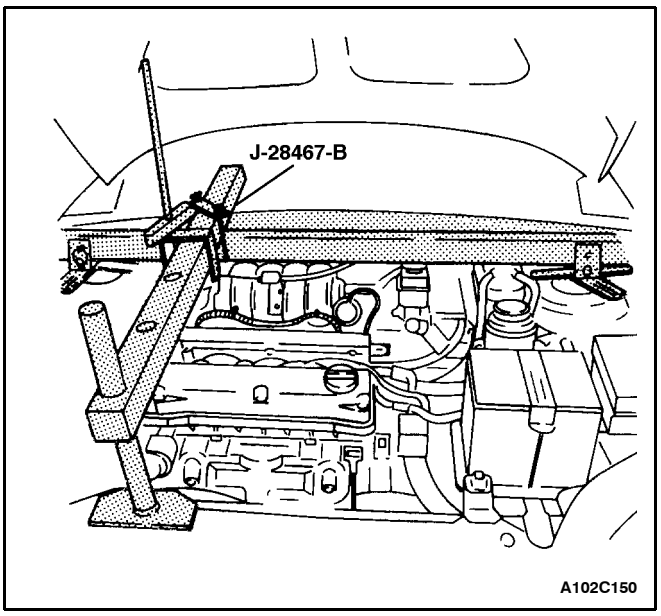
Tighten the engine mount retaining nuts to 40 NSm (30 lb-ft).


A102B020

4. Install the engine mount bracket retaining bolts.

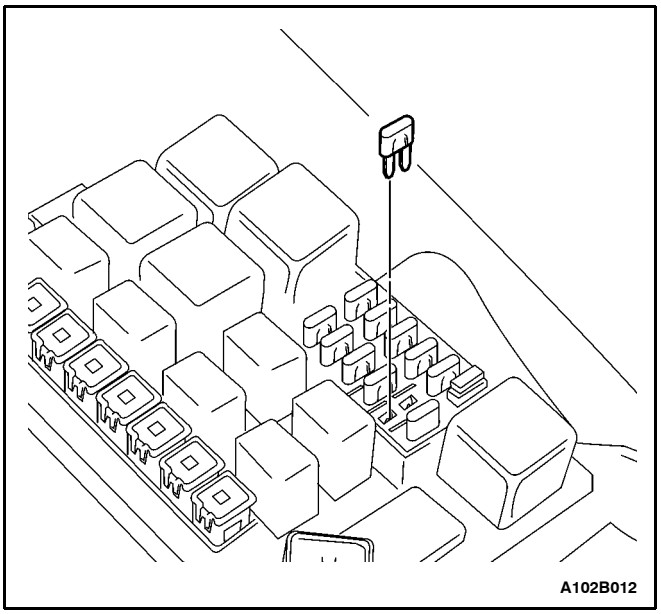
Tighten

Tighten the engine mount bracket retaining bolts to 60 NSm (44 lb-ft).



A102C150

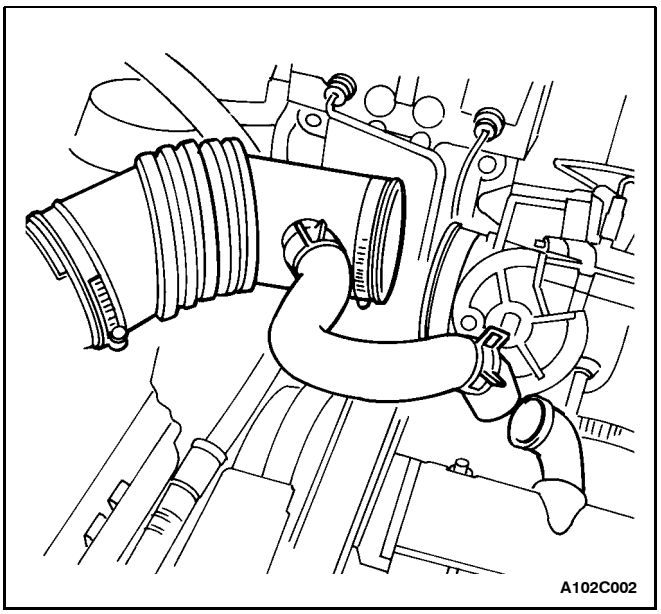
5. Remove engine assembly lift support J-28467-B.
6. Install the right front splash shield.
7. Install the upper radiator cover.
8. Connect the negative battery cable.


A102B012

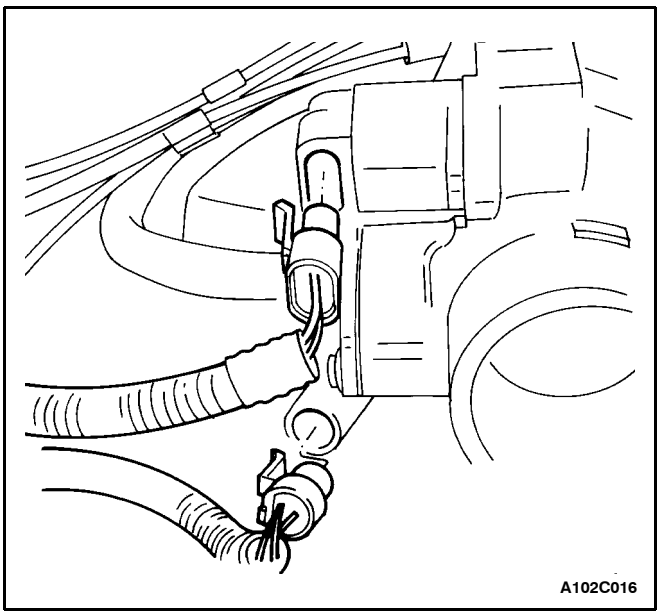
INTAKE MANIFOLD

Removal Procedure

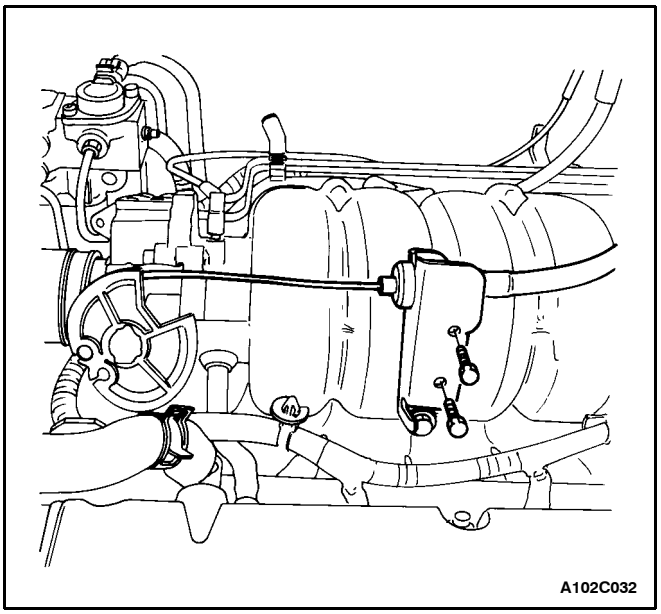
1. Remove the fuel pump fuse.
2. Start the engine. Crank the engine after it stalls for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the ECM ground terminal from the intake manifold.
5. Drain the engine coolant. Refer to Section 1D, Engine Cooling.


A102C002

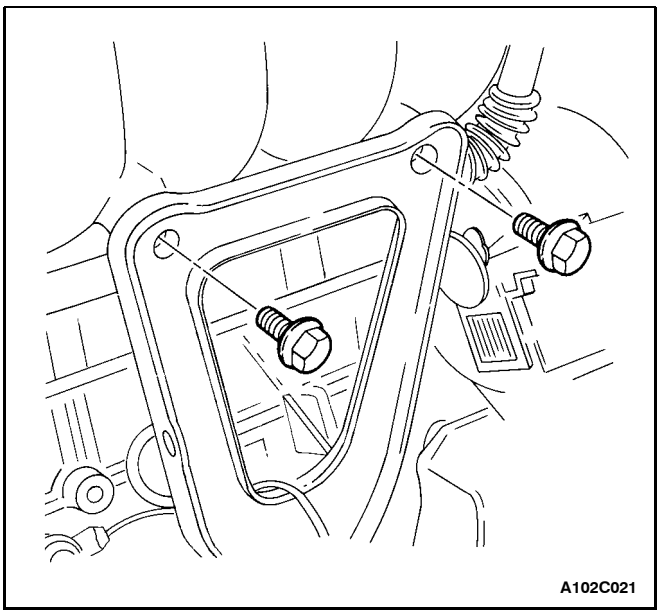
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the air intake tube from the throttle body.


A102C016

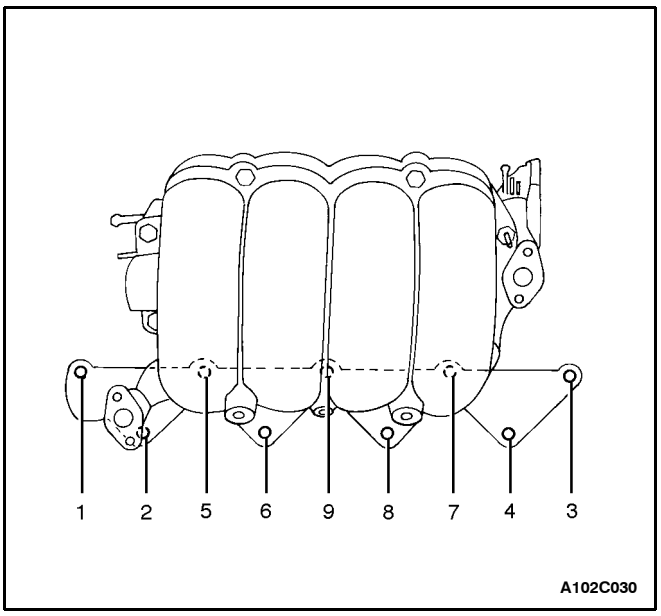
8. Disconnect the idle air control valve connector.
9. Disconnect the throttle position sensor connector.
10. Disconnect the coolant temperature sensor connector.
11. Disconnect the engine coolant temperature sensor connector.
12. Disconnect the heater inlet hose from the cylinder head.
13. Disconnect the surge tank coolant hose at the throttle body.


A102C032

14. Disconnect all of the necessary vacuum hoses, including the vacuum hose at the fuel pressure regulator and the brake booster vacuum hose at the intake manifold.
15. Disconnect the throttle cable from the throttle body and the intake manifold.
16. Remove the throttle cable bracket bolts from the intake manifold.
17. Remove the throttle cable bracket.

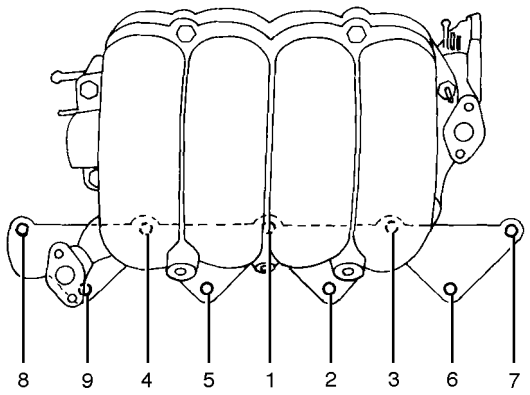

A102C021

18. Remove the fuel injector rail and fuel injectors as an assembly. Refer to Section 1F, Engine Controls.
19. Remove the alternator. Refer to Section 1E, Engine Electrical.
20. Remove the intake manifold support bracket bolts.
21. Remove the intake manifold support bracket.



A102C030

22. Remove the intake manifold retaining bolts/nuts in the sequence shown.
23. Remove the intake manifold.
24. Remove the intake manifold gasket.
25. Clean the sealing surfaces of the intake manifold and the cylinder head.



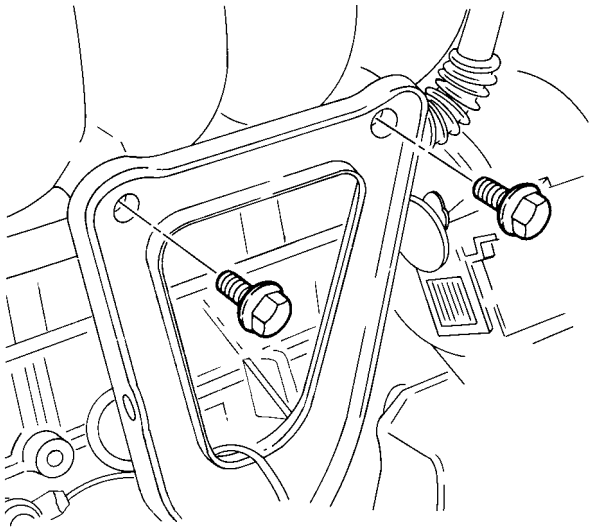
A102C031

Installation Procedure

1. Install the intake manifold gasket.
2. Install the intake manifold.
3. Install the intake manifold retaining bolts/nuts in the sequence shown.

Tighten

Tighten the intake manifold retaining bolts to 25 NSm (18 lb-ft).



A102C021

4. Install the intake manifold support bracket.
5. Install the intake manifold support bracket upper bolts to the intake manifold.

Tighten

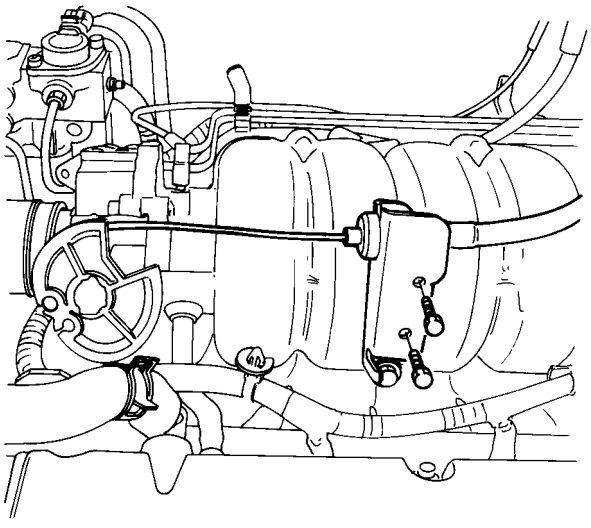
Tighten the intake manifold support bracket bolts to 25 NSm (18 lb-ft).

6. Install the intake manifold support bracket lower bolt to the engine block.

Tighten

Tighten the intake manifold support bracket lower bolt to the engine block to 40 NSm (30 lb-ft).

7. Install the alternator. Refer to Section 1E, Engine Electrical.



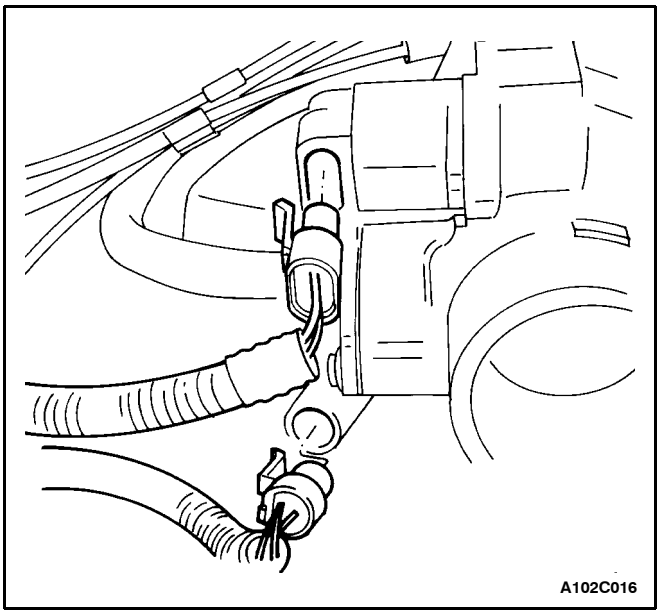
A102C032

8. Install the fuel rail and fuel injectors as an assembly. Refer to Section 1F, Engine Controls.
9. Install the throttle cable bracket.
10. Install the throttle cable bracket bolts.

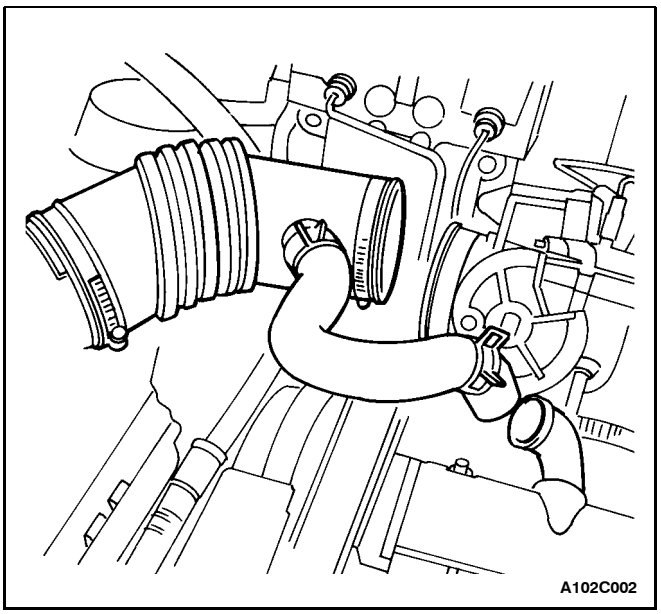
Tighten

Tighten the throttle cable bracket bolts to 8 NSm (71 lb-in).

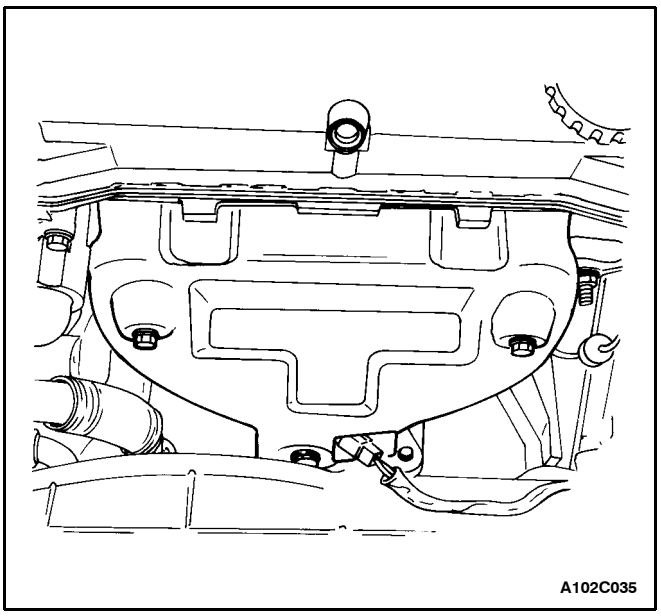
11. Connect the throttle cable to the intake manifold and the throttle body.
12. Connect all of the necessary vacuum lines that were previously disconnected.


A102C016

13. Connect the heater inlet hose to the cylinder head.
14. Connect the surge tank coolant hose to the throttle body.
15. Connect the coolant temperature sensor connector.
16. Connect the engine coolant temperature sensor connector.
17. Connect the idle air control valve connector.
18. Connect the throttle position sensor connector.


A102C002

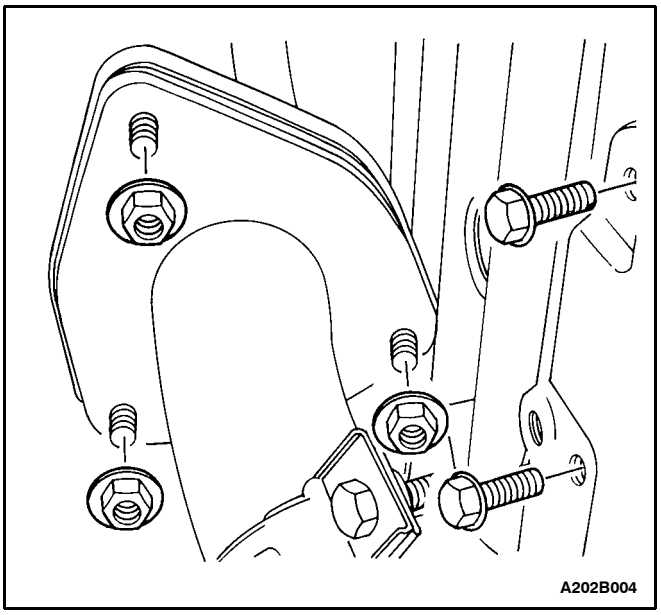
19. Connect the air intake tube to the throttle body.
20. Connect the manifold air temperature sensor connector.
21. Connect the ECM ground terminal to the intake manifold.
22. Install the fuel pump fuse.
23. Connect the negative battery cable.
24. Refill the engine cooling system. Refer to Section 1D, Engine Cooling.


A102C035

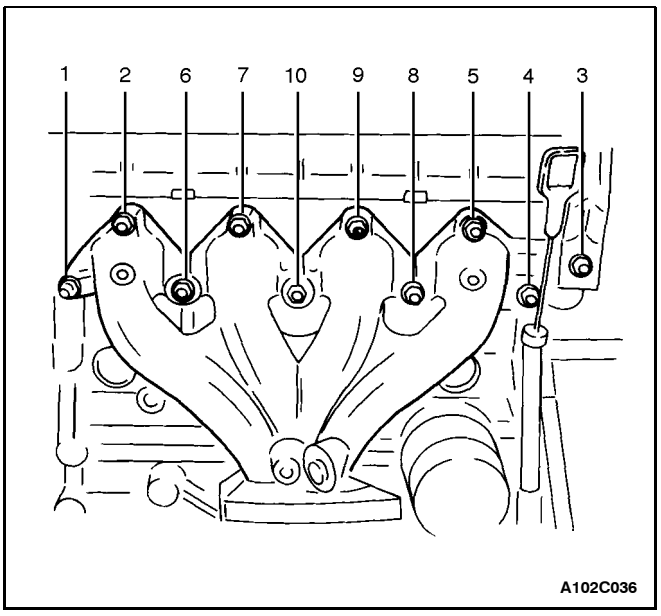
EXHAUST MANIFOLD

Removal Procedure

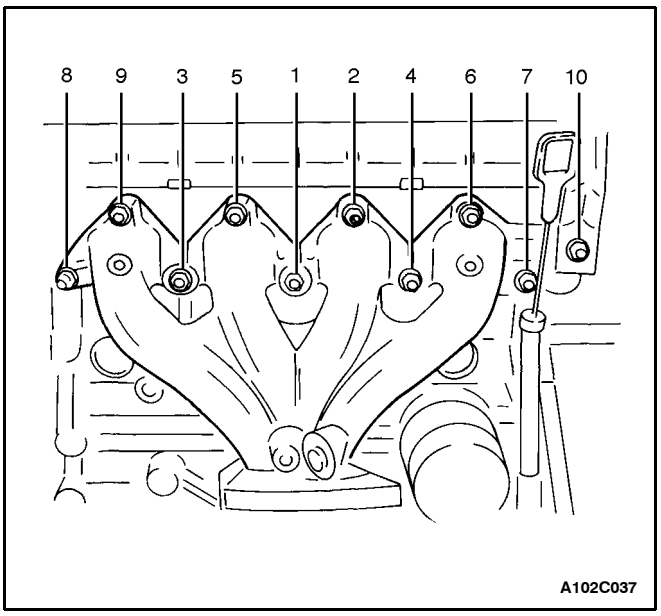
1. Disconnect the negative battery cable.
2. Disconnect the oxygen sensor connector.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.



5. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs.



6. Remove the exhaust manifold retaining nuts in the sequence shown.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket.
9. Clean the sealing surfaces of the exhaust manifold and the cylinder head.

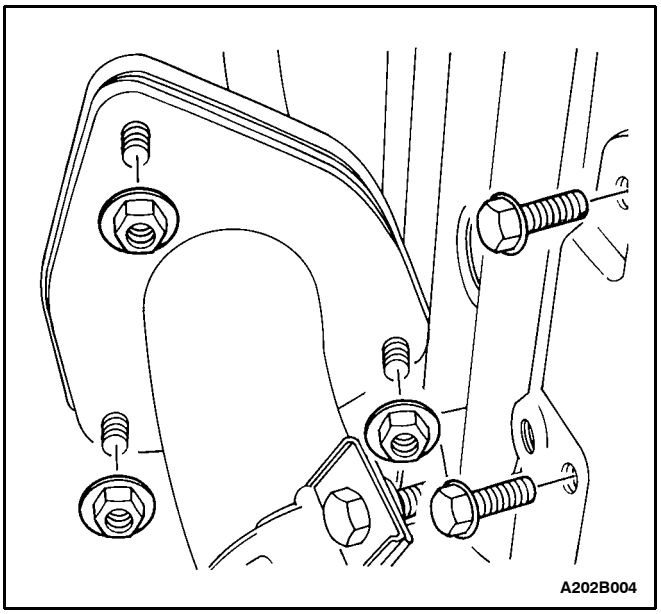


Installation Procedure

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the exhaust manifold retaining nuts and tighten in the sequence shown.

Tighten

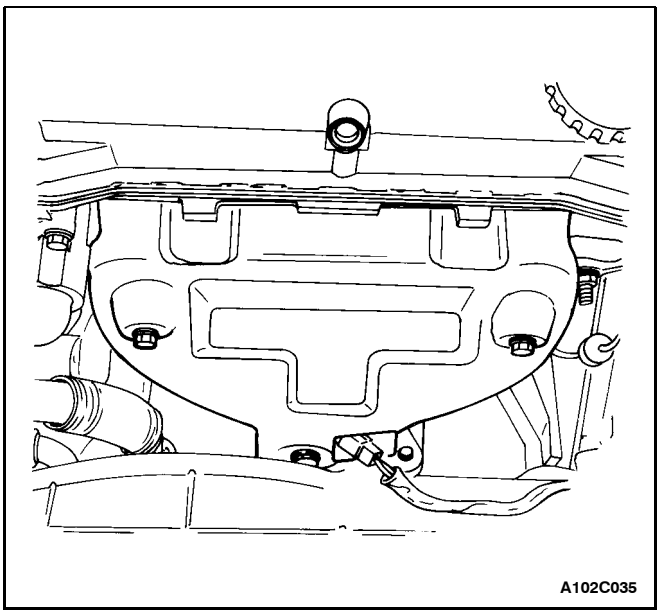
Tighten the exhaust manifold retaining nuts 25 NSm (18 lb-ft).


A202B004

4. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs.

Tighten

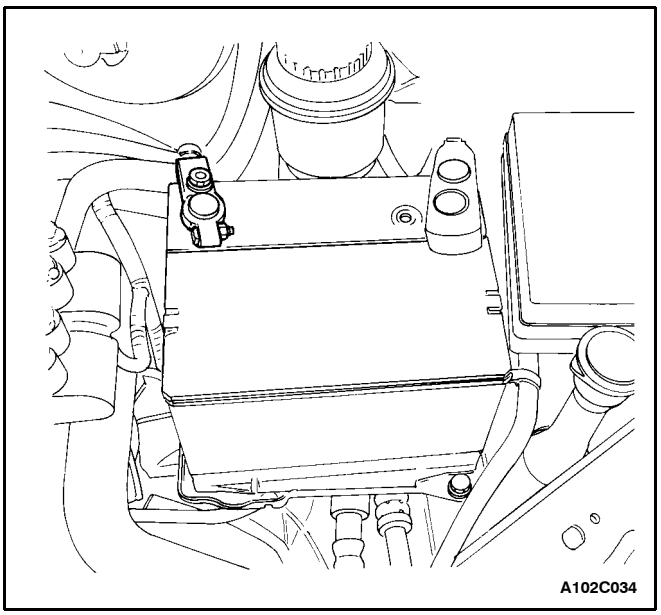
Tighten the exhaust flex pipe retaining nuts to 40 NSm (30 lb-ft).


A102C035

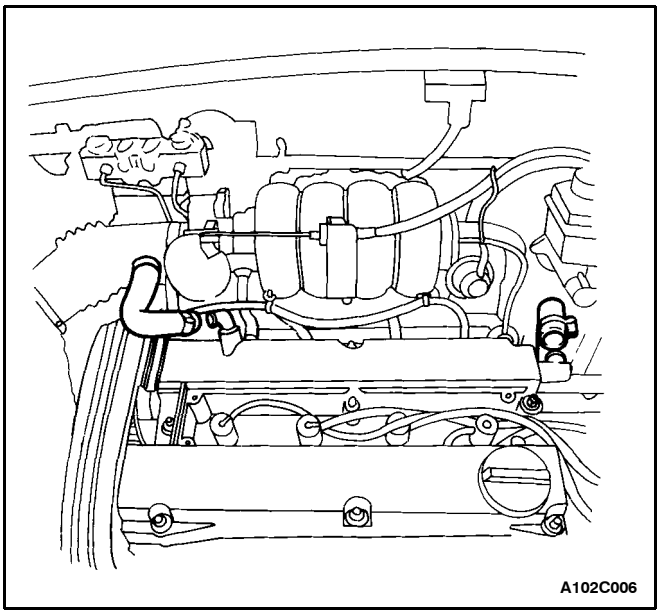
5. Install the exhaust manifold heat shield.
6. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 15 NSm (11 lb-ft).


