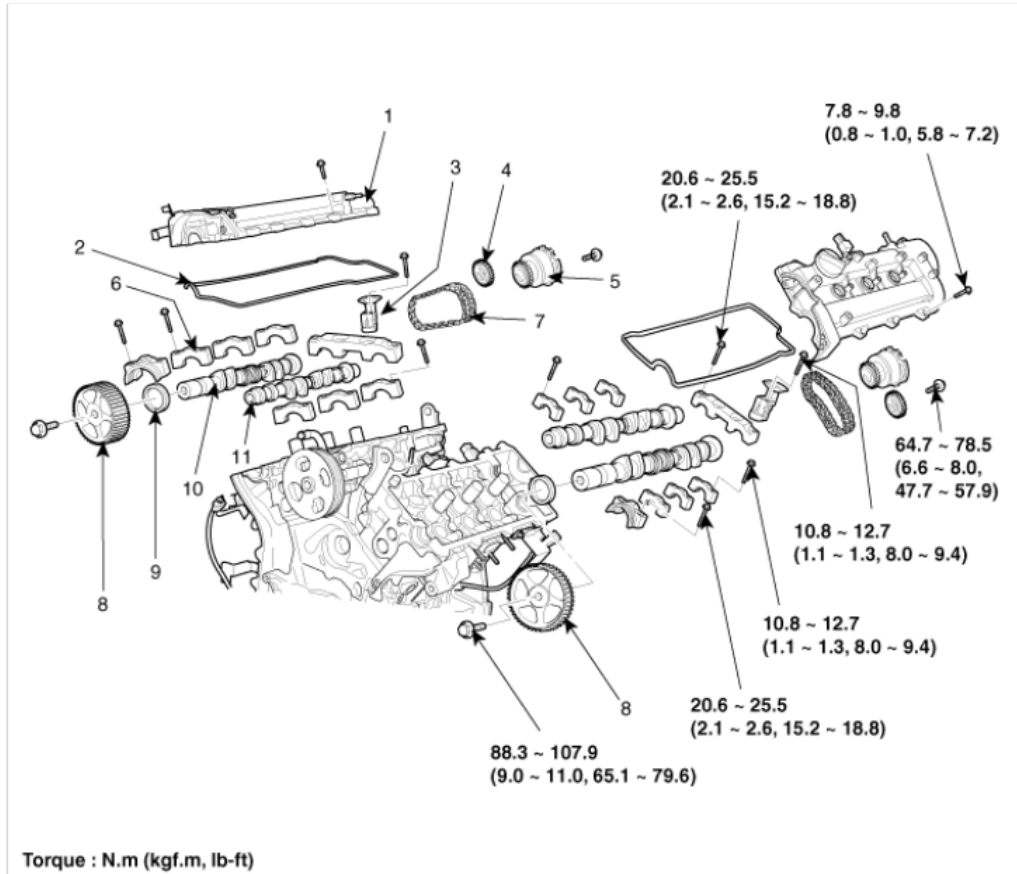


2009 ENGINE

Cylinder Head Assembly - 2.7L - Magentis & Optima

COMPONENTS AND COMPONENT LOCATION

COMPONENTS



1. Cylinder head cover
2. Cylinder head cover gasket
3. Timing chain auto tensioner
4. Exhaust camshaft chain sprocket
5. CVVT assembly
6. Camshaft bearing cap

7. Timing chain
8. Exhaust camshaft sprocket
9. Camshaft oil seal
10. Exhaust camshaft
11. Intake camshaft

Fig. 1: Exploded View Of Cylinder Head Assembly With Torque Specifications (1 Of 2)
 Courtesy of KIA MOTORS AMERICA, INC.

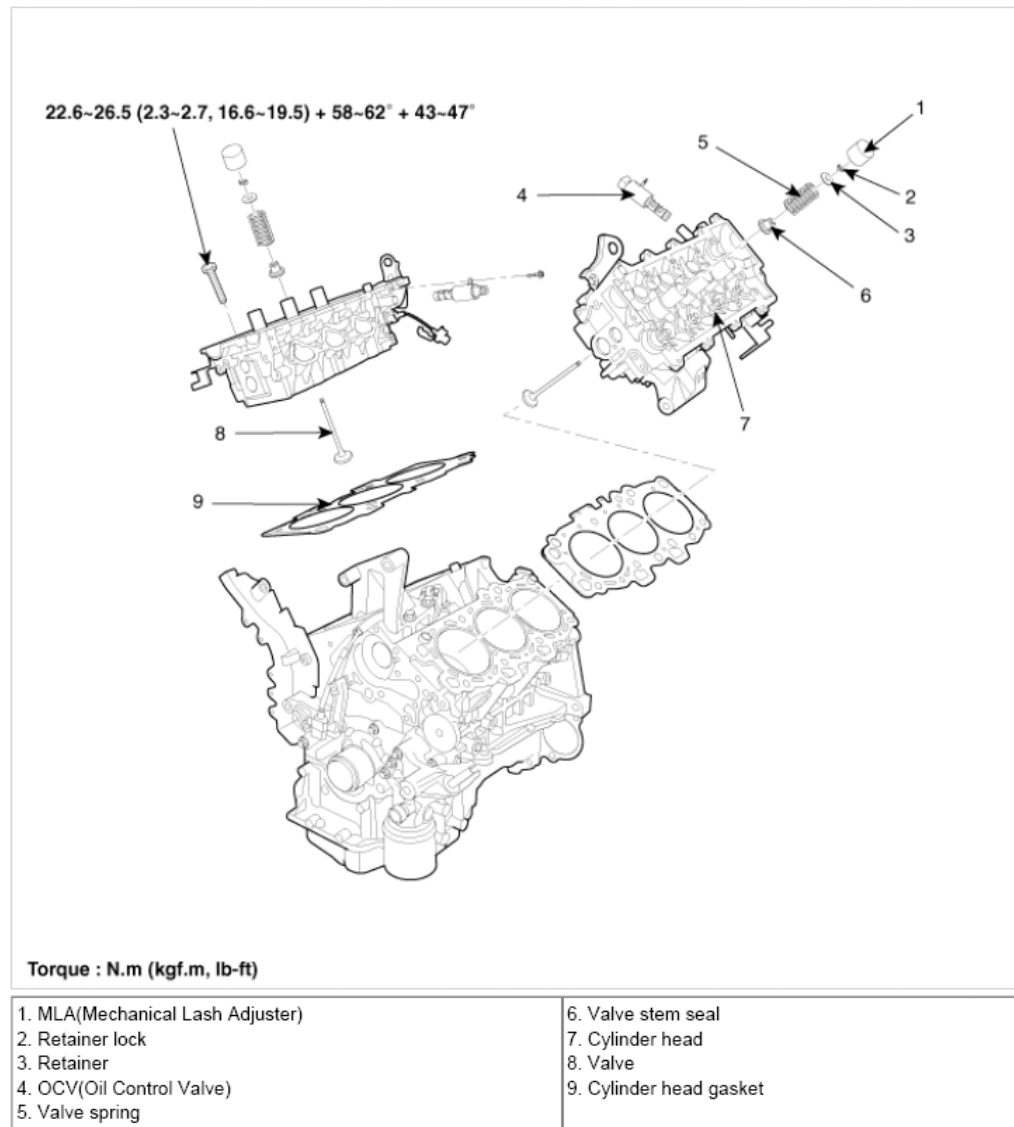


Fig. 2: Exploded View Of Cylinder Head Assembly With Torque Specifications (2 Of 2)
 Courtesy of KIA MOTORS AMERICA, INC.

REPAIR PROCEDURES

REMOVAL

CAUTION:

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTE:

- Mark all wiring and hoses to avoid mis-connection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

1. Remove the air duct (A) and the battery (B) after disconnecting the terminals (C) from the battery.

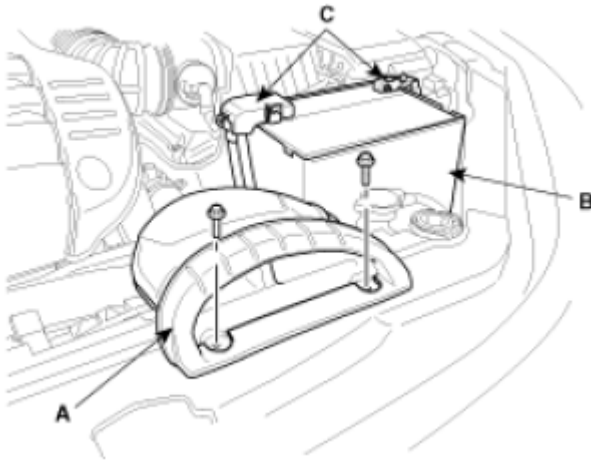


Fig. 3: Identifying Air Duct And Battery
Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the engine cover (A).

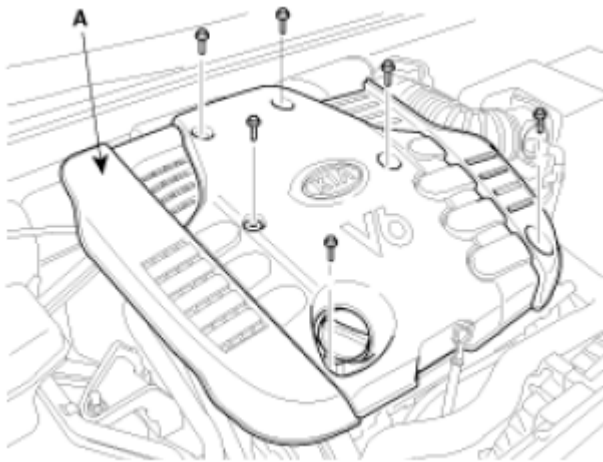


Fig. 4: Identifying Engine Cover
Courtesy of KIA MOTORS AMERICA, INC.

3. Remove the intake air hose and air cleaner assembly.
 1. Disconnect the MAF connector (A).
 2. Disconnect the breather hose (B) from air cleaner hose.
 3. Remove the intake air hose and air cleaner assembly (C).
 4. Disconnect the PCM connectors (D).

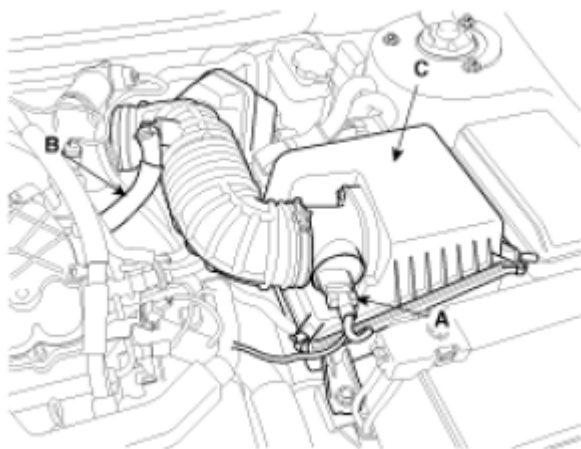


Fig. 5: Identifying MAF Connector, Breather Hose And Air Cleaner Assembly
Courtesy of KIA MOTORS AMERICA, INC.

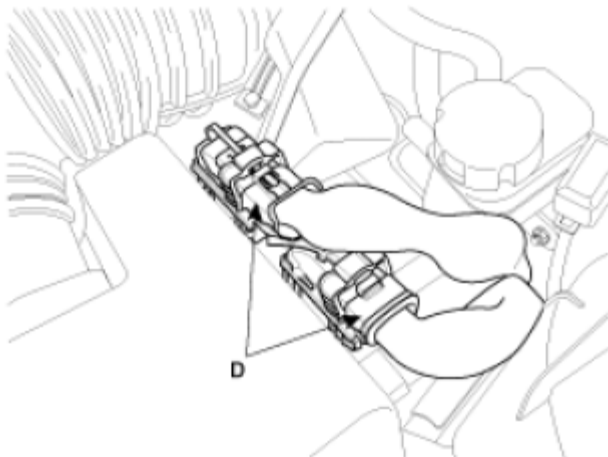


Fig. 6: Identifying PCM Connectors
Courtesy of KIA MOTORS AMERICA, INC.

4. Remove the upper radiator hose (A) and lower radiator hose (B).

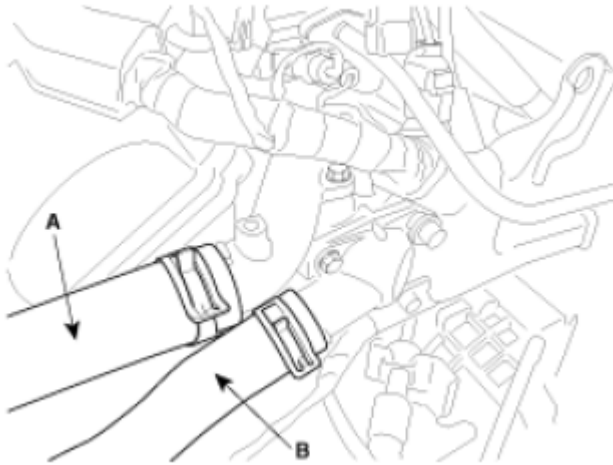


Fig. 7: Identifying Upper Radiator Hose And Lower Radiator Hose
Courtesy of KIA MOTORS AMERICA, INC.

5. Remove the fuel inlet hose (A) from the delivery pipe.

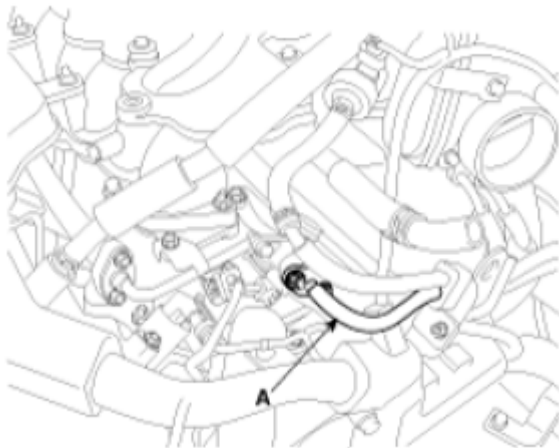


Fig. 8: Identifying Fuel Inlet Hose From Delivery Pipe
Courtesy of KIA MOTORS AMERICA, INC.

6. Disconnect the engine wiring harness connectors.
 1. Disconnect the No. 1/No. 2 knock sensor connectors (A, B), injector connector (C), the ignition coil harness (D) and the No. 1 VIS (Variable Induction System) connector (E).

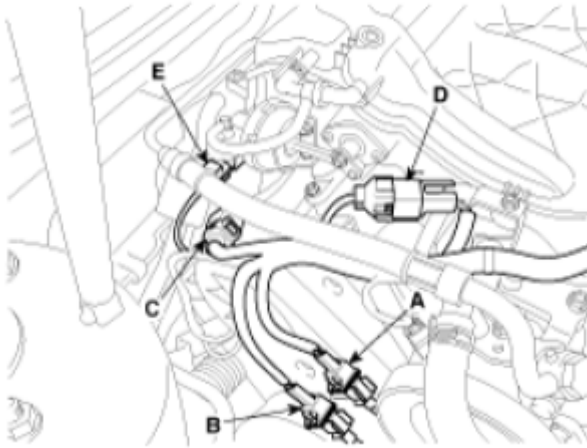


Fig. 9: Identifying No. 1/No. 2 Knock Sensor Connectors, Injector Connector And Ignition Coil Harness

Courtesy of KIA MOTORS AMERICA, INC.

2. Disconnect the bank 1 front/rear O2 sensor connectors (A).

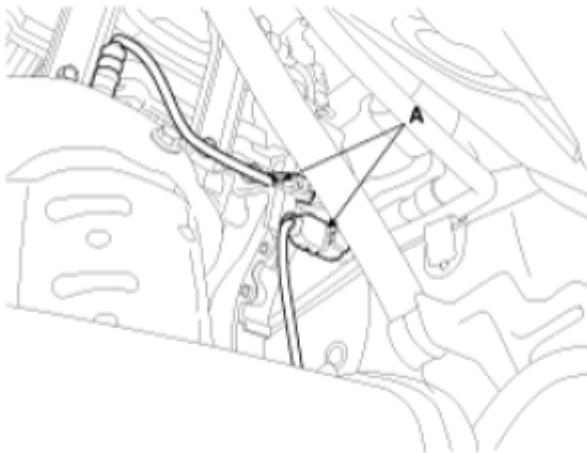


Fig. 10: Identifying Bank 1 Front/Rear O2 Sensor Connectors

Courtesy of KIA MOTORS AMERICA, INC.

3. Disconnect the injection connectors (A, B, C), the ground lines (D), the condenser connector (E) and the Ignition coil connectors (F).

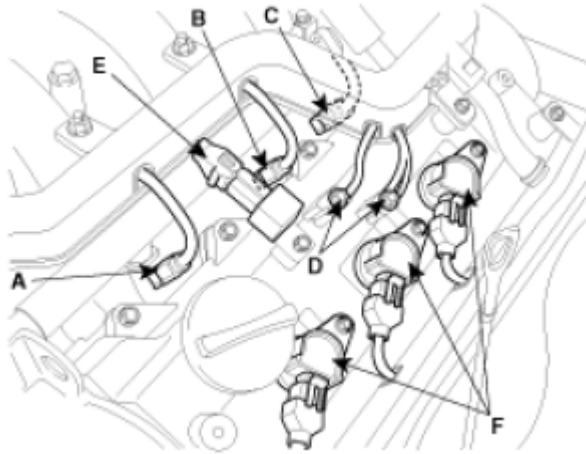


Fig. 11: Identifying Injection Connectors, Ground Lines, Condenser Connector And Ignition Coil Connectors

Courtesy of KIA MOTORS AMERICA, INC.

4. Disconnect the No. 1/No. 2 OCV (Oil Control Valve) connectors (A, B), and the OTS (Oil Temperature Sensor) connector (C).

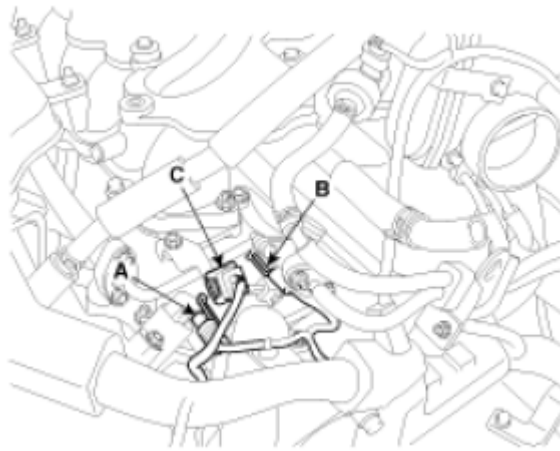


Fig. 12: Identifying No. 1/No. 2 OCV Connectors And OTS Connector

Courtesy of KIA MOTORS AMERICA, INC.

5. Disconnect the MAPS (Manifold Absolute Pressure Sensor) connector (A), the ETC (Electronic Throttle Control) connector (B) and the PCSV (Purge Control Solenoid Valve) connector (C).

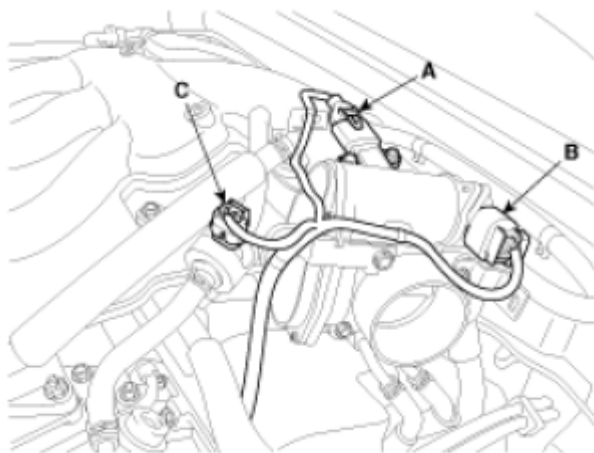


Fig. 13: Identifying MAPS Connector, ETC Connector And PCSV Connector
Courtesy of KIA MOTORS AMERICA, INC.

6. Disconnect the generator connector (A) and the air conditioning compressor connector (B).

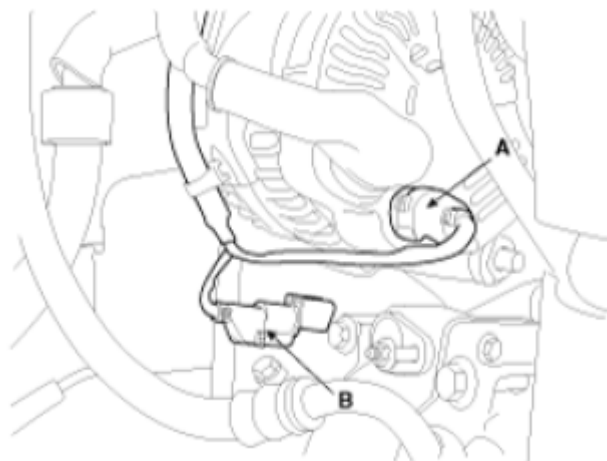


Fig. 14: Identifying Generator Connector And Air Conditioning Compressor Connector
Courtesy of KIA MOTORS AMERICA, INC.

7. Disconnect the bank 2 CMP sensor connector (A) and the ECT (Engine Coolant Temperature) sensor connector (B).

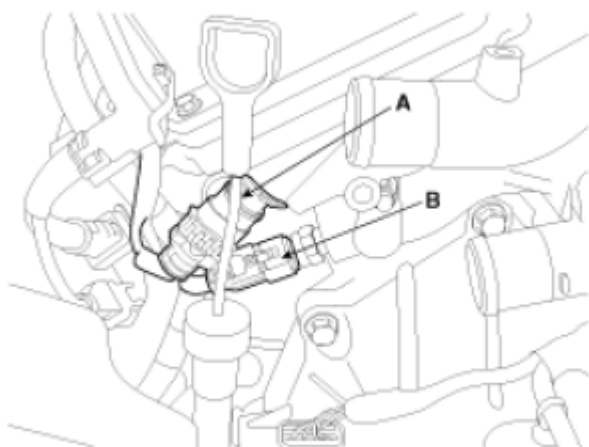


Fig. 15: Identifying Bank 2 CMP Sensor Connector And ECT Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

8. Disconnect the bank 2 front/rear O2 sensor connectors (A, B) and the CKP sensor connector (C).

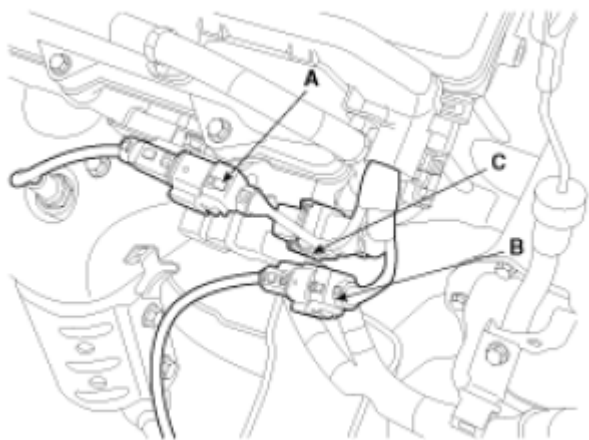


Fig. 16: Identifying Bank 2 Front/Rear O2 Sensor Connectors And CKP Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

9. Disconnect the bank 1 CMP sensor connector (A).

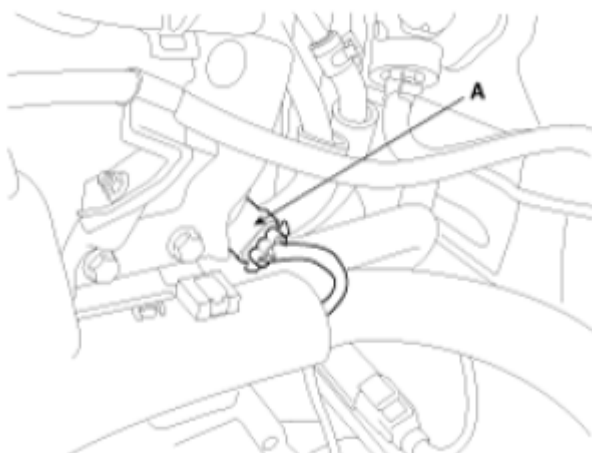


Fig. 17: Identifying Bank 1 CMP Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

7. Disconnect the brake vacuum hose (A).

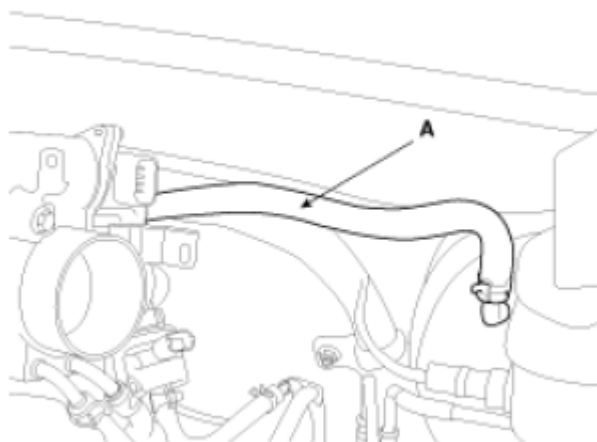
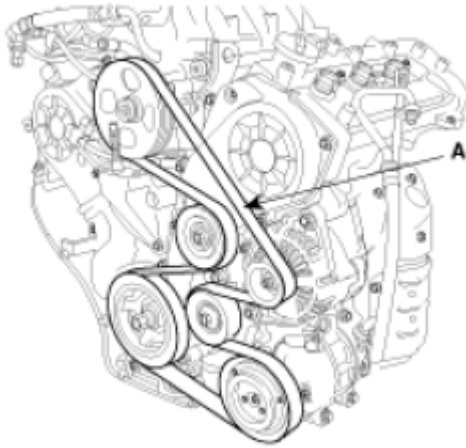


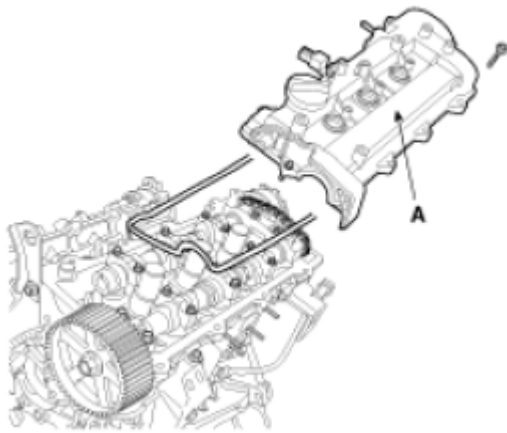
Fig. 18: Identifying Brake Vacuum Hose
Courtesy of KIA MOTORS AMERICA, INC.

8. Remove the heater hoses.
9. Remove the drive belt (A).

**Fig. 19: Identifying Drive Belt**

Courtesy of KIA MOTORS AMERICA, INC.

10. Remove the power steering pump. Refer to **POWER STEERING OIL PUMP** .
11. Remove the exhaust manifold assembly. Refer to **INTAKE AND EXHAUST SYSTEM-2.7L** .
12. Remove the intake manifold assembly. Refer to **INTAKE AND EXHAUST SYSTEM-2.7L** .
13. Remove the timing belt. Refer to **TIMING SYSTEM** .
14. Remove the ignition coils.
15. Remove the water temp. control assembly.
16. Remove the cylinder head cover (A).

**Fig. 20: Identifying Cylinder Head Cover**

Courtesy of KIA MOTORS AMERICA, INC.

17. Remove the camshaft bearing cap (A).

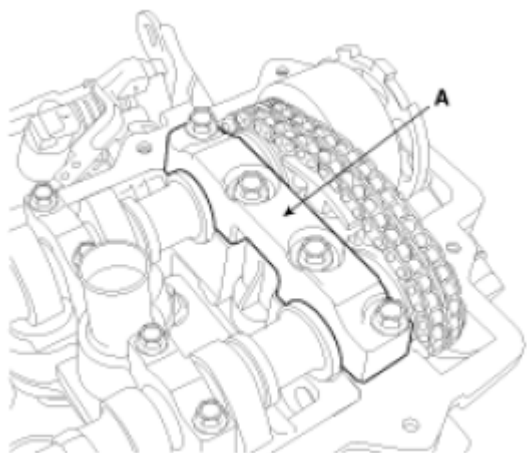


Fig. 21: Identifying Camshaft Bearing Cap
Courtesy of KIA MOTORS AMERICA, INC.

18. Remove the timing chain tensioner (A).

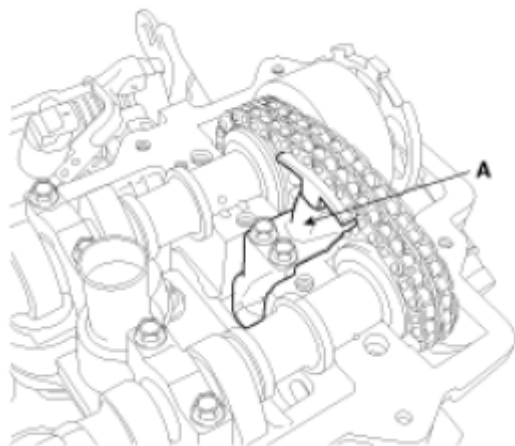


Fig. 22: Identifying Timing Chain Tensioner
Courtesy of KIA MOTORS AMERICA, INC.

19. Remove the camshaft.
20. Remove the bank 2 timing belt rear cover (A).



Fig. 23: Identifying Bank 2 Timing Belt Rear Cover
Courtesy of KIA MOTORS AMERICA, INC.

21. Remove the bank 1 timing belt rear cover (A).

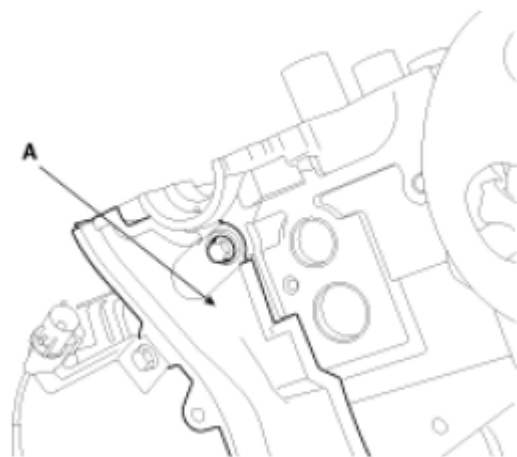


Fig. 24: Identifying Bank 1 Timing Belt Rear Cover
Courtesy of KIA MOTORS AMERICA, INC.

22. Remove the CKP sensor connector bracket (A).

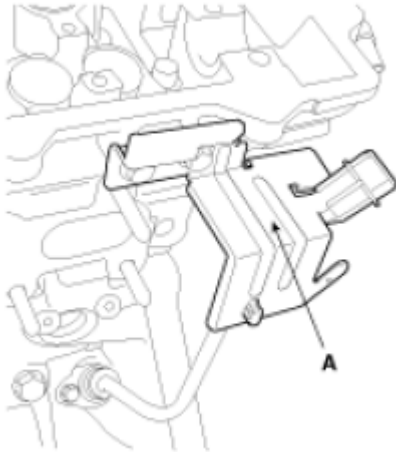


Fig. 25: Identifying CKP Sensor Connector Bracket
 Courtesy of KIA MOTORS AMERICA, INC.

23. Remove the cylinder head assembly.
 1. Remove the bolts in 2-3 steps as following orders.

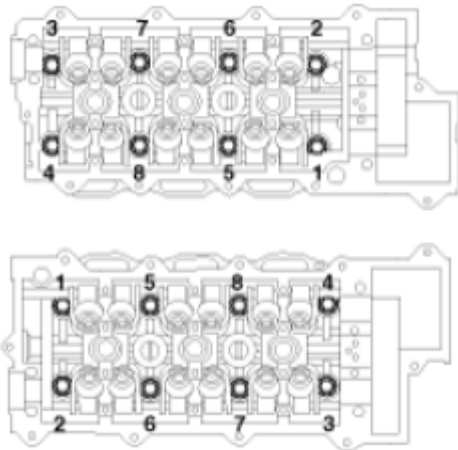


Fig. 26: Identifying Cylinder Head Assembly And Bolts In Sequence
 Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: If the bolts are not removed as the order, the deformation of the head assembly can be occurred.

2. Put the cylinder head assembly on a wooden block after removal from the cylinder block.

CAUTION: Ensure that the surface between the cylinder head and the block is not damaged.

REPLACEMENT

Valve Guide

1. Using the SST (09221-3F100A), remove the valve guide from the downside of the cylinder head assembly.

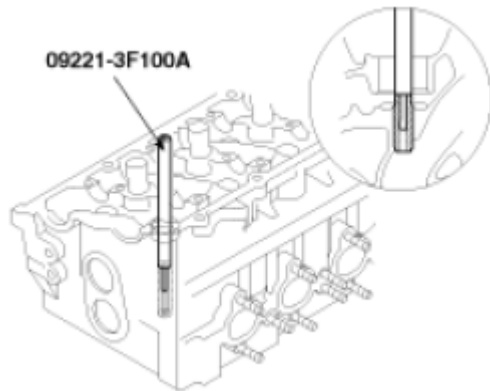


Fig. 27: Inserting Valve Guide From Downside Of Cylinder Head Assembly
Courtesy of KIA MOTORS AMERICA, INC.

2. Reprocess the valve guide hole for the oversized valve guide newly installed.
3. Using the SST (09221-3F100A/B), insert the valve guide in the upside of the cylinder head assembly. Be aware of the difference in length between the intake and the exhaust valve guides.

Specification

Intake valve guide:

45.8-46.2 mm (1.8031-1.8189 in.)

Exhaust valve guide:

46.8-47.2 mm (1.8425-1.8583 in.)

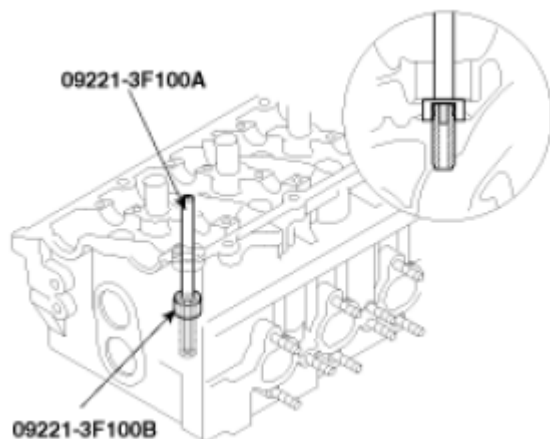


Fig. 28: Inserting Valve Guide In Upside Of Cylinder Head Assembly
Courtesy of KIA MOTORS AMERICA, INC.

4. After installing the valve guides, insert new valves and check the clearance between the valve stems and the valve guides.
5. After replacing the valve guides, check if they are properly installed with the valve seats. Reprocess valve seats if necessary.

DISASSEMBLY

NOTE: Identify MLA (Mechanical Lash Adjuster), valves and valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove MLA (Mechanical Lash Adjusters) (A).

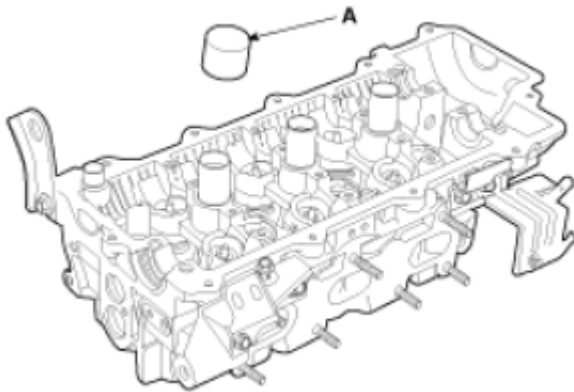


Fig. 29: Identifying MLA (Mechanical Lash Adjuster)
Courtesy of KIA MOTORS AMERICA, INC.

2. Remove valves.
 1. Using SST (09222-3K000, 09222-3C300), compress the valve spring and remove retainer lock.

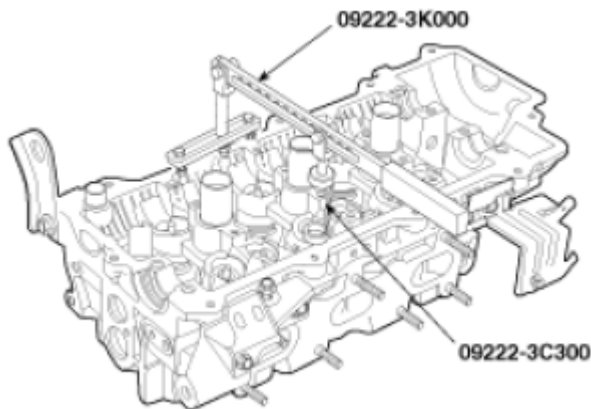


Fig. 30: Compressing Valve Spring And Retainer Lock

Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the spring retainer.
3. Remove the valve spring.
4. Remove the valve.
5. Using SST (09222-29000), remove the valve stem seal.

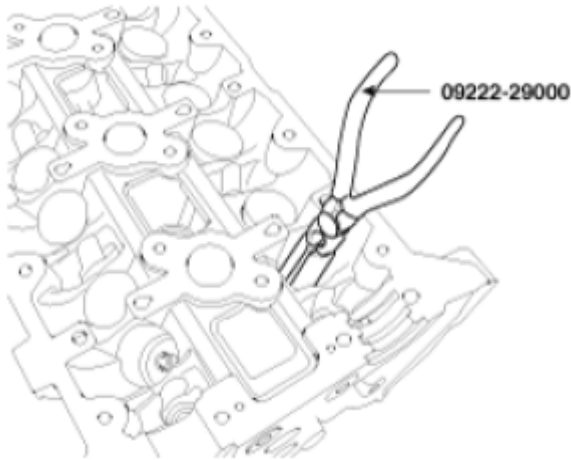


Fig. 31: Removing Valve Stem Seal
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: Do not reuse the removed valve stem seals.

3. Remove OCV (Oil Control Valve) (A).

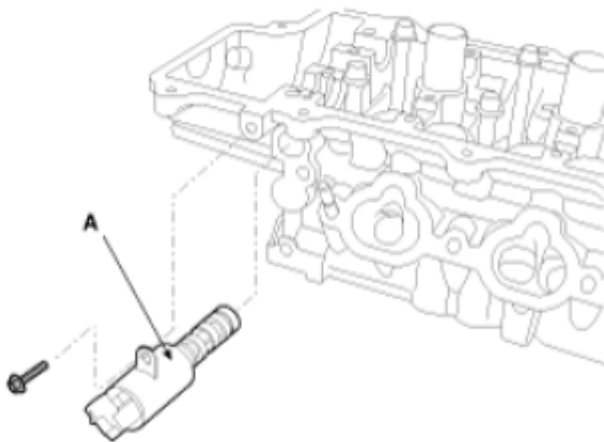


Fig. 32: Identifying OCV (Oil Control Valve)
Courtesy of KIA MOTORS AMERICA, INC.

INSPECTION

Cylinder Head

1. Inspect for flatness.

Using a precision straight edge and feeler gauge, measure the surface contacting cylinder block and the manifolds for warpage.

Flatness of cylinder head gasket surface

Standard: 0.03 mm (0.0012 in.) or less

Flatness of manifold gasket surface

Standard: 0.15 mm (0.0059 in.) or less

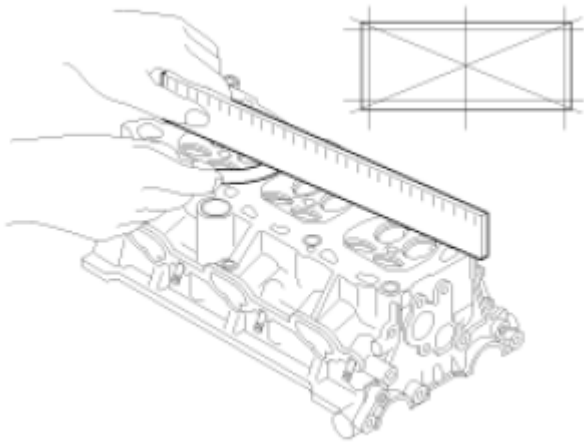


Fig. 33: Measuring Surface Contacting Cylinder Block And Manifolds For Warpage
Courtesy of KIA MOTORS AMERICA, INC.

2. Inspect for cracks.

Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

1. Inspect valve stems and valve guides.
 1. Using a caliper gauge, measure the inside diameter of the valve guide.

Valve guide inside diameter

Intake/Exhaust:

6.000-6.015 mm (2.2362-2.2368 in.)

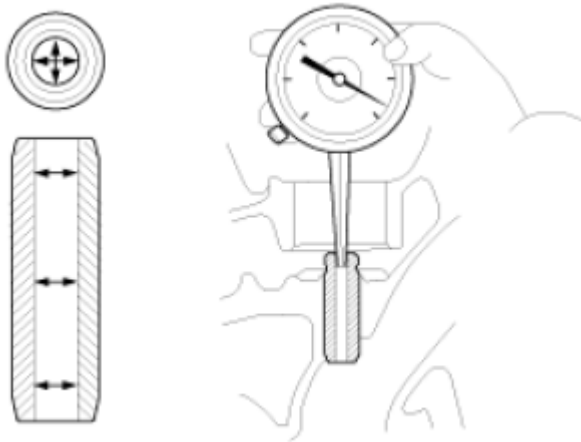


Fig. 34: Measuring Inside Diameter Of Valve Guide
Courtesy of KIA MOTORS AMERICA, INC.

2. Using a micrometer, measure the outer diameter of the valve stem.

Valve stem outer diameter

Intake: 5.965-5.980 mm (0.2348-0.2354 in.)

Exhaust: 5.950-5.965 mm (0.2343-0.2348 in.)

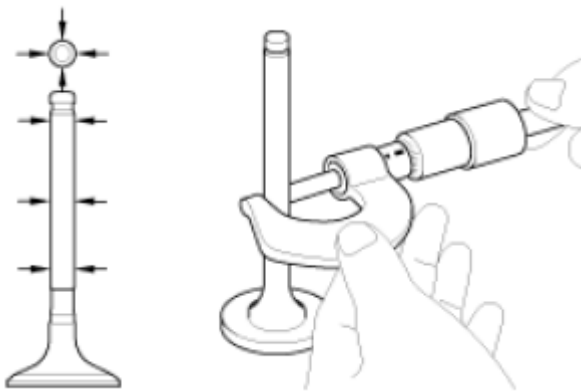


Fig. 35: Measuring Outer Diameter Of Valve Stem
Courtesy of KIA MOTORS AMERICA, INC.

3. Calculate the clearance between the valve guides and the stems by difference between the valve stem measured diameter and the valve guide measured inside diameter.

Valve stem-to-guide clearance

[Standard]

Intake: 0.020-0.050 mm (0.0008-0.0020 in.)

Exhaust: 0.035-0.065 mm (0.0014-0.0026 in.)

[Limit]

Intake: 0.10 mm (0.0039 in.) or less

Exhaust: 0.13 mm (0.0051 in.) or less

2. Inspect valves.

1. Check the valve face angle.
2. Check that the surface of the valve for wear.

If the valve face is worn, replace the valve.

3. Check the valve head margin thickness.

If the margin thickness is less than the specification, replace the valve.

Specification

Intake: 1.0 mm (0.0394 in.)

Exhaust: 1.3 mm (0.0512 in.)

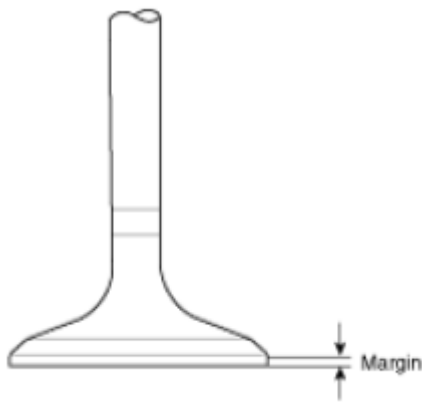


Fig. 36: Checking Valve Head Margin Thickness
Courtesy of KIA MOTORS AMERICA, INC.

4. Check the valve length.

Length

Intake: 110.1 mm (4.3346 in.)

Exhaust: 111.1 mm (4.3740 in.)

5. Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, replace the valve.

3. Inspect valve seats

1. Check the valve seat for evidence of overheating or improper contact with the valve face.

If the valve seat is worn, replace cylinder head.

2. Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace the valve guide first.
 3. Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

4. Inspect valve springs.

1. Using a steel square, measure the out-of-square of the valve spring.
 2. Using vernier calipers, measure the free length of the valve spring.

Valve spring

[Standard]

Free height: 46.8 mm (1.8425 in.)

Out-of-square: 1.5° or less

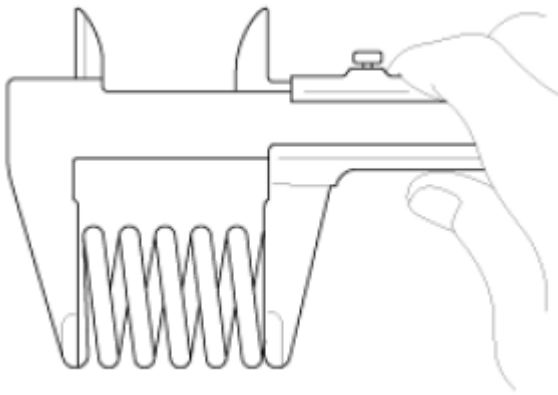


Fig. 37: Measuring Free Length Of Valve Spring
Courtesy of KIA MOTORS AMERICA, INC.

MLA (Mechanical Lash Adjuster)

1. Inspect MLA.

Using a micrometer, measure the MLA outside diameter.

MLA O.D.

Intake/Exhaust:

29.964-29.980 mm (1.1797-1.1803 in.)

2. Using a caliper gauge, measure MLA tappet bore inner diameter of cylinder head.

Tappet bore I.D.

Intake/Exhaust:

30.000-30.025 mm (1.1811-1.1821 in.)

3. Calculate the clearance by subtracting MLA outside diameter measurement from tappet bore inside diameter measurement.

MLA to tappet bore clearance

[Standard]

Intake/Exhaust: 0.020-0.061 mm (0.0008-0.0024 in.)

[Limit]

Intake/Exhaust: 0.07 mm (0.0027 in.) or less

Camshaft

1. Inspect cam lobes.

Using a micrometer, measure the cam lobe height.

Cam height

[Standard value]

Intake: 44.5 mm (1.7520 in.)

Exhaust: 44.5 mm (1.7520 in.)

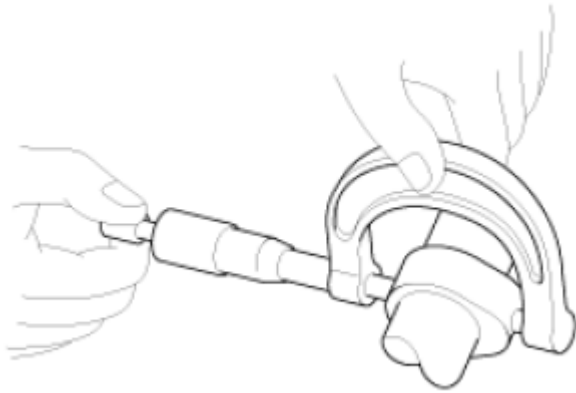


Fig. 38: Measuring Cam Lobe Height
Courtesy of KIA MOTORS AMERICA, INC.