A102C034

7. Connect the oxygen sensor connector.
8. Connect the negative battery cable.

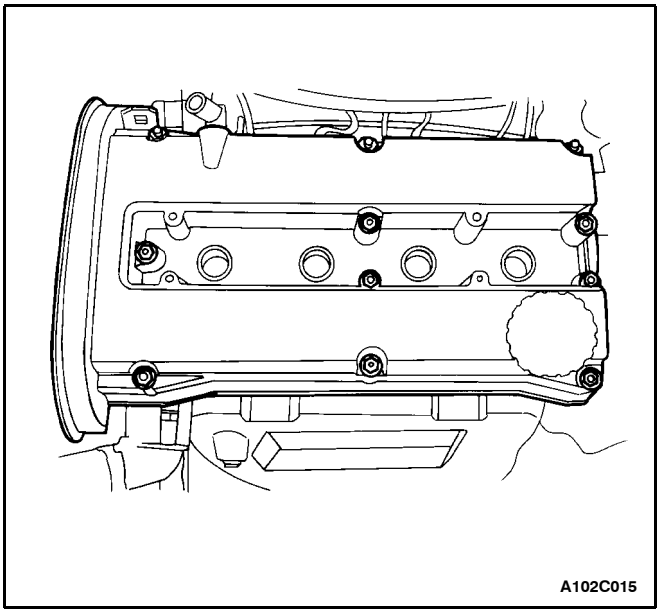

A102C006

CAMSHAFT GEARS

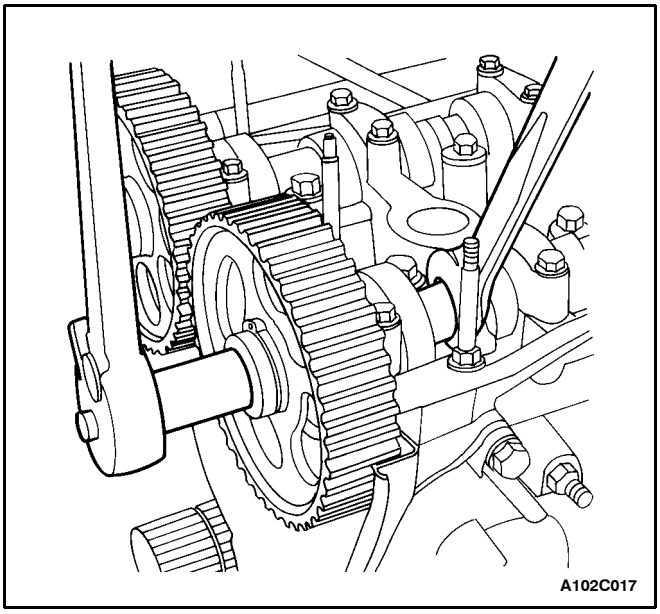
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the spark plug cover bolts.
4. Remove the spark plug cover.
5. Disconnect the ignition wires from the spark plugs.
6. Disconnect the crankcase ventilation tubes from the valve cover.

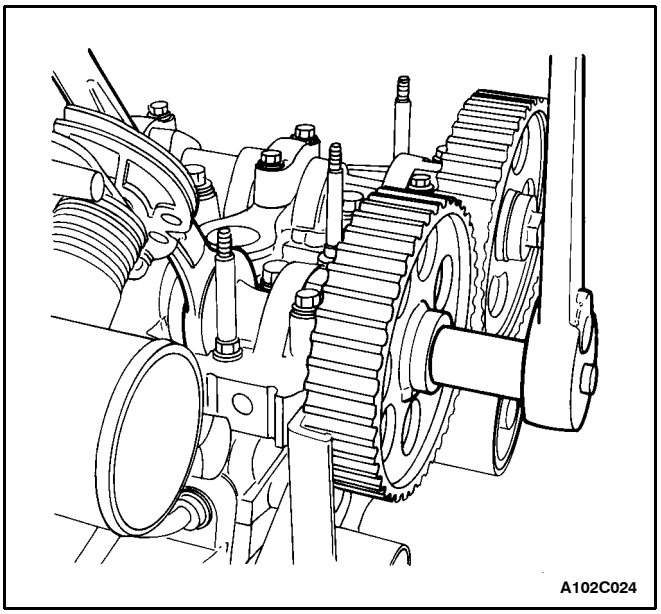

A102C015

7. Remove the valve cover nuts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.


A102C017

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.


A102C024

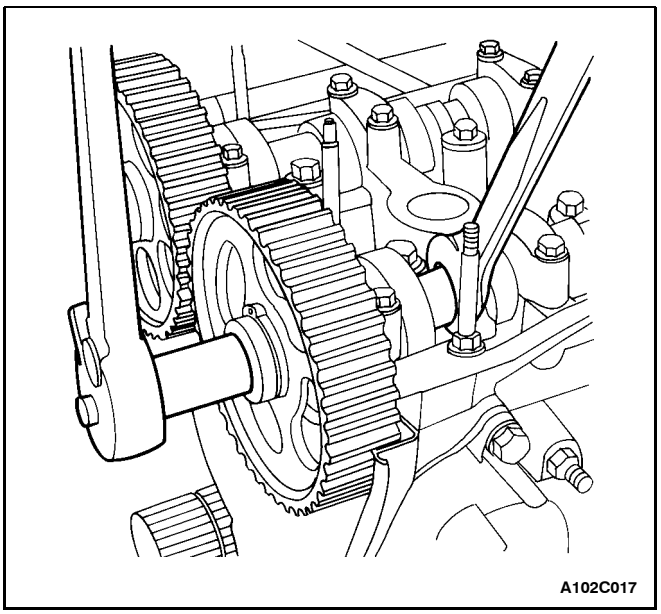
Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Install the intake camshaft gear.
2. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten

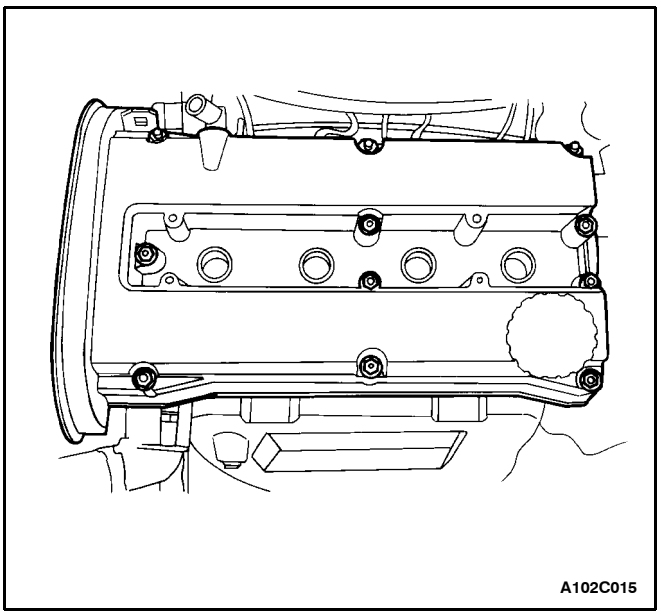
Tighten the intake camshaft gear bolt to 67.5 NSm (49 lb-ft).


A102C017

3. Install the exhaust camshaft gear.
4. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

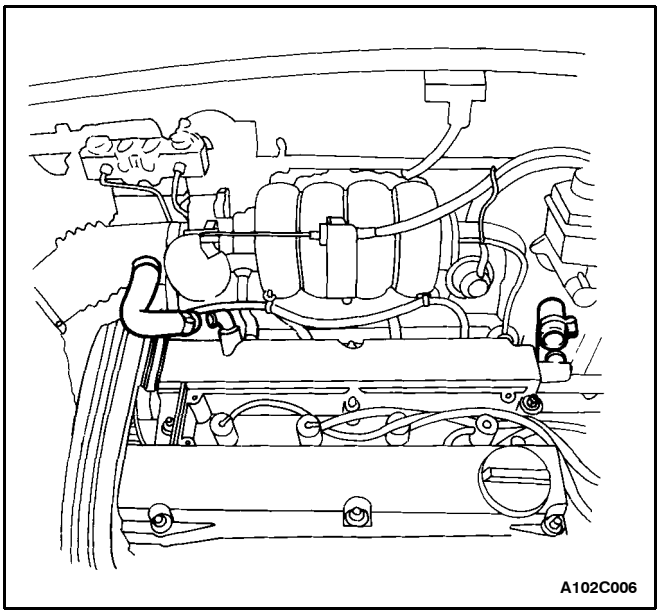
Tighten the exhaust camshaft gear bolt to 67.5 NSm (49 lb-ft).


A102C015

5. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover to cylinder head seal.
6. Install the valve cover and the valve cover gasket.
7. Install the valve cover washers.
8. Install the valve cover nuts.

Tighten

Tighten the valve cover nuts to 10 NSm (89 lb-in).

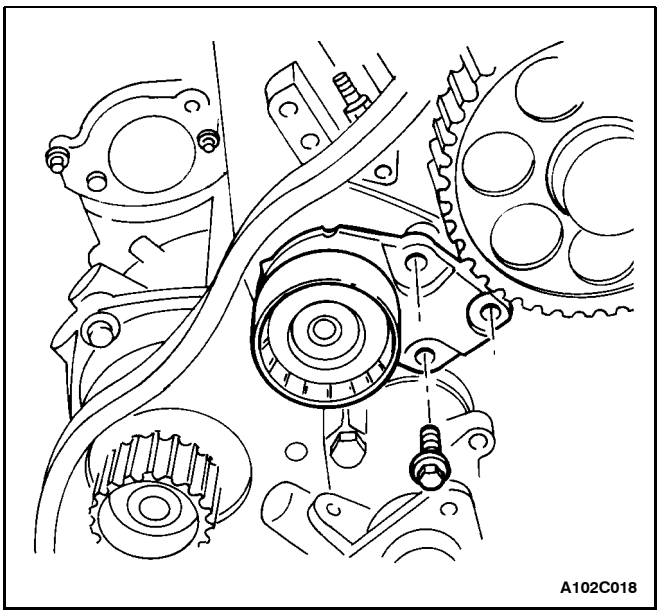

A102C006

9. Connect the crankcase ventilation tubes to the valve cover.
10. Connect the ignition wires to the spark plugs.
11. Install the spark plug cover.
12. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 NSm (27 lb-in).

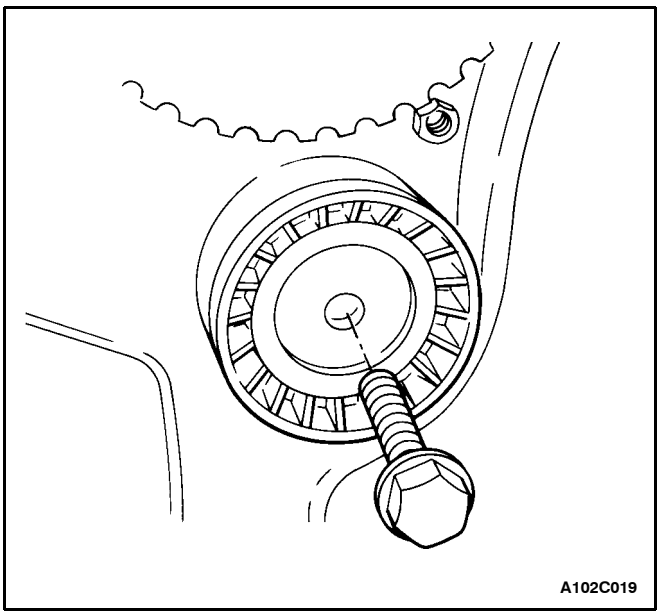
13. Install the timing belt. Refer to "Timing Belt" in this section.
14. Connect the negative battery cable.


A102C018

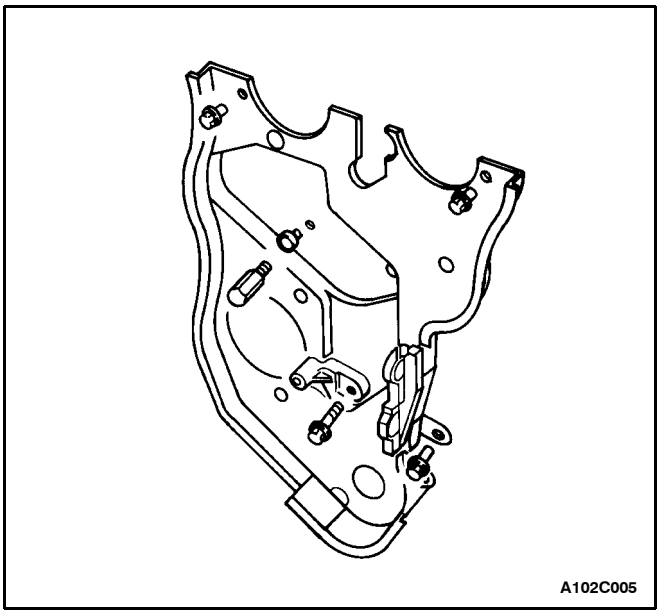
REAR TIMING BELT COVER

Removal Procedure

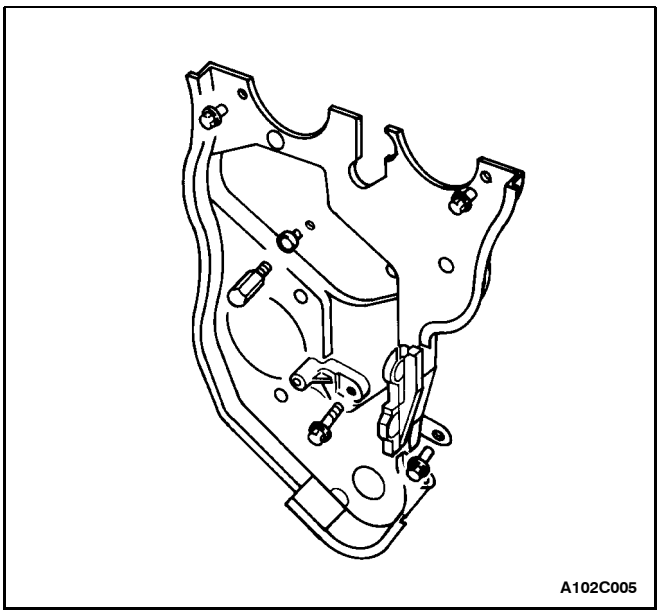
1. Remove the timing belt and the timing belt cover. Refer to "Timing Belt" in this section.
2. Remove the camshaft gears. Refer to "Camshaft Gears" in this section.
3. Remove the crankshaft gear.
4. Remove the timing belt automatic tensioner bolts.
5. Remove the timing belt automatic tensioner.


A102C019

6. Remove the timing belt idler pulley bolt.
7. Remove the timing belt idler pulley.


A102C005

8. Remove the rear timing belt cover bolts.
9. Remove the rear timing belt cover.

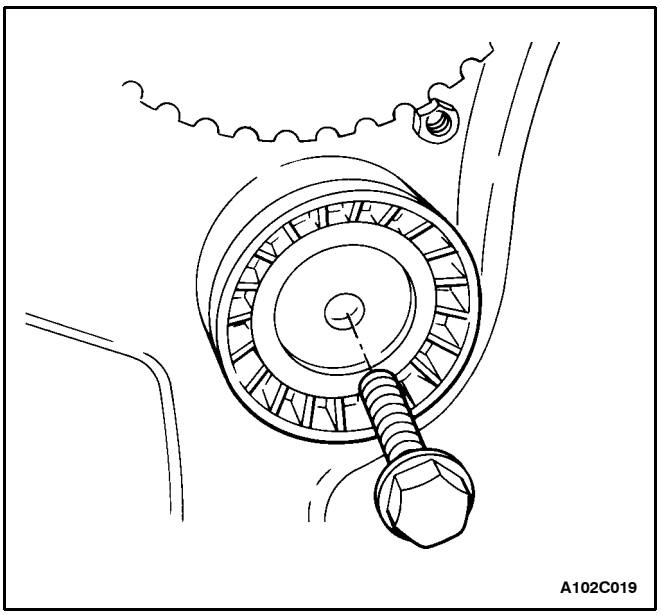

A102C005

Installation Procedure

1. Install the rear timing belt cover.
2. Install the rear timing belt cover bolts.

Tighten

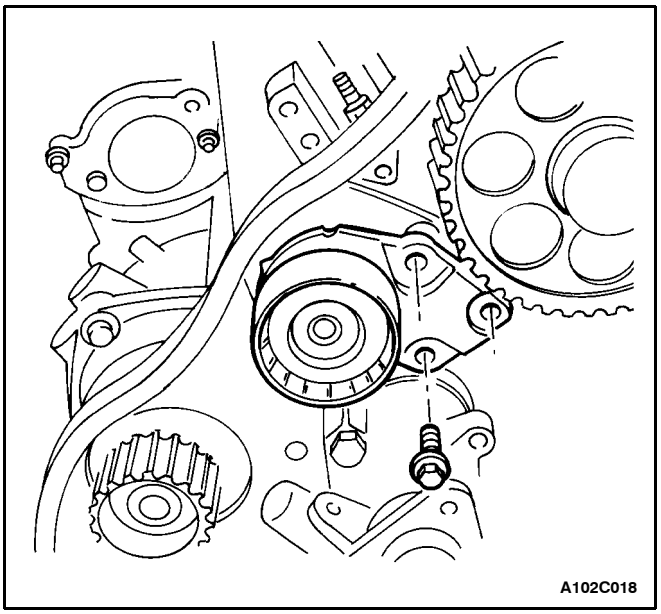
Tighten the rear timing belt cover bolts to 10 NSm (89 lb-in).


A102C019

3. Install the timing belt idler pulley.
4. Install the timing belt idler pulley bolt.

Tighten

Tighten the timing belt idler pulley bolt to 40 NSm (30 lb-ft).

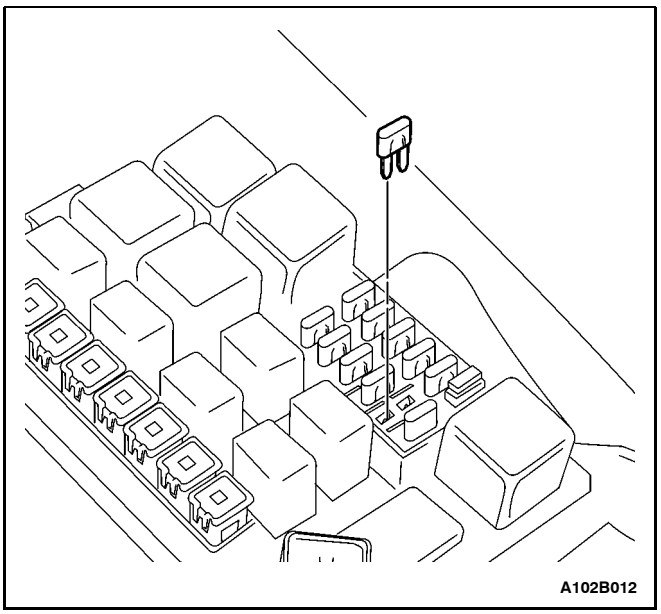

A102C018

5. Install the timing belt automatic tensioner.
6. Install the timing belt automatic tensioner bolts.

Tighten

Tighten the timing belt automatic tensioner bolts to 25 NSm (18 lb-ft).

7. Install the crankshaft gear.
8. Install the camshaft gears. Refer to "Camshaft Gears" in this section.
9. Install the timing belt and timing belt cover. Refer to "Timing Belt" in this section.


A102B012

ENGINE

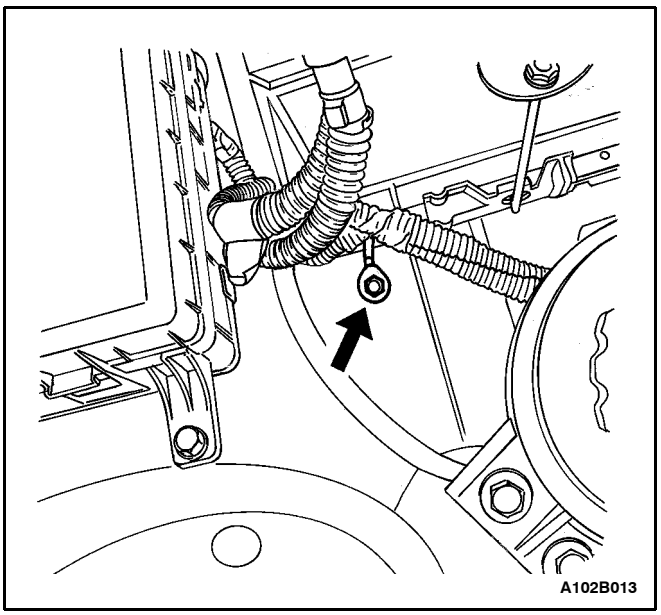
Tools Required

KM-470-B Angular Torque Gauge

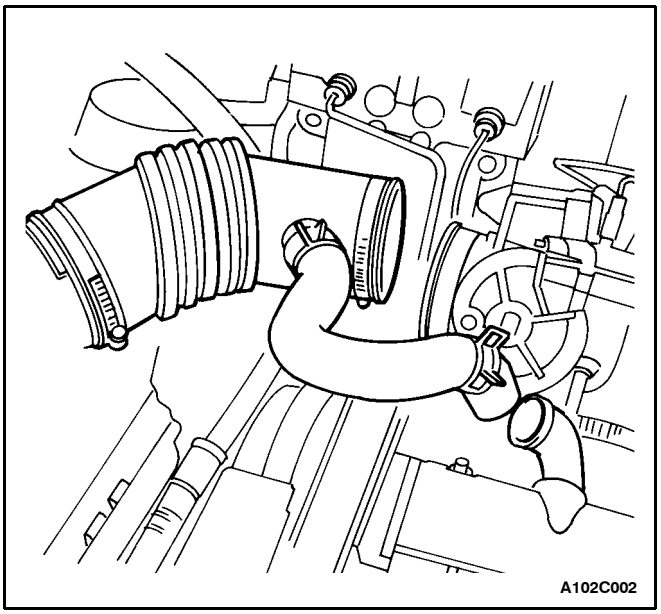
Removal Procedure

Important: On vehicles equipped with manual transaxle, the manual transaxle must be removed before the engine is removed. Refer to Section 5B, Manual Transaxle.

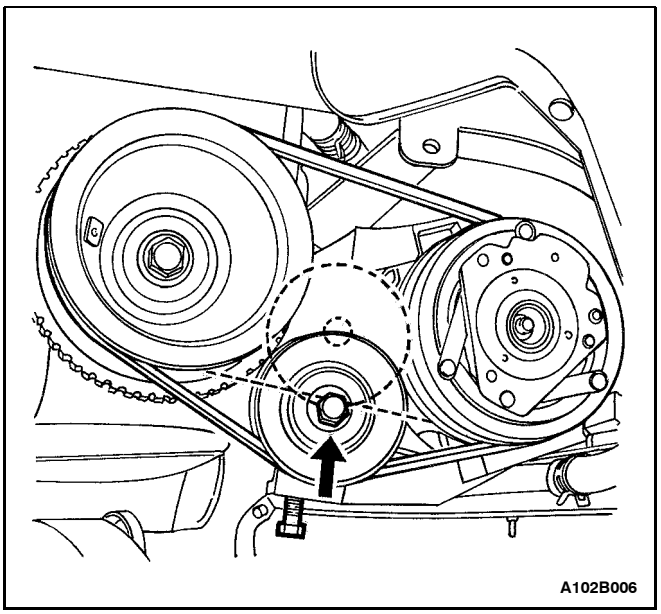
1. Remove the fuel pump fuse.
2. Start the engine. Crank the engine after it stalls for 10 seconds to rid the fuel system of fuel pressure.
3. Remove the hood. Refer to Section 9R, Body Front End.
4. Drain the engine oil.


A102B013

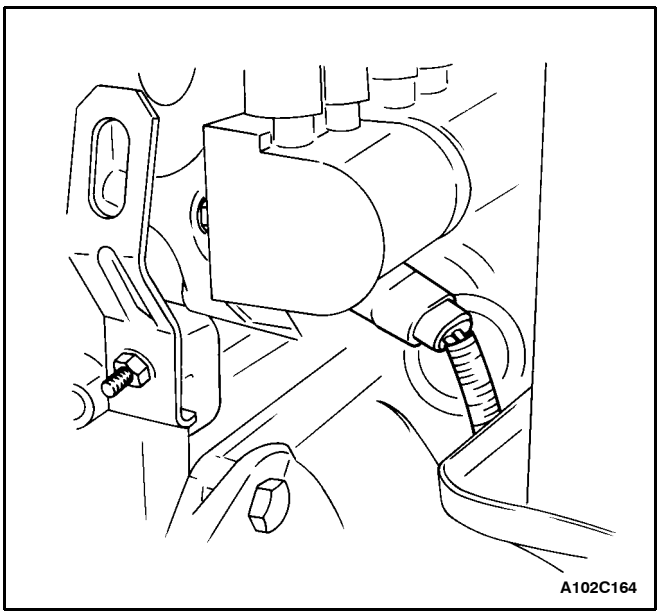
5. Disconnect the negative battery cable.
6. Disconnect and separate the positive battery cable.
7. Disconnect the negative battery cable from the vehicle frame.


A102C002

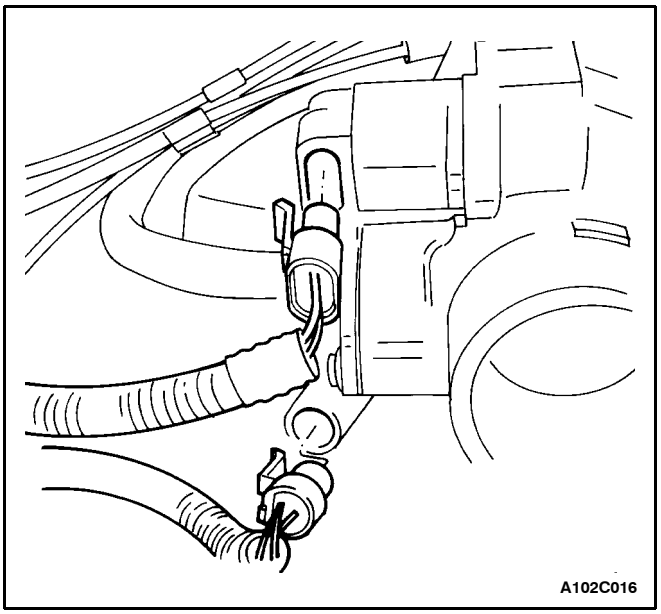
8. Discharge the air conditioning system, if equipped. Refer to Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.
9. Disconnect the manifold air temperature sensor connector.
10. Remove the air intake tube from the throttle body and air filter housing.
11. Disconnect the breather tubes from the valve cover.


A102B006

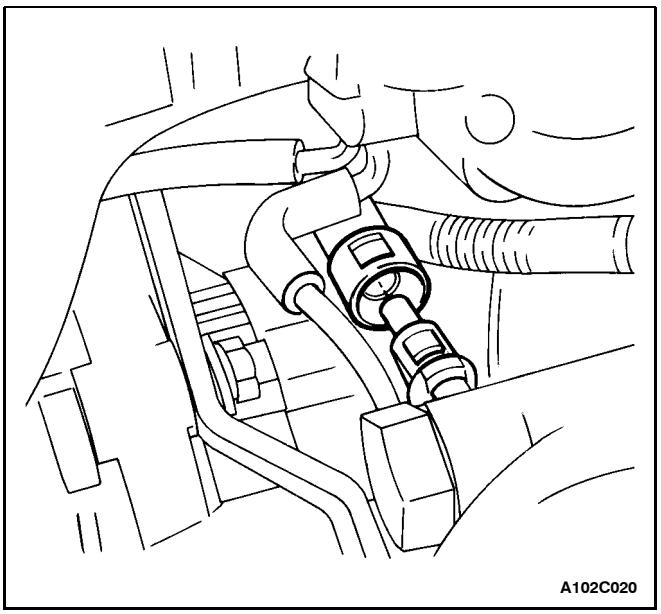
12. Remove the right front wheel. Refer to Section 2E, Tires and Wheels.
13. Remove the right front splash shield.
14. Remove the A/C compressor drive belt, if equipped.
15. Remove the alternator drive belt.
16. Remove the power steering pump pulley bolts.
17. Remove the power steering pump pulley.