If the cam lobe height is less than standard, replace the camshaft.

2. Check the cam lobe surface for wear or damage. If necessary, replace it.
3. Inspect camshaft journal clearance.
 1. Clean the bearing caps and camshaft journals.
 2. Place the camshafts on the cylinder head.
 3. Lay a strip of plastigage across each of the camshaft journals.

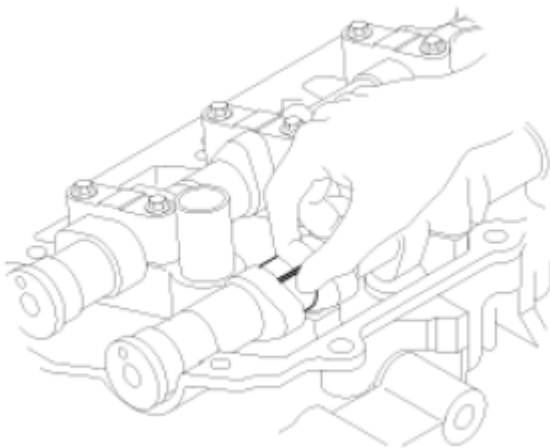


Fig. 39: Inspecting Camshaft Journal Clearance
Courtesy of KIA MOTORS AMERICA, INC.

4. Install the bearing caps with the tightening torque.

CAUTION: Do not turn the camshaft.

5. Remove the bearing caps.

6. Measure the plastigage at its widest point.

Bearing oil clearance

[Standard value]

Intake: 0.020-0.057 mm (0.0008-0.0022 in.)

Exhaust: 0.020-0.057 mm (0.0008-0.0022 in.)

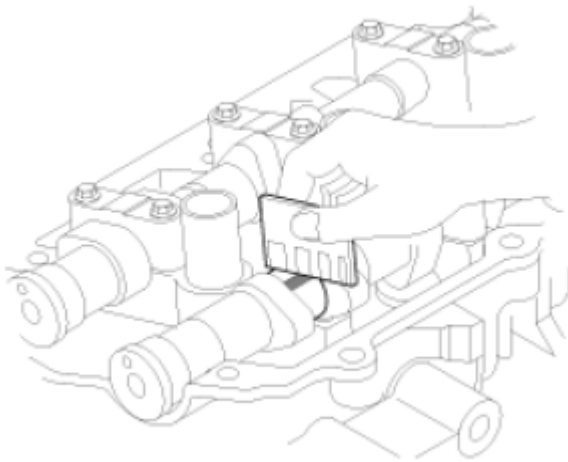


Fig. 40: Measuring Plastigage At Widest Point
Courtesy of KIA MOTORS AMERICA, INC.

If the oil clearance is greater than the maximum, replace the camshaft. If necessary, replace the cylinder head.

7. Completely remove the plastigage.
8. Remove the camshafts.
4. Inspect camshaft end play.
 1. Install the camshafts.
 2. Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play

[Standard value]: 0.1-0.2 mm (0.0039-0.0079 in.)

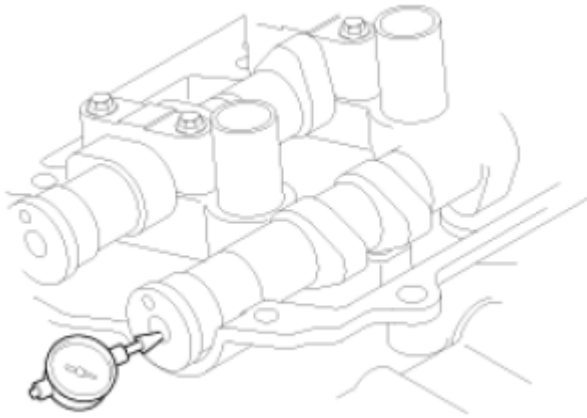


Fig. 41: Measuring Camshaft End Play Back And Forth
 Courtesy of KIA MOTORS AMERICA, INC.

If the end play is greater than the maximum, replace the camshaft. If necessary, replace the cylinder head.

3. Remove the camshafts.

CVVT Assembly

1. Inspect CVVT assembly.
 1. Fix the CVVT assembly with a vice. Ensure that the cam lobe and journal is not damaged.
 2. Check that the CVVT assembly will not turn.

It should not be turned.

3. Apply vinyl tape to the retard hole except the one (A) indicated by the arrow in the illustration.

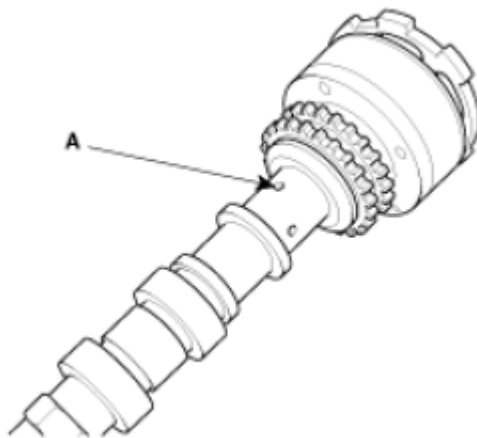


Fig. 42: Identifying CVVT Assembly
 Courtesy of KIA MOTORS AMERICA, INC.

4. Wind tape around the tip of the air gun and apply air of approx. 150 kPa (1.5 kgf/cm² , 21 psi) to the port of the camshaft.

(Perform this in order to release the lock pin for the maximum delay angle locking.)

NOTE: When the oil splashes, wipe it off with a shop rag.

5. After the lock pin released, the CVVT assembly can turned in advanced direction.

If the air applied is leaked much, the lock pin can not be released.

6. Except the position where the lock pin meets at the maximum delay angle, let the CVVT assembly turn back and forth and check the movable range and that there is no resistance to movement.

Standard: Movable smoothly in the range about 30°

7. Turn the CVVT assembly with your hand in retard direction and lock it at the maximum delay angle position.

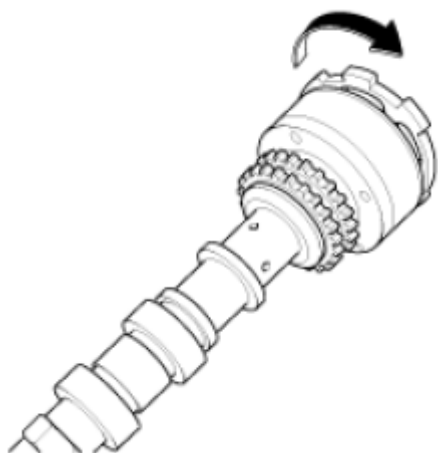


Fig. 43: Turning CVVT Assembly
Courtesy of KIA MOTORS AMERICA, INC.

REASSEMBLY

NOTE:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace oil seals with new ones.

1. Install valves.

1. Using SST (09222-22001), push in a new valve stem seal with applying engine oil.

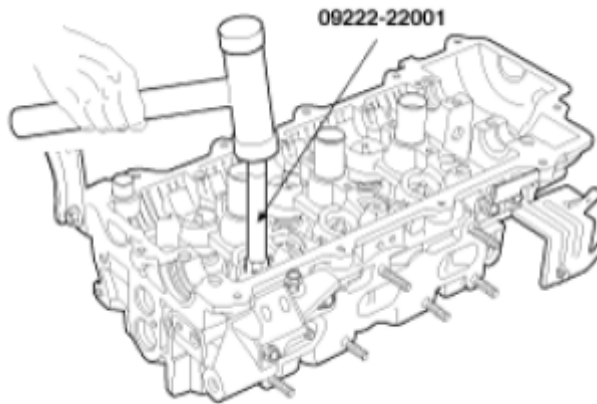


Fig. 44: Pushing Valve Stem Seal
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Do not reuse old valve stem seals.

Incorrect installation of the seal could result in oil leakage past the valve guides.

- Reassemble the valve stem seals

2. After applying engine oil on the outer surface of each valve stem, insert the valve in the valve guide. Install the valve, valve spring and spring retainer.

NOTE:

When installing valve springs, the side coated with enamel should face toward the valve spring retainer.

3. Using the SST (09222-3K000, 09222-3C300), compress the springs and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.

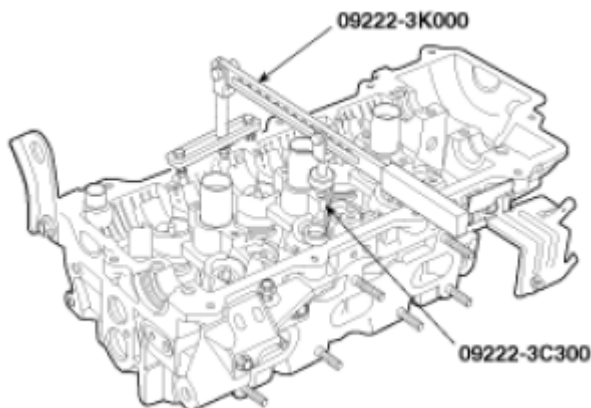


Fig. 45: Compressing Springs And Retainer Locks
Courtesy of KIA MOTORS AMERICA, INC.

4. Lightly tap the end of each valve stem two or three times with the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.
2. Install MLAs with engine oil applied on its surface.

Check that the MLA rotates smoothly by hand.

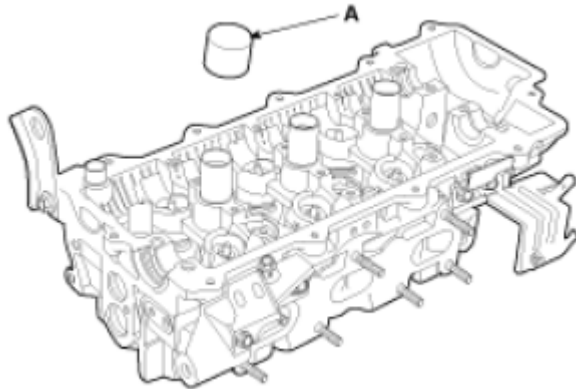


Fig. 46: Identifying MLAs With Engine Oil On Surface
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: MLA should be reinstalled in its original position.

3. Install OCV (Oil Control Valve) (A).

Tightening torque

7.8-9.8 N.m (0.8-1.0 kgf.m, 5.8-7.2 lb-ft)

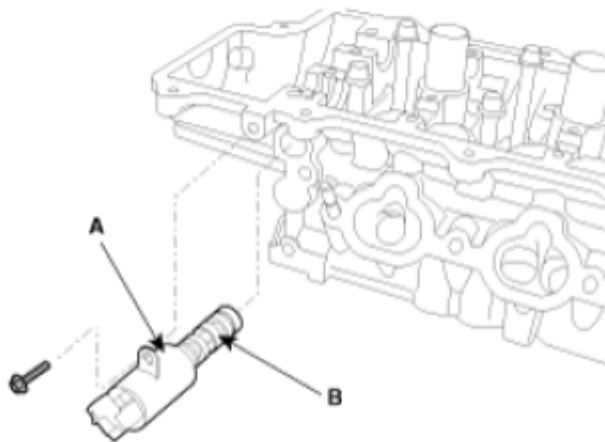


Fig. 47: Identifying OCV (Oil Control Valve)
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: • To install OCV with gray colored connector into RH bank.

- To install OCV with black colored connector into LH bank.

CAUTION:

- Do not reuse the OCV when dropped.
- Keep clean the OCV.
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.
- If there is dust on the filter (B) of the OCV, clean it all.

INSTALLATION**NOTE:**

- Thoroughly clean all parts to be assembled.
- Always use a new head and manifold gasket.
- The cylinder head gasket is a metal gasket. Take care not to bend it.
- Rotate the crankshaft to set the No. 1 cylinder piston at TDC.

1. After putting the cylinder head gasket on the cylinder block, install the cylinder head.

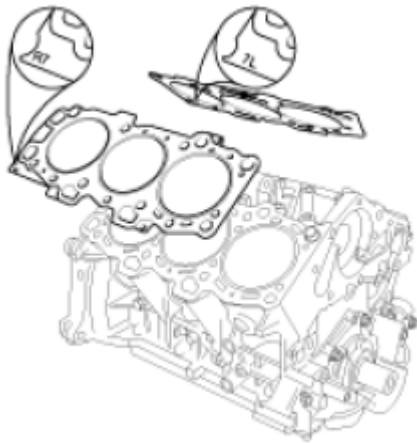


Fig. 48: Identifying Cylinder Head Gasket On Cylinder Block
Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: Ensure the LH/RH classification of the cylinder head gasket when installing.

2. Tighten the cylinder head bolts with the plain washers in several steps as following order.

NOTE:

- In assembling washers, the marked surface should face upward.
- In installing the cylinder head bolts, apply engine oil on the thread of the bolts and the surface of the washers.

CAUTION: Always use new cylinder head bolts.

Tightening torque

22.6-26.5 N.m (2.3-2.7 kgf.m, 16.6-19.5 lb-ft) + 58-62° + 43-47°

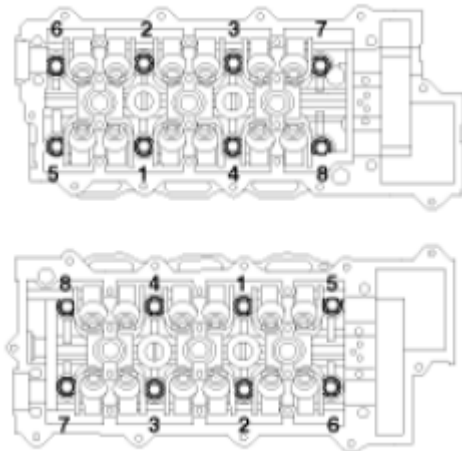


Fig. 49: Identifying Cylinder Head Bolts In Sequence
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: Using the SST (09221-4A000), tighten the bolts which need to be tightened with the angular tightening method.

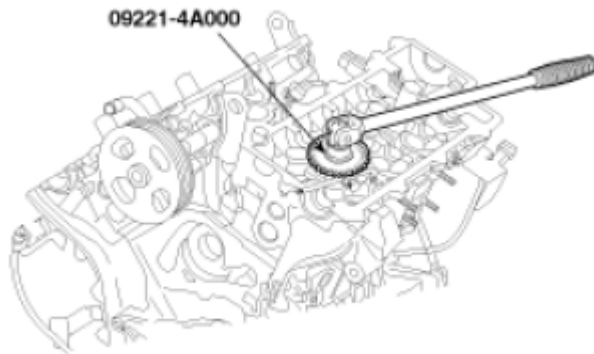


Fig. 50: Tightening Bolts
Courtesy of KIA MOTORS AMERICA, INC.

3. Install the CVVT assembly and camshaft chain sprocket with the dowel pin in the CVVT installed to the intake camshaft. Ensure that the pin will not be installed in the hole for oil feeding.

Tightening torque

66.7-78.5 N.m (6.8-8.0 kgf.m, 49.2-57.9 lb-ft)

NOTE: After tightening the CVVT bolts, rotate the CVVT assembly housing counterclockwise by hand to seat the lock pin in the CVVT assembly in good position.

CAUTION: Fix the hexagonal part of the camshaft in a vice when tightening the CVVT bolts. Do not fix the CVVT housing or sprocket in a vice.

4. Install the camshaft in the cylinder head assembly.
 1. Align the timing marks of the intake and exhaust camshaft chain sprockets and the timing chain.

CAUTION: Both timing marks should face upward for reassembly.

2. Install the intake and exhaust camshafts on the cylinder head with the timing marks aligned.

LH camshaft chain timing mark

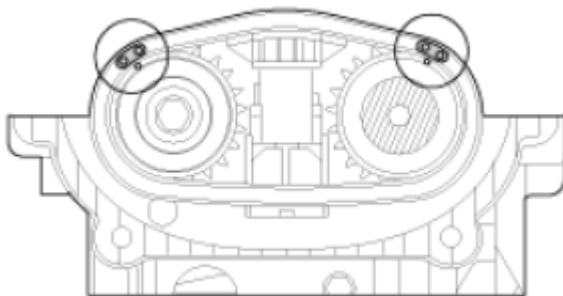


Fig. 51: Identifying LH Camshaft Chain Timing Mark
Courtesy of KIA MOTORS AMERICA, INC.

RH camshaft chain timing mark

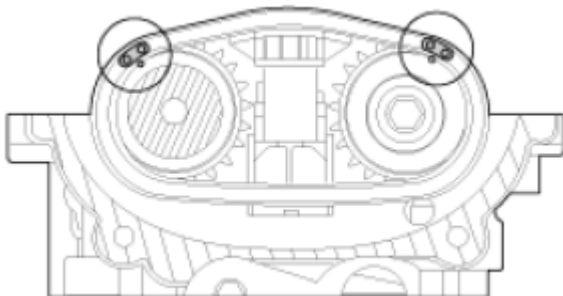


Fig. 52: Identifying RH Camshaft Chain Timing Mark
Courtesy of KIA MOTORS AMERICA, INC.

5. Install the timing chain tensioner.

1. Insert the set pin by pressing the timing chain tensioner.
2. Install the chain tensioner (A) in the cylinder head assembly.
3. Remove the set pin from the tensioner after installing.

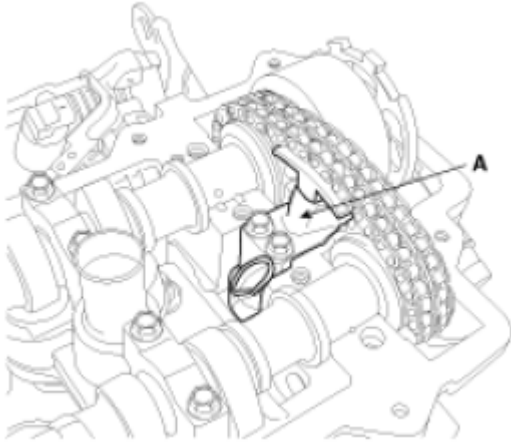


Fig. 53: Identifying Chain Tensioner In Cylinder Head Assembly
Courtesy of KIA MOTORS AMERICA, INC.

6. Install the camshaft bearing caps.

Tightening torque

Bearing cap bolt (A: 6x38):

10.8-12.7 N.m (1.1-1.3 kgf.m, 8.0-9.4 lb-ft)

Bearing cap bolt (B: 8x38):

20.6-22.5 N.m (2.1-2.6 kgf.m, 15.2-18.8 lb-ft)

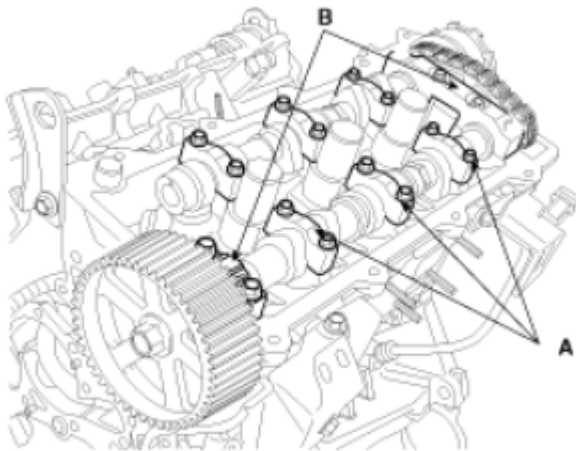


Fig. 54: Identifying Camshaft Bearing Caps

Courtesy of KIA MOTORS AMERICA, INC.

NOTE: When installing the bearing caps, check the marks on them as shown below and install them in its proper position.

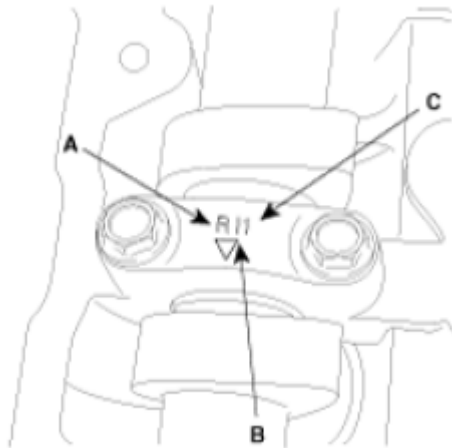


Fig. 55: Identifying Bearing Caps Marks On Proper Position
Courtesy of KIA MOTORS AMERICA, INC.

- A. (LH/RH HEAD): L (LH), R (RH)
- B. (Intake/Exhaust): I (Intake), E (Exhaust)
- C. (Cap no.): 1,2,3

CAUTION: When installing the bearing caps, turn the crankshaft to place a piston in the middle of the block because interference between valves and pistons can occur.

7. Using the SST (09214-21000), install the camshaft oil seal.

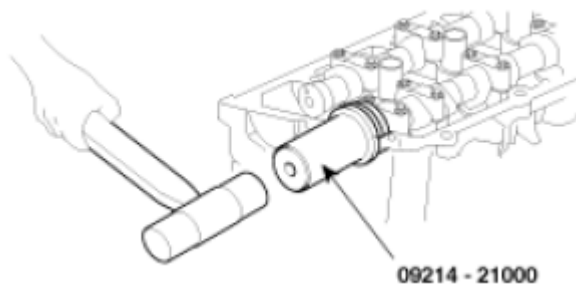


Fig. 56: Identifying Camshaft Oil Seal
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Before installing, apply engine oil.
- The camshaft cap surface should adhere to the cylinder head

assembly.

- **Do not press an eccentric load.**

8. Install the camshaft sprocket.

1. Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt.

Tightening torque

88.3-107.9 N.m (9.0-11.0 kgf.m, 65.1-79.6 lb-ft)

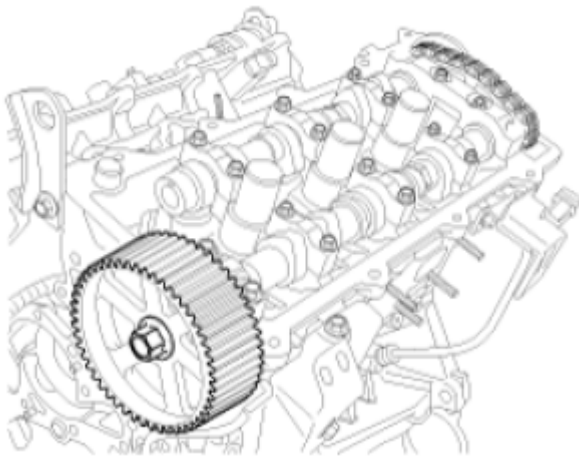


Fig. 57: Identifying Camshaft Sprocket
Courtesy of KIA MOTORS AMERICA, INC.

2. In case that the camshaft is replaced with new one, inspect the valve clearances and then install appropriate MLA tappet. Refer to **VALVE CLEARANCE INSPECTION AND ADJUSTMENT** .

CAUTION: To prevent the valve from interfering with the piston, rotate the crankshaft sprocket at 3 pitches counterclockwise from the No. 1 cylinder piston at TDC position before inspecting the valve clearances.

9. Install the CKP sensor connector bracket (A).

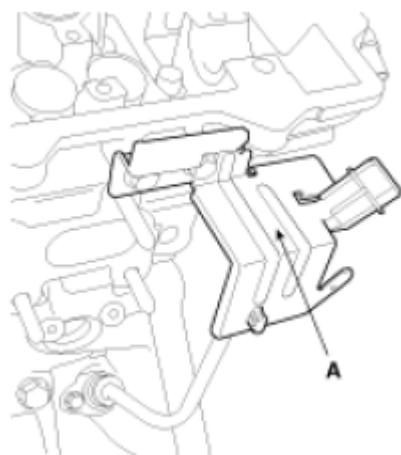


Fig. 58: Identifying CKP Sensor Connector Bracket
Courtesy of KIA MOTORS AMERICA, INC.

10. Install the bank 1 timing belt rear cover (A).

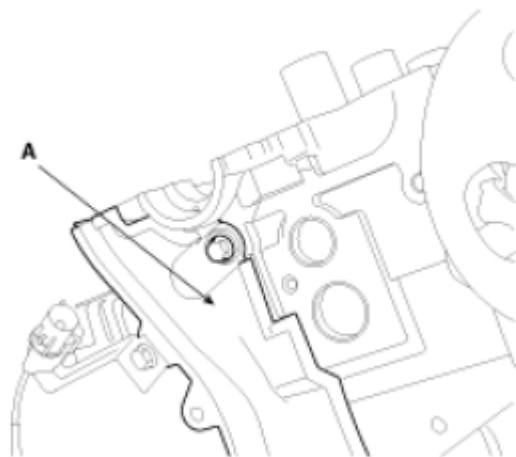


Fig. 59: Identifying Bank 1 Timing Belt Rear Cover
Courtesy of KIA MOTORS AMERICA, INC.

11. Install the bank 2 timing belt rear cover (A).

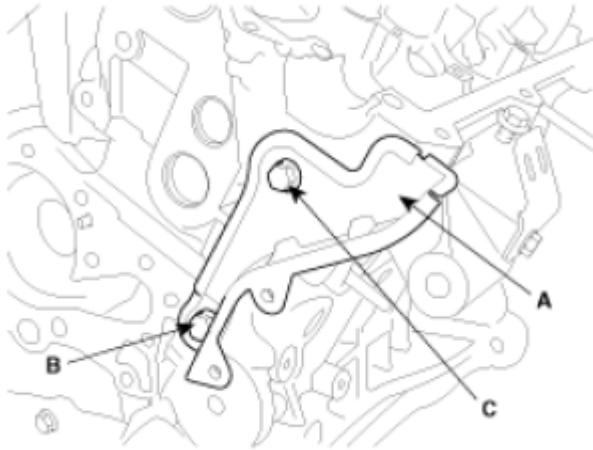


Fig. 60: Identifying Bank 2 Timing Belt Rear Cover
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: The length of the bolt B is longer than that of the bolt C.

12. Install the cylinder head cover.
 1. Remove oil, dust or sealant on the upper surface of the cylinder before assembling cylinder head cover.
 2. Assemble the cylinder head cover in five minutes after applying liquid gasket (LOCTITE 5900) on the camshaft cap and packing part.

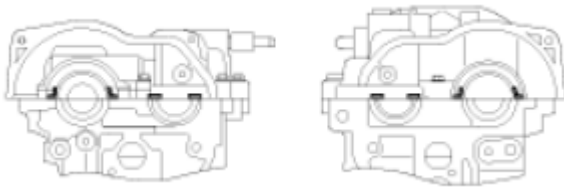


Fig. 61: Identifying Liquid Gasket On Camshaft Cap And Packing Part
Courtesy of KIA MOTORS AMERICA, INC.

3. Tighten the cylinder head cover bolts as following order (A).

Tightening torque

7.8-9.8 N.m (0.8-1.0 kgf.m, 5.8-7.2 lb-ft)

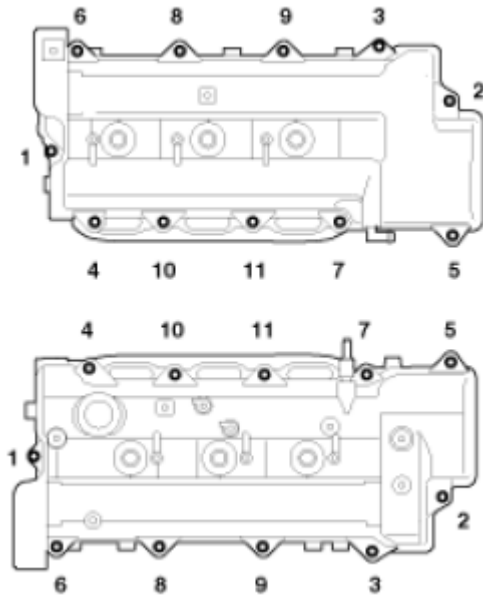


Fig. 62: Identifying Cylinder Head Cover Bolts In Tightening Sequence
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Do not start engine for thirty minutes after assembling the cylinder head cover.
- Do not reuse the cylinder head cover gasket.

13. Install the timing belt.

1. Align the timing marks of the LH/RH camshaft sprockets.

CAUTION: To prevent the valve from interfering with the piston, rotate the crankshaft sprocket at 3 pitches counterclockwise from the No. 1 cylinder piston at TDC position before aligning the timing marks of the camshaft sprockets.

2. After aligning the timing marks of the camshaft sprockets, rotate the crankshaft sprocket at 3 pitches clockwise then align the timing mark of the crankshaft sprocket to set the crankshaft to the No. 1 cylinder piston at TDC position.
3. Install the timing belt. Refer to **TIMING SYSTEM**.

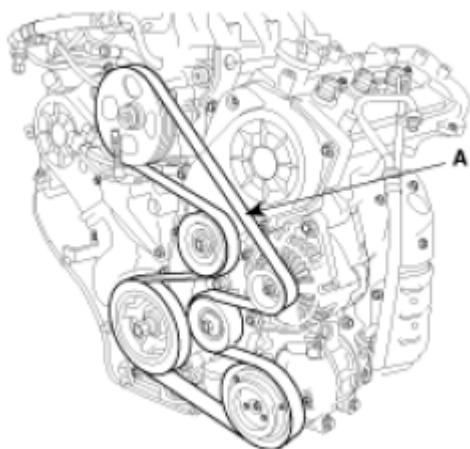
14. Install the water temp. control assembly.

15. Install the intake manifold assembly.

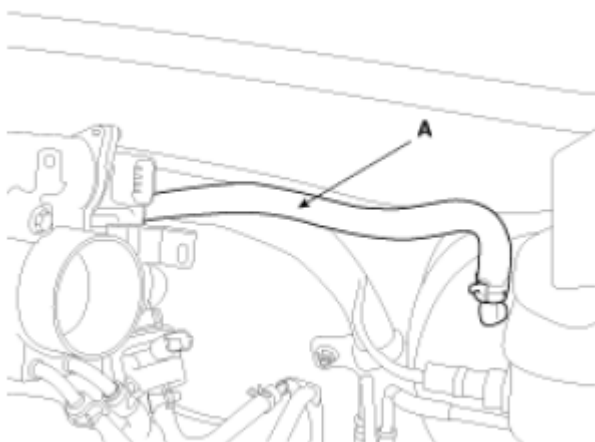
16. Install the exhaust manifold assembly.

17. Install the power steering pump. Refer to **POWER STEERING OIL PUMP**.

18. Install the drive belt (A).

**Fig. 63: Identifying Drive Belt****Courtesy of KIA MOTORS AMERICA, INC.**

19. Install the heater hose.
20. Connect the brake vacuum hose (A).

**Fig. 64: Identifying Brake Vacuum Hose****Courtesy of KIA MOTORS AMERICA, INC.**

21. Connect the engine wiring harness connectors.
 1. Connect the bank 1 CMP sensor connector (A).

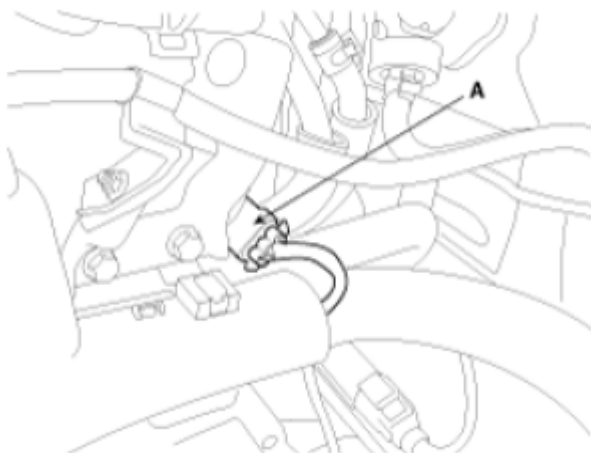


Fig. 65: Identifying Bank 1 CMP Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

2. Connect the bank 2 front/rear O2 sensor connectors (A, B) and the CKP sensor connector (C).

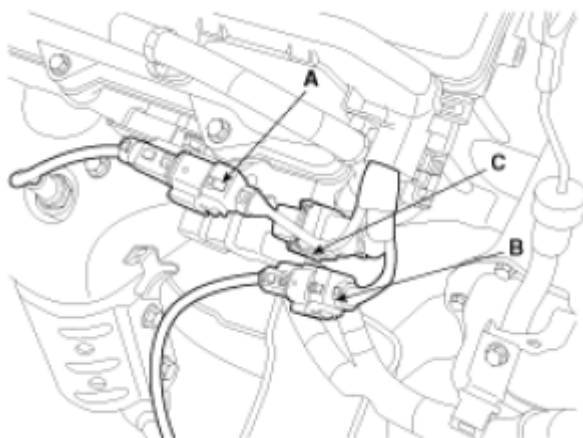


Fig. 66: Identifying Bank 2 Front/Rear O2 Sensor Connectors And CKP Sensor Connector
Courtesy of KIA MOTORS AMERICA, INC.

3. Connect the bank 2 CMP sensor connector (A) and the WTS (Water Temperature Sensor) connector (B).

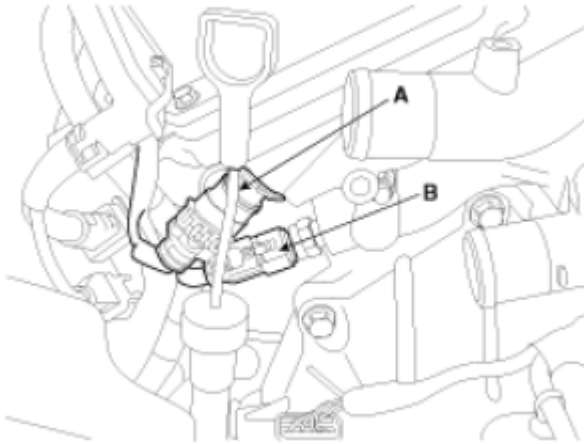


Fig. 67: Identifying Bank 2 CMP Sensor Connector And WTS (Water Temperature Sensor) Connector

Courtesy of KIA MOTORS AMERICA, INC.

4. Connect the generator connector (A) and the air conditioning compressor connector (B).

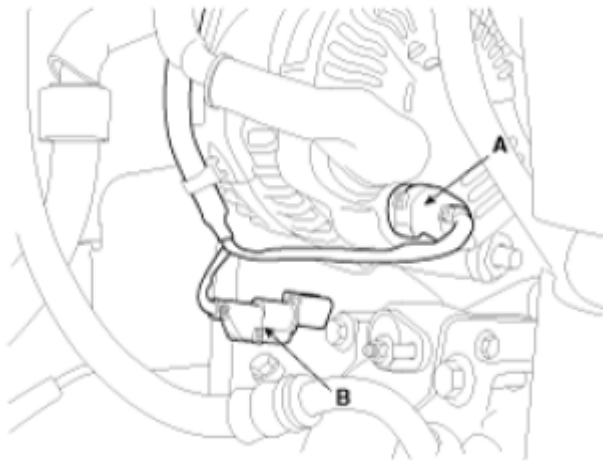


Fig. 68: Identifying Generator Connector And Air Conditioning Compressor Connector

Courtesy of KIA MOTORS AMERICA, INC.

5. Connect the MAPS (Manifold Absolute Pressure Sensor) connector (A), the ETC (Electronic Throttle Control) connector (B) and the PCSV (Purge Control Solenoid Valve) connector (C).

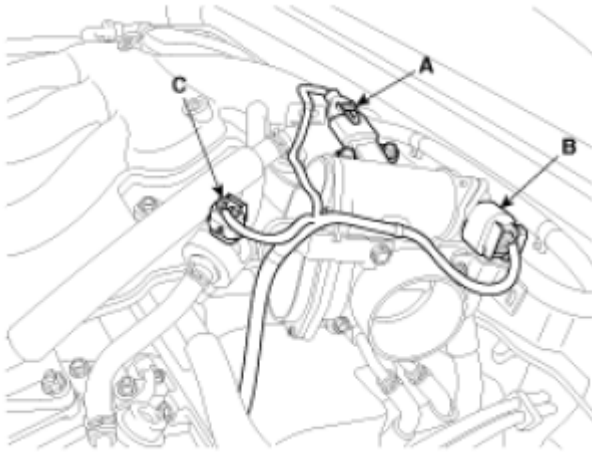


Fig. 69: Identifying MAPS Connector, ETC Connector And PCSV Connector
Courtesy of KIA MOTORS AMERICA, INC.

6. Connect the No. 1/No. 2 OCV (Oil Control Valve) connectors (A, B) and the OTS (Oil Temperature Sensor) connector (C).

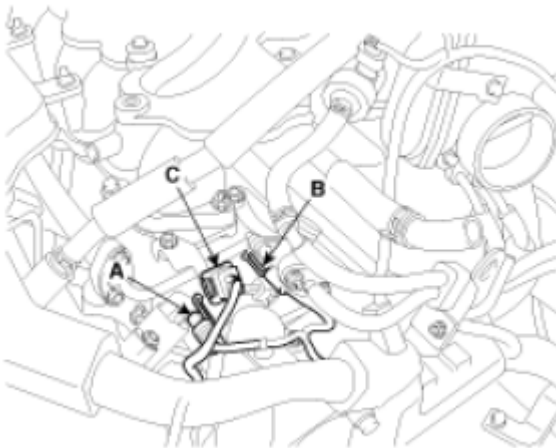


Fig. 70: Identifying No. 1/No. 2 OCV Connectors And OTS Connector
Courtesy of KIA MOTORS AMERICA, INC.

7. Connect the injection connectors (A, B, C), the ground lines (D), the condenser connector (E) and the Ignition coil connectors (F).

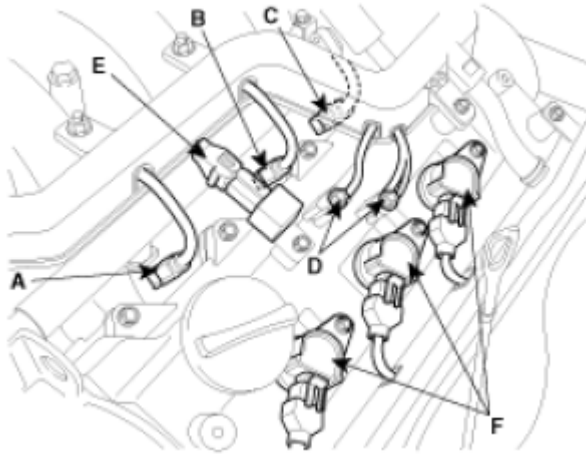


Fig. 71: Identifying Injection Connectors, Ground Lines, Condenser Connector And Ignition Coil Connectors

Courtesy of KIA MOTORS AMERICA, INC.

8. Connect the bank 1 front/rear O2 sensor connectors (A).

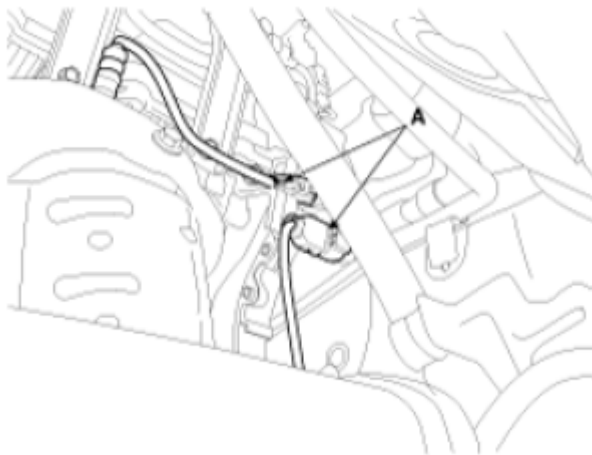


Fig. 72: Identifying Bank 1 Front/Rear O2 Sensor Connectors

Courtesy of KIA MOTORS AMERICA, INC.

9. Connect the No. 1/No. 2 knock sensor connectors (A, B), the injector connector (C), the ignition coil harness (D) and the No. 1 VIS (Variable Induction System) connector (E).

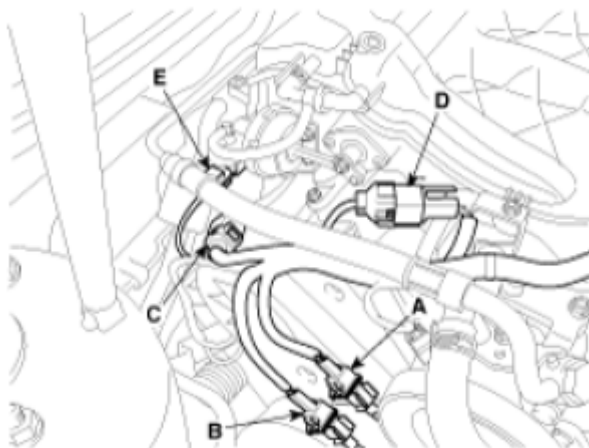


Fig. 73: Identifying No. 1/No. 2 Knock Sensor Connectors, Injector Connector And Ignition Coil Harness

Courtesy of KIA MOTORS AMERICA, INC.

22. Install the fuel inlet hose (A) to the delivery pipe.

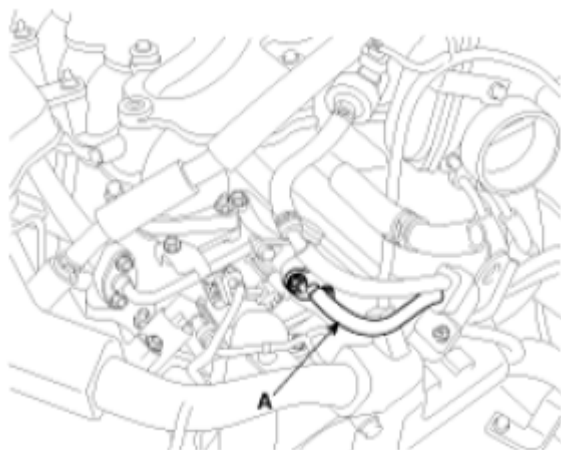


Fig. 74: Identifying Fuel Inlet Hose To Delivery Pipe

Courtesy of KIA MOTORS AMERICA, INC.

23. Install the upper radiator hose (A) and lower radiator hose (B).

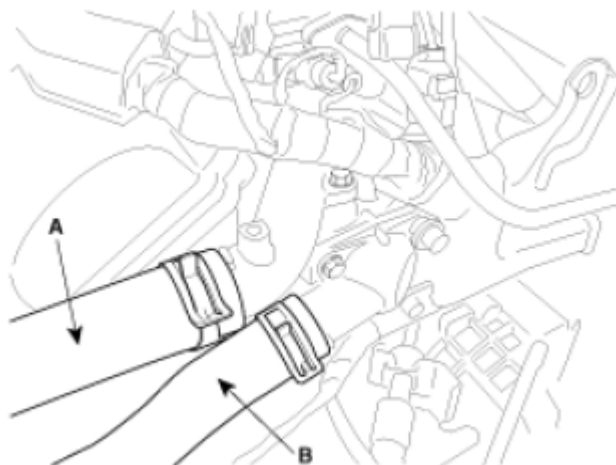


Fig. 75: Identifying Upper Radiator Hose And Lower Radiator Hose
Courtesy of KIA MOTORS AMERICA, INC.

24. Install the intake air hose and air cleaner assembly.
 1. Connect the PCM connectors (D).

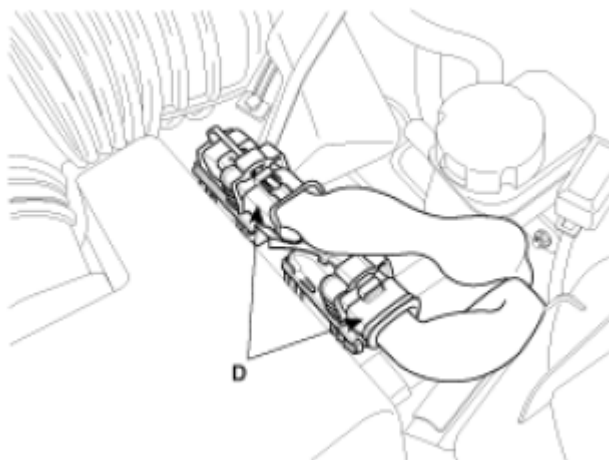


Fig. 76: Identifying PCM Connectors
Courtesy of KIA MOTORS AMERICA, INC.

2. Install the intake air hose and air cleaner assembly (C).
3. Connect the breather hose (B) from air cleaner hose.
4. Connect the MAF connector (A).

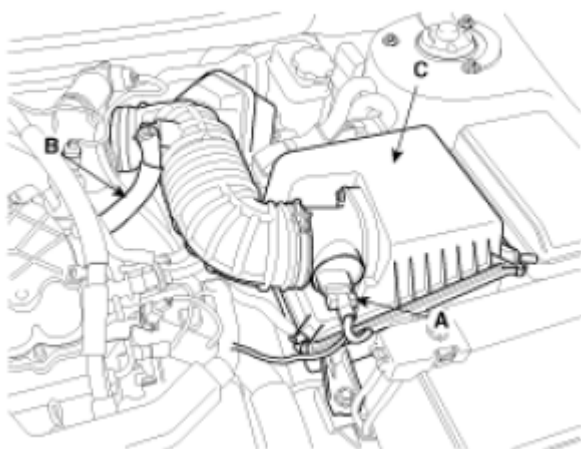


Fig. 77: Identifying MAF Connector, Breather Hose And Air Cleaner Assembly
Courtesy of KIA MOTORS AMERICA, INC.

25. Install the engine cover (A).

Tightening torque

7.8-11.8 N.m (0.8-1.2 kgf.m, 5.8-8.7 lb-ft)

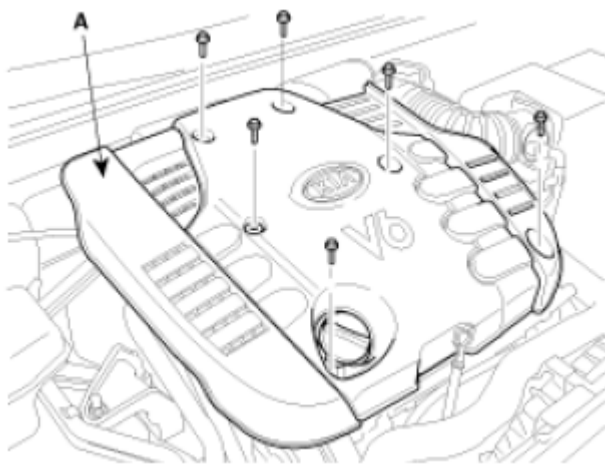


Fig. 78: Identifying Engine Cover
Courtesy of KIA MOTORS AMERICA, INC.