A102C164

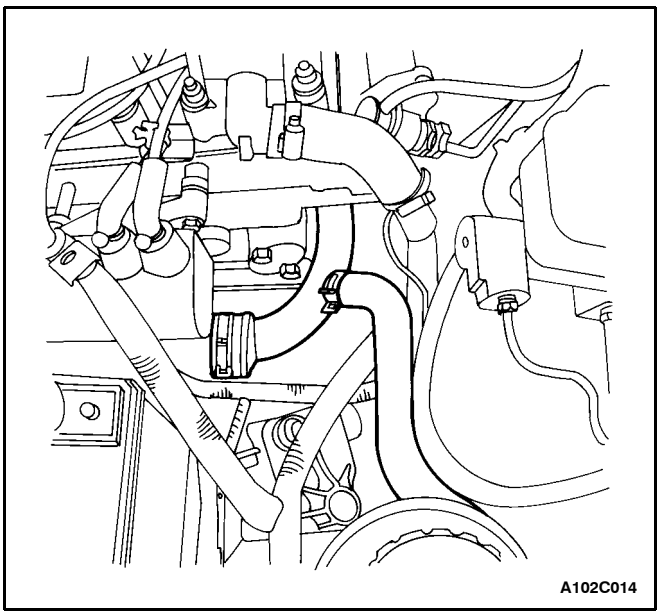
18. Drain the engine coolant. Refer to Section 1D, Engine Cooling.
19. Remove the cooling system radiator and the engine cooling fans. Refer to Section 1D, Engine Cooling.
20. Disconnect the upper radiator hose from the thermostat housing.
21. Disconnect the power steering return hose from the power steering pump, if equipped. Refer to Section 6A, Power Steering System.
22. Disconnect the power steering pressure hose from the power steering pump, if equipped. Refer to Section 6A, Power Steering System.
23. Disconnect the electrical connector at the DIS ignition coil and the ECM ground terminal at the intake manifold and at the starter motor.



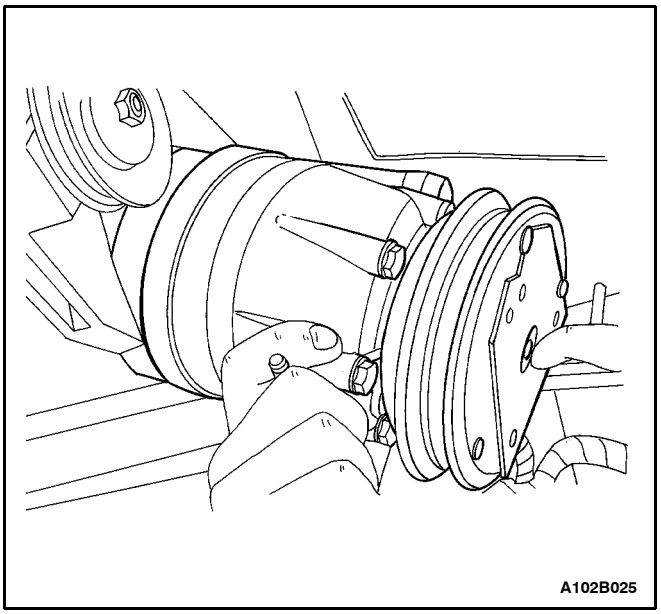
24. Disconnect the oxygen sensor connector.
25. Disconnect the fuel injector harness connectors.
26. Disconnect the idle air control valve connector.
27. Disconnect the throttle position sensor connector.
28. Disconnect the engine coolant temperature sensor connector.
29. Disconnect the coolant temperature sensor connector.
30. Disconnect the alternator voltage regulator connector.



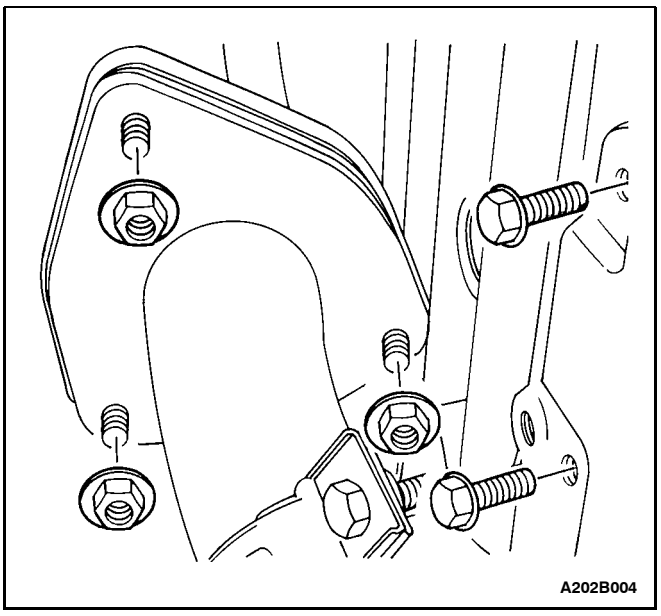
31. Disconnect all of the necessary vacuum lines including the brake booster vacuum hose.
32. Disconnect the fuel return line at the fuel pressure regulator.
33. Disconnect the fuel feed line at the fuel rail.



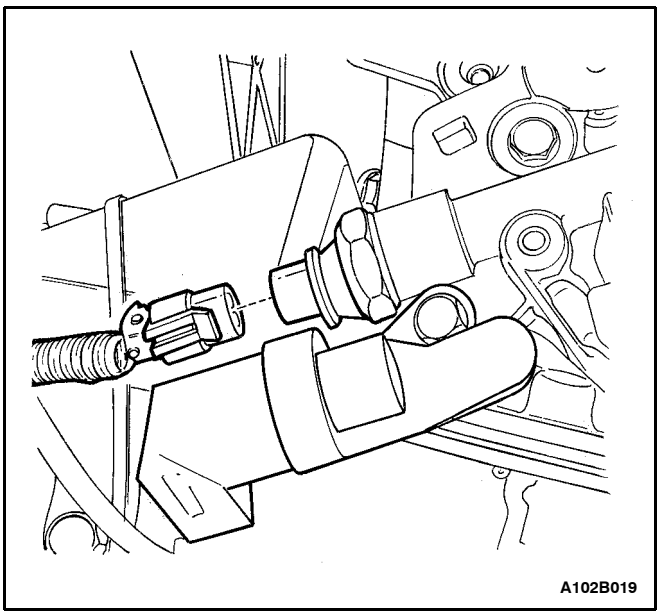
34. Disconnect the throttle cable from the throttle body and the intake manifold bracket.
35. Disconnect the surge tank coolant hose at the throttle body.
36. Disconnect the heater outlet hose at the coolant pipe.
37. Disconnect the heater inlet hose from the cylinder head.
38. Disconnect the surge tank coolant hose from the coolant pipe.
39. Disconnect the lower radiator hose from the coolant pipe.


A102B025

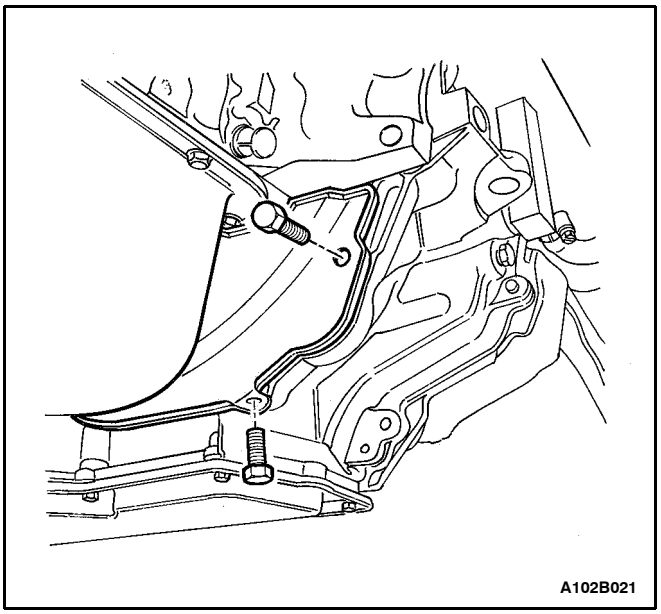
40. Disconnect the starter solenoid "S" terminal wire.
41. Remove the A/C compressor hose assembly retaining bolt.
42. Disconnect the A/C compressor hose assembly from the compressor.
43. Disconnect the electrical connector at the A/C compressor coil.
44. Remove the A/C compressor mounting bolts.
45. Remove the A/C compressor.
46. Remove the A/C compressor mounting bracket bolts from the engine block.
47. Remove the A/C compressor mounting bracket.


A202B004

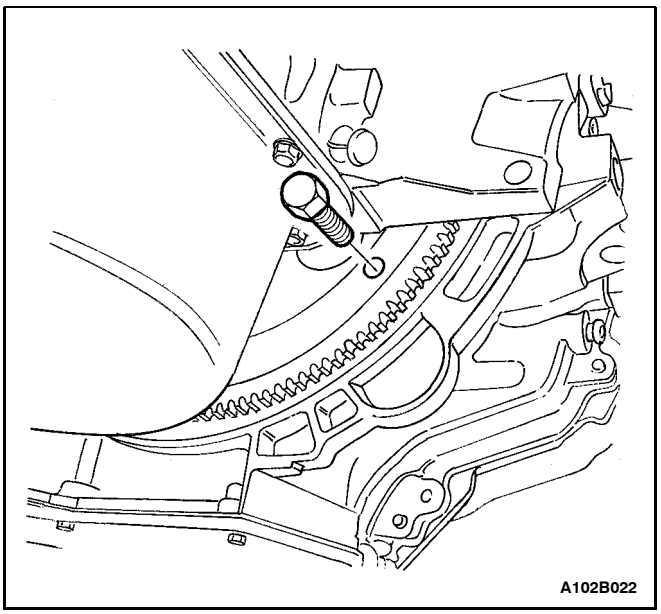
48. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs and the bolts at the bracket.
49. Remove the exhaust flex pipe retaining nuts from the catalytic converter or the connecting pipe.
50. Remove the exhaust flex pipe.


A102B019

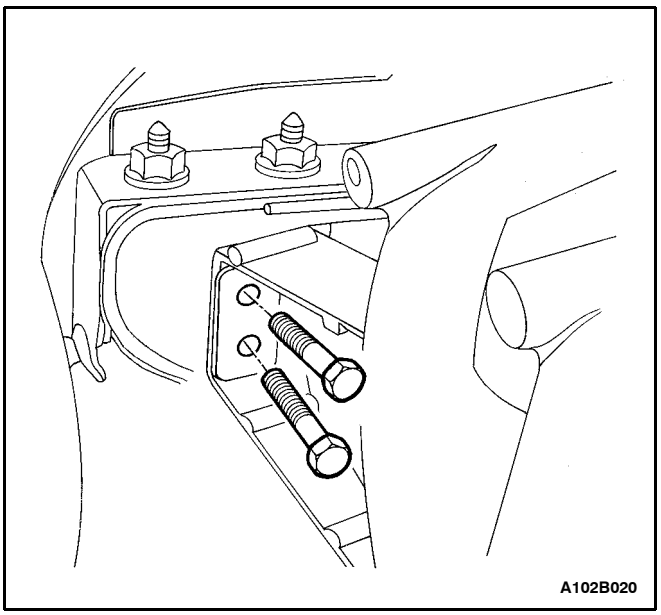
51. Remove the crankshaft pulley bolt.
52. Remove the crankshaft pulley.
53. Disconnect the vacuum lines at the charcoal canister purge and exhaust gas recirculation (EGR) solenoid.
54. Disconnect the electrical connector at the charcoal canister purge and EGR solenoid.
55. Disconnect the electrical connector at the oil pressure switch.
56. Disconnect the crankshaft position sensor and the knock sensor connectors.
57. Remove the crankshaft position sensor retaining bolt.
58. Remove the crankshaft position sensor.


A102B021

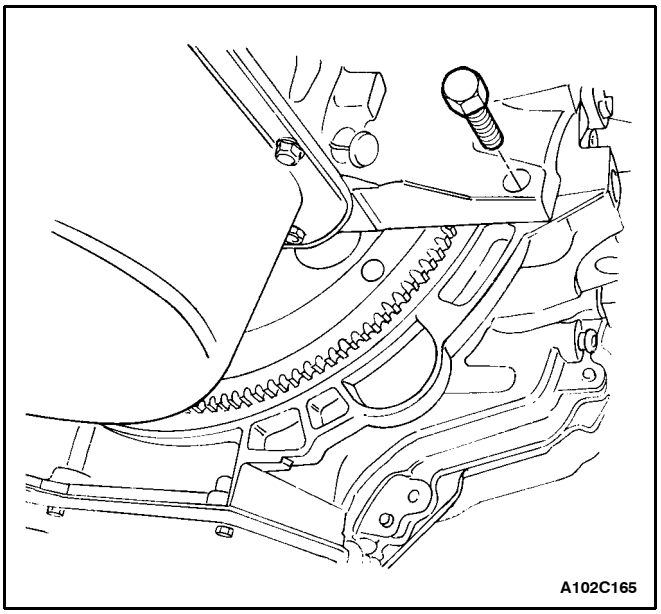
59. Remove the right transaxle brace bolts from the transmission.
60. Remove the flywheel or flexible plate inspection cover bolts.
61. Remove the flywheel or flexible plate inspection cover.


A102B022

62. Remove the transaxle torque converter bolts, if automatic transaxle equipped.
63. Remove the transmission/transaxle bell housing bolts.
64. Support the transmission with a floor jack.
65. Install the engine lifting device.


A102B020

66. Disconnect the right engine mount bracket from the engine mount by removing the retaining bolts.
67. Remove the right engine mount bracket from the engine block.
68. Separate the engine block from the transmission.
69. Remove the engine.

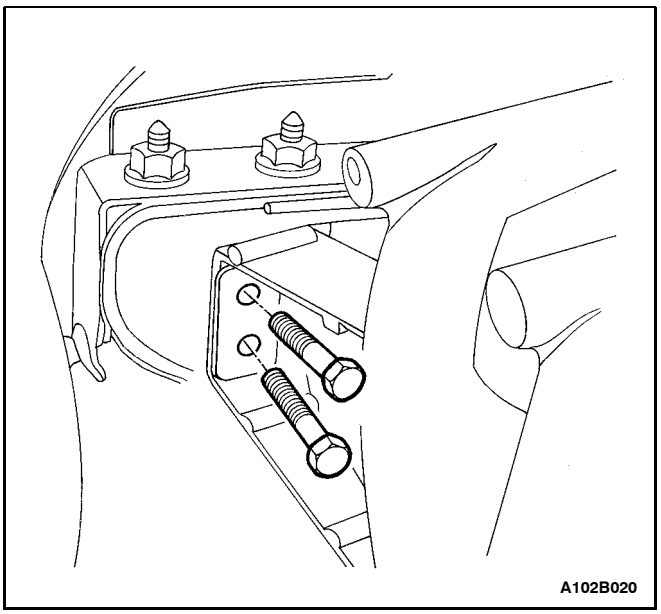

A102C165

Installation Procedure

1. Install the engine into the engine compartment.
2. Align the engine alignment pins to the transmission.
3. Install the transmission/transaxle bell housing bolts.

Tighten

Tighten the transmission/transaxle bell housing bolts to 75 NSm (55 lb-ft).


A102B020

4. Install the right engine mount bracket to the engine block.
5. Install the right engine mount bracket retaining bolts.

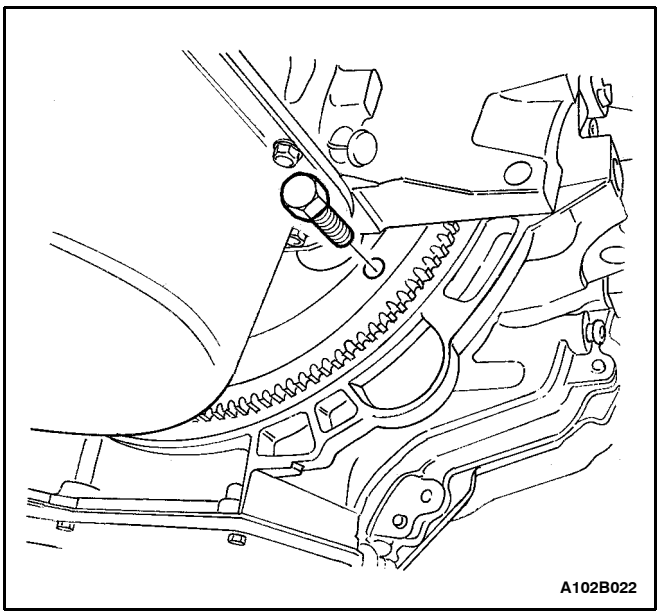
Tighten

Tighten the right engine mount bracket retaining bolts to 60 NSm (44 lb-ft).

6. Connect the right engine mount bracket to the engine mount by installing the two retaining bolts.

Tighten

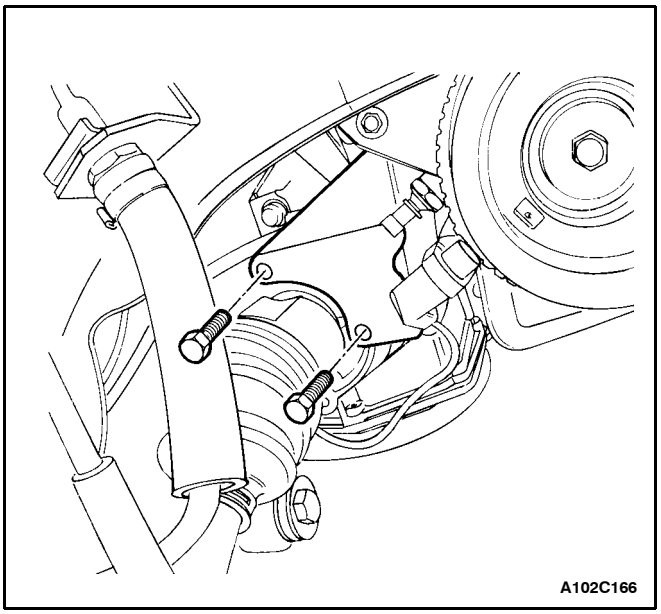
Tighten the right engine mount-to-engine mount bracket retaining bolts to 60 NSm (44 lb-ft).


A102B022

7. Remove the floor jack used for support of the transmission.
8. Remove the engine lifting device.
9. Install the transaxle torque converter bolts, if automatic transaxle equipped.

Tighten

Tighten the transaxle torque converter bolts to 65 NSm (48 lb-ft).


A102C166

10. Install the flywheel or flexible plate inspection cover.
11. Install the flywheel or flexible plate inspection cover bolts.

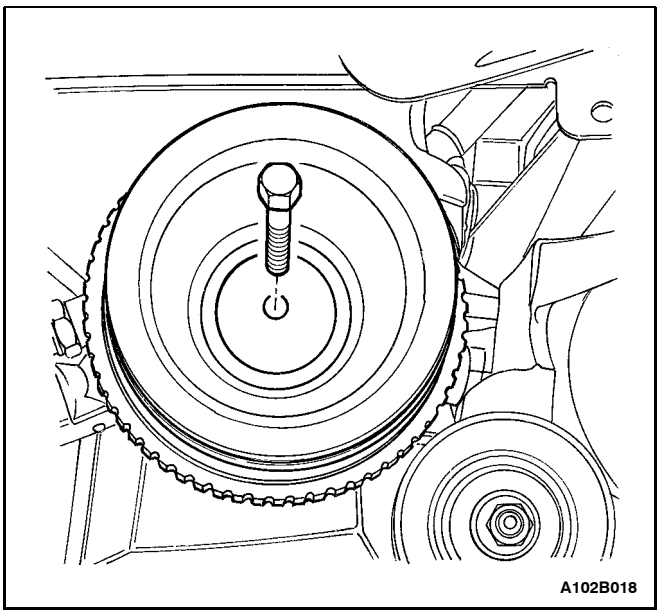
Tighten

Tighten the flywheel inspection cover bolts to 12 NSm (106 lb-in) or the flexible plate inspection cover bolts to 10 NSm (89 lb-in).

12. Install the right transaxle brace bolts to the transmission.

Tighten

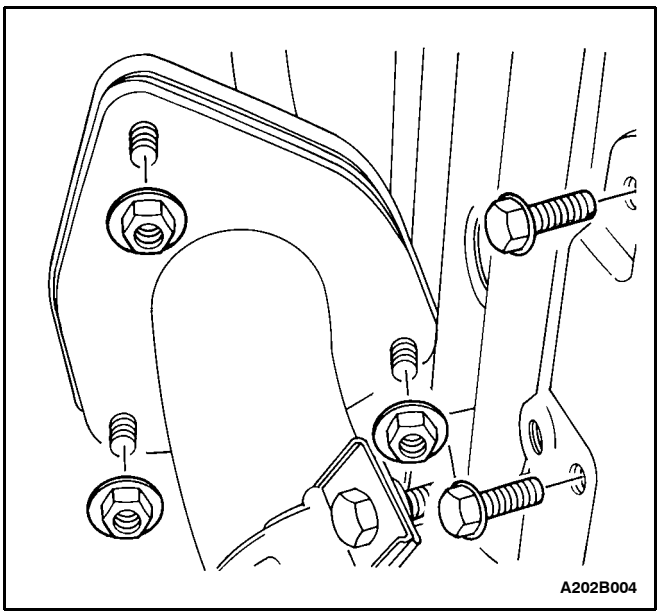
Tighten the right transaxle brace bolts to 40 NSm (30 lb-ft).


A102B018

13. Connect the vacuum lines at the charcoal canister purge and EGR solenoid.
14. Connect the electrical connector charcoal canister purge and EGR solenoid.
15. Connect the oil pressure switch connector.
16. Install the crankshaft pulley.
17. Install the crankshaft pulley bolt.

Tighten

Tighten the crankshaft pulley bolt to 95 NSm (70 lb-ft) using a torque wrench. Using the angular torque gauge KM-470-B, tighten the crankshaft pulley bolt to 30 degrees +15 degrees.


A202B004

18. Install the crankshaft position sensor and the crankshaft position sensor retaining bolt.

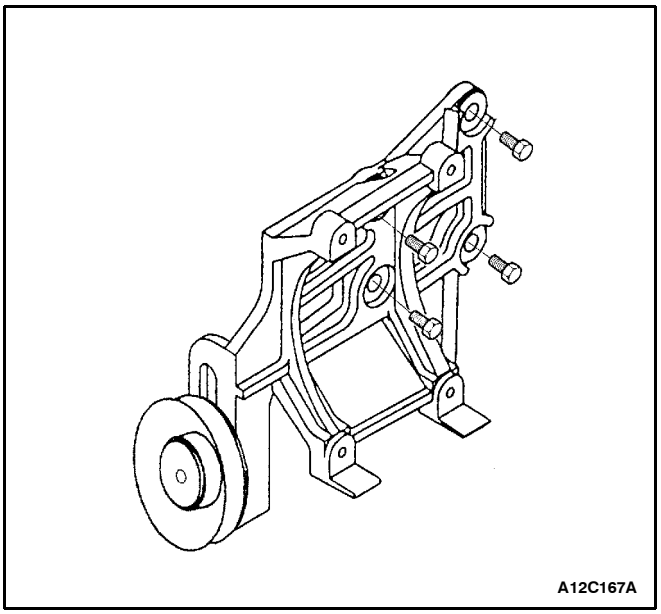
Tighten

Tighten the crankshaft position sensor retaining bolt to 10 NSm (89 lb-in).

19. Connect the crankshaft position sensor and the knock sensor connectors.
20. Install the exhaust flex pipe.
21. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs and the bolts at the bracket.

Tighten

Tighten the exhaust flex pipe retaining nuts and the bolts at the bracket to 40 NSm (30 lb-ft).


A12C167A

22. Install the exhaust flex pipe retaining nuts to the catalytic converter.

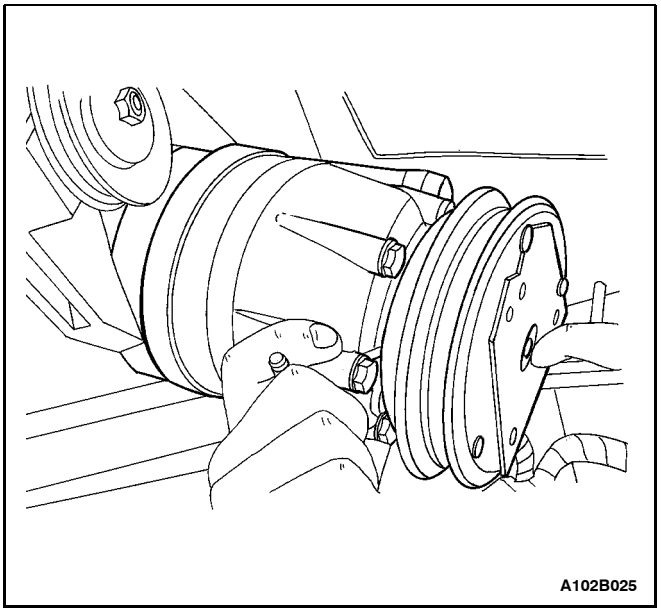
Tighten

Tighten the exhaust flex pipe retaining nuts to the catalytic converter on the connecting pipe or the connecting pipe to 30 NSm (22 lb-ft).

23. Connect the power steering pressure hose, if equipped. Refer to Section 6A, Power Steering System.
24. Connect the power steering return hose, if equipped. Refer to Section 6A, Power Steering System.
25. Install the A/C compressor mounting bracket, if equipped.
26. Install the A/C compressor mounting bracket bolts, if equipped.

Tighten

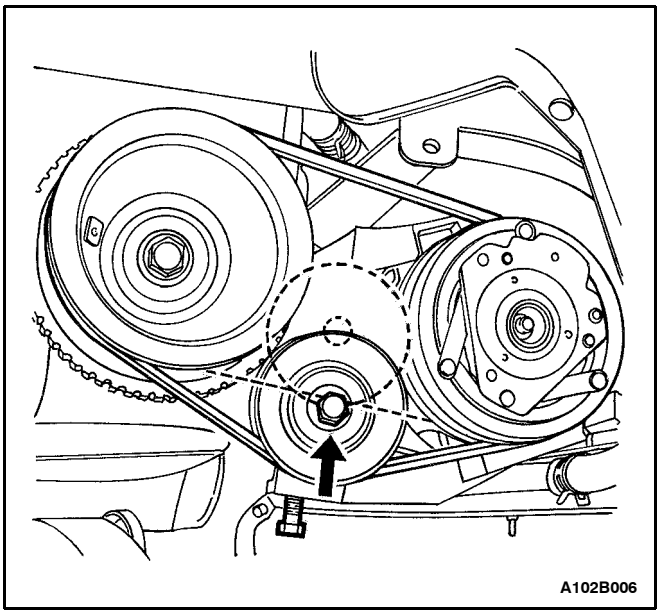
Tighten the A/C compressor mounting brackets bolts to 50 NSm (37 lb-ft).


A102B025

27. Install the A/C compressor, if equipped.
28. Install the A/C compressor mounting bolts, if equipped.

Tighten

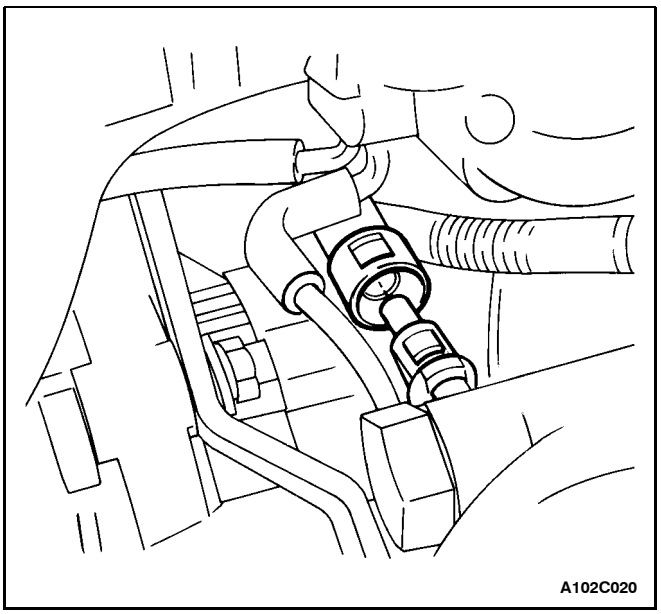
Tighten the A/C compressor mounting bolts to 27 NSm (20 lb-ft).


A102B006

29. Connect the A/C compressor coil connector, if equipped.
30. Install the alternator drive belt.
31. Install the A/C compressor drive belt, if equipped.
32. Connect the A/C compressor hose assembly and the A/C compressor hose assembly retaining bolt, if equipped.

Tighten

Tighten the A/C compressor hose assembly retaining bolt to 33 NSm (24 lb-ft).