26. Refill engine coolant.

2009 ENGINE

Cylinder Block - 2.7L - Magnetis & Optima

COMPONENTS AND COMPONENTS LOCATION

COMPONENTS

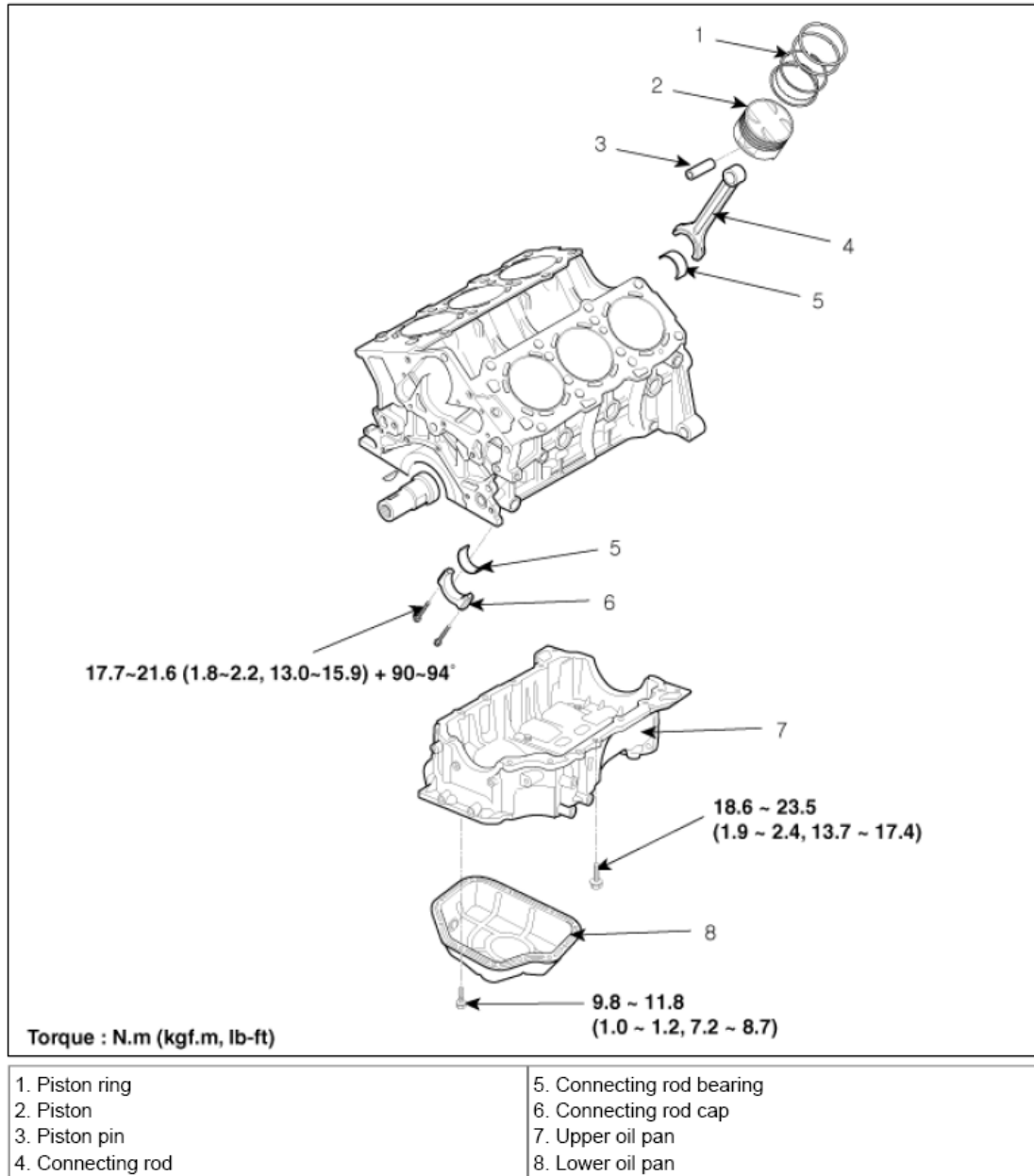


Fig. 1: Identifying Cylinder Block Components With Torque Specifications (1 Of 2)
Courtesy of KIA MOTORS AMERICA, INC.

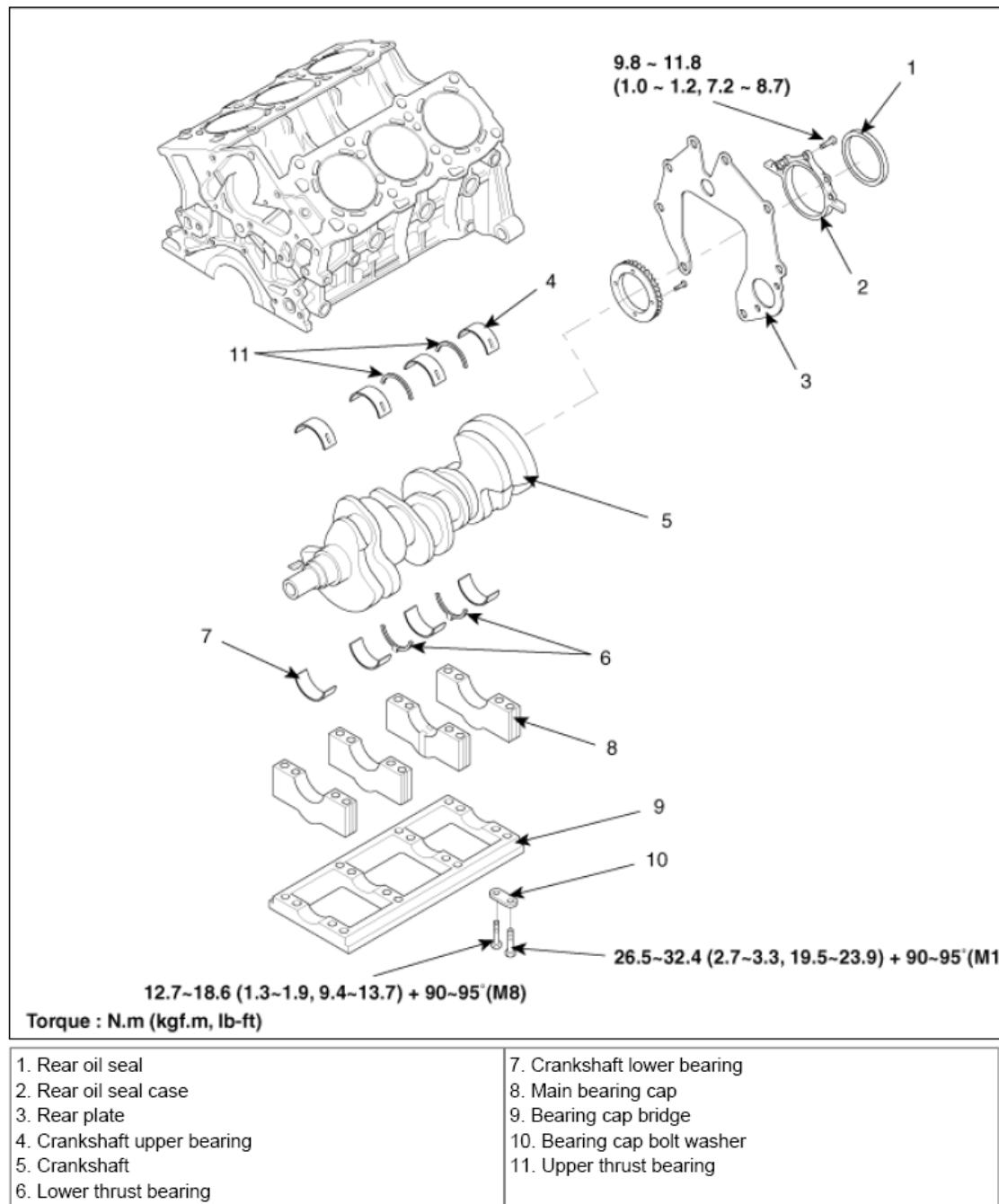
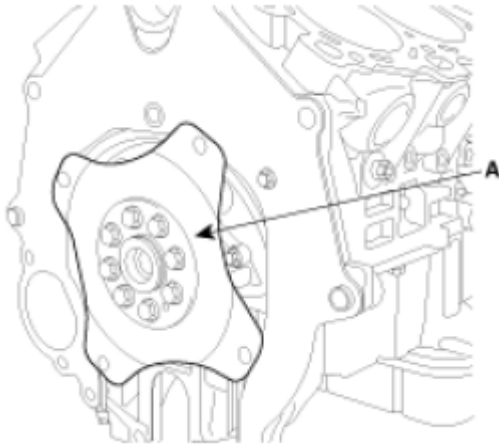


Fig. 2: Identifying Cylinder Block Components With Torque Specifications (2 Of 2)
Courtesy of KIA MOTORS AMERICA, INC.

REPAIR PROCEDURES

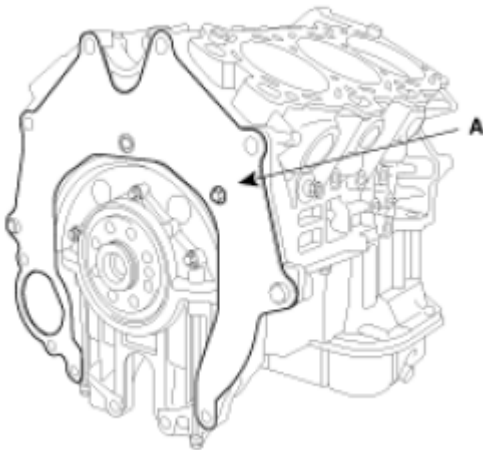
REMOVAL

1. Remove the drive plate (A).

**Fig. 3: Identifying Drive Plate**

Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the rear plate (A).

**Fig. 4: Identifying Rear Plate**

Courtesy of KIA MOTORS AMERICA, INC.

3. Remove timing belt.
4. Remove intake manifold.
5. Remove exhaust manifold.
6. Remove generator from engine.(Refer to **CHARGING SYSTEM**).
7. Remove power steering pump from engine.(Refer to **HYDRAULIC POWER STEERING SYSTEM**).
8. Remove cylinder head.
9. Remove A/C compressor from engine.(Refer to **AIR CONDITIONING SYSTEM**).
10. Remove water pump assembly.

DISASSEMBLY

1. Remove the power steering pump bracket (A) and the knock sensor (B).

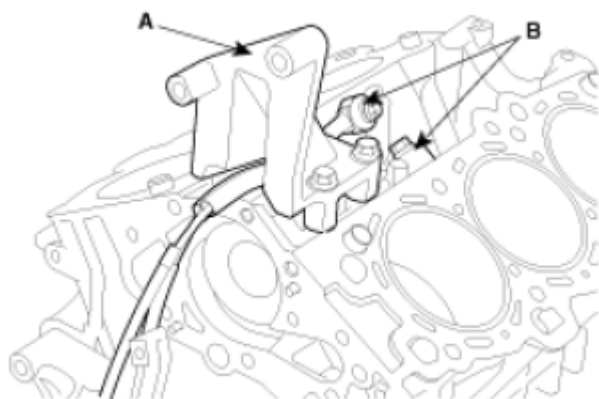


Fig. 5: Identifying Power Steering Pump Bracket And Knock Sensor
Courtesy of KIA MOTORS AMERICA, INC.

2. Remove the air conditioning compressor bracket (A).

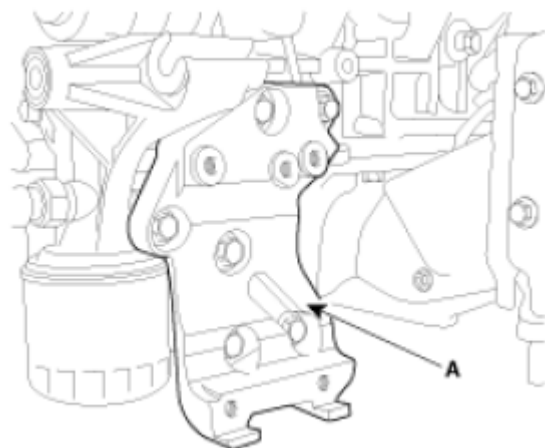


Fig. 6: Identifying Air Conditioning Compressor Bracket
Courtesy of KIA MOTORS AMERICA, INC.

3. Remove the lower oil pan (A).

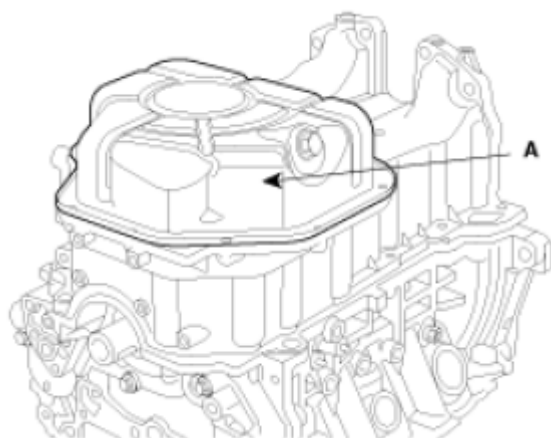


Fig. 7: Identifying Lower Oil Pan

Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: When removing the oil pan, use the SST (09215-3C000) not to damage the contacting surface of the oil pan.

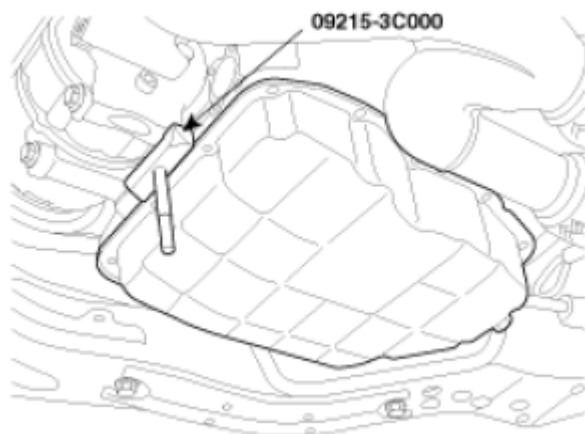


Fig. 8: Contacting Surface Of Oil Pan

Courtesy of KIA MOTORS AMERICA, INC.

4. Remove the oil screen (A).

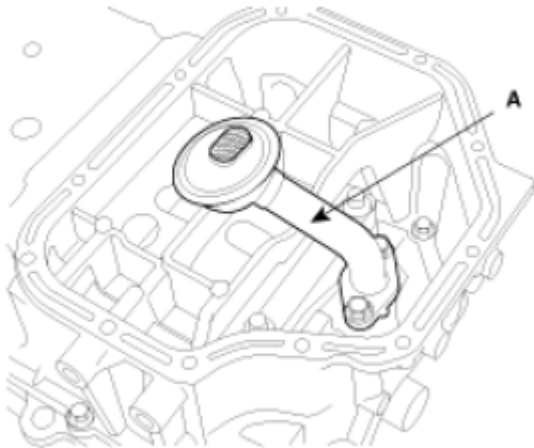


Fig. 9: Identifying Oil Screen

Courtesy of KIA MOTORS AMERICA, INC.

5. Remove the upper oil pan (A).

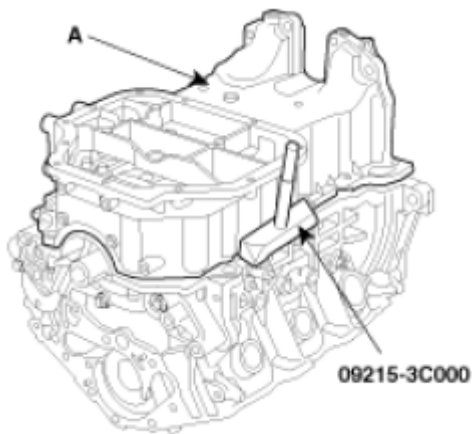


Fig. 10: Identifying Upper Oil Pan

Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: When removing the oil pan, use the SST (09215-3C000) not to damage the contacting surface of the oil pan.

6. Check the connecting rod side clearance.
7. Check the connecting rod bearing oil clearance.
8. Remove the piston and connecting rod assemblies.

NOTE:

- Keep the bearings the connecting rods and the caps together.
- Arrange the piston and connecting rod assemblies in the correct order.

9. Remove the oil pump case.
10. Remove the oil seal case (A).

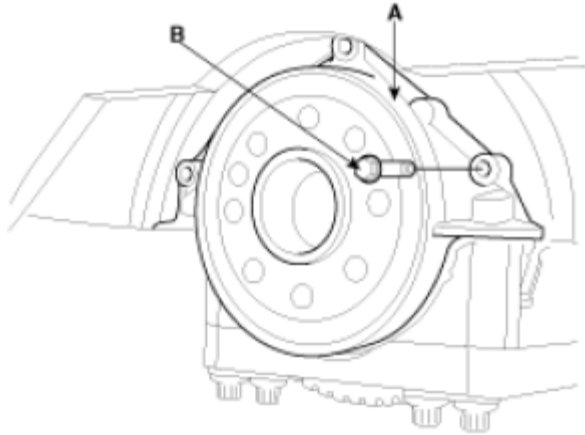


Fig. 11: Identifying Oil Seal Case
Courtesy of KIA MOTORS AMERICA, INC.

11. Check the crankshaft end play.
12. Remove the crankshaft bearing cap and check oil clearance.

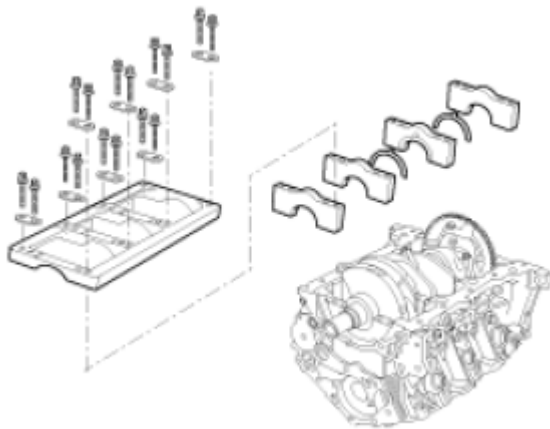


Fig. 12: Identifying Crankshaft End Play
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: **Arrange the bearings and the bearing caps in order.**

13. Lift the crankshaft (A) out of the block, being careful not to damage journals.

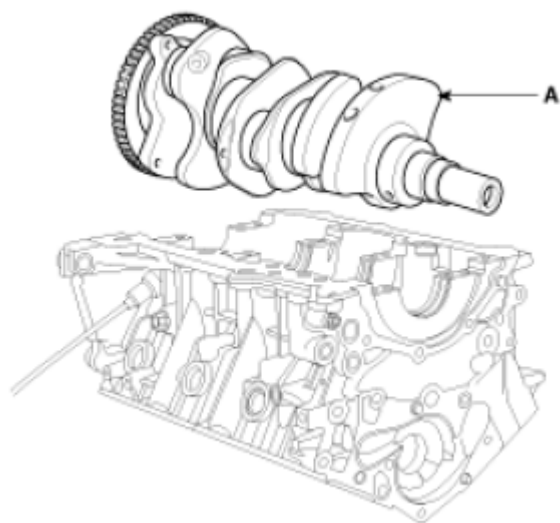


Fig. 13: Identifying Crankshaft Of Block
Courtesy of KIA MOTORS AMERICA, INC.

14. Remove and arrange the main bearings and thrust bearings in the correct order.

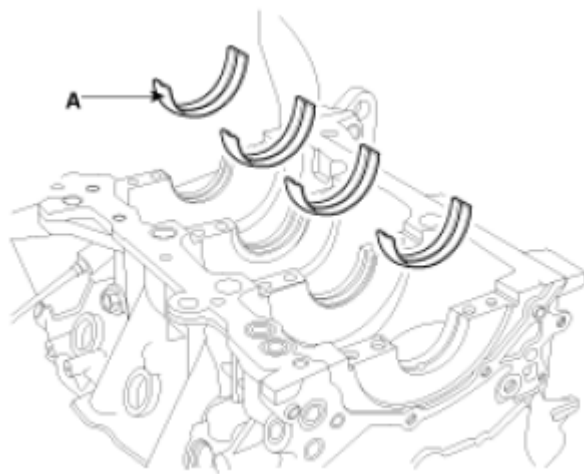


Fig. 14: Identifying Main Bearings And Thrust Bearings
Courtesy of KIA MOTORS AMERICA, INC.

15. Remove the CKP sensor (A).

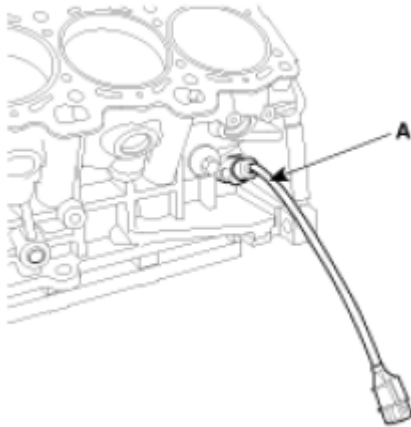


Fig. 15: Identifying CKP Sensor

Courtesy of KIA MOTORS AMERICA, INC.

16. Check the free play between a piston and a piston pin.

Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and the piston pin as a set.

17. Remove the piston rings.
1. Using a piston ring expander, remove the 2 compression rings.
 2. Remove the 2 side rails and the oil ring by hand.

NOTE: Arrange the piston rings in the correct order only.

18. Disconnect the connecting rod from the piston.

Using a press, remove the piston pin from the piston.

(Press-in load: 2451.7 ~ 12258.3N (250 ~ 1250kg, 551.2 ~ 2755.81lb))

INSPECTION

Connecting Rod And Crankshaft

1. Check the connecting rod side clearance.

Using a feeler gauge, measure the side clearance while moving the connecting rod back and forth.

Specification

Standard: 0.1~ 0.25mm (0.0039 ~ 0.0098in.)

Limit: 0.4mm (0.0157in.)

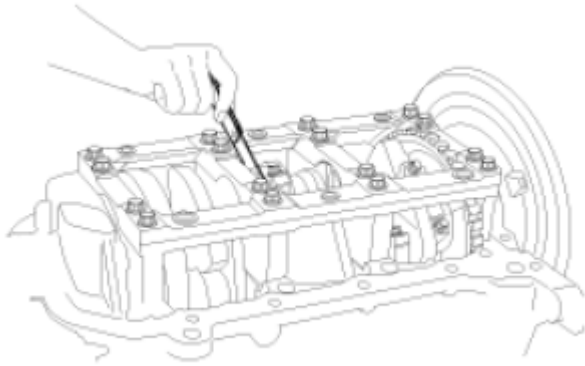


Fig. 16: Checking Connecting Rod Side Clearance
Courtesy of KIA MOTORS AMERICA, INC.

- A. If out-of-tolerance, install a new connecting rod.
- B. If still out-of-tolerance, replace the crankshaft.
2. Check the connecting rod bearing oil clearance.
 1. Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.
 2. Remove the 2 connecting rod cap bolts.
 3. Remove the connecting rod cap and the lower bearing.
 4. Clean the crankshaft pin journal and the bearing.
 5. Place a plastigage across the crankshaft pin.
 6. Reinstall the lower bearing and the connecting rod cap and torque the bolts.

Tightening torque

17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 90~94°

NOTE: **Do not turn the crankshaft.**

7. Remove the connecting rod cap again.
8. Measure the plastigage at its widest point.

Standard oil clearance

0.018 ~ 0.036mm (0.0007 ~ 0.0014in.)

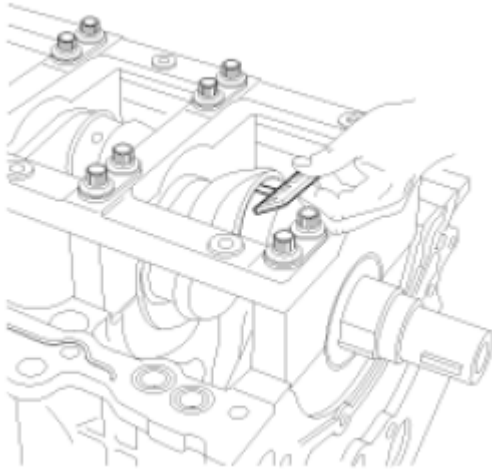


Fig. 17: Measuring Plastigage At Its Widest Point
Courtesy of KIA MOTORS AMERICA, INC.

9. If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

CAUTION: Do not file, shim, or scrape the bearings or the caps to adjust clearance.

10. If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

NOTE: If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

CAUTION: If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

Connecting Rod Mark Location



Fig. 18: Identifying Connecting Rod Mark Location
Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Connecting Rod

CONNECTING ROD MARK SPECIFICATION

Class	Mark	Inside Diameter
0	a	51.000 ~ 51.006mm (2.0079 ~ 2.0081in.)
1	b	51.006 ~ 51.012mm (2.0081 ~ 2.0083in.)
2	c	51.012 ~ 51.018mm (2.0083 ~ 2.0086in.)

Crankshaft Pin Mark Location

Discrimination Of Crankshaft

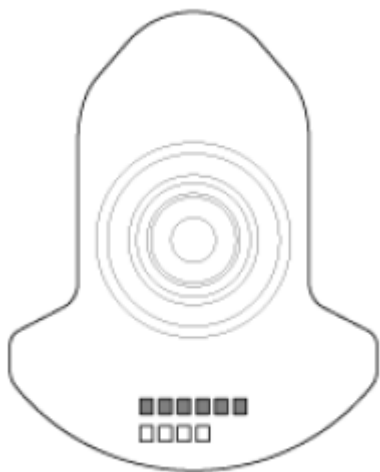


Fig. 19: Identifying Crankshaft Pin Mark Location

Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Crankshaft

CRANKSHAFT PIN MARK CHART

Class	Mark	Outside Diameter Of Pin
I	1 or A	47.994 ~ 48.000mm (1.8895 ~ 1.8898in.)
II	2 or B	47.988 ~ 47.994mm (1.8893 ~ 1.8895in.)
III	3 or C	47.982 ~ 47.988mm (1.8891 ~ 1.8893in.)

Place Of Identification Mark (Connecting Rod Bearing)

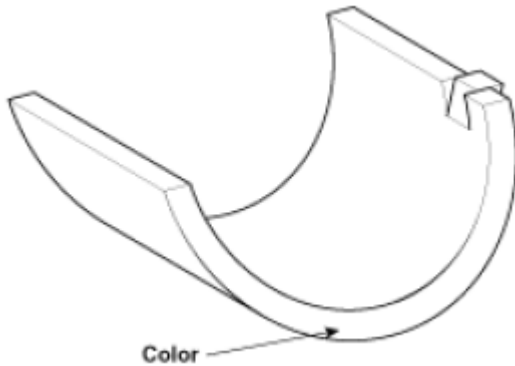


Fig. 20: Identifying Connecting Rod Bearing Identification Mark
Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Connecting Rod Bearing

BEARING THICKNESS CHART

Class	Mark	Thickness Of Bearing
A	Blue	1.5000 ~ 1.503mm (0.0591 ~ 0.0592in.)
B	Black	1.497 ~ 1.500mm (0.0589 ~ 0.0591in.)
C	-	1.494 ~ 1.497mm (0.0588 ~ 0.0589in.)
D	Green	1.491 ~ 1.494mm (0.0587 ~ 0.0588in.)
E	Yellow	1.488 ~ 1.491mm (0.0586 ~ 0.0587in.)

11. Select the proper connecting rod bearing from the table below.

CONNECTING ROD IDENTIFICATION MARK CHART

		Connecting Rod Identification Mark		
		0 (A)	1 (B)	2 (C)
Crankshaft Identification Mark	I (A)	E (Yellow)	D (Green)	C (-)
	II (B)	D (Green)	C (-)	B (Black)
	III (C)	C (-)	B (Black)	A (Blue)

3. Check the connecting rod.

1. When reinstalling, check the cylinder numbers on the connecting rods and the caps. When installing a new connecting rod, the notches for bearing fixing on the connecting rods and caps should face the same direction.
2. If one or both edge of the connecting rod thrust surface is damaged, replace the rod. If the inner surface of the rod is damaged or rough, also replace it.
3. Using a connecting rod aligner, measure the bent or torsion of the rod. If the measurement is near the specification, adjust the rod with a press. If the rod is bent or twisted excessively, replace it.

Bending : 0.05mm/100mm (0.0020in./3.9370in.)

Torsion : 0.1mm/100mm (0.0039in./3.9370in.)

NOTE: **When assembling the rod without a bearing, there should be no difference.**

4. Check the crankshaft bearing oil clearance.

1. To check main bearing-to-journal oil clearance, remove the main bearing caps and bearing halves.
2. Clean each main journal and bearing half with a clean shop towel.
3. Place one strip of plastigage across each main journal.
4. Reinstall the bearings and caps, then torque the bolts.

Tightening torque

M8: 12.7~18.6Nm (1.3~1.9kgf.m, 9.4~13.7lb-ft) + 90~95°

M10: 26.5~32.4Nm (2.7~3.3kgf.m, 19.5~23.9lb-ft) + 90~95°

NOTE: **Tighten the bolts in order.**

5. Remove the cap and bearing again, and measure the widest part of the plastigage.

Standard oil clearance

0.004~ 0.022mm (0.0002 ~ 0.0009in.)

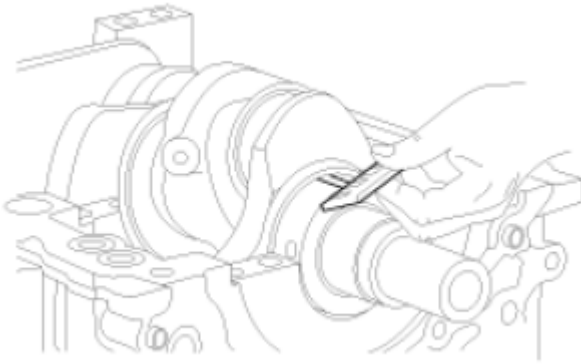


Fig. 21: Measuring Widest Part Of Plastigage
Courtesy of KIA MOTORS AMERICA, INC.

6. If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

CAUTION: Do not file, shim, or scrape the bearings or the caps to adjust clearance.

7. If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

NOTE: If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

CAUTION: If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

Crankshaft bore mark location

Letters have been stamped on the block as a mark for the each size of the 4 main journal bores.

No. 1 journal stamping mark starts from the front of the engine.

Use the size marks which are stamped on the block and the crankshaft for the journal bore inner diameter and the journal outer diameter to choose the correct bearings.

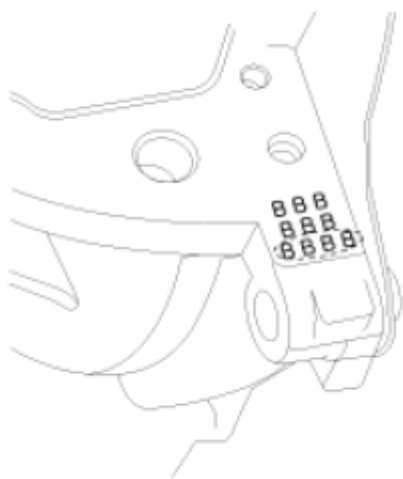


Fig. 22: Identifying Crankshaft Bore Mark Location
Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Cylinder Block

CYLINDER BLOCK SPECIFICATION

Class	Mark	Inside Diameter
a	A	66.000 ~ 66.006mm (2.5984 ~ 2.5987in.)
b	B	66.006 ~ 66.012mm (2.5987 ~ 2.5989in.)
c	C	66.012 ~ 66.018mm (2.5989 ~ 2.5991in.)

Crankshaft Journal Mark Location

Discrimination Of Crankshaft



Fig. 23: Crankshaft Journal Mark Location
Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Crankshaft

CRANKSHAFT SPECIFICATION

Class	Mark	Outside Diameter Of Journal
I	A	61.994 ~ 62.000mm (2.4407 ~ 2.4409in.)
II	B	61.988 ~ 61.994mm (2.4405 ~ 2.4407in.)
III	C	61.982 ~ 61.988mm (2.4402 ~ 2.4405in.)

Place Of Identification Mark (Crankshaft Bearing)

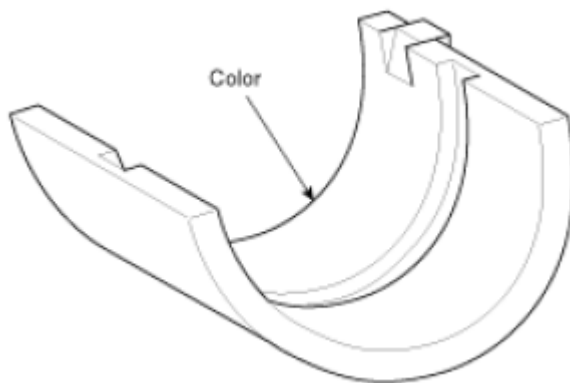


Fig. 24: Identifying Crankshaft Bearing Identification Mark
Courtesy of KIA MOTORS AMERICA, INC.

Discrimination Of Crankshaft Bearing

BEARING THICKNESS CHART

Class	Mark	Thickness Of Bearing
A	Blue	2.007 ~ 2.010mm (0.0790 ~ 0.0791in.)
B	Black	2.004 ~ 2.007mm (0.0789 ~ 0.0790in.)
C	-	2.001 ~ 2.004mm (0.0788 ~ 0.0789in.)
D	Green	1.998 ~ 2.001mm (0.0787 ~ 0.0788in.)
E	Yellow	1.995 ~ 1.998mm (0.0785 ~ 0.0787in.)

Selection Table**CRANKSHAFT BORE IDENTIFICATION MARK CHART**

		Crankshaft Bore Identification Mark		
		a (A)	b (B)	c (C)
Crankshaft Identification Mark	I (A)	E (Yellow)	D (Green)	C (-)
	II (B)	D (Green)	C (-)	B (Black)
	III (C)	C (-)	B (Black)	A (Blue)

5. Check crankshaft end play.

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard end play

0.07 ~ 0.25mm (0.0028 ~ 0.0098in.)

[Limit]

0.3mm (0.0118in.)

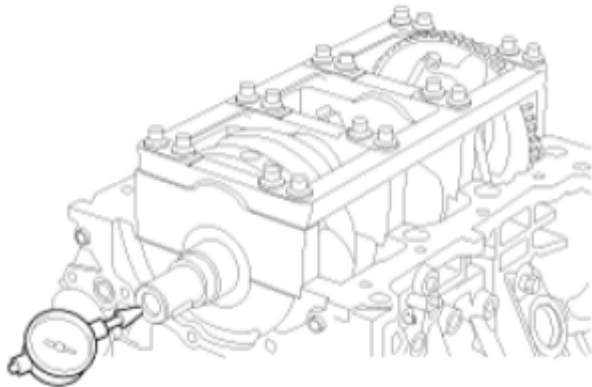


Fig. 25: Checking Crankshaft End Play
Courtesy of KIA MOTORS AMERICA, INC.

If the end play is greater than the maximum, replace the center bearing.

Thrust bearing thickness

1.925 ~ 1.965mm (0.0758 ~ 0.0774in.)

6. Inspect the main journals and the pin journals of the crankshaft.
7. Using a micrometer, measure the outer diameter of each main journal and pin journal.

Main journal diameter:

61.982~ 62.000mm (2.4402 ~ 2.4409in.)

Crank pin diameter:

47.982 ~ 48.000mm (1.8891 ~ 1.8898in.)

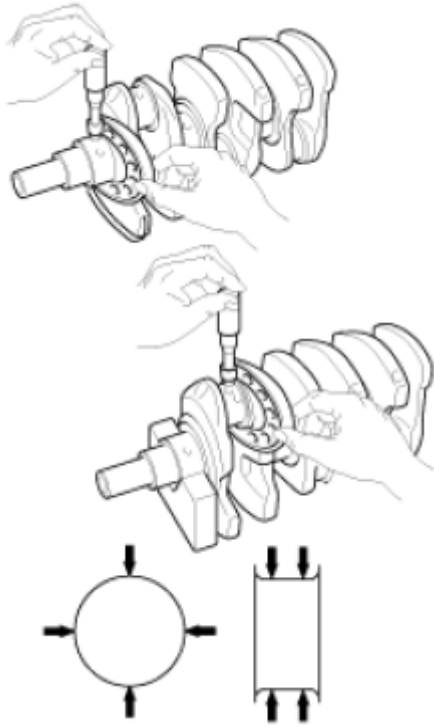


Fig. 26: Measuring Outer Diameter Of Main Journal And Pin Journal
Courtesy of KIA MOTORS AMERICA, INC.

CYLINDER BLOCK

1. Remove gasket materials.

Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

2. Clean cylinder block

Using a soft brush and solvent, thoroughly clean the cylinder block.

3. Inspect the top surface of cylinder block for flatness.

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

Flatness of cylinder block gasket surface

Standard: 0.03mm (0.0012in.) or less

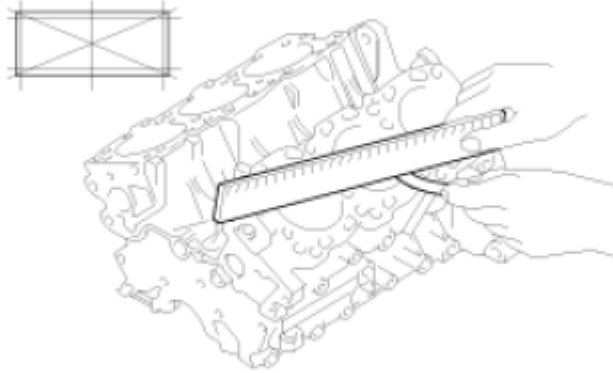


Fig. 27: Inspecting Top Surface Of Cylinder Block For Flatness
Courtesy of KIA MOTORS AMERICA, INC.

4. Inspect cylinder bore diameter

Visually check the cylinder for vertical scratches.

If deep scratches are present, replace the cylinder block or process the piston to be oversized.

5. Inspect the cylinder bore diameter

Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

Standard diameter

86.70 ~ 86.73mm (3.4134 ~ 3.4146in.)

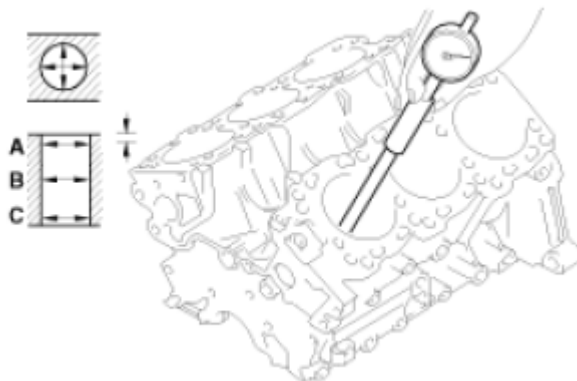


Fig. 28: Measuring Cylinder Bore Diameter At Position In Thrust And Axial Directions
Courtesy of KIA MOTORS AMERICA, INC.

6. Check the cylinder bore size code (A) on the cylinder block.

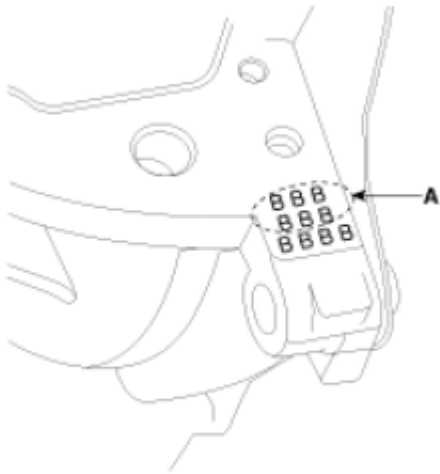


Fig. 29: Locating Cylinder Bore Size Code On Cylinder Block
Courtesy of KIA MOTORS AMERICA, INC.

CYLINDER BORE INNER DIAMETER CHART

Class	Size code	Cylinder bore inner diameter
A	A	86.70 ~ 86.71mm (3.4134 ~ 3.4138in.)
B	B	86.71 ~ 86.72mm (3.4138 ~ 3.4142in.)
C	C	86.72 ~ 86.73mm (3.4142 ~ 3.4146in.)

7. Check the piston size code (A) on the piston top face.

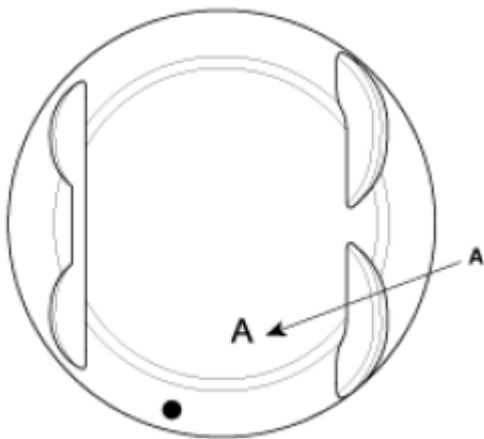


Fig. 30: Identifying Piston Size Code On Piston Top Face
Courtesy of KIA MOTORS AMERICA, INC.

PISTON OUTER DIAMETER CHART

Class	Size code	Piston outer diameter
A	A	86.67 ~ 86.68mm (3.4122 ~ 3.4126in.)
B	B	86.68 ~ 86.69mm (3.4126 ~ 3.4130in.)
C	C	86.69 ~ 86.70mm (3.4130 ~ 3.4134in.)

8. Select the proper piston related to the cylinder bore class.

Clearance : 0.02 ~ 0.04mm (0.0008 ~ 0.0016in.)

CYLINDER BORING

1. The over size piston is chosen on the maximum inner diameter of the cylinder.

NOTE: The piston size mark is on the top surface of the piston.

2. Measure the outer diameter of the piston which is installed before.
3. Calculate the new bore size with the measurement in the step 2.

New bore size = measured outer diameter of piston + 0.02 ~ 0.04mm (0.0008~0.0016in.)[clearance] - 0.01mm (0.0004in.)[for honing]

4. Bore the cylinder to the calculated size.

CAUTION: Bore the cylinders in firing order to prevent the cylinders from be twisted by high temperature.

5. Stop boring and start honing for the proper clearance.
6. Measure the clearance between a piston and a cylinder.

Specification

0.02 ~ 0.04mm (0.0008 ~ 0.0016in.)

NOTE: Bore all the cylinders with the same over size.

PISTON AND RINGS

1. Clean pistons.
 1. Using a gasket scraper, remove the carbon from the piston top.
 2. Using a groove cleaning tool or a broken ring, clean the piston ring grooves.

3. Using solvent and a brush, thoroughly clean the piston.

CAUTION: Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 14 mm (0.5512 in.) from the bottom of the piston.

Standard diameter

86.67 ~ 87.00 (3.4122 ~ 3.4252in.)



Fig. 31: Measuring Piston Outside Diameter From Bottom Of Piston
Courtesy of KIA MOTORS AMERICA, INC.

3. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

Piston-to-cylinder clearance

0.02 ~ 0.04mm (0.0008 ~ 0.0016in.)

4. Inspect the piston ring side clearance.

Using a feeler gauge, measure the clearance between a new piston ring and the ring groove.

Piston ring side clearance

Standard

No. 1: 0.04 ~ 0.08mm (0.0016 ~ 0.0031in.)

No. 2: 0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)

Oil ring: 0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)

Limit

No. 1: 0.1mm (0.004in.)

No. 2: 0.1mm (0.004in.)

Oil ring: 0.2mm (0.008in.)



Fig. 32: Measuring Clearance Between Piston Ring And Ring Groove
Courtesy of KIA MOTORS AMERICA, INC.

If the clearance is greater than the maximum, replace the piston.

5. Inspect piston ring end gap.

To measure the piston ring end gap, insert a piston ring into the cylinder bore. Position the ring at right angles to the cylinder wall by gently pressing it down with a piston. Measure the gap with a feeler gauge. If the gap exceeds the service limit, replace the piston ring. If the gap is too large, recheck the cylinder bore diameter. If the bore is over the service limit, the cylinder block must be replaced or bored

Piston ring end gap

Standard

No. 1: 0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)

No. 2: 0.30 ~ 0.45m (0.0118 ~ 0.0177in.)

Oil ring: 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)

Limit

No. 1: 0.6mm (0.0236in.)

No. 2: 0.7mm (0.0275in.)

Oil ring: 0.8mm (0.0315in.)

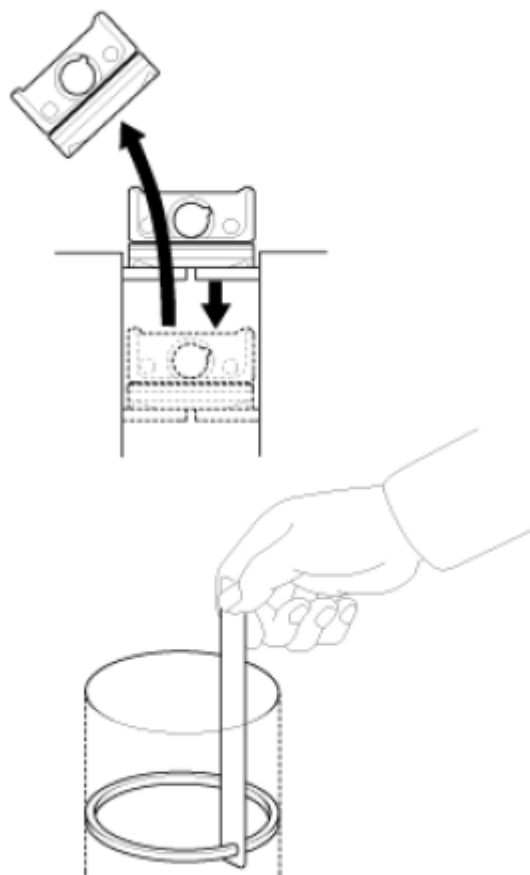


Fig. 33: Measuring Gap Using Feeler Gauge
Courtesy of KIA MOTORS AMERICA, INC.

PISTON PINS

1. Measure the outer diameter of the piston pin.

Piston pin outer diameter

21.001 ~ 21.007mm (0.8268 ~ 0.8270in.)

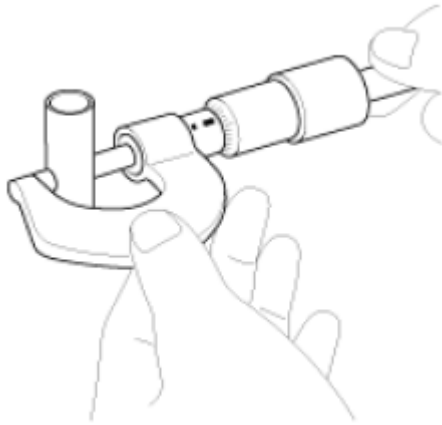


Fig. 34: Measuring Outer Diameter Of Piston Pin
Courtesy of KIA MOTORS AMERICA, INC.

2. Measure the piston pin-to-piston clearance.

Piston pin-to-piston clearance

0.011 ~ 0.018mm (0.0004 ~ 0.0007in.)

3. Check the difference between the piston pin outer diameter and the connecting rod small end inner diameter.

Piston pin-to-connecting rod interference

-0.033 ~ -0.016mm (-0.0013 ~ -0.0006in.)

REASSEMBLY

NOTE:

- Thoroughly clean all parts before reassembling.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

1. Assemble the piston and the connecting rod.
 1. Use a hydraulic press for installation.
 2. The piston front mark (A) and the connecting rod front mark must face the timing belt side of the engine.

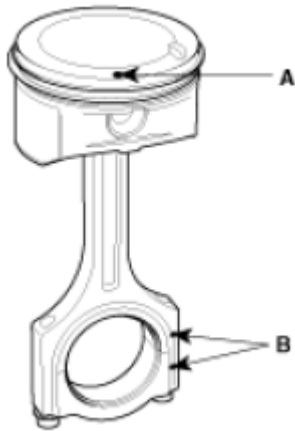


Fig. 35: Identifying Piston Front Mark And Connecting Rod Front Mark
 Courtesy of KIA MOTORS AMERICA, INC.

2. Install piston rings.
 1. Install the oil ring spacer and 2 side rails by hand.
 2. Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
 3. Position the piston rings so that the ring ends are as shown.