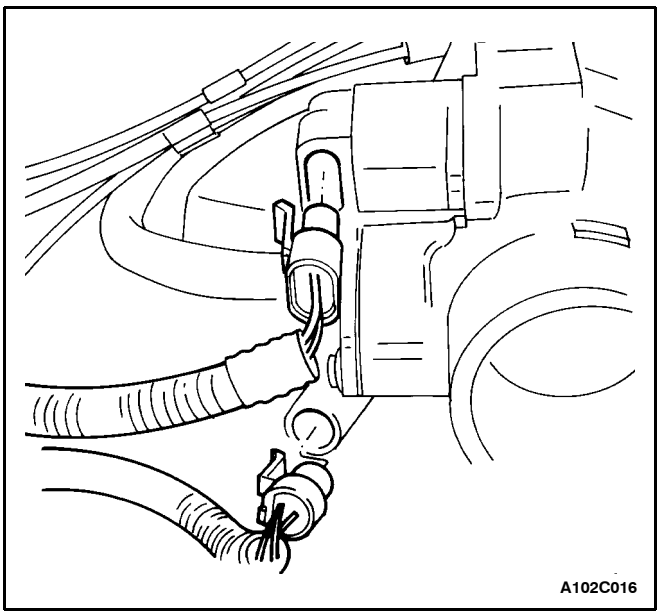

A102C020

33. Install the power steering pump pulley, if equipped.
34. Install the power steering pump pulley bolts, if equipped.

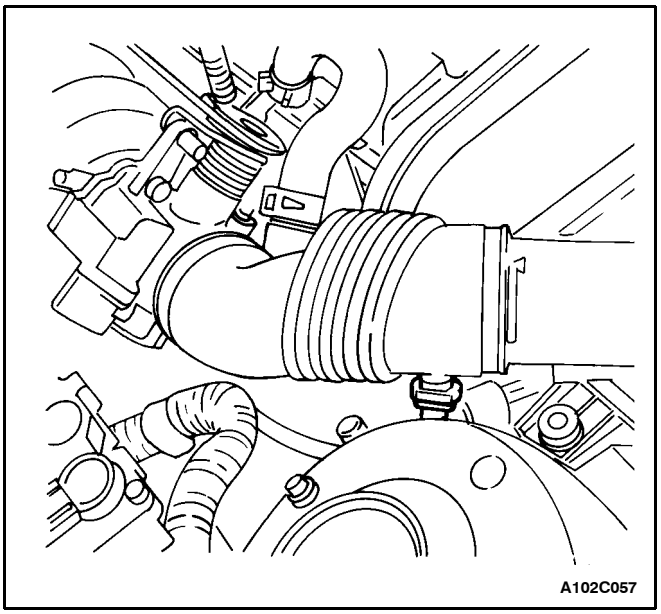
Tighten

Tighten the power steering pump pulley bolts to 25 NSm (18 lb-ft).

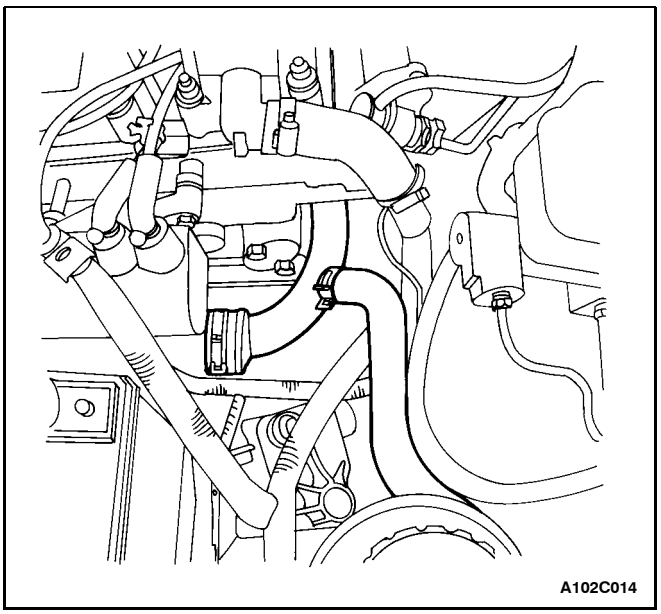
35. Install the right front splash shield.
36. Install the right front wheel. Refer to Section 2E, Tires and Wheels.
37. Connect the fuel feed line to the fuel rail.
38. Connect the fuel return line to the fuel pressure regulator.


A102C016

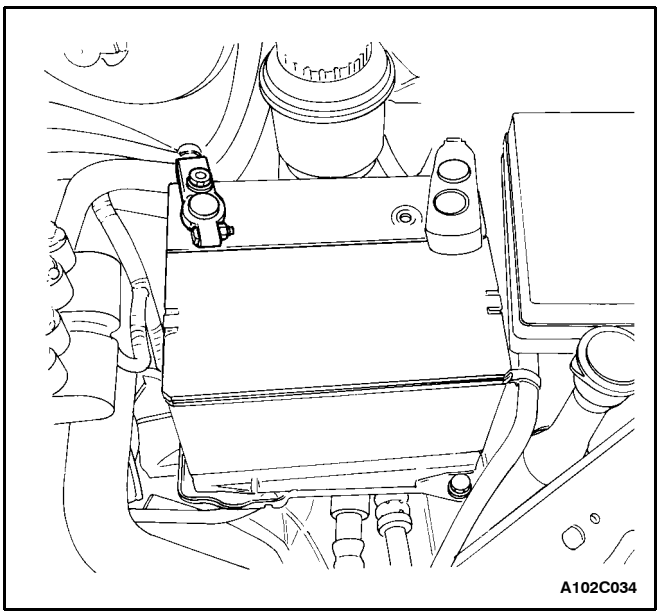
39. Connect all of the necessary vacuum lines including the brake booster vacuum hose.
40. Connect the oxygen sensor connector.
41. Connect the starter solenoid "S" terminal wire.
42. Connect the alternator voltage regulator connector.
43. Connect the coolant temperature sensor connector.
44. Connect the engine coolant temperature sensor connector.
45. Connect the throttle position sensor connector.
46. Connect the idle air control valve connector.


A102C057

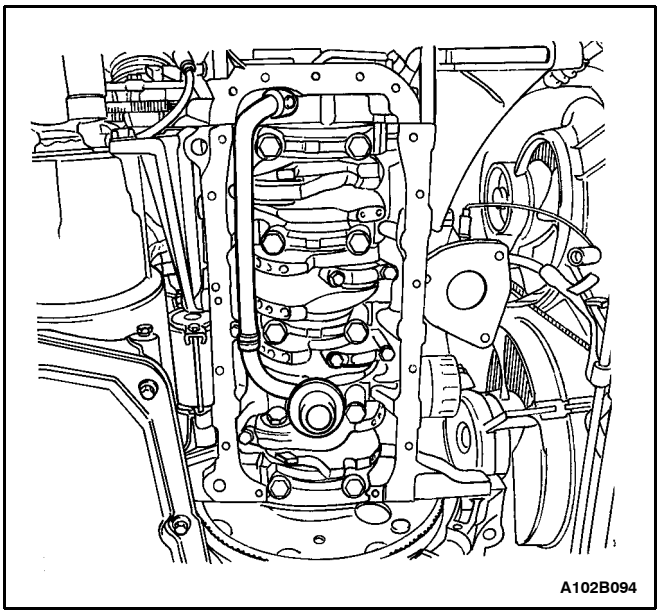
47. Connect the fuel injector harness connectors.
48. Connect the electrical connector at the DIS ignition coil and the ECM ground terminal at the intake manifold and the starter motor.
49. Install the air intake tube between the throttle body and the air filter housing.
50. Connect the breather tubes to the valve cover.
51. Connect the manifold air temperature sensor connector.
52. Install the cooling system radiator and the engine cooling fans. Refer to Section 1D, Engine Cooling.


A102C014

53. Connect the lower radiator hose to the coolant pipe.
54. Connect the upper radiator hose to the thermostat housing.
55. Connect the heater inlet hose to the cylinder head.
56. Connect the heater outlet hose to the coolant pipe.
57. Connect the coolant surge tank hose to the coolant pipe.
58. Connect the surge tank coolant hose to the throttle body.


A102C034

59. Connect the throttle cable to the throttle body and the intake manifold bracket.
60. Install the fuel pump fuse.
61. Connect the negative battery cable to the vehicle frame.
62. Connect the negative battery cable.
63. Connect and assemble the positive battery cable.
64. Refill the engine crankcase with engine oil.
65. Refill the engine coolant system. Refer to Section 1D, Engine Cooling.
66. Bleed the power steering system, if equipped. Refer to Section 6A, Power Steering System.
67. Refill the A/C refrigerant system, if equipped. Refer to Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.
68. Install the hood. Refer to Section 9R, Body Front End.


A102B094

PISTONS AND RODS

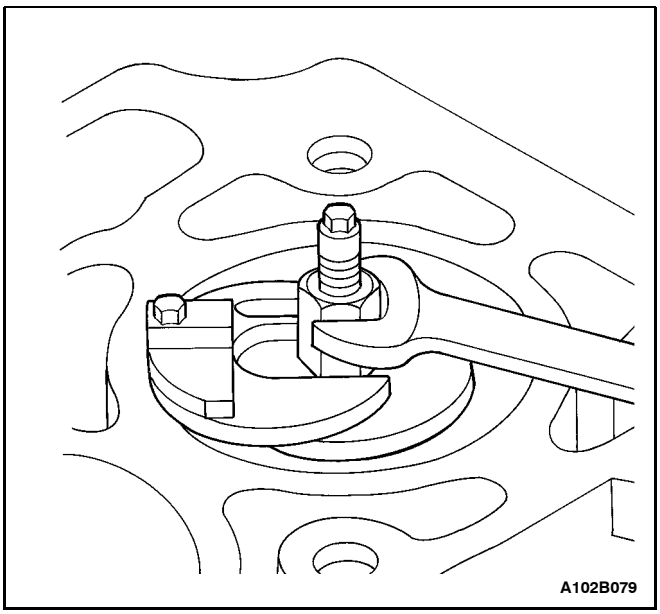
Tools Required

KM-427 Piston Pin Service Set

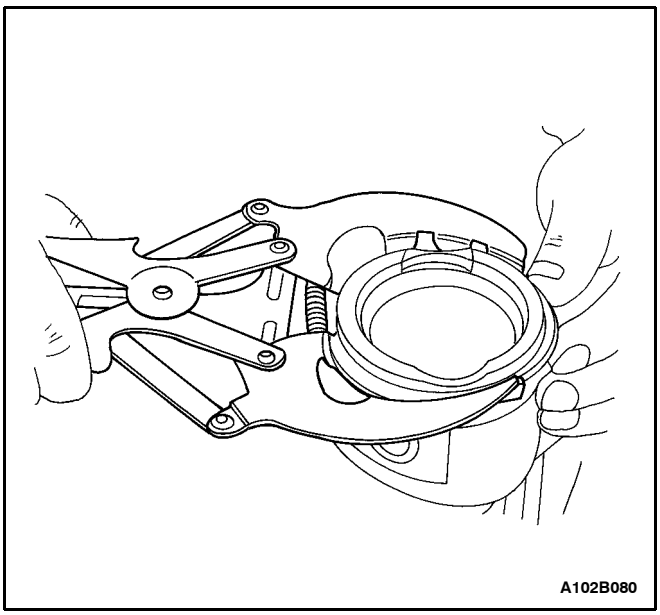
KM 470-B Angular Torque Gauge

Removal Procedure

1. **Remove the cylinder head with the intake manifold and exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.**
2. **Remove the oil pan. Refer to "Oil Pan" in this section.**
3. **Remove the oil pump/pickup tube bolts.**
4. **Remove the oil pump/pickup tube.**

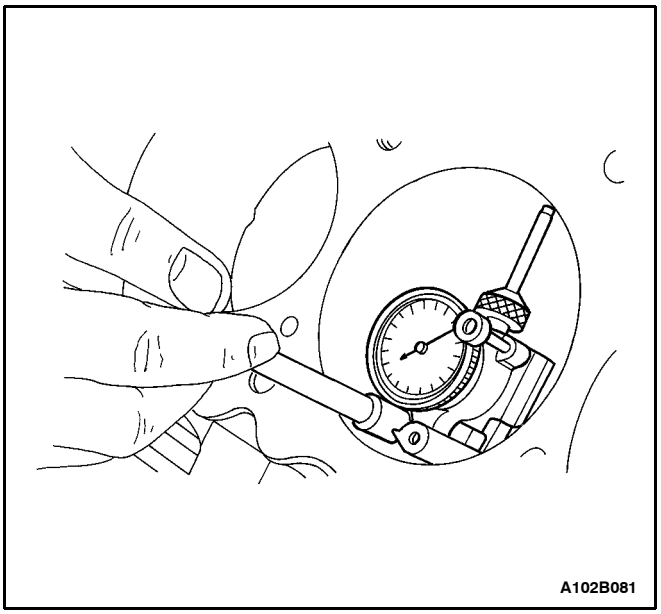

A102B079

5. **Move the piston to the bottom of the piston stroke.**
6. **Mark the connecting rod cap for position.**
7. **Remove the connecting rod cap bolts.**
8. **Remove the connecting rod cap and lower connecting rod bearing.**
9. **Remove the upper piston connecting rod bearing.**
10. **Ridge ream the cylinder wall.**

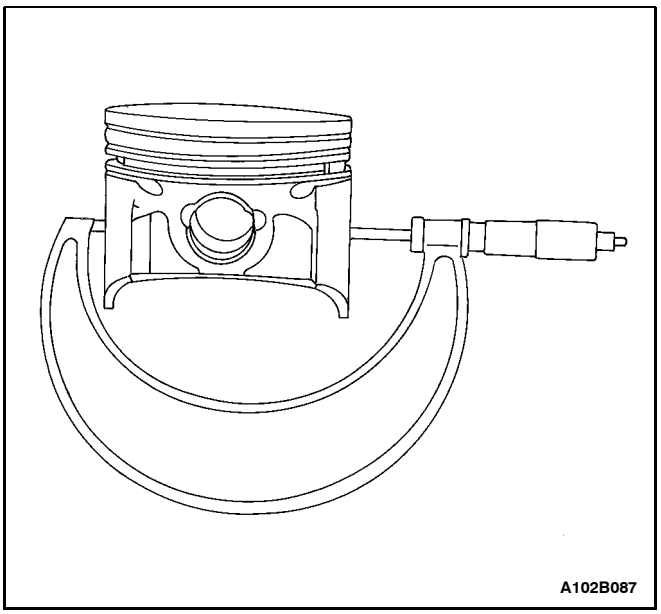

A102B080

Caution: Use care when handling the piston. Worn piston rings are sharp and may cause injury.

11. **Remove the piston.**
12. **Use a piston ring expander tool to expand the piston rings.**
13. **Remove the piston rings.**

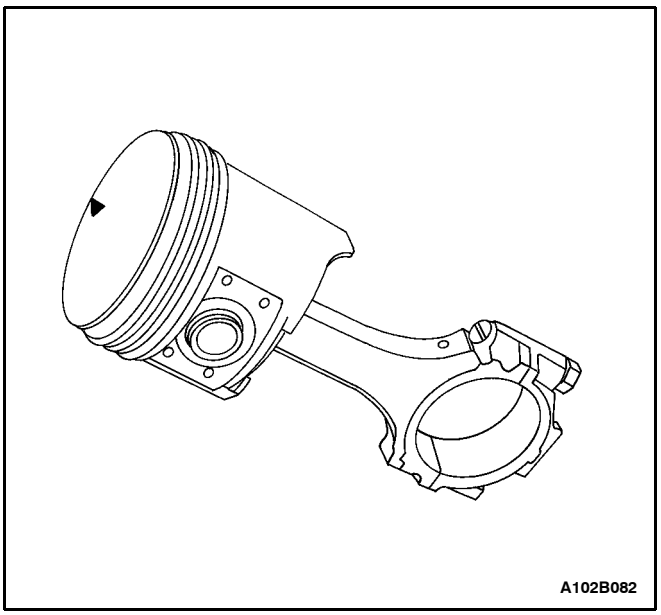

A102B081

14. Remove the piston pin from the piston and connecting rod assembly using the piston pin service set KM-427.
15. Separate the piston from the connecting rod.

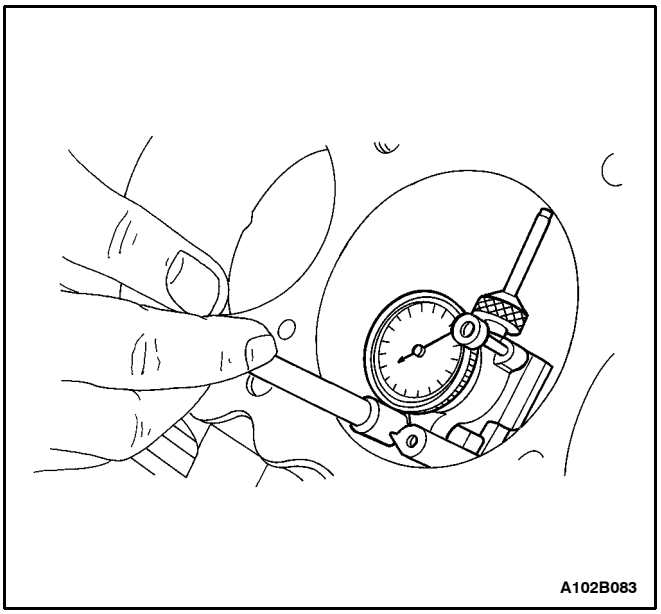

A102B087

Inspection Procedure

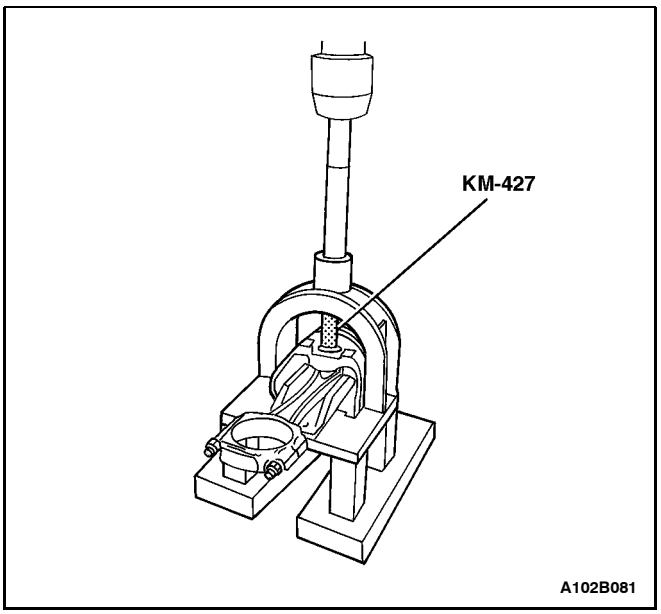
1. Inspect the connecting rod for bending or twisting. If the connecting rod is bent or twisted, replace the connecting rod.
2. Inspect the connecting rod bearings.
3. Inspect the connecting rod lower end for wear.
4. Inspect the connecting rod upper end for scoring.
5. Inspect the crankshaft rod bearing journal for wear. Refer to "Engine Specifications" in this section.
6. Inspect the piston for scoring, cracks, and wear.
7. Inspect the piston for taper using a micrometer.


A102B082

8. Inspect the piston for fit to the connecting rod.


A102B083

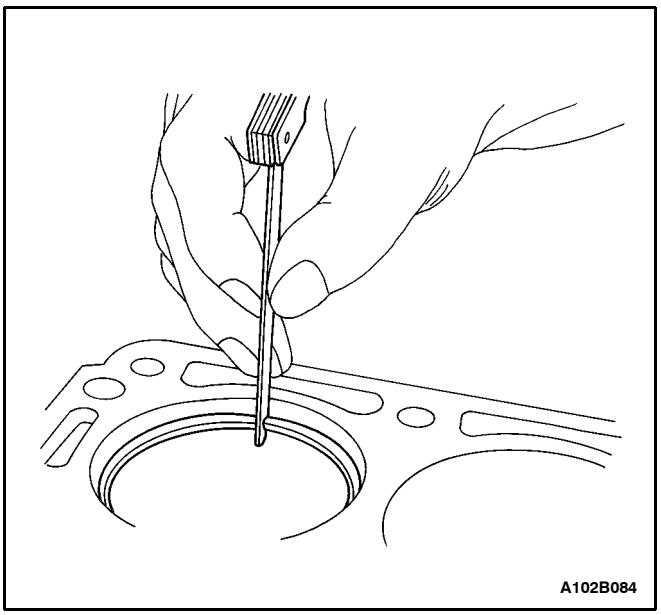
9. Inspect the engine block deck surface for flatness using a straight edge and a feeler gauge. Refer to "Engine Specifications" in this section.
10. Inspect the bearing bore for concentricity and alignment using a bore gauge. Refer to "Engine Specifications" in this section. If the bearing bore is beyond specifications, replace the engine block.
11. Inspect the engine block cylinder bore for wear, runout, ridging and taper using a bore gauge. Refer to "Engine Specifications" in this section.
12. Inspect the engine block cylinder bore for glazing. Lightly hone the cylinder bore as necessary.



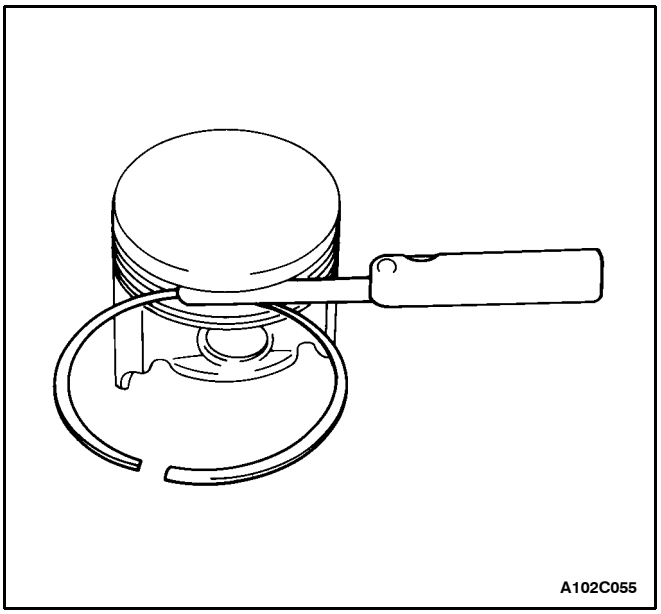
A102B081

Installation Procedure

1. Align the notch on the piston and connecting rod so that the proper sides will be facing the front of the engine.
2. Install the piston pin guide through the piston and the connecting rod.
3. Coat the piston pin with clean oil.
4. Install the piston pin into the opposite side of the piston.
5. Install the piston pin into the piston and connecting rod assembly using the piston pin service set KM-427.

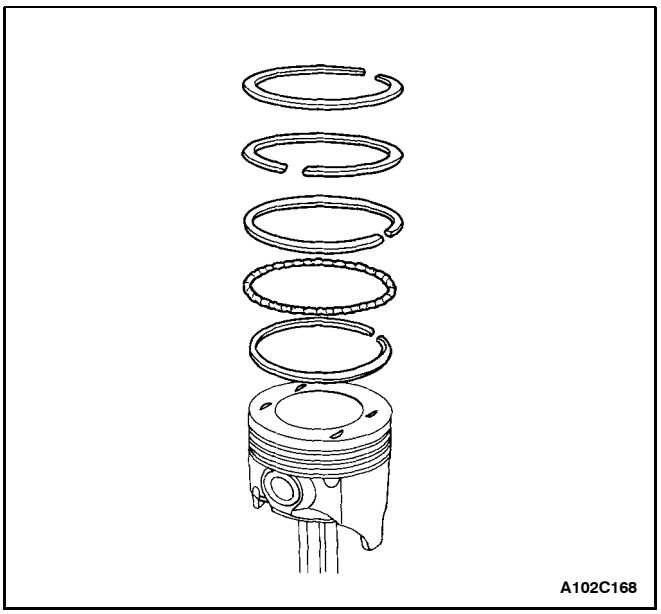

A102B084

6. Select a set of new piston rings.
7. Measure the piston ring gap using a feeler gauge. Refer to "Engine Specifications" in this section.
8. Increase the piston ring gap by carefully filing off excess material if the piston ring gap is below specifications.



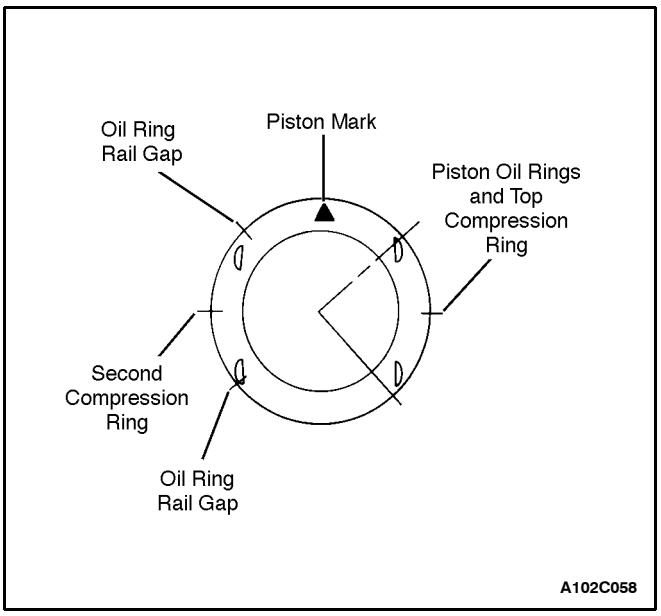
A102C055

9. Measure the piston ring side clearance using a feeler gauge. Refer to "Engine Specifications" in this section.
10. If the piston ring is too thick, try another piston ring.
11. If no piston ring can be found that fits to specifications, the piston ring may be ground to size with emery paper placed on a sheet of glass.



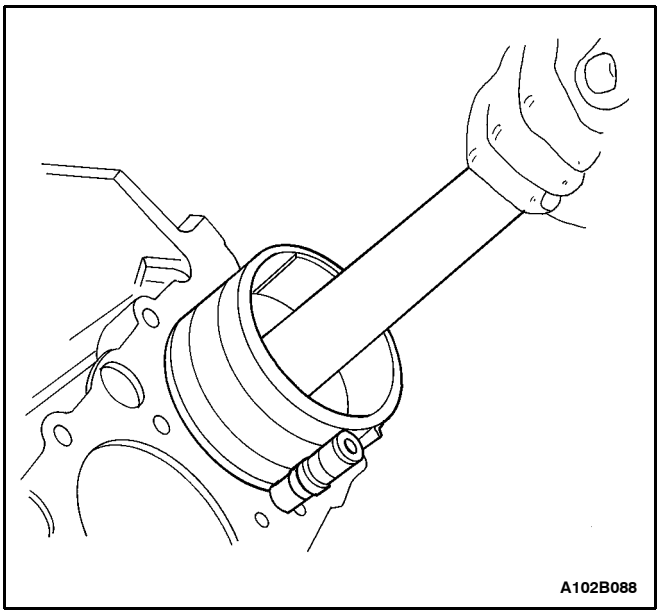
A102C168

12. Install a piston oil ring, the expander, then the second piston oil ring to the bottom ring groove of the piston.
13. Install the second compression ring to the middle ring groove of the piston.
14. Install the top compression ring to the top ring groove of the piston.

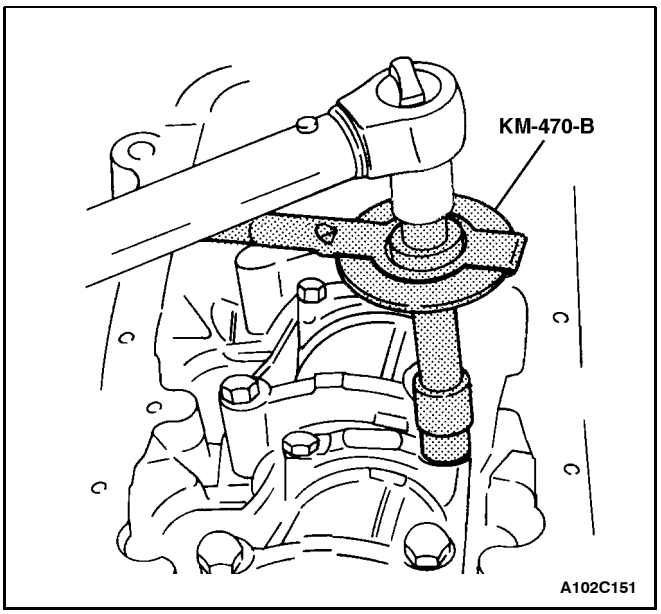


A102C058

15. Use a piston ring expander to install the piston rings. Do not expand the piston rings beyond the expansion necessary for installation.
16. Stagger the piston oil rings, the oil ring rail gaps, the second compression ring, and the top compression ring in relation to the notch on the top of the piston.