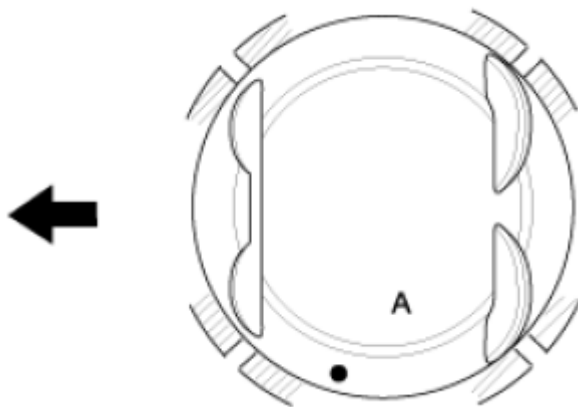


Fig. 36: Positioning Piston Rings
 Courtesy of KIA MOTORS AMERICA, INC.

3. Install the connecting rod bearings.
 1. Align the bearing (A) claw with the groove of the connecting rod or connecting rod cap (B).
 2. Install the bearings (A) in the connecting rod and connecting rod cap (B).

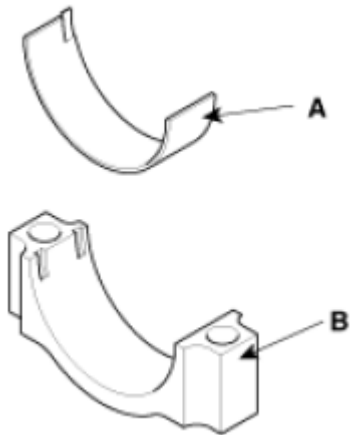


Fig. 37: Identifying Bearings And Connecting Rod Cap
Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: When reassembling the connecting rods and the caps, ensure the front marks on them.

4. Install the CKP sensor (A).

Tightening torque:

6.9 ~ 9.8Nm (0.7 ~ 1.0kgf.m, 5.1 ~ 7.2lb-ft)

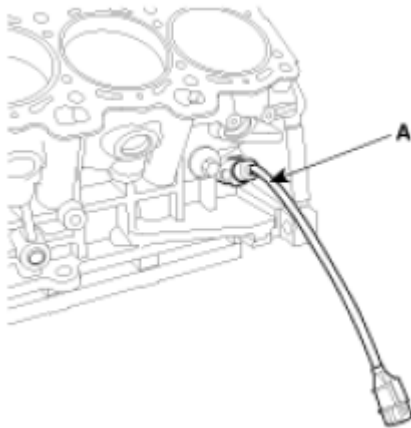


Fig. 38: Identifying CKP Sensor
Courtesy of KIA MOTORS AMERICA, INC.

5. Install main bearings.

NOTE: Upper bearings have the oil grooves of the oil holes; Lower bearings do not.

1. Aligning the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings (A).

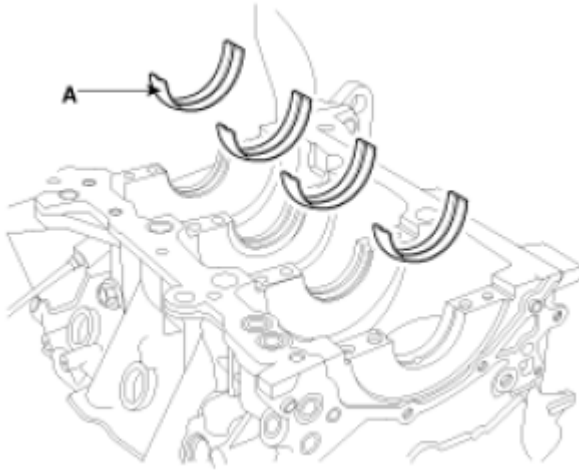


Fig. 39: Identifying Upper Bearings
Courtesy of KIA MOTORS AMERICA, INC.

2. Aligning the bearing claw with the claw groove of the main bearing cap, push in the 4 lower bearings (B) on the bearing caps (A).

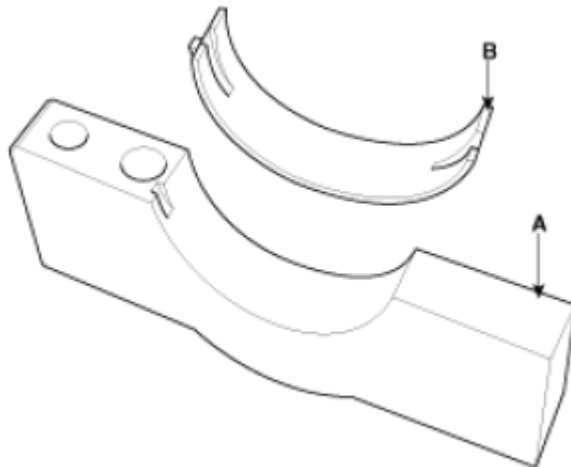


Fig. 40: Identifying Lower Bearings And Bearing Caps
Courtesy of KIA MOTORS AMERICA, INC.

6. Install thrust bearings.

Install the 2 thrust bearings (A) under the No. 3 journal position of the cylinder block with the oil grooves facing outward.



Fig. 41: Identifying Thrust Bearings
Courtesy of KIA MOTORS AMERICA, INC.

7. Place crankshaft (A) on the cylinder block.

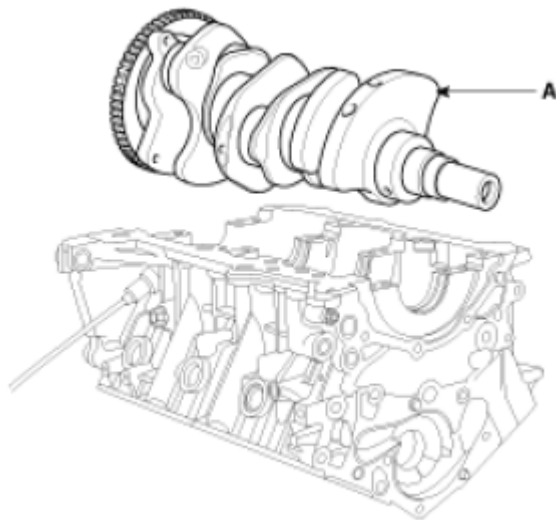


Fig. 42: Identifying Crankshaft On Cylinder Block
Courtesy of KIA MOTORS AMERICA, INC.

8. Place main bearing caps on cylinder block.
9. Install main bearing cap bolts.
 1. Install and uniformly tighten the bearing cap bolts, in two steps, in the sequence shown.

Tightening torque

M8: 12.7~18.6Nm (1.3~1.9kgf.m, 9.4~13.7lb-ft) + 90~95°

M10: 26.5~32.4Nm (2.7~3.3kgf.m, 19.5~23.9lb-ft) + 90~95°

NOTE:

- Use new main bearing cap bolt with engine oil applied.
- If any of the bearing cap bolts are broken or deformed, replace it.
- Washers have their direction (Up/Down)
- Assemble the bearing cap bridge on which its arrow mark faces the engine front.
- Before tightening, make the bearing caps be seated on the block firmly.

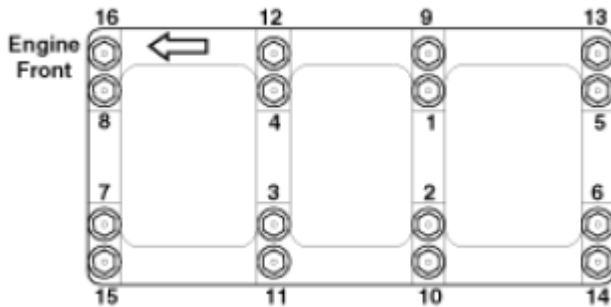


Fig. 43: Identifying Main Bearing Cap Bolt Tighten Sequence
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

Use SST (09221-4A000), install main bearing cap bolts.

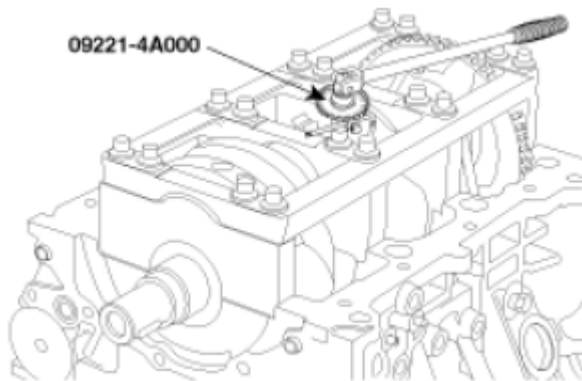


Fig. 44: Installing Main Bearing Cap Bolts
Courtesy of KIA MOTORS AMERICA, INC.

2. Check that the crankshaft turns smoothly.
10. Check crankshaft end play.
11. Install the piston and connecting rod assemblies.

NOTE:

- Before installing the pistons, apply a coat of engine oil to the ring grooves and cylinder bores.

- **When installing the piston, ensure that the coat on the cylinder wall is not damaged or scratched.**

1. Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.
2. Stop inserting the piston when the ring inserted in the cylinder and check the alignment of the journal and the connecting rod.
3. Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque

17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 90~94°

NOTE:

- **Always use new connecting rod bolts.**
- **Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.**

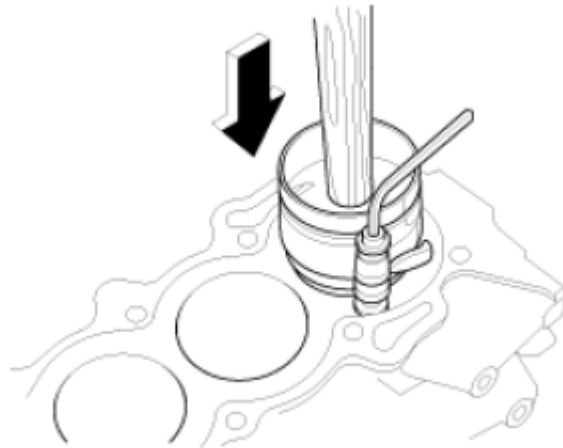


Fig. 45: Installing Main Bearing Cap Bolts
Courtesy of KIA MOTORS AMERICA, INC.

- **Use SST (09221-4A000), install connecting rod bearing cap bolts.**

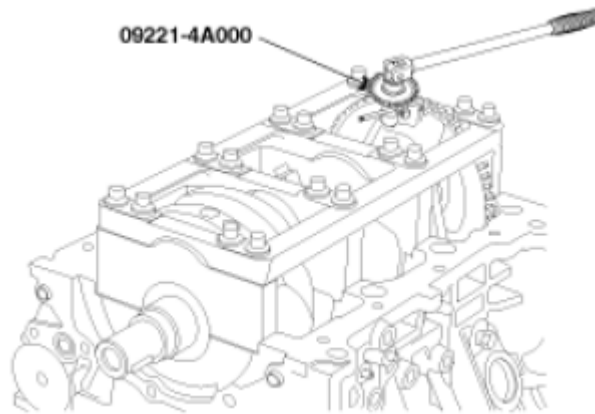


Fig. 46: Installing Connecting Rod Bearing Cap Bolts
Courtesy of KIA MOTORS AMERICA, INC.

12. Install the rear oil seal case.

Tightening torque

9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.67lb-ft)

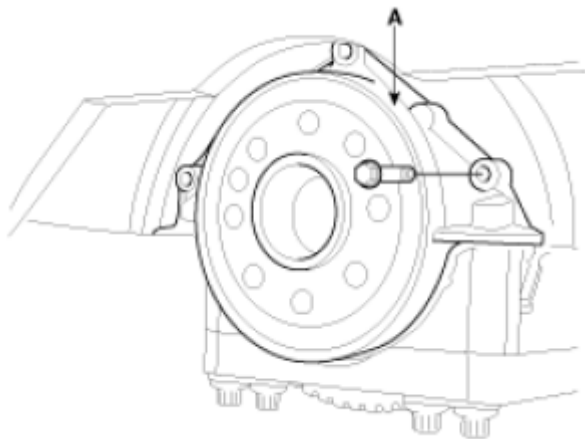


Fig. 47: Identifying Rear Oil Seal Case
Courtesy of KIA MOTORS AMERICA, INC.

1. Make clean the sealing face before assembling two parts.

NOTE:

- Remove harmful foreign materials on the sealing face before applying sealant
 - Apply sealant to the inner threads of the bolt holes.
2. Assembling rear oil seal case, the liquid sealant TB1217H should be applied to the rear oil seal case. The part must be assembled within 5 minutes after sealant was applied.

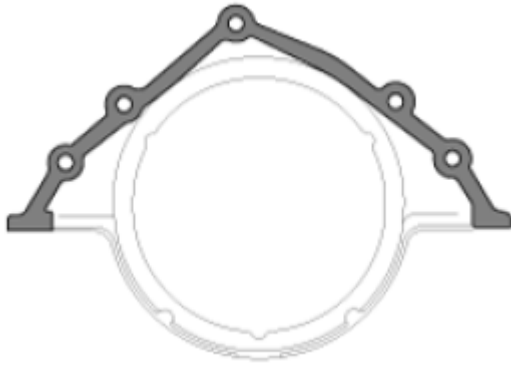


Fig. 48: Identifying Rear Oil Seal Case
Courtesy of KIA MOTORS AMERICA, INC.

13. Using SST (09231-33000), install rear oil seal after applying engine oil on the rip of the oil seal.
14. Install the oil pump case.
15. Install upper oil pan.
 1. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
 2. Before assembling the oil pan, the liquid sealant TB1217H should be applied on upper oil pan. The part must be assembled within 5 minutes after the sealant was applied.

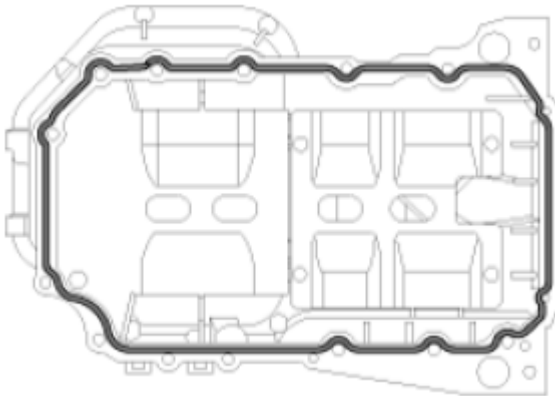


Fig. 49: Identifying Upper Oil Pan Gasket Area
Courtesy of KIA MOTORS AMERICA, INC.

NOTE:

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant.
- When applying sealant gasket, sealant must not protrude into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

3. Install upper oil pan.

Uniformly tighten the bolts in several passes.

Tightening torque

Bolts 1~15:

18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

Bolts 16, 17:

4.9 ~ 6.9Nm (0.5 ~ 0.7kgf.m, 3.6 ~ 5.1lb-ft)

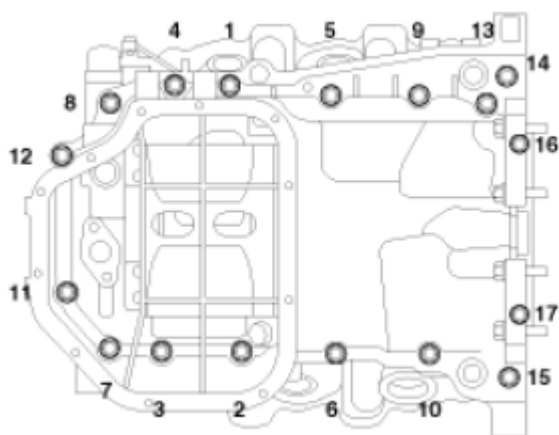


Fig. 50: Identifying Upper Oil Pan Bolts Tighten Sequence
Courtesy of KIA MOTORS AMERICA, INC.

16. Install the oil screen (A).

Tightening torque

14.7 ~ 21.6Nm (1.5 ~ 2.2kgf.m, 10.8 ~ 15.9lb-ft)

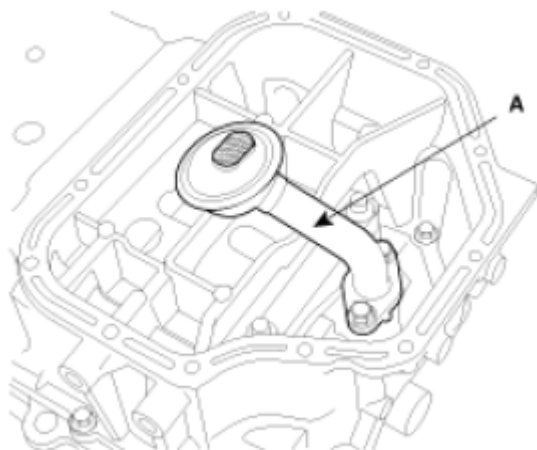


Fig. 51: Installing Oil Screen

Courtesy of KIA MOTORS AMERICA, INC.

17. Install the lower oil pan.

1. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
2. Before assembling the oil pan, the liquid sealant TB1217H should be applied on lower oil pan.

The part must be assembled within 5 minutes after the sealant was applied.

NOTE:

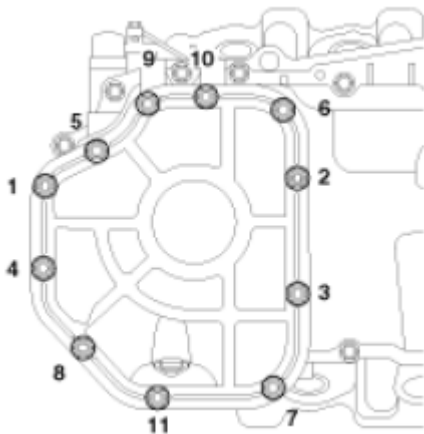
- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant.
- When applying sealant gasket, sealant must not protrude into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

3. Install lower oil pan.

Uniformly tighten the bolts in several passes.

Tightening torque

9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

**Fig. 52: Identifying Lower Oil Pan Bolts Tighten Sequence**

Courtesy of KIA MOTORS AMERICA, INC.

18. Install the air conditioning compressor bracket (A). (Refer to **AIR CONDITIONING SYSTEM**)

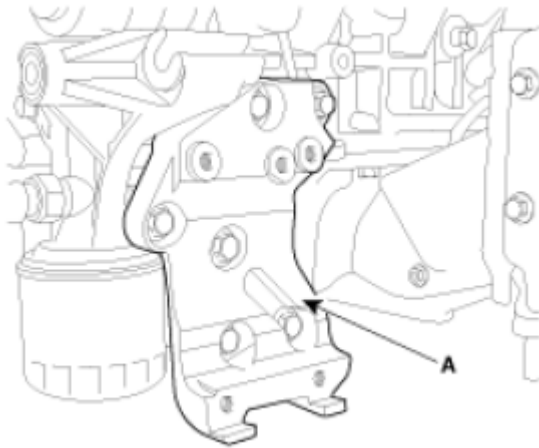


Fig. 53: Identifying Air Conditioning Compressor Bracket
 Courtesy of KIA MOTORS AMERICA, INC.

19. Install the power steering pump bracket (A) and the knock sensor (B).

Tightening torque

18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

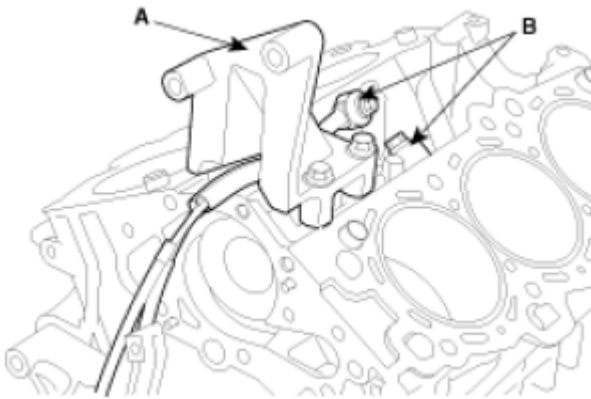


Fig. 54: Identifying Power Steering Pump Bracket And Knock Sensor
 Courtesy of KIA MOTORS AMERICA, INC.

- CAUTION:**
- On Bank 1, the black knock sensor connector should be installed and on Bank 2, the gray one should.

INSTALLATION

1. Install the water pump.
2. Install the air conditioning compressor.(Refer to **AIR CONDITIONING SYSTEM**).
3. Install the cylinder head.

4. Install the power steering pump.(Refer to **HYDRAULIC POWER STEERING SYSTEM**).
5. Install the generator.
6. Install the intake manifold.
7. Install the exhaust manifold.
8. Install the timing belt.
9. Install the rear plate (A).

Tightening torque

9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

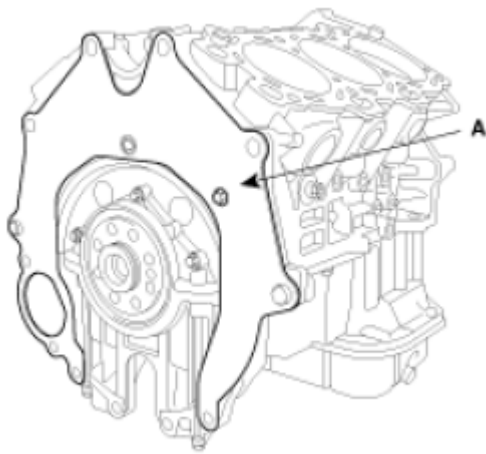


Fig. 55: Identifying Rear Plate

Courtesy of KIA MOTORS AMERICA, INC.

10. Install the drive plate (A).

Tightening torque

71.6 ~ 75.5Nm (7.3 ~ 7.7kgf.m, 52.8 ~ 55.7lb-ft)

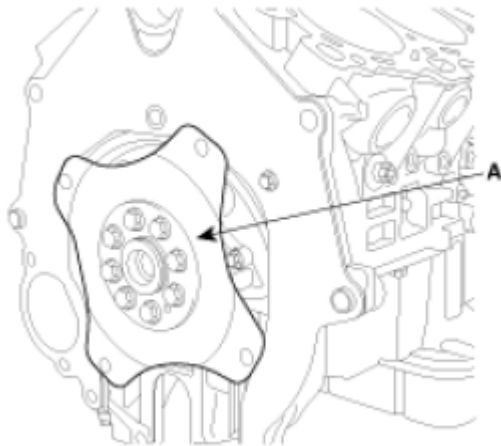


Fig. 56: Identifying Drive Plate

Courtesy of KIA MOTORS AMERICA, INC.

2009 Kia Magentis LX

2009 ENGINE General Information - 2.7L (Engine Mechanical System) - Magentis & Optima

2009 ENGINE**General Information - 2.7L (Engine Mechanical System) - Magentis & Optima****SPECIFICATIONS****SPECIFICATIONS****GENERAL SPECIFICATIONS**

Description			Specifications	Limit
General				
Type			V-type, DOHC	
Number of cylinder			6	
Bore			86.7mm (3.4134in.)	
Stroke			75mm (2.9528in.)	
Total displacement			2,656cc	
Compression ratio			10.4	
Firing order			1-2-3-4-5-6	
Valve timing				
Intake valve	Opens (ATDC)		4° ~ -56°	
	Closes (ABDC)		60° ~ 0°	
Exhaust valve	Opens (BBDC)		46°	
	Closes (ATDC)		10°	
Cylinder head				
Flatness of gasket surface			0.03mm (0.0012in.) or less	0.05mm (0.0020in.)
Flatness of manifold mounting	Intake		0.15mm (0.0059in.) or less	
	Exhaust		0.15mm (0.0059in.) or less	
Camshaft				
Cam height	LH Camshaft	Intake	44.5mm (1.7520in.)	
		Exhaust	44.5mm (1.7520in.)	
	RH Camshaft	Intake	44.5mm (1.7520in.)	
		Exhaust	44.5mm (1.7520in.)	
Journal outer diameter	LH Camshaft	Intake	27.964 ~ 27.980mm (1.1009 ~ 1.1016in.)	
		Exhaust	27.964 ~ 27.980mm (1.1009 ~ 1.1016in.)	
	RH Camshaft	Intake	27.964 ~ 27.980mm (1.1009 ~ 1.1016in.)	
		Exhaust	27.964 ~ 27.980mm (1.1009 ~ 1.1016in.)	

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Bearing oil clearance	Intake	0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)	
	Exhaust	0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)	
End play		0.1 ~ 0.2mm (0.0039 ~ 0.0079in.)	
Valve			
Valve length	Intake	110.1mm (4.3346in.)	
	Exhaust	111.1mm (4.3740in.)	
Stem outer diameter	Intake	5.965 ~ 5.980mm (0.2348 ~ 0.2354in.)	
	Exhaust	5.950 ~ 5.965mm (0.2343 ~ 0.2348in.)	
Face angle		45° ~ 45.5°	
Thickness of valvehead (margin)	Intake	1.0mm (0.0394in.)	
	Exhaust	1.3mm (0.0512in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.050mm (0.0008 ~ 0.0020in.)	0.10mm (0.0039in.) or less
	Exhaust	0.035 ~ 0.065mm (0.0014 ~ 0.0026in.)	0.13mm (0.0051in.) or less
Valve guide			
Inner diameter	Intake	6.000 ~ 6.015mm (2.2362 ~ 2.2368in.)	
	Exhaust	6.000 ~ 6.015mm (2.2362 ~ 2.2368in.)	
Length	Intake	45.8 ~ 46.2mm (1.8031 ~ 1.8189in.)	
	Exhaust	46.8 ~ 47.2mm (1.8425 ~ 1.8583in.)	
Valve spring			
Free length		46.8mm (1.8425in.)	
Load	Height: 35mm	180.5 ~ 199.5N (18.4 ~ 20.3Kgf, 40.6 ~ 44.8lb)	
	Height: 26.5mm	342 ~ 378N (34.9 ~ 38.6Kgf, 76.9 ~ 85.1lb)	
Out of squareness		1.5° or less	
MLA (Mechanical Lash Adjuster)			
MLA outer diameter	Intake	29.964 ~ 29.980mm (1.1797 ~ 1.1803in.)	
	Exhaust	29.964 ~ 29.980mm (1.1797 ~ 1.1803in.)	
Cylinder head	Intake	30.000 ~ 30.025mm	

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tappet bore inner diameter		(1.1811 ~ 1.1821in.)	
	Exhaust	30.000 ~ 30.025mm (1.1811 ~ 1.1821in.)	
MLA to tappet bore clearance	Intake	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.) or less
	Exhaust	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.) or less
Valve clearance (Engine coolant temperature 20°C [68°F])			
Intake		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)
Cylinder block			
Cylinder bore		86.70 ~ 86.73mm (3.4134 ~ 3.4146in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.)/150x150]	
Piston			
Piston outer diameter		86.67 ~ 86.70mm (3.4122 ~ 3.4134in.)	
Piston to cylinder clearance		0.02 ~ 0.04mm (0.0008 ~ 0.0016in.)	
Ring groove width	No. 1 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in.)	
	No. 2 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	
Piston O.S.		0.25mm (0.0098in.), 0.50mm (0.0197in.)	
Piston ring			
Side clearance	No. 1 ring	0.04 ~ 0.08mm (0.0016 ~ 0.0031in.)	0.1mm (0.0039in.)
	No. 2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.0039in.)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)	0.2mm (0.0079in.)
End gap	No. 1 ring	0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)	0.6mm (0.0236in.)
	No. 2 ring	0.30 ~ 0.45mm (0.0118 ~ 0.0177in.)	0.7mm (0.0275in.)
	Oil ring	0.20 ~ 0.70mm	0.8mm (0.0315in.)

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	(0.0078 ~ 0.0275in.)	
Piston ring O.S.	0.25mm (0.0098in.), 0.50mm (0.0197in.)	
Piston pin		
Piston pin outer diameter	21.001 ~ 21.007mm (0.8268 ~ 0.8270in.)	
Piston pin hole inner diameter	21.014 ~ 21.023mm (0.8273 ~ 0.8277in.)	
Piston pin hole clearance	0.011 ~ 0.018mm (0.0004 ~ 0.0007in.)	3 Grade
Connecting rod small end inner diameter	20.974 ~ 20.985mm (0.8257 ~ 0.8262in.)	
Connecting rod small end hole interference	0.016 ~ 0.033mm (0.0006 ~ 0.0013in.)	
Connecting rod		
Connecting rod big end inner diameter	51.000 ~ 51.018mm (2.0079 ~ 2.0086in.)	
Connecting rod bearing oil clearance	0.018 ~ 0.036mm (0.0007 ~ 0.0014in.)	
Side clearance	0.1 ~ 0.25mm (0.0039 ~ 0.0098in.)	0.4mm (0.0157in.)
Crankshaft		
Main journal outer diameter	61.982 ~ 62.000mm (2.4402 ~ 2.4409in.)	
Pin journal outer diameter	47.982 ~ 48.000mm (1.8891 ~ 1.8898in.)	
Main bearing oil clearance	0.004 ~ 0.022mm (0.0002 ~ 0.0009in.)	
End play	0.07 ~ 0.25mm (0.0028 ~ 0.0098in.)	0.30mm (0.0118in.)
Oil pump		
Relief valve opening pressure	490.33 ~ 588.40kPa (5.0 ~ 6.0kgf/cm ² , 71.12 ~ 85.34 psi)	
Engine oil		
Oil quantity (Total)	4.8 L (5.07 US qt, 4.22 Imp qt)	
Oil quantity (Oil pan)	4.2 L (4.43 US qt, 3.69 Imp qt)	
Oil filter	0.3 L (0.32 US qt, 0.26 Imp qt)	
Oil quantity (Drain and refill including oil filter)	4.5 L (4.75 US qt, 3.95 Imp qt)	
Oil quality	ABOVE API SJ/SL or	

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		SAE 5W-20	
Oil pressure		127kPa (1.3kgf/cm ² , 18 psi) [at 1000rpm, 110°C (230°F)]	
Cooling system			
Cooling method		Forced circulation with electrical fan	
Coolant quantity		8.2~8.3L (8.66~8.77U.S.qts, 7.22~7.30Imp.qts)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±35.6° F)	
	Fully opened temperature	95°C (203°F)	
	Full lift	10mm (0.3937in.) or more	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25 kg/cm ² , 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05 kg/cm ² , 0.14 ~ 0.71 psi)	
Engine coolant temperature sensor			
Type		Thermistor type	
Resistance	20°C (68°F)	2.31 ~ 2.59 kohms	
	80°C (176°F)	0.3222 kohms	

Tightening Torques

TIGHTENING TORQUES SPECIFICATION

Item	Quantity	Nm	kgf.m	lb-ft
Oil seal case bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Main bearing cap bolt (M10)	8	(26.5~32.4) + (90~95°)	(2.7~3.3) + (90~95°)	(19.5~23.9) + (90~95°)
Main bearing cap bolt (M8)	8	(12.7~18.6) + (90~95°)	(1.3~1.9) + (90~95°)	(9.4~13.7) + (90~95°)
Rear plate bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump case bolt (8x25)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil pump case bolt (8x35)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Timing Oil pump	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4

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case bolt (8x65)				
Timing Oil relief plug	1	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.2
Oil filter bracket bolt (8x35)	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil filter bracket bolt (8x65)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil filter insert	1	44.1 ~ 53.9	4.5 ~ 5.5	32.5 ~ 39.8
Timing belt cover bolt	21	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Upper oil pan bolt (8x22)	15	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Upper oil pan bolt (163.5mm)	1	4.9 ~ 6.9	0.5 ~ 0.7	3.6 ~ 5.1
Upper oil pan bolt (154.5mm)	1	4.9 ~ 6.9	0.5 ~ 0.7	3.6 ~ 5.1
Lower oil pan bolt	11	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil drain plug	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Engine support bracket bolt (10x94)	2	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Engine support bracket bolt (10x102.5)	1	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Camshaft bearing cap bolt (6x38)	24	10.8 ~ 12.7	1.1 ~ 1.3	8.0 ~ 9.4
Camshaft bearing cap bolt (8x38)	12	20.6 ~ 25.5	2.1 ~ 2.6	15.2 ~ 18.8
Cylinder head bolt	16	(22.6~26.5) + (58~62°) + (43~47°)	(2.3~2.7) + (58~62°) + (43~47°)	(16.6~19.5) + (58~62°) + (43~47°)
Cylinder head cover bolt	22	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Crankshaft pulley bolt	1	166.7 ~ 176.5	17.0 ~ 18.0	123.0 ~ 130.2
Drive plate bolt	8	71.6 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Connecting rod bearing cap bolt	12	(17.7~21.6) + (90~94°)	(1.8~2.2) + (90~94°)	(13.0~15.9) + (90~94°)
OCV (Oil Control Valve) bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
CVVT & exhaust cam sprocket bolt	4	66.7 ~ 78.5	6.8 ~ 8.0	49.2 ~ 57.9
Timing chain auto tensioner bolt	4	10.8 ~ 12.7	1.1 ~ 1.3	8.0 ~ 9.4
Camshaft sprocket bolt	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6

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Timing belt idler bolt	1	49.0 ~ 58.8	5.0 ~ 6.0	36.2 ~ 43.4
Timing belt tensioner bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing belt tensioner arm bolt	1	34.3 ~ 53.9	3.5 ~ 5.5	25.3 ~ 39.8
Water pump bolt (8x20)	3	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Water pump bolt (8x25)	4	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Drive belt idler bolt	1	34.3 ~ 53.9	3.5 ~ 5.5	25.3 ~ 39.8
Drive belt tensioner bolt	1	34.3 ~ 53.9	3.5 ~ 5.5	25.3 ~ 39.8
Water pipe bolt	1	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water temp. control assembly nut	4	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Oil level gauge bolt	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil screen bolt	2	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Water outlet fitting bolt	3	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water inlet fitting bolt	2	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water inlet fitting nut	1	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Surge tank bolt (8x28)	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank bolt (8x80)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank nut	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake manifold bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Intake manifold nut	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Surge tank bracket bolt	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold bolt	14	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
Heat protect bolt	6	16.7 ~ 21.6	1.7 ~ 2.2	12.3 ~ 15.9
Front muffler bolt	2	39.2 ~ 53.9	4.0 ~ 5.5	28.9 ~ 39.8

REPAIR PROCEDURES**COMPRESSION PRESSURE INSPECTION****NOTE:** If the there is lack of power, excessive oil consumption or poor fuel economy,

measure the compression pressure.

1. Warm up the engine until the normal operating temperature becoming 80~95°C (176~203°F).
2. Remove the surge tank.
3. Remove the ignition coil connectors (A) and ignition coils (B).

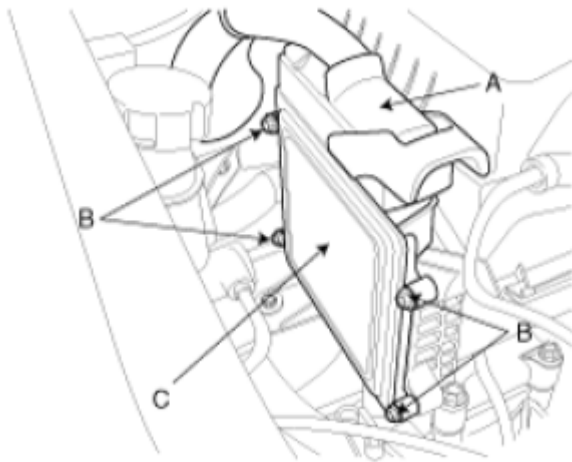


Fig. 1: Identifying Ignition Coil Connectors And Ignition Coils
Courtesy of KIA MOTORS AMERICA, INC.

4. Using a 16mm plug wrench, remove the 6 spark plugs.
5. Check cylinder compression pressure.
 1. Insert a compression gauge into the spark plug hole.
 2. Open the throttle fully.
 3. With the fully-open throttle in cranking, measure the compression pressure.

NOTE: Always use a fully charged battery to get the engine speed of 250 rpm or more.

Repeat steps 1) through 3) for each cylinder.

NOTE: This measurement must be done in as short a time as possible.

Compression pressure:

1,176.79kPa (12.0kgf/cm² , 170.68psi) - 200 ~ 250rpm

Minimum pressure:

1,029.69kPa (10.5kgf/cm² , 149.34psi)

Difference between cylinders:

98.07kPa (1.0kgf/cm² , 14.22psi)

4. If the compression pressure in 1 or more cylinders is lower than the specification above, pour a small amount of engine oil into the cylinder through the spark plug hole, repeat the steps (1) through (3) for the cylinder and measure the pressure again.
 - A. If adding oil increases the pressure up, the piston rings or cylinder bores might be worn or damaged.
 - B. If the pressure doesn't increase, a valve may be sticking or seating may be improper, or there may be leakage from the gasket.
6. Reinstall the spark plugs.
7. Install the ignition coils and connect ignition coil connectors.
8. Install the surge tank.

Valve Clearance Inspection And Adjustment

NOTE: **Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature: 20°C±5°C (59~77°F)) and cylinder head is installed on the cylinder block.**

1. Remove the engine cover.
2. Remove air cleaner assembly.
3. Remove the surge tank.
4. Remove the cylinder head cover.
 1. Disconnect the ignition coil connector and remove the ignition coil.
 2. Remove the cylinder head cover.

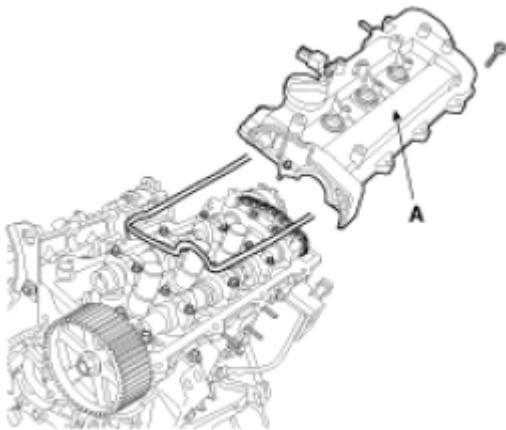


Fig. 2: Identifying Cylinder Head Cover
Courtesy of KIA MOTORS AMERICA, INC.

5. Set the piston of the No. 1 cylinder to TDC (Top Dead Center) position.
 1. Turn the crankshaft pulley clockwise and align its groove with the timing mark "T" of the timing chain cover.
 2. Check that the timing marks of the camshaft sprocket are in straight line on that of the cylinder head cover surface as shown in the illustration. It makes the piston of the No. 1 cylinder position at TDC.

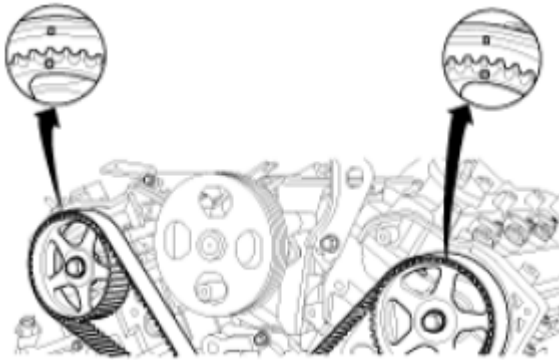


Fig. 3: Identifying Timing Marks Of Camshaft Sprocket
Courtesy of KIA MOTORS AMERICA, INC.

NOTE: If not, turn the crankshaft one revolution clockwise.

6. Inspect the intake and the exhaust valve clearance.
 1. With the piston of the No. 1 cylinder positioning at TDC, the valves which can be measured its clearance are as shown below.

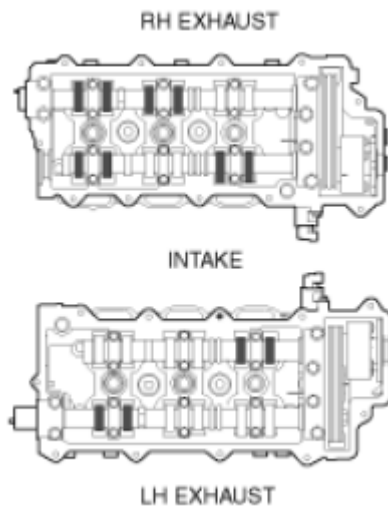


Fig. 4: Identifying Intake And Exhaust Valve Clearance
Courtesy of KIA MOTORS AMERICA, INC.

Measurement method.

- A. Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.
- B. Record the out-of-specification valve clearance measurements. They will be used later to determine the required adjusting tappet for replacement.

Specification

Limit (Engine coolant temperature: 20°C [68°F])

Intake: 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)

Exhaust: 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

2. Turn the crankshaft pulley one revolution (360°) clockwise and align the groove with the timing mark "T" of the timing chain cover.
3. With the piston of the No. 4 cylinder positioning at TDC, the valves which can be measured its clearance are as shown below.

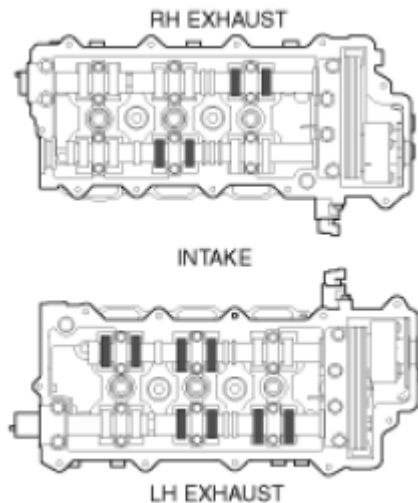


Fig. 5: Identifying Intake And Exhaust Valve Clearance
Courtesy of KIA MOTORS AMERICA, INC.

7. Adjust the intake and the exhaust valve clearances.
 1. Set the piston of the No. 1 cylinder to the TDC/position.
 2. Remove the timing belt.
 3. Remove the camshaft bearing caps (A, B).

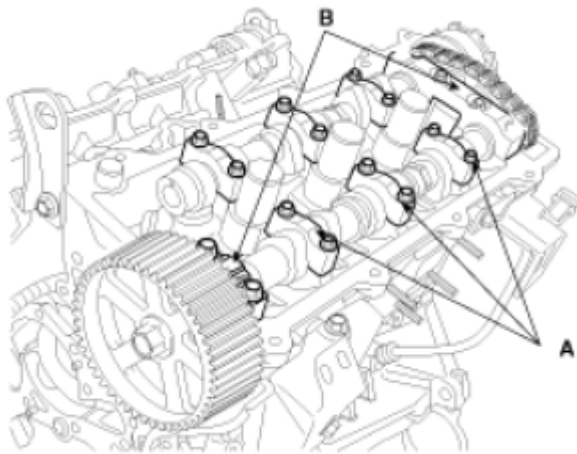


Fig. 6: Identifying Camshaft Bearing Caps
Courtesy of KIA MOTORS AMERICA, INC.

4. Remove the camshaft assembly.
5. Remove MLA (Mechanical Lash Adjuster)s.
6. Measure the thickness of the removed tappet using a micrometer.

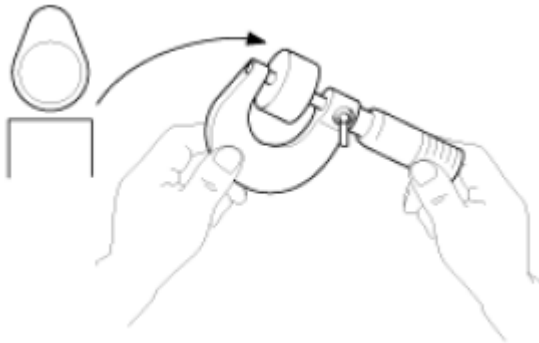


Fig. 7: Measuring Thickness Of Tappet Using Micrometer
Courtesy of KIA MOTORS AMERICA, INC.

7. Calculate the thickness of a new tappet so that the valve clearance comes within the specified value.

T: Thickness of removed tappet

A: Measured valve clearance

N: Thickness of new tappet

Intake: $N = T + [A - 0.20\text{mm (0.0079in.)}]$

Exhaust: $N = T + [A - 0.25\text{mm (0.0098in.)}]$

8. Select a new tappet with a thickness as close as possible to the calculated value.

NOTE: Tappets are available with 41 different size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.600mm (0.1417in.)

9. Place a new tappet on the cylinder head.

NOTE: Apply engine oil on the periphery surface of the selected tappet.

10. Install the intake and exhaust camshafts.
11. Install the bearing caps.
12. Install the timing belt.
13. Turn the crankshaft two revolutions in the operating direction (clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks (A).
14. Recheck the valve clearance.

Specification (Engine coolant temperature: 20°C[68°F])

Intake: 0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)

Exhaust: 0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)

TROUBLESHOOTING

TROUBLESHOOTING

TROUBLESHOOTING SYMPTOM CHART

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or improper engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as required.
	Worn crankshaft thrust bearings	Replace the crankshaft and bearings as required.
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and valve lifters.
Engine misfire with coolant	Faulty cylinder head gasket	Inspect the cylinder head

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consumption.	and/or cranking or other damage to the cylinder head and engine block cooling system. • Coolant consumption may or may not cause the engine to overheat.	and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.
Engine misfire with excessive oil consumption.	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	• Inspect the cylinder for a loss of compression. • Repair or replace as required.
Engine noise on startup, but only lasting a few seconds.	Incorrect oil viscosity.	• Drain the oil. • Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Upper engine noise, regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves. Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required.
Lower engine noise, regardless of engine speed.	Low oil pressure.	Repair as required.
	Loose or damaged drive plate.	Repair or replace the drive plate.
	Damaged oil pan, contacting the oil pump screen.	• Inspect the oil pan. • Inspect the oil pump

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		screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	• Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	• Inspect the piston, piston pin and cylinder bore. • Repair as required.
	Excessive piston pin-to-piston clearance.	• Inspect the piston, piston pin and the connecting rod. • Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
	Incorrect piston, piston pin and connecting rod installation	• Verify the piston pins and connecting rods are installed correctly. • Repair as required.
Engine noise under load.	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance.	Inspect the following components and repair as required: • The connecting rod bearings.

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		• The connecting rods. • The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
Engine will not crank-crank shaft will not rotate.	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain and/or timing chain gears.	1. Inspect timing chain and gears. 2. Repair as required.
	Material in cylinder. • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearing. 2. Repair as required.
	Bent or broken connecting rod.	1. Inspect connecting rods. 2. Repair as required.
	Broken crankshaft.	1. Inspect crankshaft. 2. Repair as required.

SPECIAL SERVICE TOOLS

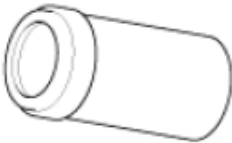
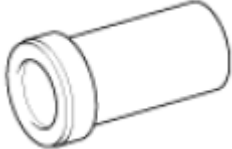
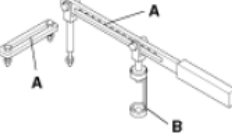
SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS CHART

Tool (Number and name)	Illustration	Use
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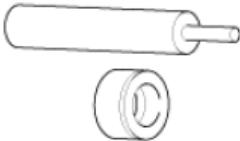
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Crankshaft front oil seal installer (09214-33000)		Installation of the front oil seal
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method
Valve stem seal remover (09222-29000)		Removal of the valve stem seal
Valve stem seal installer (09222-22001)		Installation of the valve stem seal
Camshaft oil seal installer (09214-21000)		Installation of the camshaft oil seal
Valve spring compressor & holder (09222-3K000) (09222-3C300)		Removal and installation of the intake or exhaust valves. A. 09222-3K000 B. 09222-3C300 (holder)
Crankshaft rear oil seal installer (09231-33000)		Installation of the crankshaft rear oil seal
Oil pan remover (09215-3C000)		Removal of oil pan

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Valve guide installer (09221-3F100 A/B)		Removal and installation of the valve guide