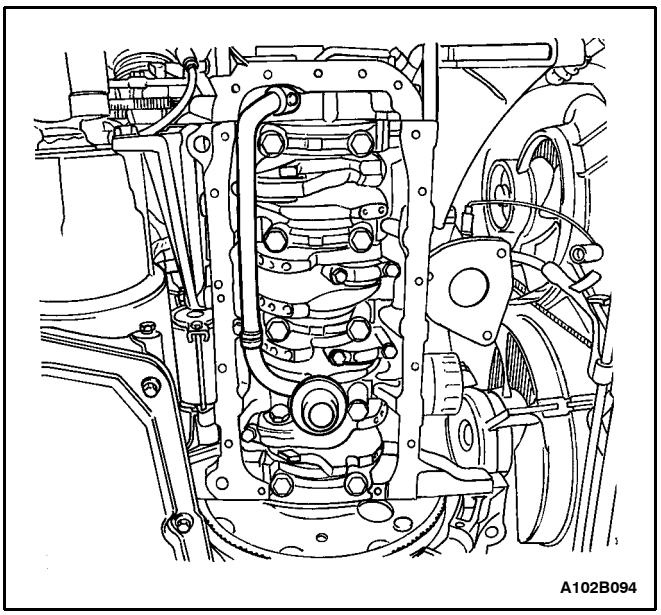
17. Lubricate the cylinder wall and the piston rings with clean engine oil.
18. Install the piston using a ring compressor and a wood handle. Guide the lower connecting rod end to prevent damaging the crankshaft journal.
19. Install the connecting rod cap and bearings. Refer to "Crankshaft Bearings and Connecting Rod Bearings - Gauging Plastic" in this section.



20. Install the connecting rod cap bolts.

Tighten

Tighten the connecting rod cap bolts to 25 NSm (18 lb-ft). Using the angular torque gauge KM 470-B, tighten the bolts one turn of 30 degrees plus one turn of 15 degrees.

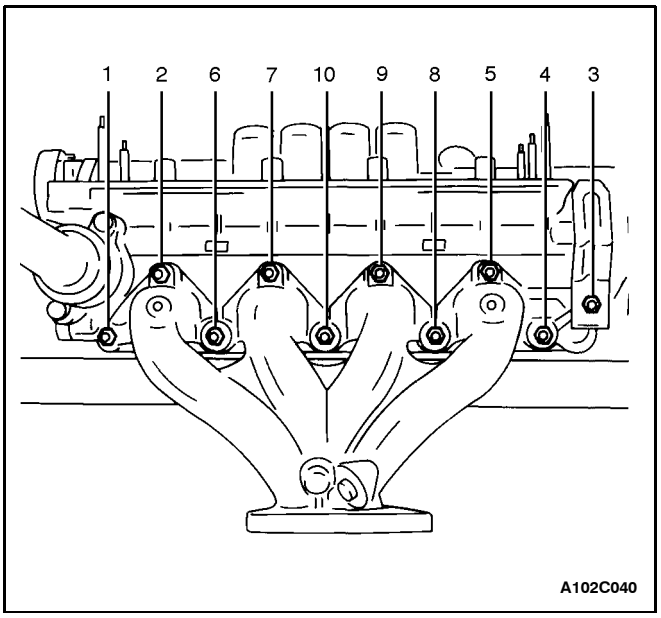


21. Install the oil pump/pickup tube.
22. Install the oil pump/pickup tube bolts.

Tighten

Tighten the oil pickup tube bolts to 10 NSm (89 lb-in).

23. Install the oil pan. Refer to "Oil Pan" in this section.
24. Install the cylinder head with the intake manifold and exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.



UNIT REPAIR

CYLINDER HEAD AND VALVE TRAIN COMPONENTS

Tools Required

MKM-571-B Gauge

KM-340-0 Cutter Set

- **KM-340-7 Guide Drift**
- **KM-340-13 Cutters**
- **KM-340-26 Cutters**

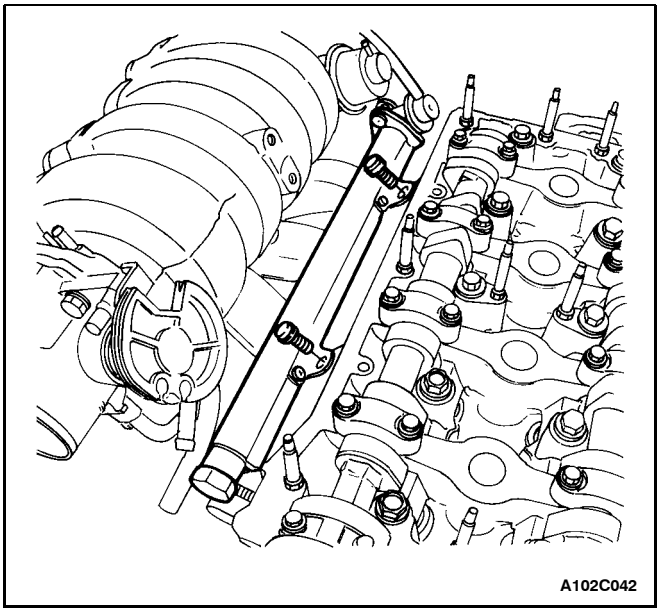
KM-348 Valve Spring Compressor

KM-653 Adapter

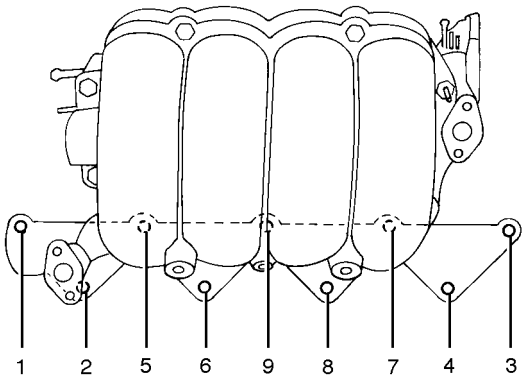
KM-805 Reamer

Disassembly Procedure

1. **Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.**
2. **Remove the coolant temperature sensor.**
3. **Remove the exhaust manifold heat shield bolts.**
4. **Remove the exhaust manifold heat shield.**
5. **Remove the exhaust manifold retaining nuts in the sequence shown.**
6. **Remove the exhaust manifold.**
7. **Remove the exhaust manifold gasket.**
8. **Remove the exhaust manifold studs.**

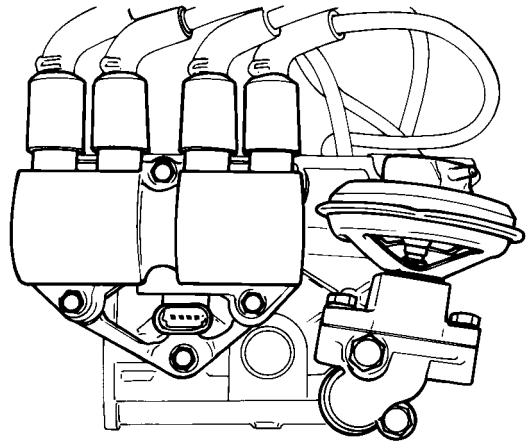


9. **Remove the thermostat housing mounting bolts.**
10. **Remove the thermostat housing assembly.**
11. **Remove the fuel rail retaining bolts and the fuel rail assembly.**



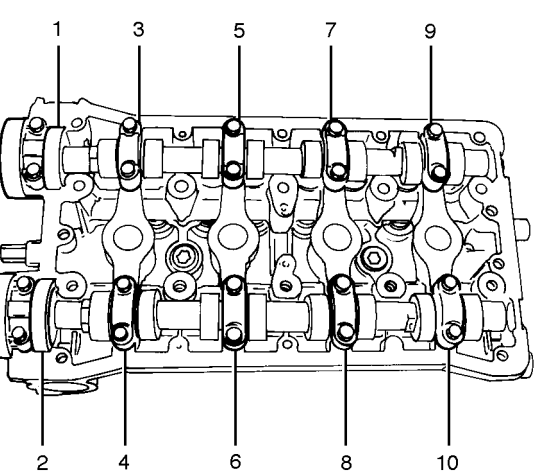
A102C030

12. Remove the intake manifold retaining nuts and retaining bolts in the sequence shown.
13. Remove the intake manifold.
14. Remove the intake manifold gasket.
15. Remove the intake manifold studs.



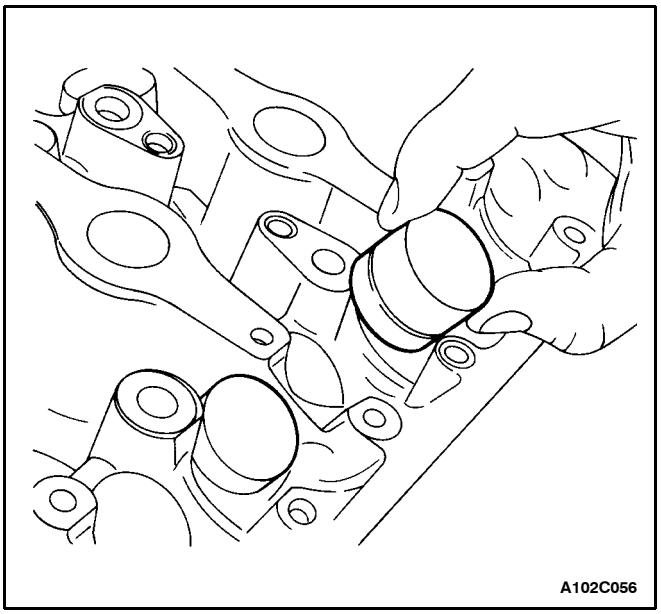
A102C043

16. Remove the DIS ignition coil mounting bolts.
17. Remove the DIS ignition coil with the ignition wires attached.
18. Remove the DIS ignition coil mounting bracket bolts.
19. Remove the DIS ignition coil mounting bracket.
20. Remove the exhaust gas recirculation valve adapter bolts.
21. Remove the exhaust gas recirculation valve adapter.
22. Remove the exhaust gas recirculation valve adapter gasket.
23. Remove the spark plugs.

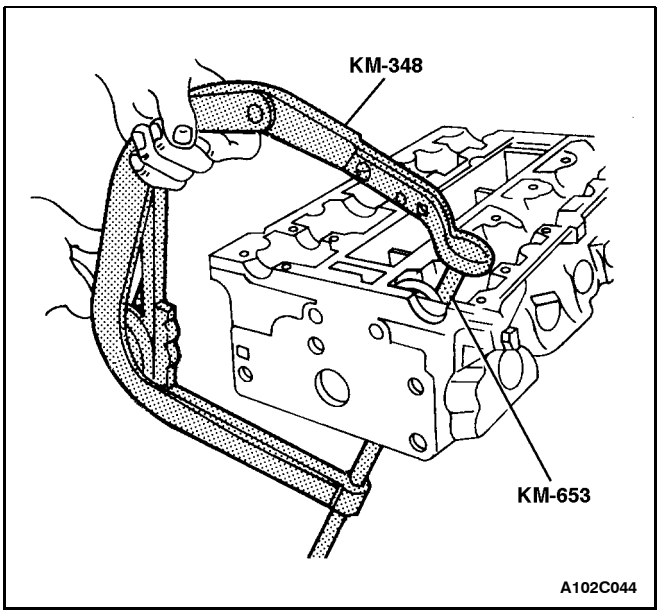


A102C053

24. Remove the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

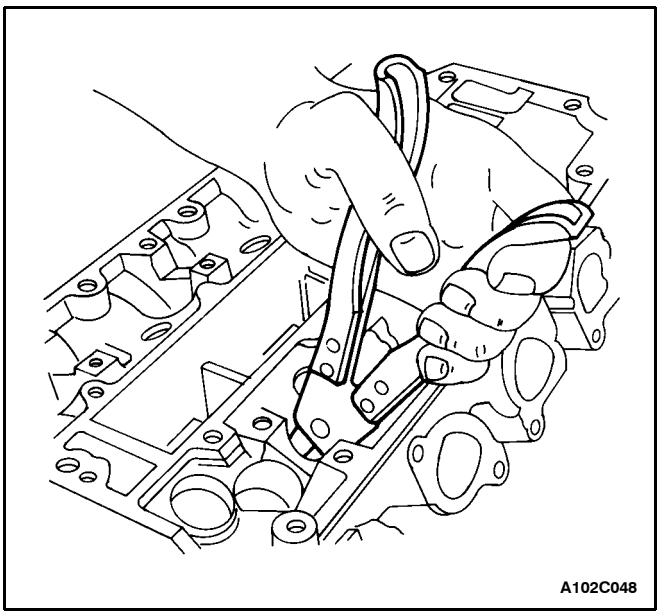

A102C056

25. Remove the intake camshaft caps. Maintain the correct positions for installation.
26. Remove the intake camshaft.
27. Remove the intake valve lash adjusters.
28. Remove the exhaust camshaft caps. Maintain the correct positions for installation.
29. Remove the exhaust camshaft.
30. Remove the exhaust valve lash adjusters.

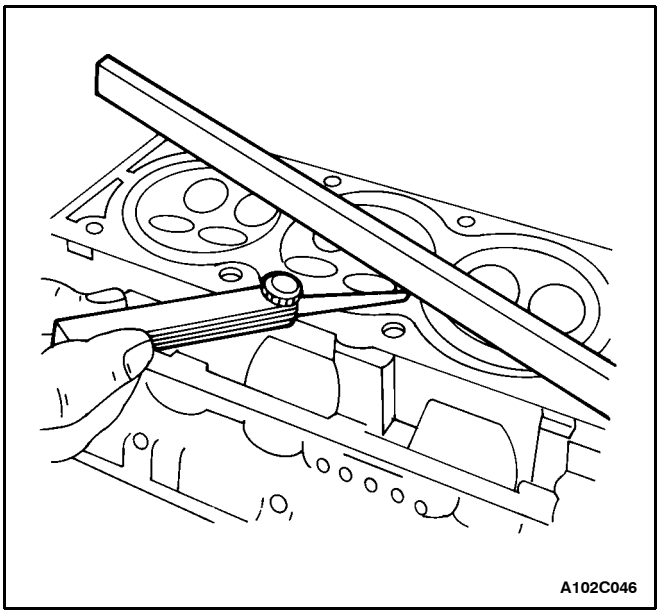


A102C044

31. Compress the valve springs with the valve spring compressor KM-348 and the adapter KM-653.
32. Remove the valve retainers.
33. Remove the valve spring compressor KM-348 and the adapter KM-653.
34. Remove the valve spring caps.
35. Remove the valve springs. Maintain the original position of the valves springs for installation.


A102C048

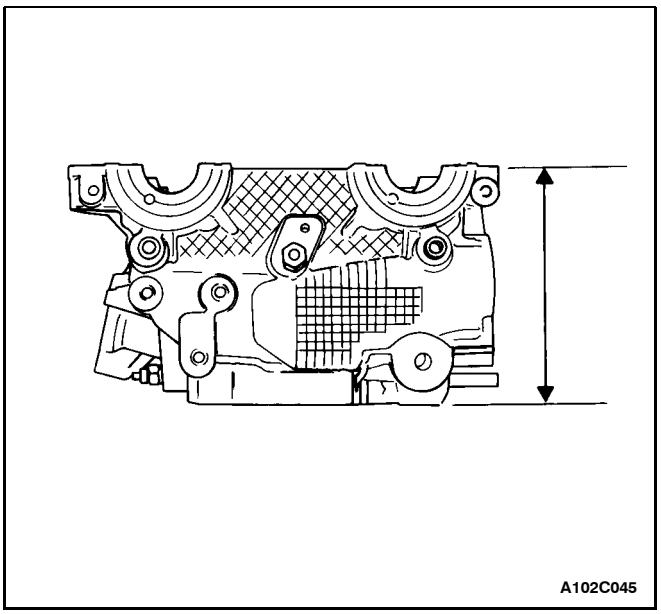
36. Remove the valves. Maintain the original position of the valves for installation.
37. Remove the valve stem seals.



A102C046

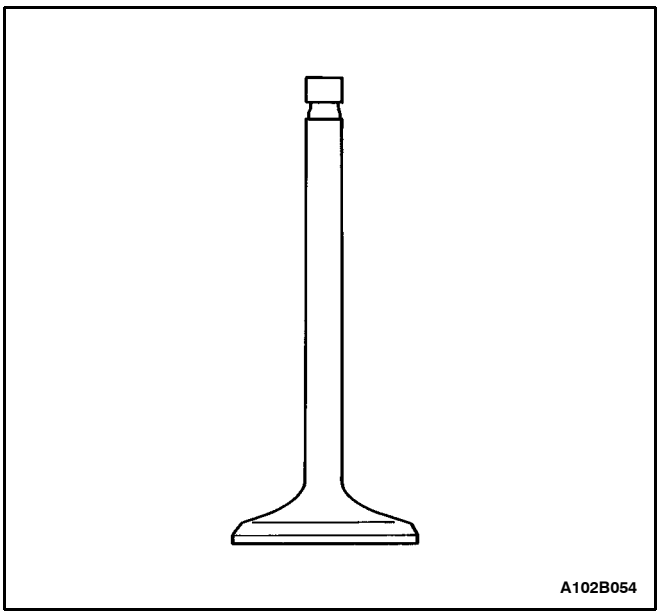
Cylinder Head Inspection

1. Clean the sealing surfaces.
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by.
3. Inspect the cylinder head for cracks.
4. Inspect the length and width of the cylinder head using a feeler gauge and a straight edge.
5. Check the sealing surfaces for deformation and warpage. The cylinder head sealing surfaces must be flat within 0.050 mm (0.002 inch) maximum.



A102C045

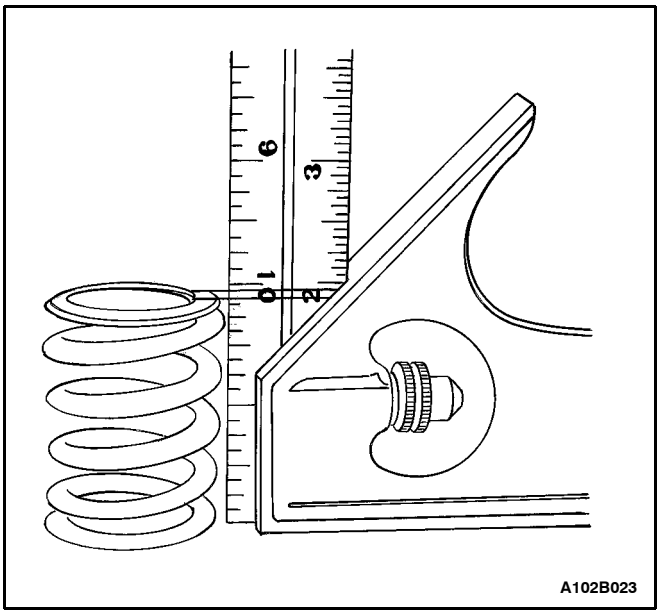
6. Measure the height of the cylinder head from sealing surface to sealing surface. The cylinder head height should be 138.13 to 138.18 mm (5.438 to 5.440 inches). If the cylinder head height is less than 138.13 mm (5.438 inches), replace the cylinder head.
7. Inspect all threaded holes for damage.
8. Valve seats for excessive wear and burned spots.



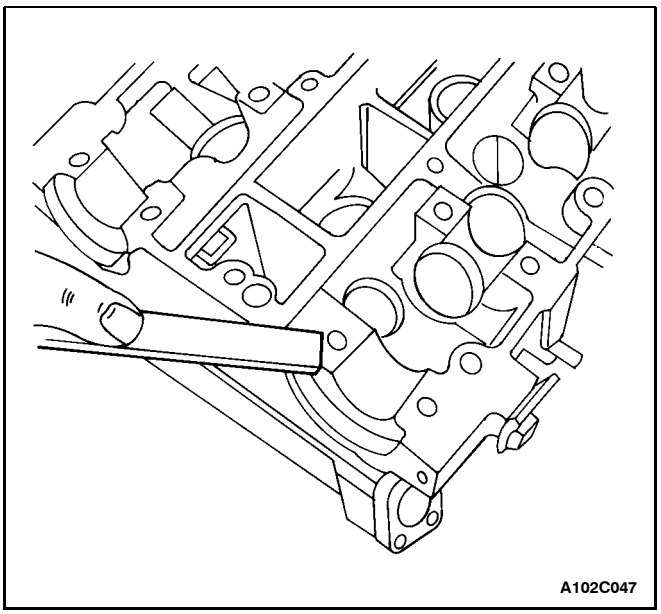
A102B054

Valve Inspection

1. Inspect the valve stem tip for wear.
2. Inspect the valve retainer grooves and the oil seal grooves for chips and wear.
3. Inspect the valves for burns or cracks.
4. Inspect the valve stem for burrs and scratches.
5. Inspect the valve stem. The valve stem must be straight.
6. Inspect the valve face for grooving. If the groove is so deep that refacing the valve would result in a sharp edge, replace the valve.

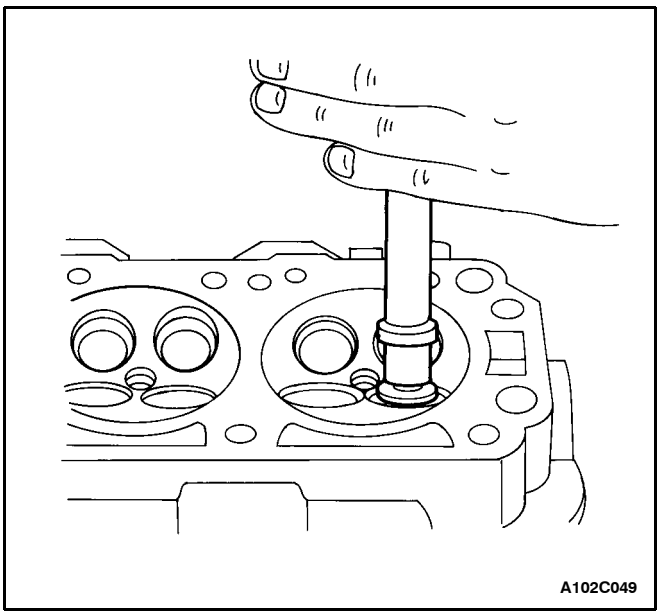


7. Inspect the valve spring. If the valve spring ends are not parallel, replace the valve spring.
8. Measure the valve spring height. Refer to "Engine Specifications" in this section. If the valve spring height does not match the specifications, replace the valve spring.
9. Inspect the valve spring seating surface of the valve rotators for wear or gouges. Replace as required.



Cleaning Procedure

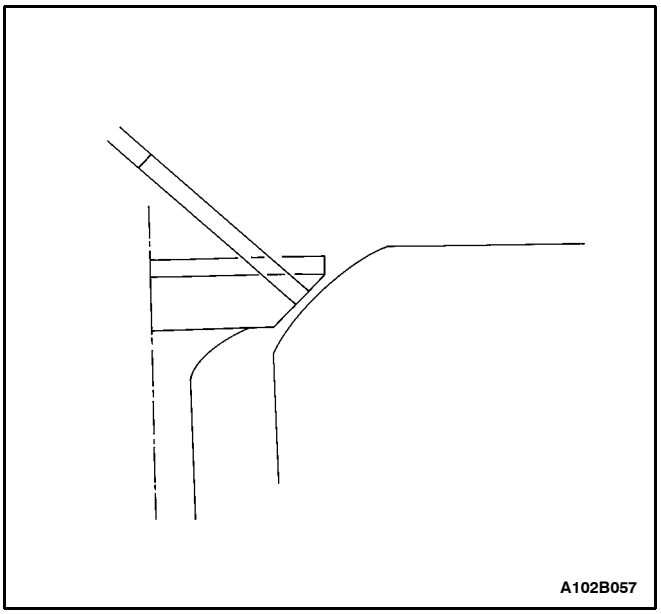
1. Clean the cylinder head.
2. Clean the valve guides.
3. Clean all of the threaded holes.
4. Clean the valves of carbon, oil and varnish.



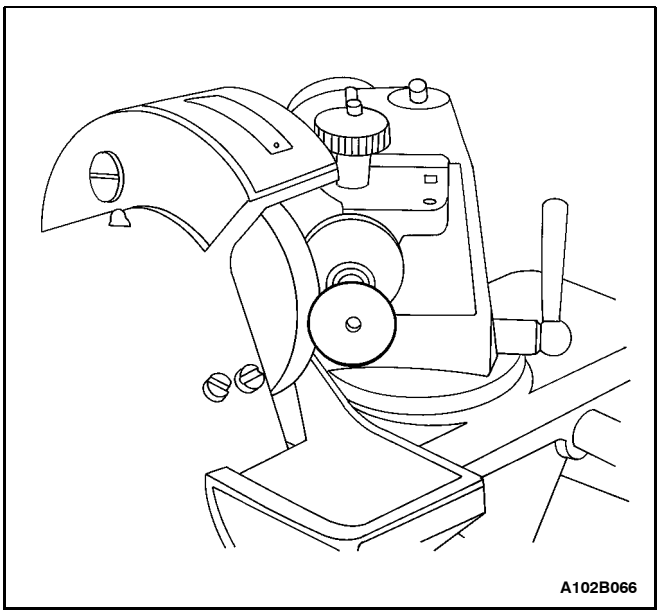
Cylinder Head Overhaul

Valve Grind-in

1. Lubricate the valve stem using a fine-grained paste.
2. Lift the valve rhythmically from the seat with a commercially-available valve grinding tool in order to distribute the paste.

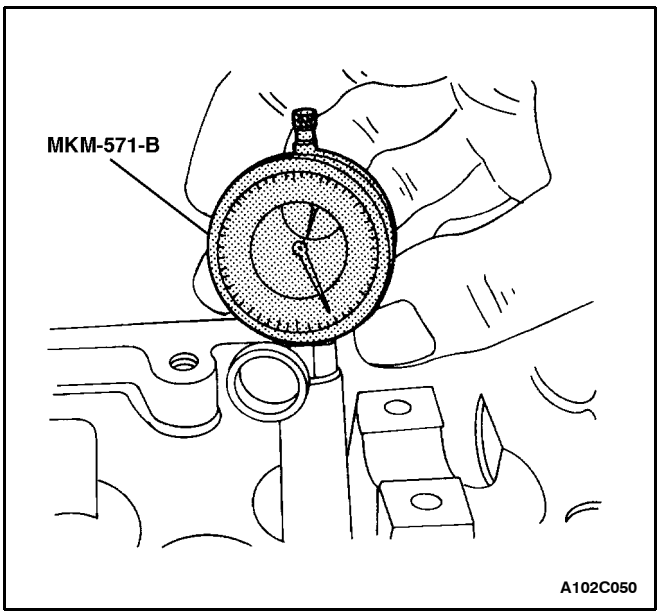

A102B057

3. Check the contact pattern on the valve head and in the cylinder head.
4. Clean the valves, the valve guides, and the cylinder head.


A102B066

Valve Grind

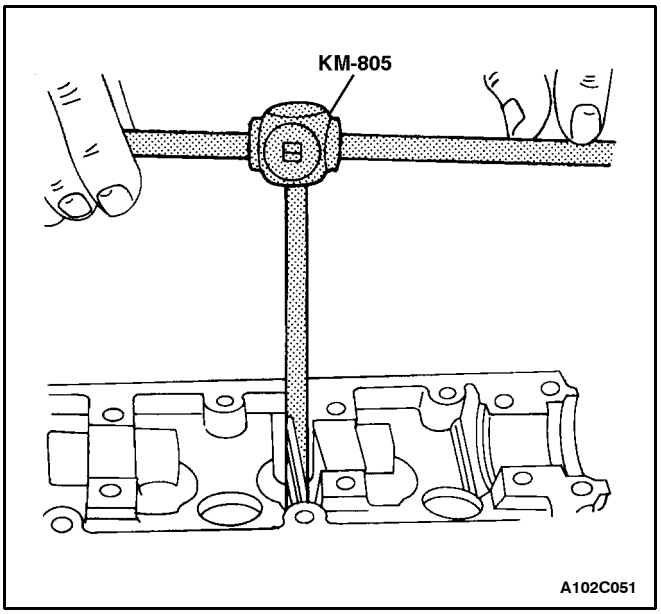
1. Ensure that there are no crater line burns on the valve cone.
2. The valve may be reground only two times. Do not grind the valve stem end.
3. The angle at the valve face is 45 degrees.
4. Inspect the assembly height of the intake valves and the exhaust valves.

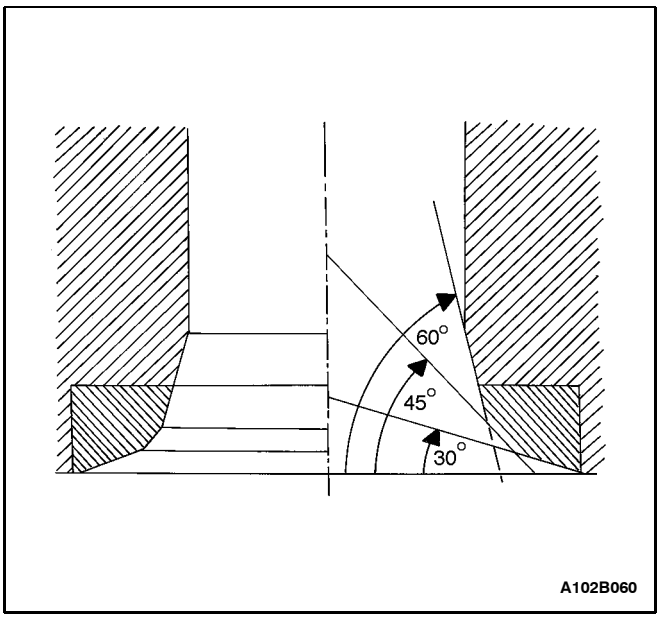


A102C050

Valve Guide - Ream

1. Measure the diameter of the valve guide using gauge MKM-571-B and a commercially-available inside micrometer.





Important: Valve oversizes may already have been fitted in production.

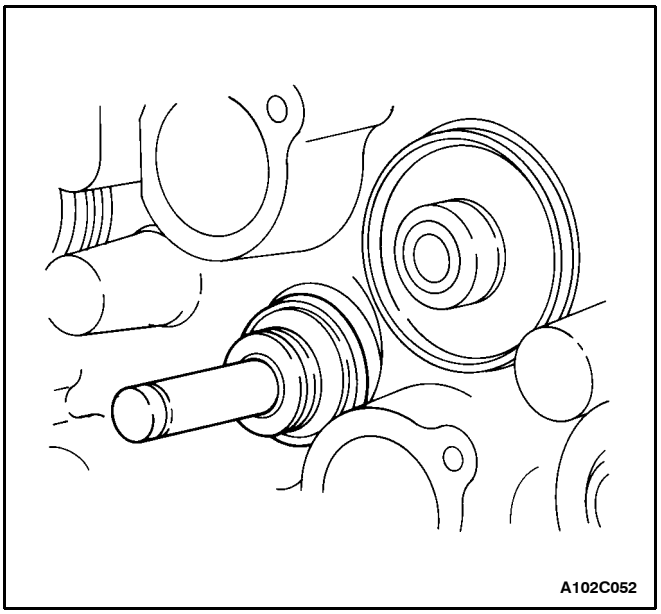
2. **An oversize service code is on the valve guide and the valve stem end. The following table gives the correct size, reamer, and production code for each service.**

Size	Reamer	Production Code	Service Code
Normal	—	—	K
0.075	KM-805	1	K1
0.150		2	K2

3. **Ream the valve guide from the upper side of the cylinder head to the next oversize.**
4. **After reaming, cross out the code and emboss the valve guide with the new code.**

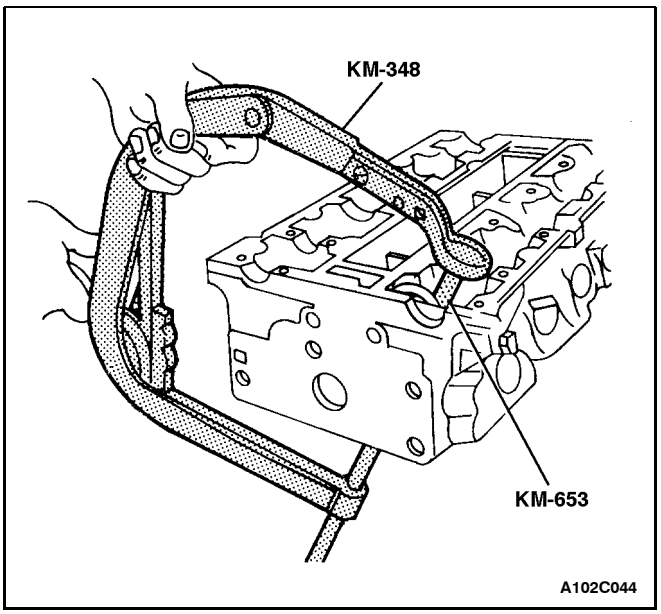
Valve Seat - Cut

1. **Place the cylinder head on wooden blocks.**
2. **Cut the intake and the exhaust valve seats using the guide drift KM-340-7 as follows:**
   - **Valve seat: * 45 degrees side using the cutter KM-340-13.**
   - **Upper correction angle: * 30 degrees side using the cutter KM-340-13.**
   - **Lower Correction Angle: * 60 degrees using cutter KM-340-26.**
3. **Clean the chippings from the cylinder head.**
4. **Inspect the dimension for the valve seat width.**
   - **Intake: 1.17 to 1.57 mm (0.046 to 0.062 inch).**
   - **Exhaust: 1.07 to 1.47 mm (0.042 to 0.058 inch).**
5. **Inspect the assembly height of the intake valves and the exhaust valves.**
6. **If the dimension is exceeded, install new valves. Inspect the assembly height of the intake valves and the exhaust valves again.**
7. **If the valve assembly height is still too large despite replacing the valves, replace the cylinder head.**


A102C052

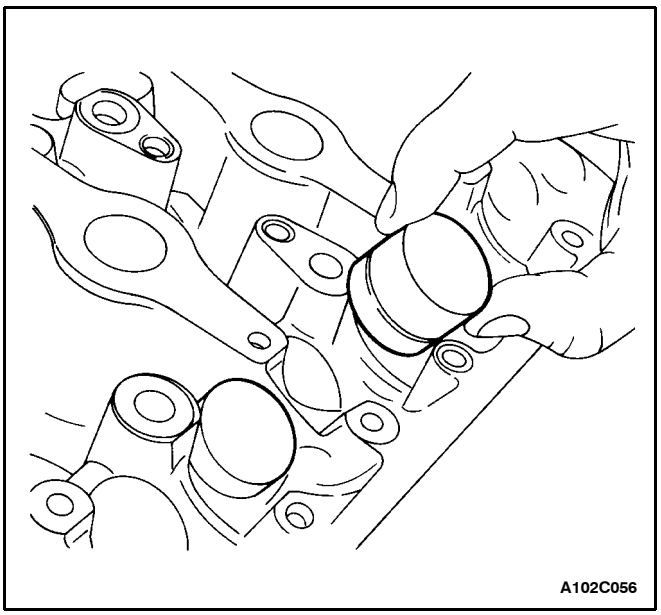
Assembly Procedure

1. Install the valve stem seals.
2. Lubricate the valve stems with engine oil.
3. Carefully install the valves in their original positions. Do not damage the valve stem seals.
4. Install the valve springs in their original positions.
5. Install the valve spring caps.

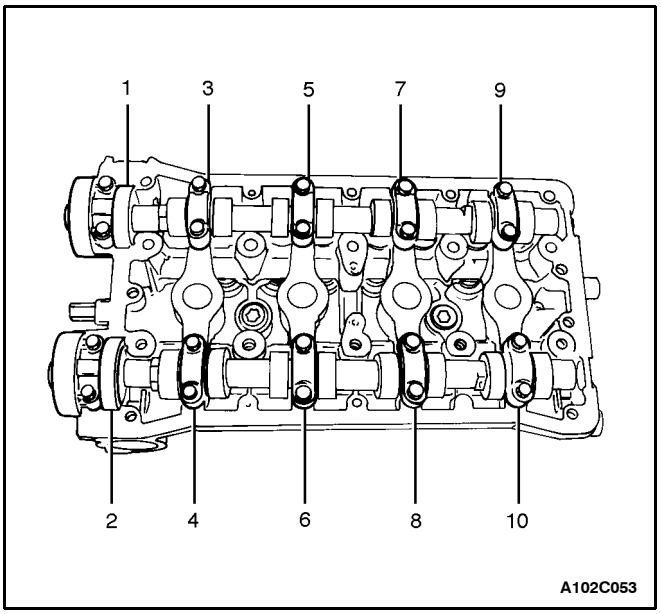


A102C044

6. Compress the valve springs with the valve spring compressor KM-348 and adapter KM-653.
7. Install the valve retainers.
8. Remove the valve spring compressor KM-348 and adapter KM-653.


A102C056

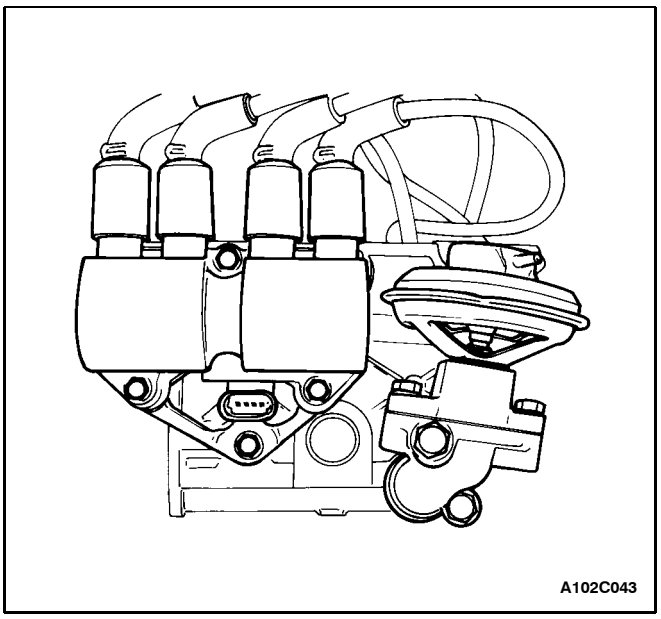
9. Lubricate the valve lash adjusters with engine oil.
10. Install the valve lash adjusters.



11. Install the intake camshaft.
12. Install the intake camshaft caps in their original positions.
13. Install the exhaust camshaft.
14. Install the exhaust camshaft caps in their original positions.
15. Install the camshaft cap bolts.
16. Tighten the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten

Tighten the camshaft cap bolts to 16 NSm (12 lb-ft).



17. Install the spark plugs.

Tighten

Tighten the spark plugs to 25 NSm (18 lb-ft).

18. Install the exhaust gas recirculation valve adapter gasket.
19. Install the exhaust gas recirculation valve adapter.
20. Install the exhaust gas recirculation valve adapter bolts.

Tighten

Tighten the exhaust gas recirculation valve adapter bolts to 25 NSm (18 lb-ft).

21. Install the DIS ignition coil mounting bracket.
22. Install the DIS ignition coil mounting bracket bolts.

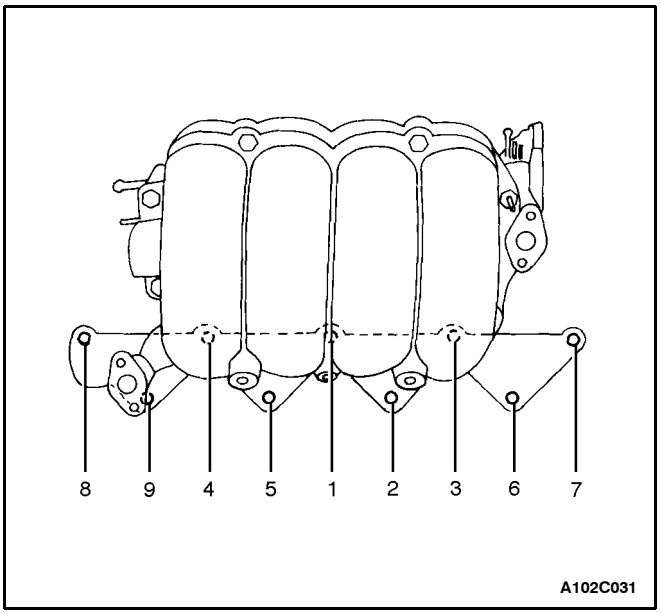
Tighten

Tighten the DIS ignition coil mounting bracket bolts to 10 NSm (89 lb-in).

23. Install the DIS ignition coil with the ignition wires attached.
24. Install the DIS ignition coil mounting bolts.

Tighten

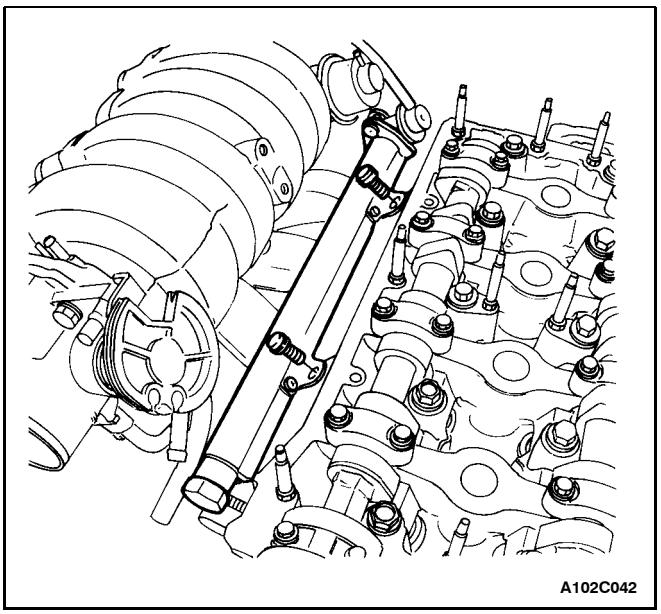
Tighten the DIS ignition coil mounting bolts to 10 NSm (89 lb-in).



25. Install the intake manifold studs.
26. Install the intake manifold gasket.
27. Install the intake manifold.
28. Install the intake manifold retaining nuts and retaining bolts in the sequence shown.

Tighten

Tighten the intake manifold retaining nuts and retaining bolts to 25 NSm (18 lb-ft).



29. Install the fuel rail assembly with the bolts.

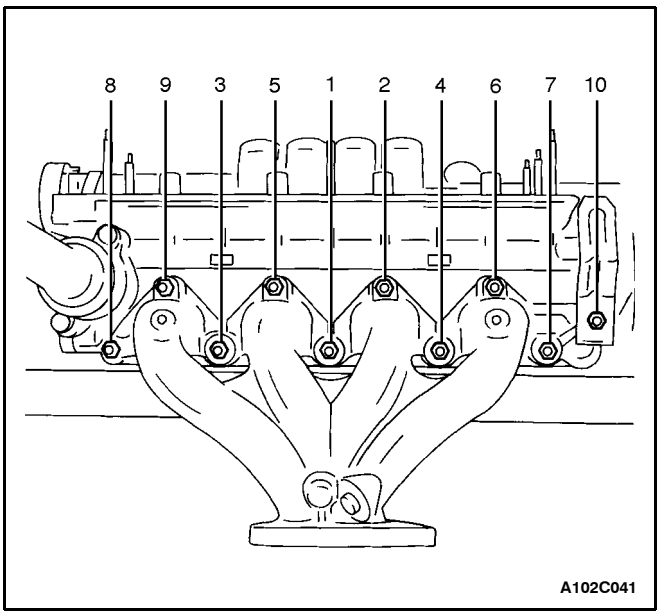
Tighten

Tighten the fuel rail retaining bolts to 25 NSm (18 lb-ft).

30. Install the thermostat housing assembly.
31. Install the thermostat housing mounting bolts.

Tighten

Tighten the thermostat housing mounting bolts to 20 NSm (15 lb-ft).



32. Install the exhaust manifold studs.
33. Install the exhaust manifold gasket.
34. Install the exhaust manifold.
35. Install the exhaust manifold retaining nuts in the sequence shown.

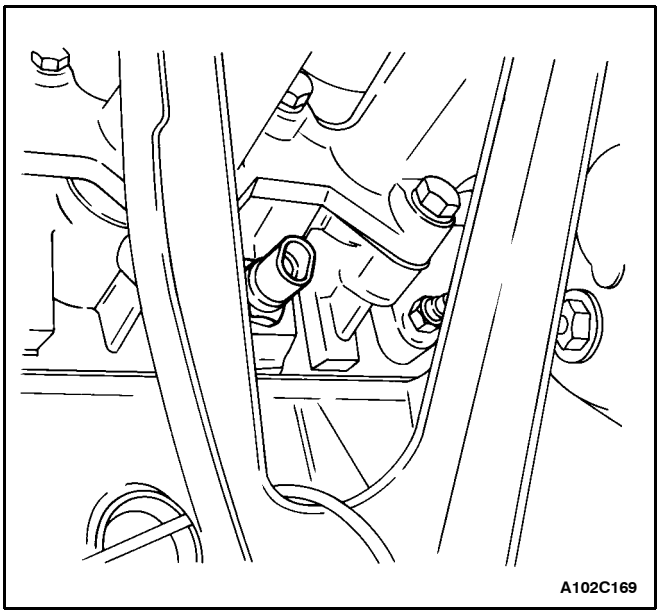
Tighten

Tighten the exhaust manifold retaining nuts to 25 NSm (18 lb-ft).

36. Install the exhaust manifold heat shield.
37. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 15 NSm (11 lb-ft).

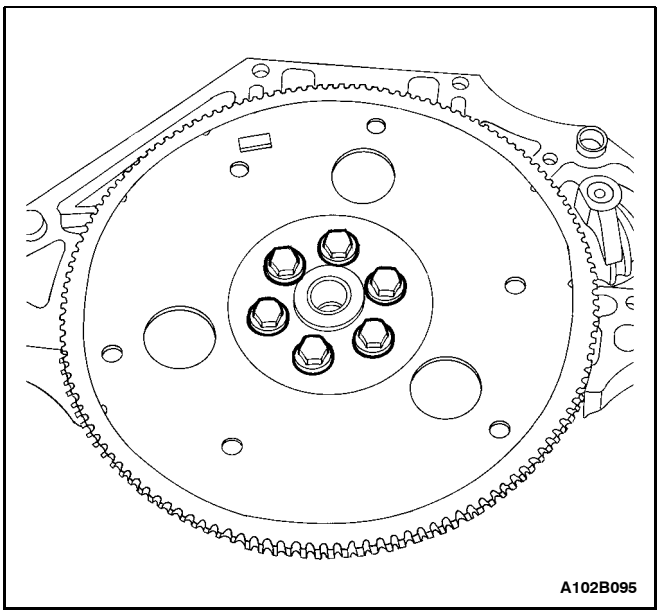

A102C169

38. Install the coolant temperature sensor.

Tighten

Tighten the coolant temperature sensor to 20 NSm (15 lb-ft).

39. Install the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.


A102B095

CRANKSHAFT

Tools Required

KM-412 Engine Overhaul Stand

J-42492 Timing Belt Adjuster

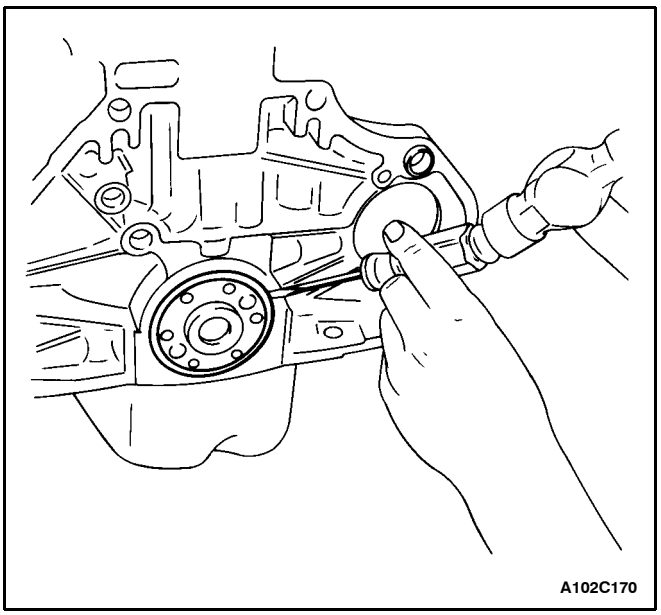
KM-470-B Angular Torque Gauge

J-36792 Crankshaft Rear Oil Seal Installer (or KM-635)

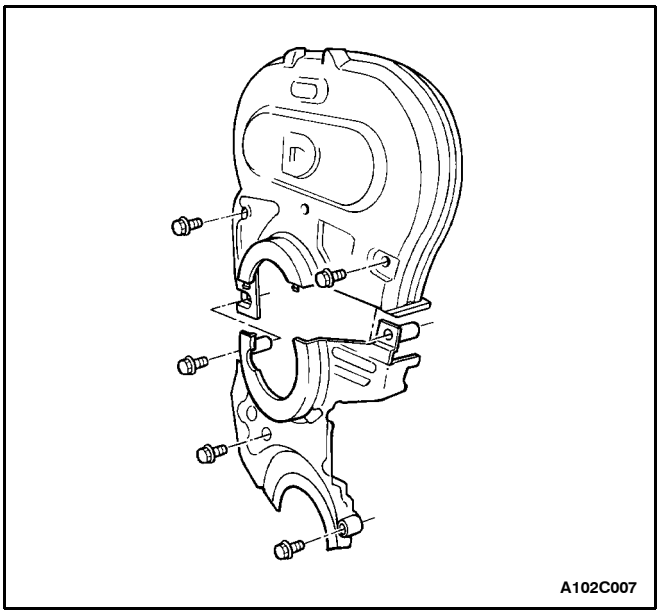
Notice: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

Disassembly Procedure

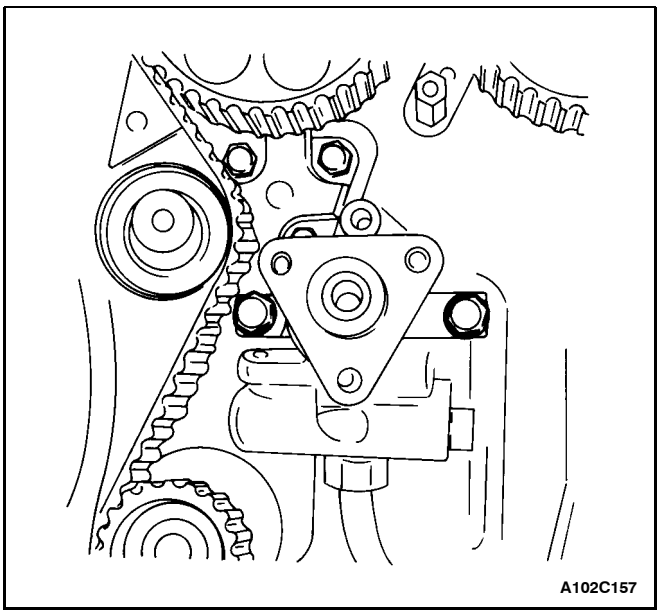
1. Remove the engine. Refer to "Engine" in this section.
2. Remove the flywheel or flexible plate bolts.
3. Remove the flywheel or the flexible plate.


A102C170

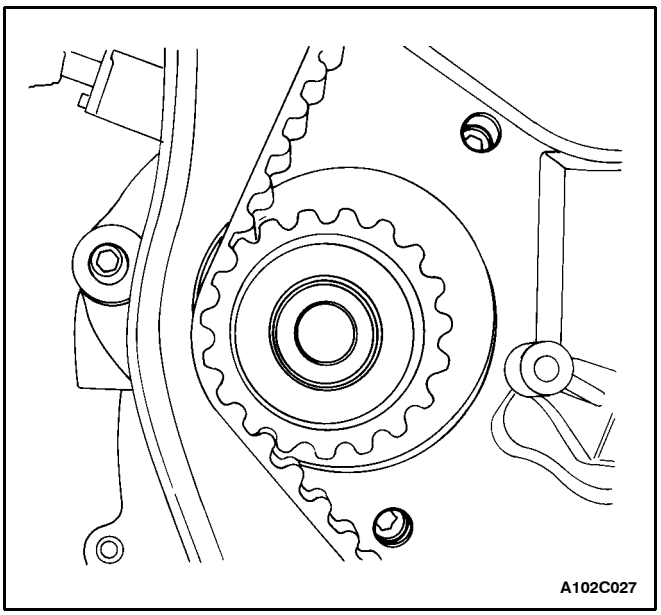
4. Remove the crankshaft rear oil seal.
5. Mount the engine assembly on the engine overhaul stand KM-412.


A102C007

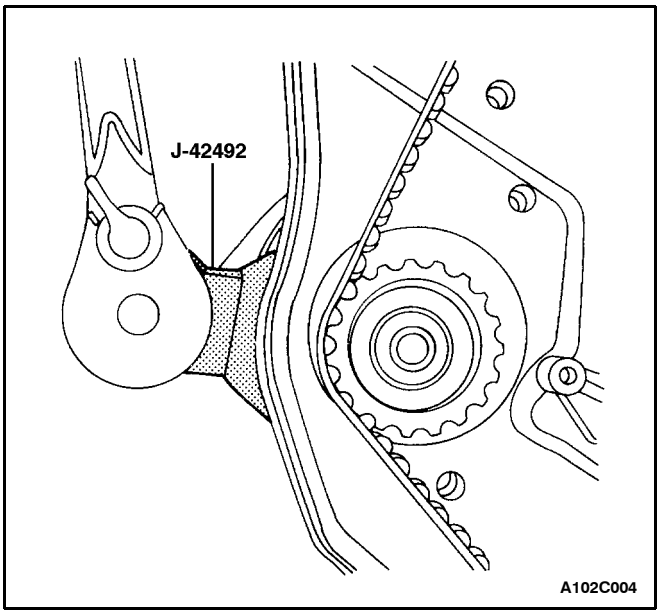
6. Remove the upper and lower front timing belt cover bolts.
7. Remove the upper and lower front timing belt cover.


A102C157

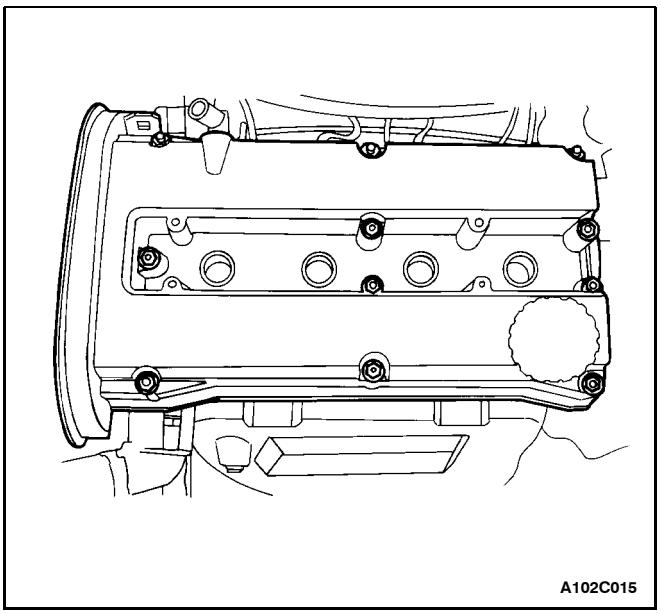
8. Remove the power steering pump mounting bolts, if equipped.
9. Remove the power steering pump, if equipped.


A102C027

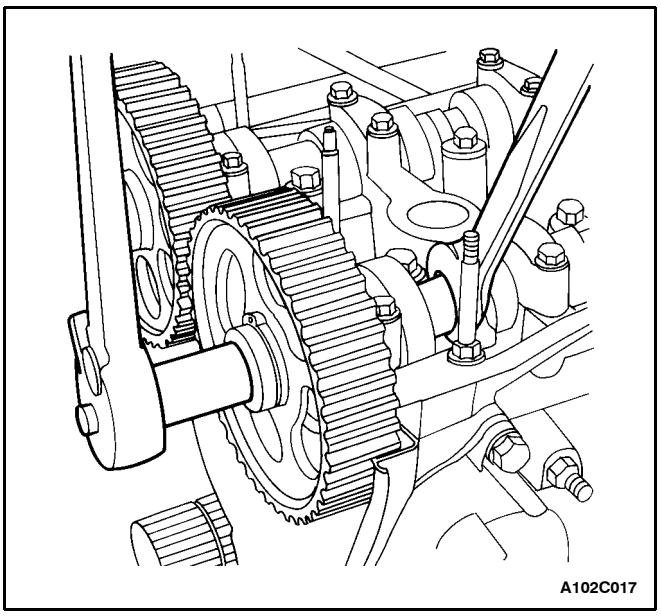
10. Slightly loosen the coolant pump retaining bolts.



11. Rotate the coolant pump using the timing belt adjuster J-42942 to remove the tension from the timing belt.
12. Remove the timing belt.

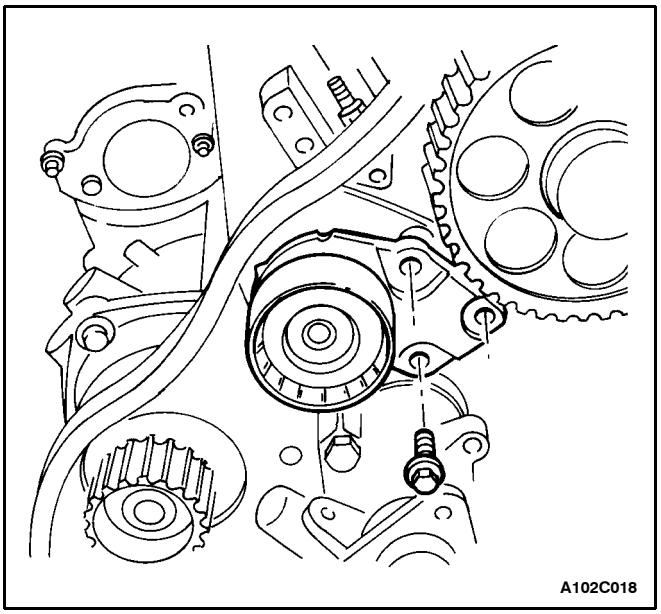


13. Disconnect the crankcase ventilation tubes from the valve cover.
14. Remove the spark plug cover bolts.
15. Remove the spark plug cover.
16. Disconnect the ignition wires from the spark plugs.
17. Remove the valve cover nuts.
18. Remove the valve cover washers.
19. Remove the valve cover and the valve cover gasket.

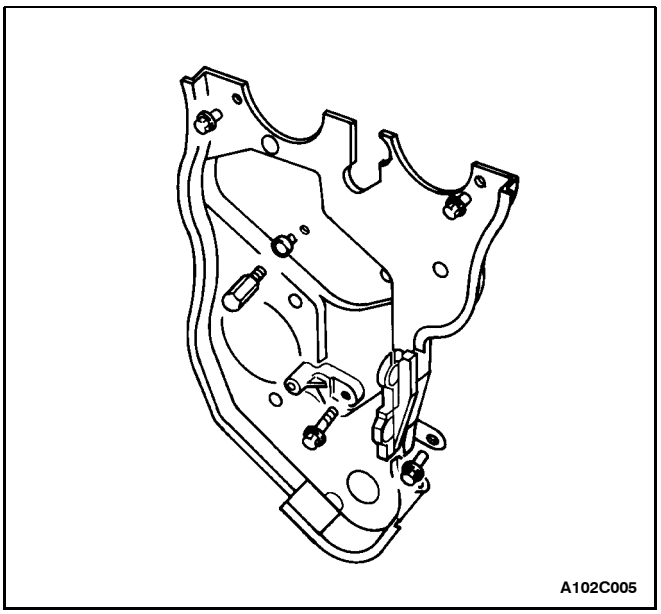


Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

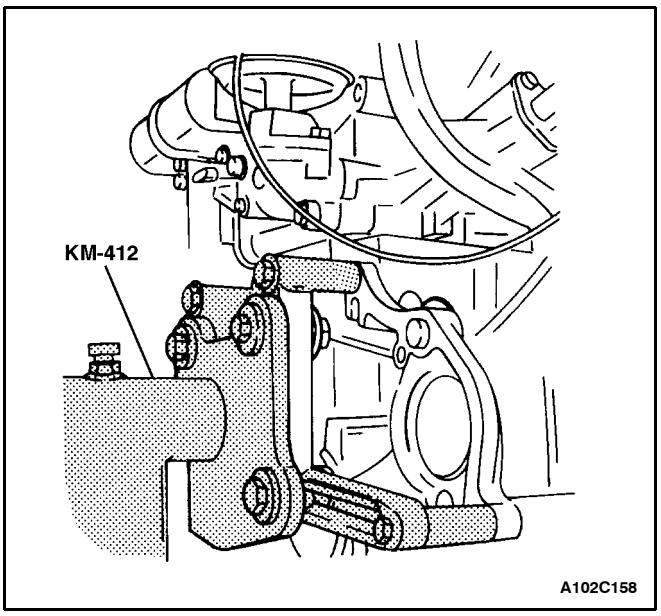
20. While holding the intake camshaft firmly in place, remove the intake camshaft bolt.
21. Remove the intake camshaft gear.
22. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft bolt.
23. Remove the exhaust camshaft gear.



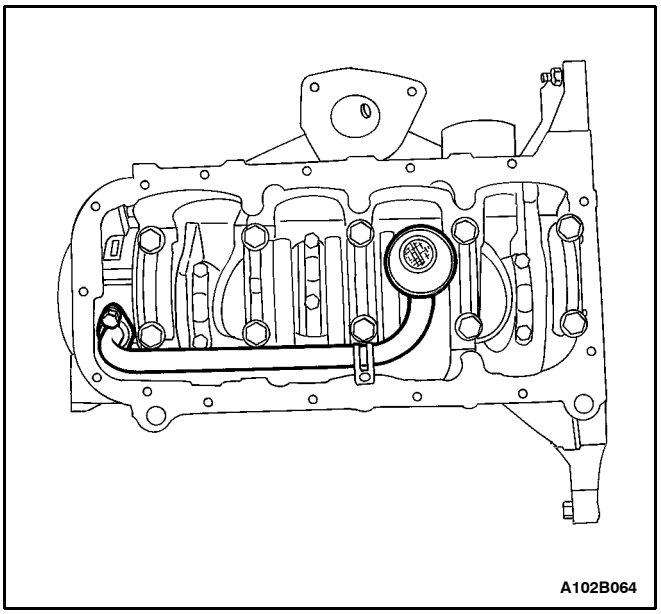
24. Remove the timing belt automatic tensioner bolts.
25. Remove the timing belt automatic tensioner.
26. Remove the timing belt idler pulley bolt.
27. Remove the timing belt idler pulley.



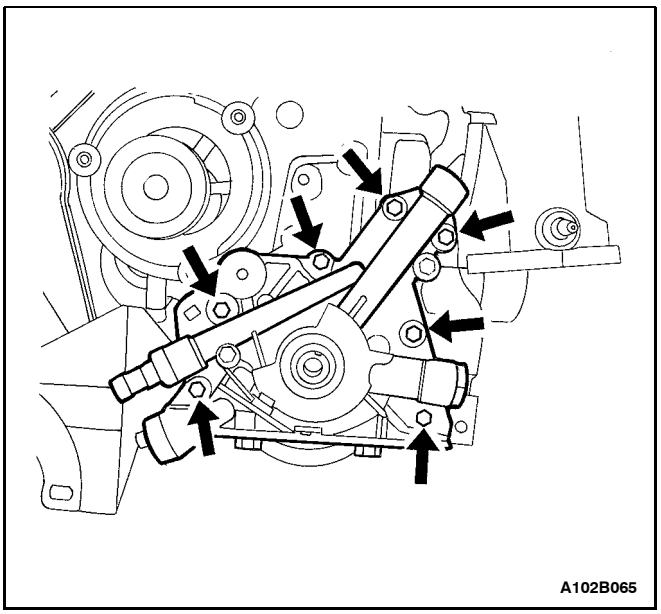
28. Remove the crankshaft timing belt gear.
29. Remove the rear timing belt cover bolts.
30. Remove the rear timing belt cover.



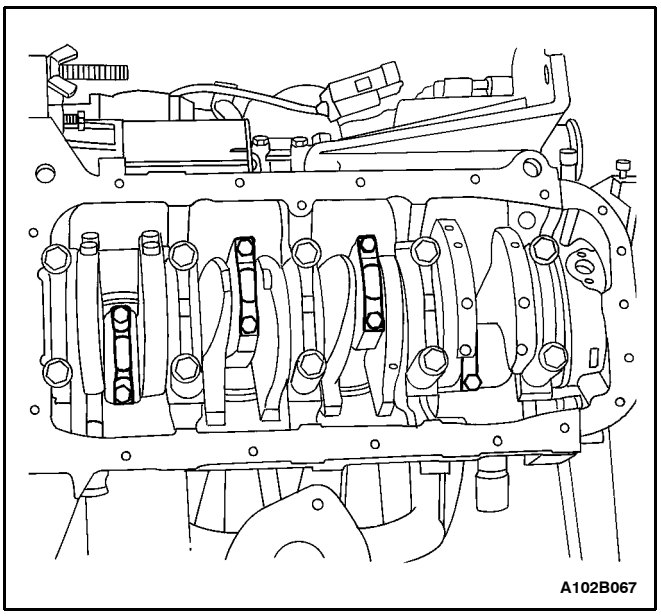
31. Rotate the engine on the engine overhaul stand KM-412.


A102B064

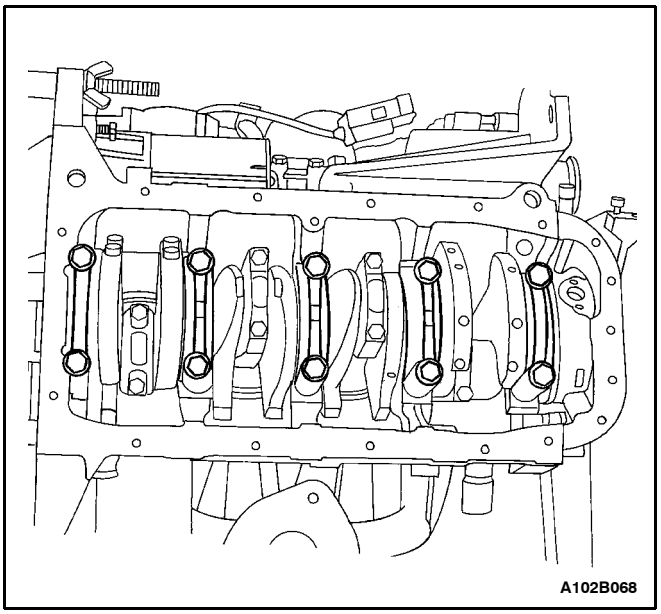
32. Remove the oil pan retaining bolts.
33. Remove the oil pan.
34. Remove the oil pickup tube bolts.
35. Remove the oil pickup tube.


A102B065

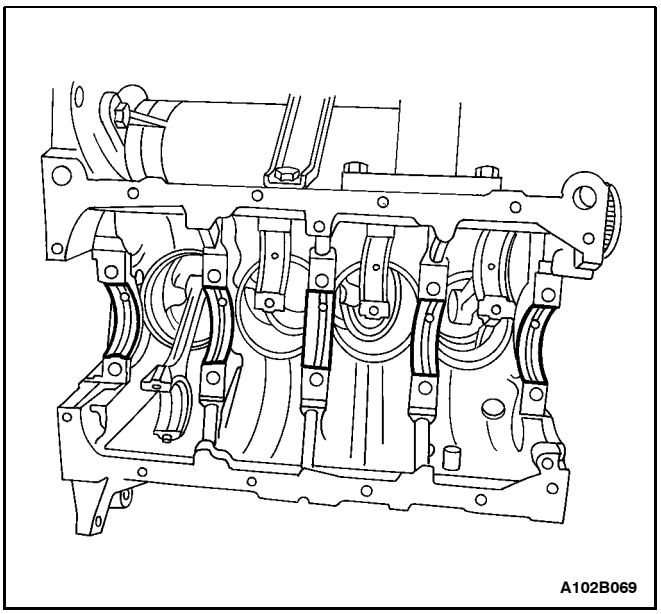
36. Remove the oil pump retaining bolts.
37. Remove the oil pump.


A102B067

38. Mark the order of the connecting rod bearing caps.
39. Remove the connecting rod bearing cap bolts for all of the pistons.
40. Remove the connecting rod bearing caps and the lower connecting rod bearings.
41. Remove the upper connecting rod bearings.

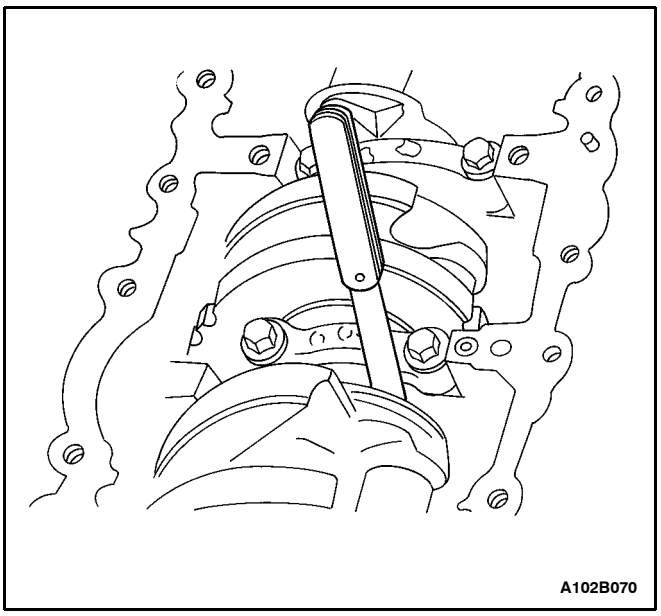

A102B068

42. Mark the order of the crankshaft bearing caps.
43. Remove the crankshaft bearing cap bolts.
44. Remove the crankshaft bearing caps and the lower crankshaft bearings.
45. Remove the crankshaft.
46. Remove the upper crankshaft bearings.
47. Clean any necessary parts.

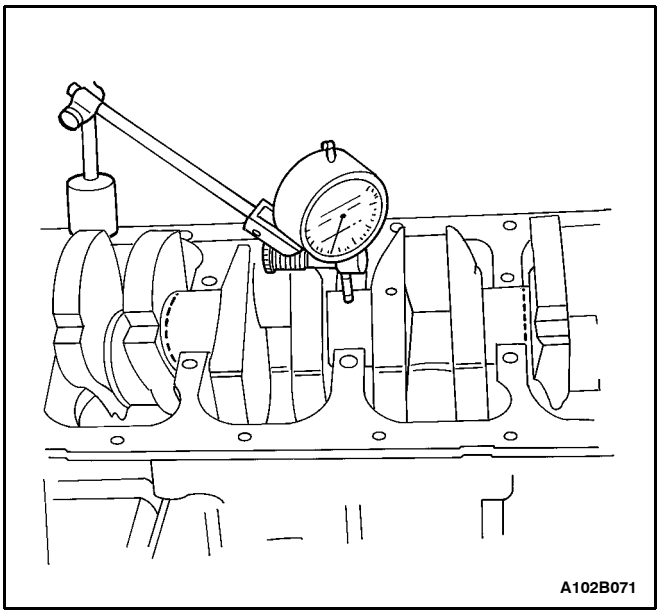

A102B069

Assembly Procedure

1. Coat the crankshaft bearings with engine oil.
2. Install the upper crankshaft bearings in the engine block.

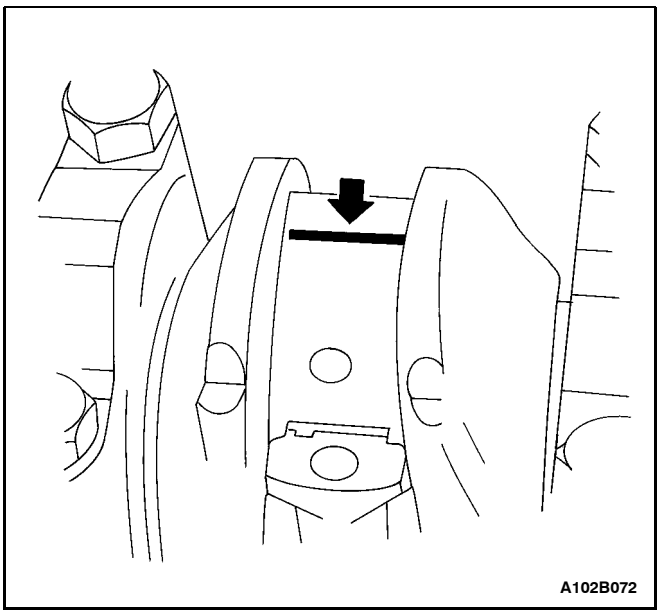

A102B070

3. Install the crankshaft.
4. Install the lower crankshaft bearings in the bearing caps.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.



A102B071

7. With the crankshaft mounted on the front and rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.



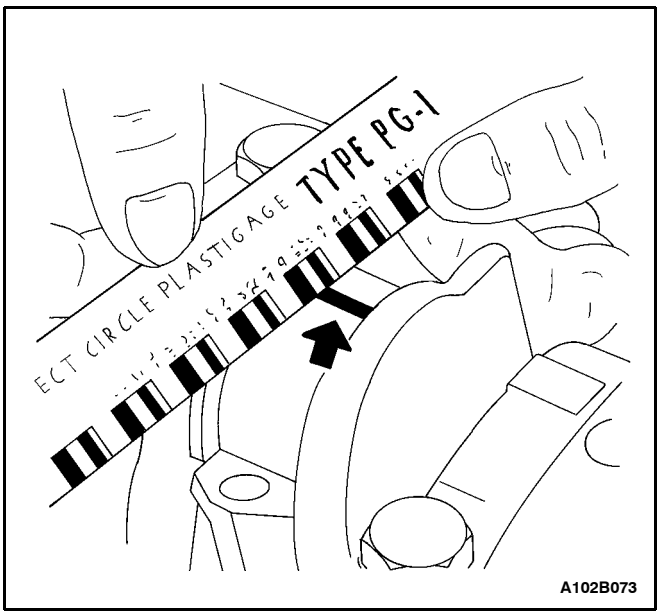
A102B072

Important: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.
10. Install the crankshaft bearing caps and the bolts.

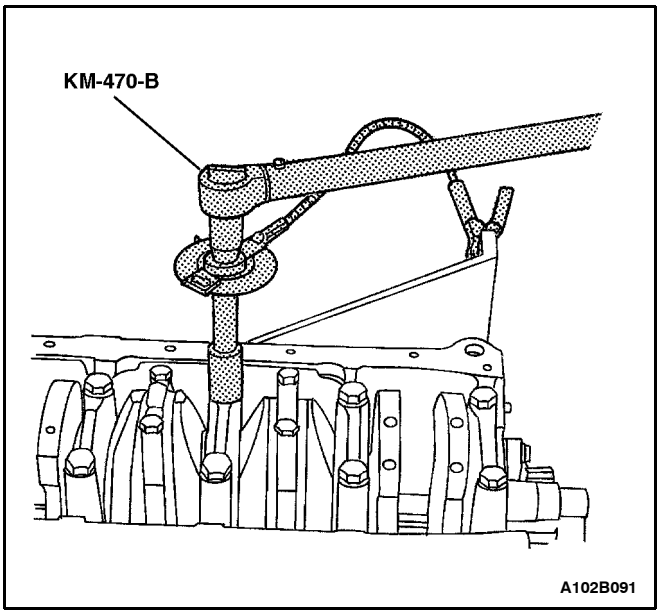
Tighten

Tighten the crankshaft bearing cap bolts to 50 NSm (37 lb-ft) 45 degrees + 15 degrees.



A102B073

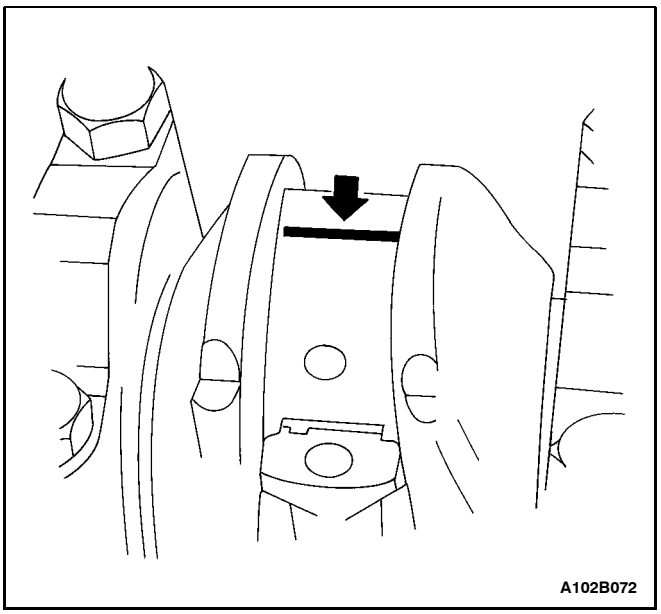
11. Remove the crankshaft bearing cap bolts and the caps.
12. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
13. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.



14. Apply a bead of adhesive sealing compound to the grooves of the crankshaft bearing caps.
15. Install the crankshaft bearing caps to the engine block.
16. Tighten the crankshaft bearing caps using new bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 NSm (37 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the crankshaft bearings 45 degrees + 15 degrees.

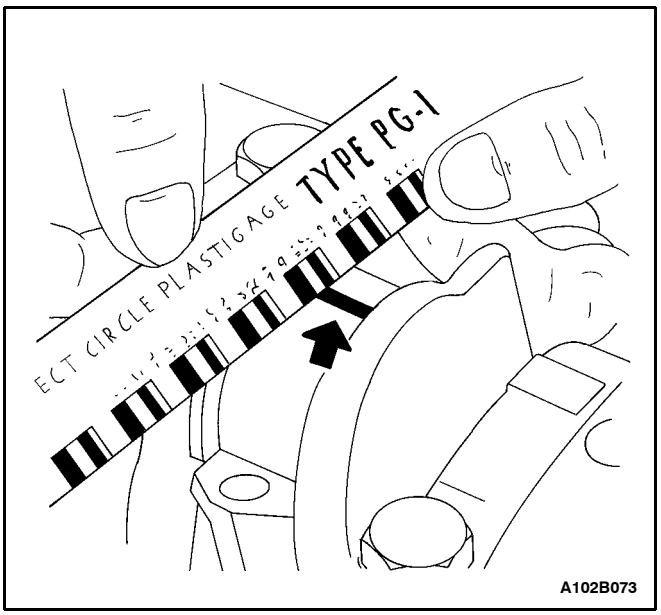


Important: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

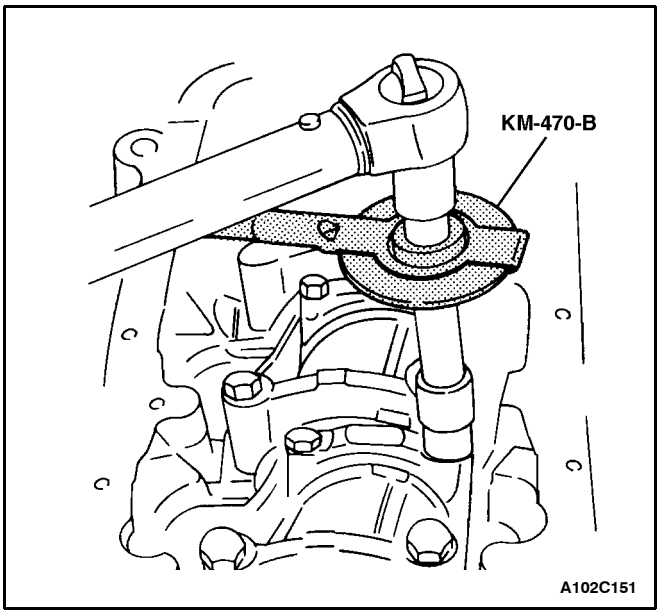
17. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).
18. Cut the plastic gauging threads to the length of the connecting rod bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.
19. Install the connecting rod bearing caps.

Tighten

Tighten the connecting rod bearing cap bolts to 25 NSm (18 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod bearing cap bolts to 30 degrees + 15 degrees.



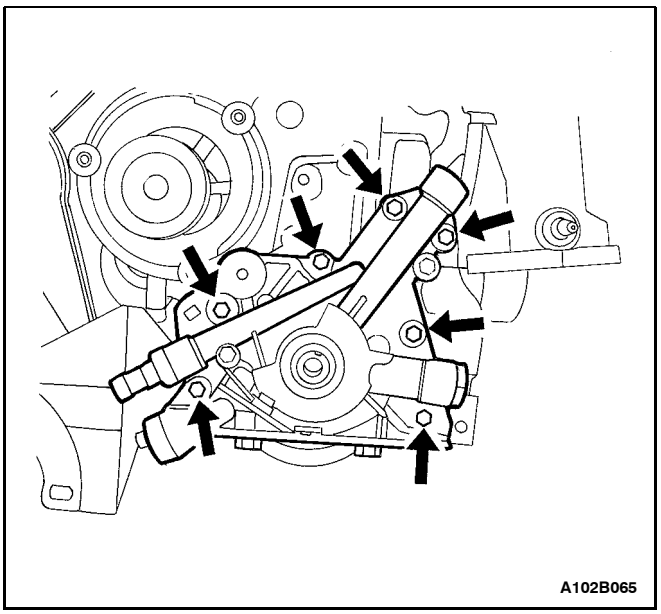
20. Remove the connecting rod bearing caps.
21. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
22. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.



23. Install the connecting rod bearing caps to the connecting rods.
24. Tighten the connecting rod bearing caps using new bolts.

Tighten

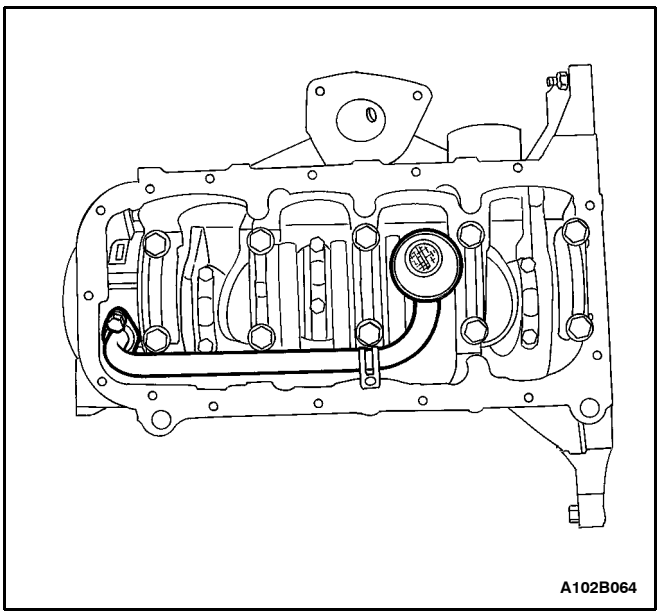
Tighten the connecting rod bearing cap bolts to 25 NSm (18 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod cap bolts to 30 degrees + 15 degrees.



25. Install the oil pump.
26. Install the oil pump retaining bolts.

Tighten

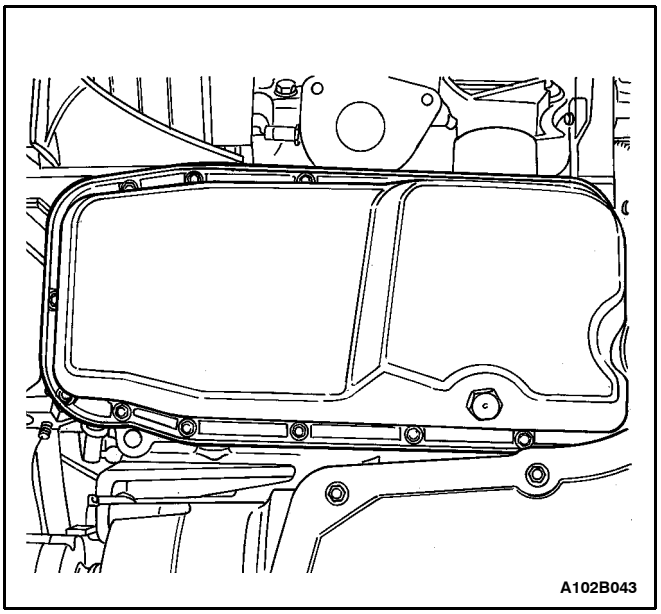
Tighten the oil pump retaining bolts to 10 NSm (89 lb-in).



27. Install the oil pump/pickup tube.
28. Install the oil pump/pickup tube bolts.

Tighten

Tighten the oil pump/pickup tube bolts to 10 NSm (89 lb-in).



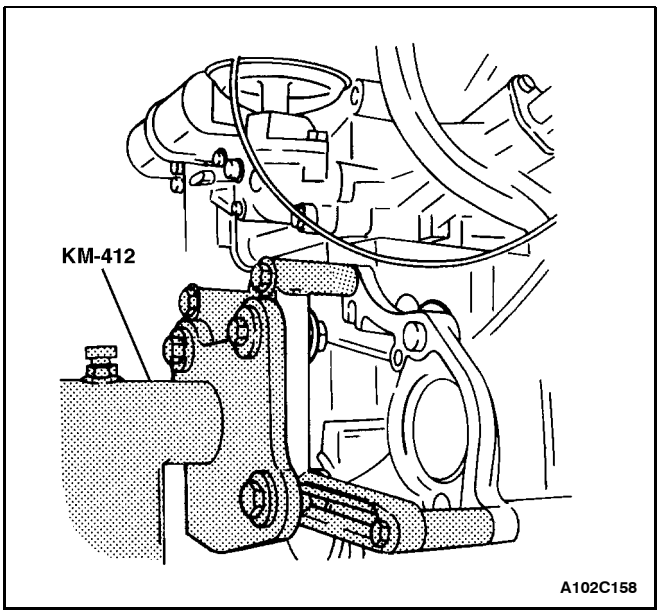
29. Install the oil pan gasket to the oil pan.
30. Install the oil pan.

Important: Install the oil pan within 5 minutes after applying the liquid gasket to the oil pan.

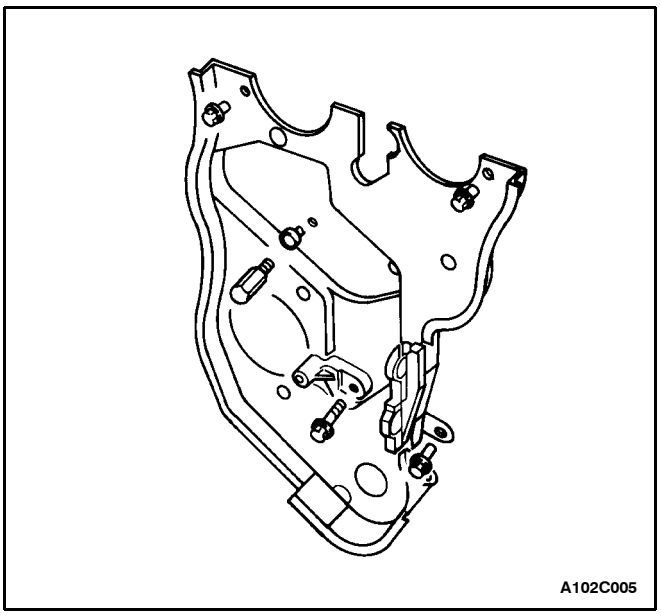
31. Install the oil pan retaining bolts.

Tighten

Tighten the oil pan retaining bolts to 10 NSm (89 lb-in).



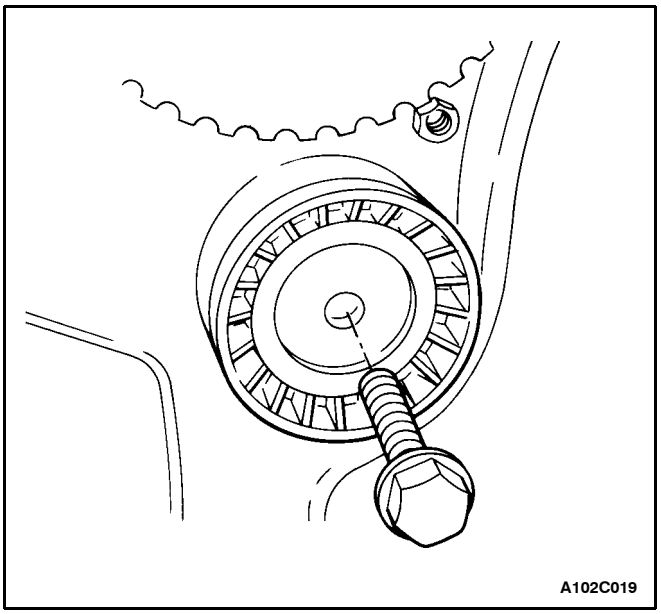
32. Rotate the engine on the engine assembly stand KM-412.



33. Install the rear timing belt cover.
34. Install the rear timing belt cover bolts.

Tighten

Tighten the rear timing belt cover bolts to 10 NSm (89 lb-in).


A102C019

35. Install the crankshaft timing belt gear.
36. Install the timing belt automatic tensioner.
37. Install the timing belt automatic tensioner bolts.

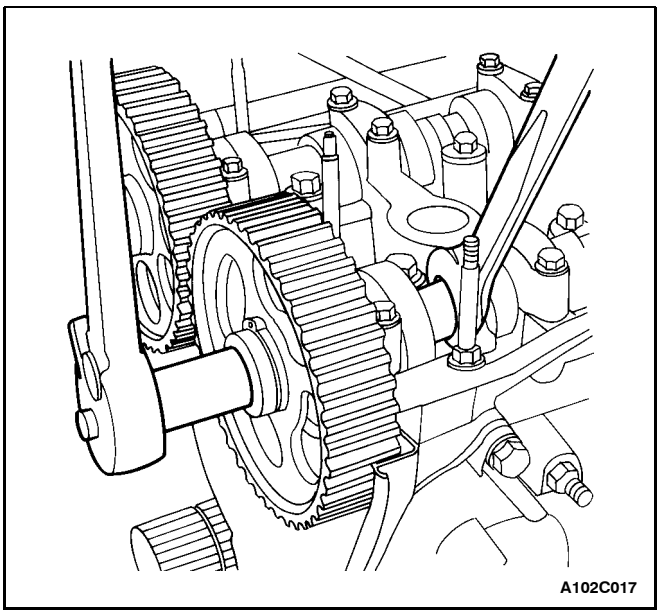
Tighten

Tighten the timing belt automatic tensioner bolts to 25 NSm (18 lb-ft).

38. Install the timing belt idler pulley.
39. Install the timing belt idler pulley bolt.

Tighten

Tighten the timing belt idler pulley bolt to 40 NSm (30 lb-ft).


A102C017

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

40. Install the intake camshaft gear.
41. Install the intake camshaft gear bolt while holding the intake camshaft firmly in place.

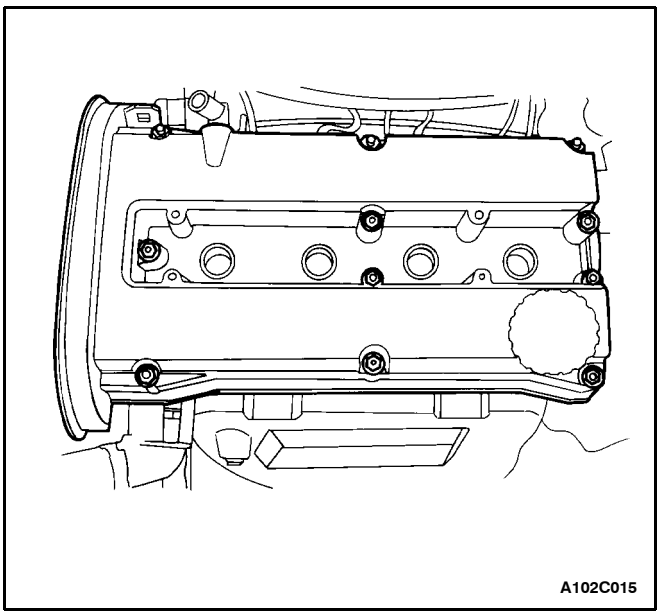
Tighten

Tighten the intake camshaft gear bolt to 67.5 NSm (49 lb-ft).

42. Install the exhaust camshaft gear.
43. Install the exhaust camshaft gear bolt while holding the exhaust camshaft firmly in place.

Tighten

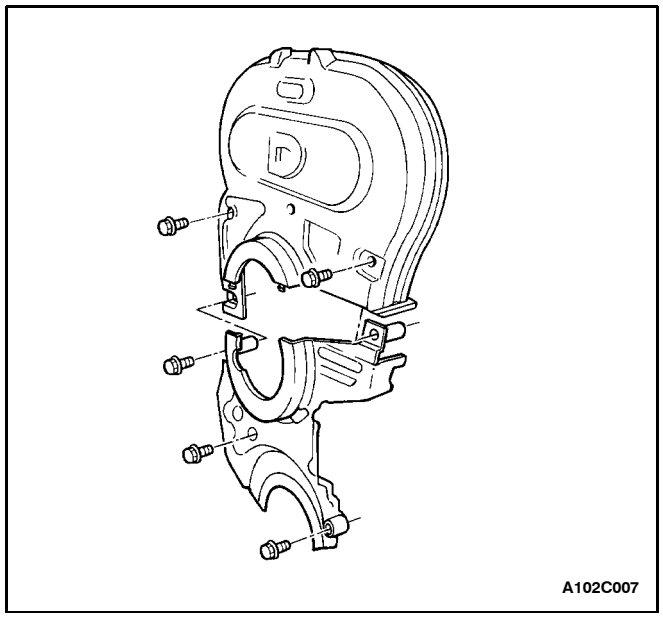
Tighten the exhaust camshaft bolt to 67.5 NSm (49 lb-ft).


A102C015

44. Install the timing belt. Refer to "Timing Belt" in this section.
45. Adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.
46. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover to cylinder head seal.
47. Install the valve cover and the valve cover gasket.
48. Install the valve cover washers.
49. Install the valve cover nuts.

Tighten

Tighten the valve cover nuts to 10 NSm (89 lb-in).


A102C007

50. Connect the ignition wires to the spark plugs.
51. Install the spark plug cover.
52. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 NSm (27 lb-in).

53. Connect the crankcase ventilation tube to the valve cover.
54. Install the upper and lower front timing belt cover.
55. Install the upper and lower front timing belt cover bolts.

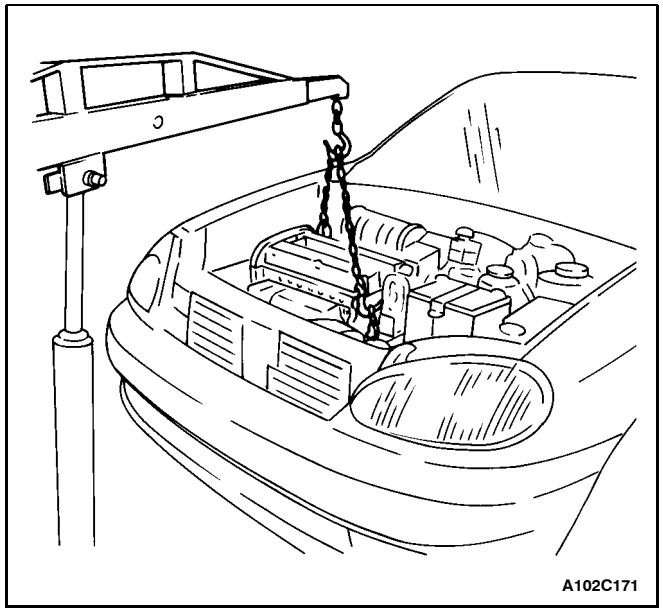
Tighten

Tighten the upper and lower front timing belt cover bolts to 10 NSm (89 lb-in).

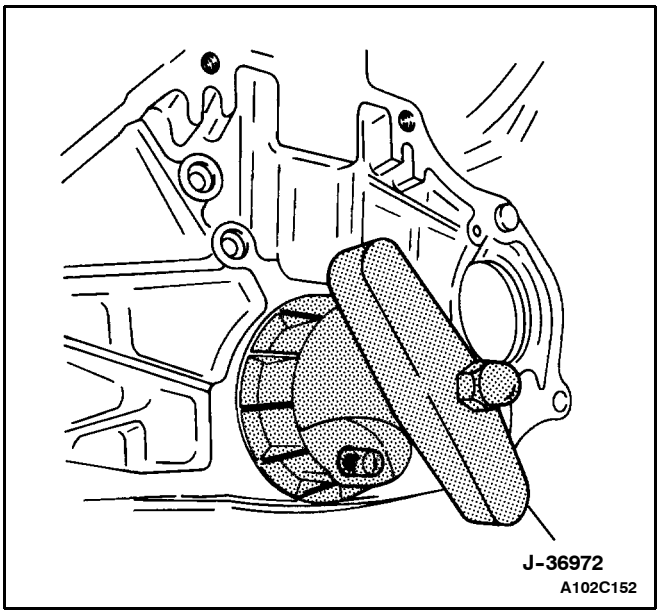
56. Install the power steering pump, if equipped.
57. Install the power steering pump mounting bolts.

Tighten

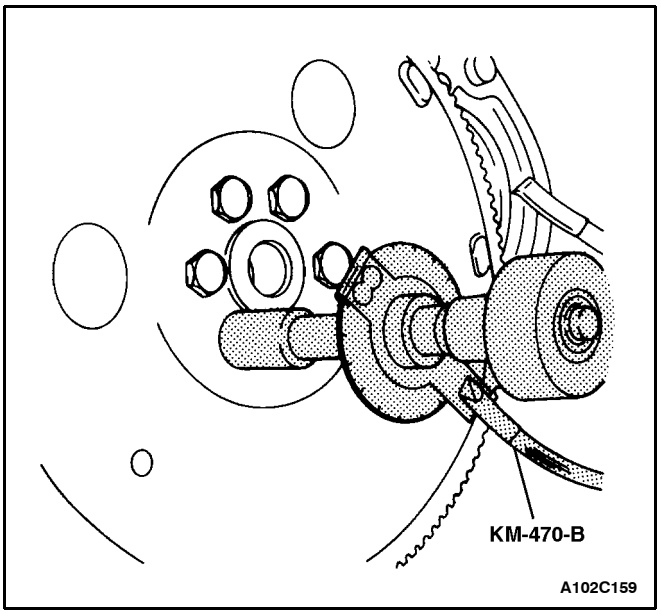
Tighten the power steering pump mounting bolts to 25 NSm (18 lb-ft).


A102C171

58. Install the engine lifting device.
59. Remove the engine from the engine assembly stand KM-412.



60. Install a new crankshaft rear oil seal using installer J-36972 (or KM-635).

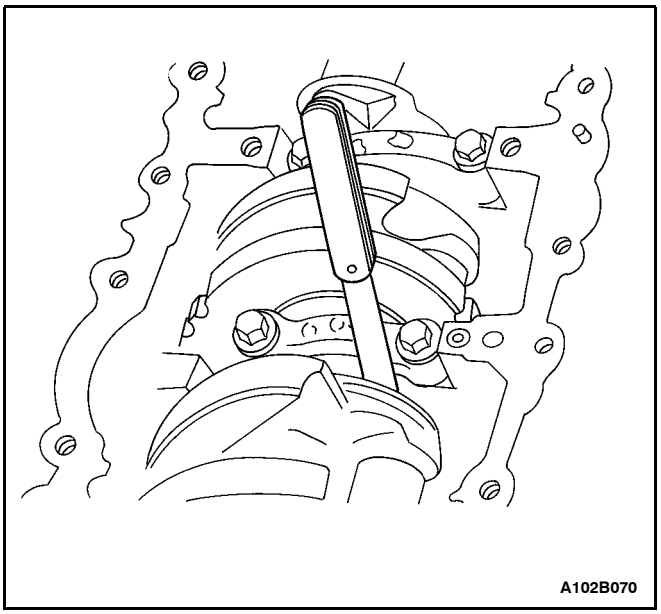


61. Install the flywheel or flexible plate.
62. Install the flywheel or the flexible plate bolts.

Tighten

Tighten the flywheel bolts to 35 NSm (25 lb-ft). Use the angular torque gauge KM-470-B to tighten the flywheel bolts to 30 degrees + 15 degrees. For the manual transmission, tighten the flexible plate bolts to 60 NSm (44 lb-ft).

63. Install the engine. Refer to "Engine" in this section.



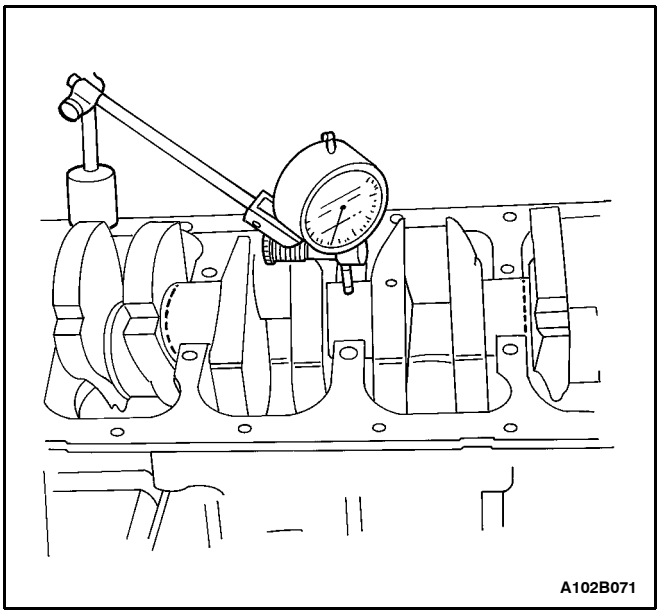
CRANKSHAFT BEARINGS AND CONNECTING ROD BEARINGS — GAUGING PLASTIC

Tools Required

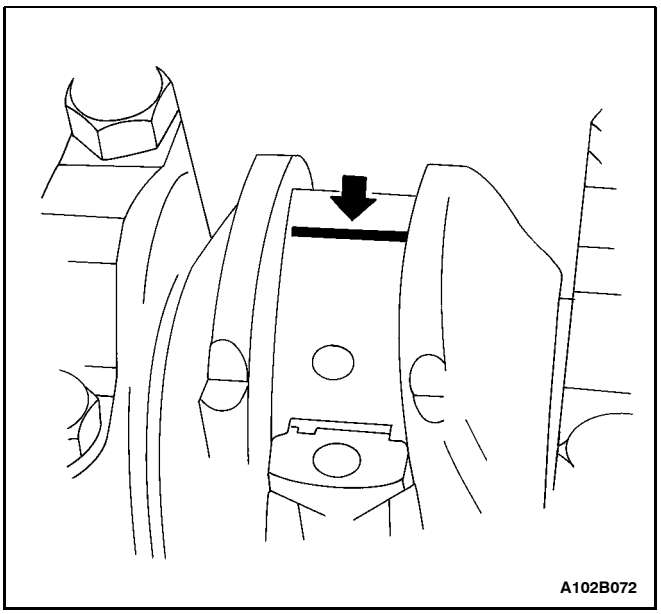
KM-470-B Angular Torque Gauge

Inspection Procedure - Crankshaft

1. Coat the crankshaft bearings with engine oil.
2. Install the upper crankshaft bearings into the engine block crankshaft journals.
3. Install the lower crankshaft bearings into the crankshaft bearing caps.
4. Install the crankshaft.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.

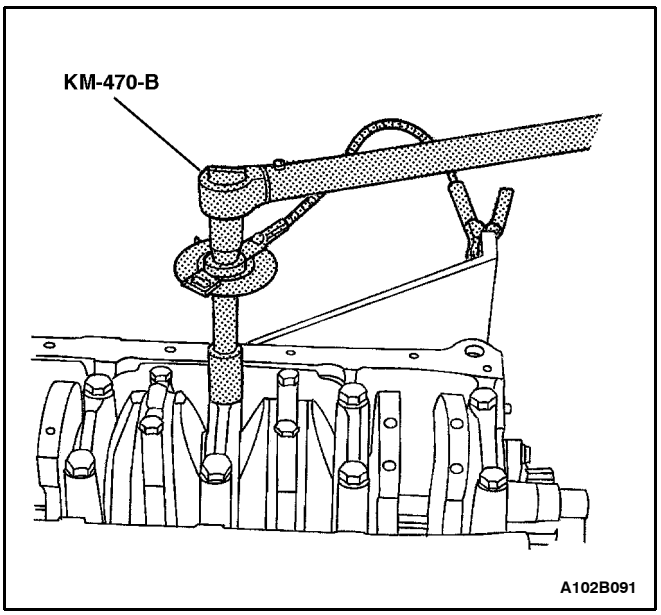

A102B071

7. With the crankshaft mounted on the front and rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.


A102B072

Notice: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.

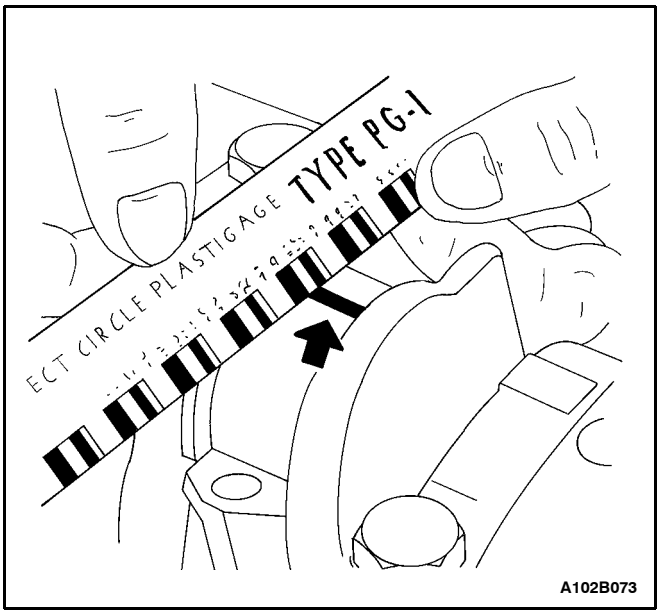


A102B091

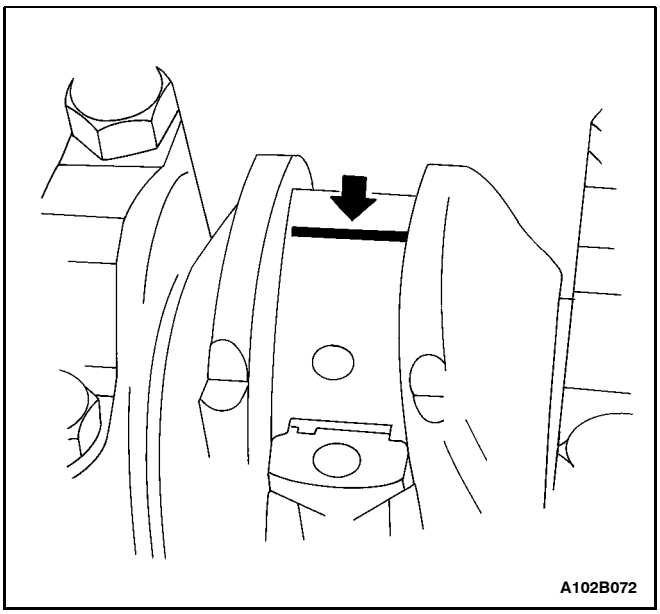
10. Install the crankshaft bearing caps.
11. Install the crankshaft bearing cap bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 NSm (37 lb-ft). Using the angular torque gauge KM-470-B, tighten the crankshaft bearing cap bolts to 45 degrees +15 degrees.



12. Remove the crankshaft bearing caps.
13. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
14. Inspect the bearing clearances for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

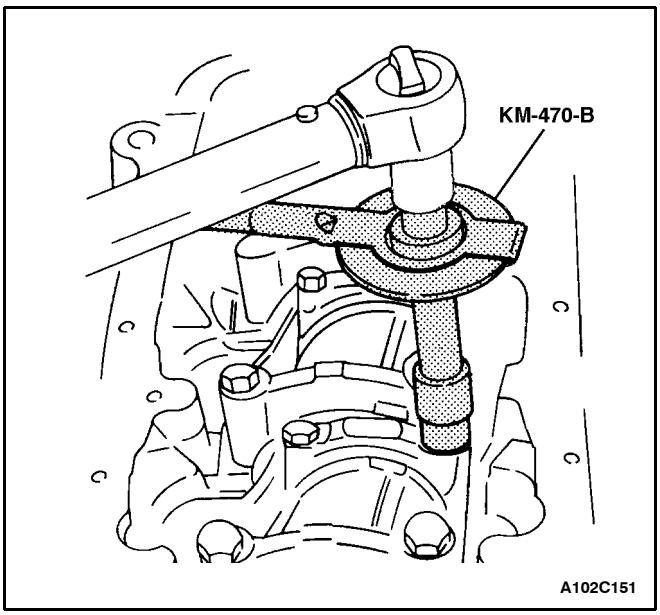


Inspection Procedure - Connecting Rods

1. Coat the connecting rod bearings with engine oil.
2. Install the upper connecting rod bearings into the connecting rod journals.
3. Install the lower connecting rod bearings into the connecting rod bearing caps.

Notice: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

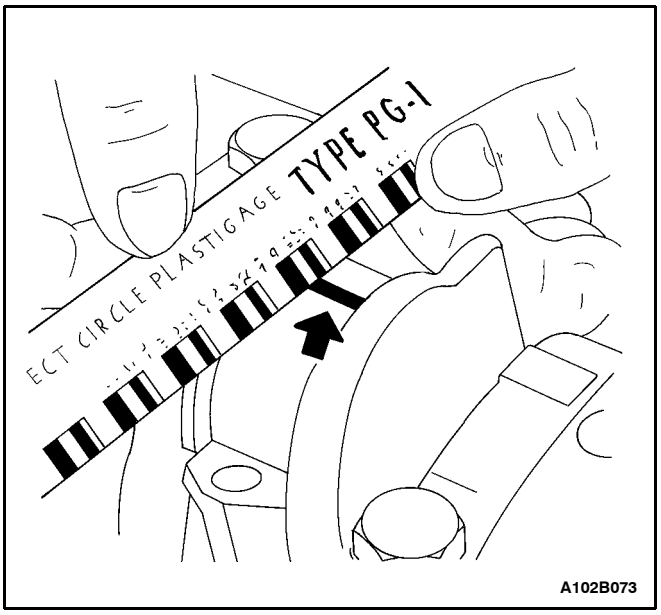
4. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).



5. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.
6. Install the connecting rod bearing caps.
7. Install the connecting rod bearing cap bolts.

Tighten

Tighten the connecting rod cap bolts to 25 NSm (18 lb-ft). Using the angular torque gauge KM-470-B, tighten the connecting rod cap bolts to 30 degrees +15 degrees.



8. Remove the connecting rod bearing caps.
9. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
10. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

CYLINDER HEAD AND GASKET

The cylinder head is made of an aluminum alloy. The cylinder head uses crossflow intake and exhaust ports. A spark plug is located in the center of each combustion chamber. The cylinder head houses the dual camshafts.

CRANKSHAFT

The crankshaft has eight integral weights which are cast with it for balancing. Oil holes run through the center of the crankshaft to supply oil to the connecting rods, the bearings, the pistons, and the other components. The end thrust load is taken by the thrust washers installed at the center journal.

TIMING BELT

The timing belt coordinates the crankshaft and the dual overhead camshafts and keeps them synchronized. The timing belt also turns the coolant pump. The timing belt and the pulleys are toothed so that there is no slippage between them. There are two idler pulleys. An automatic tensioner pulley maintains the timing belt's correct tension. The timing belt is made of a tough reinforced rubber similar to that used on the serpentine drive belt. The timing belt requires no lubrication.

OIL PUMP

The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the drive gear rotates, the driven gear rotates. This causes the space between the gears to constantly open and narrow, pulling oil in from the oil pan when the space opens and pumping the oil out to the engine as it narrows.

At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages. During normal oil supply, a coil spring and valve keeps the by-pass closed, directing all of the oil pumped to the engine. When the amount of oil being pumped increases, the pressure becomes high enough to overcome the force of the spring. This opens the valve of the oil pressure regulator, allowing the excess oil to flow through the valve and drain back to the oil pan.

OIL PAN

The engine oil pan is mounted to the bottom of the cylinder block. The engine oil pan houses the crankcase and is made of pressed sheet metal.

Engine oil is pumped from the oil pan by the oil pump. After it passes through the oil filter, it is fed through two paths to lubricate the cylinder block and cylinder head. In one path, the oil is pumped through oil passages in the crankshaft to the connecting rods, then to the pistons and cylinders. It then drains back to the oil pan. In the second path, the oil is pumped through passages to the camshaft. The oil passes through the internal passageways in the camshafts to lubricate the valve assemblies before draining back to the oil pan.

EXHAUST MANIFOLD

A single four-port, rear-takedown manifold is used with this engine. The manifold is designed to direct escaping exhaust gases out of the combustion chambers with a minimum of backpressure. The oxygen sensor is mounted to the exhaust manifold.

INTAKE MANIFOLD

The intake manifold has four independent long ports and utilizes an inertial supercharging effect to improve engine torque at low and moderate speeds. The plenum is attached to the intake manifold.

CAMSHAFTS

This engine is a dual over head camshaft (DOHC) type, which means there are two camshafts. One camshaft operates the intake valves, and the other camshaft operates the exhaust valves. The camshafts sit in journals on the top of the engine (in the cylinder head) and are held in place by camshaft caps. The camshaft journals of the cylinder head are drilled for oil passages. Engine oil travels to the camshafts under pressure where it lubricates each camshaft journal. The oil returns to the oil pan through drain holes in the cylinder head. The camshaft lobes are machined into the solid camshaft to precisely open and close the intake and the exhaust valves the correct amount at the correct time. The camshaft lobes are oiled by splash action from pressurized oil escaping the camshaft journals.

EXHAUST GAS RECIRCULATION VALVE

The exhaust gas recirculation (EGR) system is used to lower oxides of nitrogen (NOX) emission levels caused by high combustion temperatures. The main element of the system is the EGR valve which is operated by vacuum.

The EGR valve feeds small amounts of exhaust gas into the intake manifold to decrease the combustion temperature. The amount of exhaust gas recirculated is controlled by variations in vacuum and exhaust back pressure. If too much exhaust gas enters, combustion will not take place. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle.

The EGR valve is usually open under the following conditions:

- Warm engine operation.
- Above idle speed.