

2011 ENGINE

General Information (Engine Mechanical System) - Equus

GENERAL INFORMATION

SPECIFICATIONS

ENGINE MECHANICAL SYSTEM SPECIFICATIONS

Description		Specifications	Limit
General			
Type		V-type, DOHC	
Number of cylinders		8	
Bore		92mm (3.6220in)	
Stroke		87mm (3.4252in)	
Total displacement		4,627 cc (282.4 cu.in)	
Compression ratio		10.4: 1	
Firing order		1-2-7-8-4-5-6-3	
Valve timing			
Intake valve	Opens (ATDC)	9°	
	Closes (ABDC)	85°	
Exhaust valve	Opens (BBDC)	65°	
	Closes (ATDC)	5°	
Cylinder head			
Flatness of gasket surface		Less than 0.05mm (0.0020in) Less than 0.02mm (0.0008in)/100 x 100	
Flatness of manifold mounting surface		Less than 0.1mm (0.0039in) Less than 0.03mm (0.0012in)/110 x 110	
Camshaft			
Cam height	Intake	41.77329mm (1.6446in)	
	Exhaust	41.55202mm (1.6357in)	
Camshaft bearing oil clearance (Intake/Exhaust)	No. 1 journal	0.025 ~ 0.057mm (0.0010 ~ 0.0022in)	
	No. 2, 3, 4, 5 journal	0.020 ~ 0.057mm (0.0008 ~ 0.0022in)	
Camshaft journal outer diameter (Intake/Exhaust)	No. 1 journal	35.964 ~ 35.980mm (1.4159 ~ 1.4165in)	
	No. 2, 3, 4, 5 journal	25.964 ~ 25.980mm (1.0222 ~ 1.0228in)	

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Camshaft journal bore inner diameter (Intake/Exhaust)	No. 1 journal	36.005 ~ 36.021mm (1.4175 ~ 1.4181in)	
	No. 2, 3, 4, 5 journal	26.000 ~ 26.021mm (1.0236 ~ 1.0244in)	
End play		0.12 ~ 0.22mm (0.0047 ~ 0.0086in)	
Valve			
Valve length	Intake	107.77mm (4.2429in)	
	Exhaust	107.75mm (4.2421in)	
Stem outer diameter	Intake	5.965 ~ 5.980mm (0.2348 ~ 0.2354in)	
	Exhaust	5.958 ~ 5.970mm (0.2346 ~ 0.2350in)	
Face angle (Intake/Exhaust)		45.25° ~ 45.75°	
Thickness of valve head (margin)	Intake	1.2mm (0.0472in)	
	Exhaust	1.2mm (0.0472in)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.0008 ~ 0.0018in)	
	Exhaust	0.030 ~ 0.054mm (0.0012 ~ 0.0021in)	
Valve guide			
Inner diameter	Intake	6.000 ~ 6.012mm (0.2362 ~ 0.2367in)	
	Exhaust	6.000 ~ 6.012mm (0.2362 ~ 0.2367in)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm (0.0453 ~ 0.0571in)	
	Exhaust	1.35 ~ 1.65mm (0.0531 ~ 0.0650in)	
Seat angle	Intake	44.75° ~ 45.10°	
	Exhaust	44.75° ~ 45.10°	
Valve spring			
Free length		48.44mm (1.9070in)	
Load		22.5±1.1kg/38.3mm (49.7±2.5 lb/1.5078in) 55.0±1.9kg/28.0mm (121.2±4.3 lb/1.123in)	
Out of squareness		Less than 1.5°	
Cylinder block			
Cylinder bore		92.000 ~ 92.030mm (3.6220 ~ 3.6232in)	
	Total	Less than 0.05mm	

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Flatness of gasket surface		(0.0020in)	
	Bore to bore	Less than 0.02mm (0.0008in)	
Piston			
Piston outer diameter		91.945 ~ 91.975mm (3.6199 ~ 3.6211in)	
Piston to cylinder clearance		0.045 ~ 0.065mm (0.0018 ~ 0.0026in)	
Ring groove width	No. 1 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in)	
	No. 2 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in)	
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in)	
Piston ring			
Ring width	No. 1 ring	1.17 ~ 1.19mm (0.0461 ~ 0.0469in)	
	No. 2 ring	1.17 ~ 1.19mm (0.0461 ~ 0.0469in)	
	Oil ring	1.88 ~ 1.95mm (0.0740 ~ 0.0768in)	
Side clearance	No. 1 ring	0.04 ~ 0.08mm (0.0016 ~ 0.0031in)	
	No. 2 ring	0.04 ~ 0.08mm (0.0016 ~ 0.0031in)	
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in)	
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in)	
	No. 2 ring	0.37 ~ 0.52mm (0.0146 ~ 0.0205in)	
	Oil ring	0.20 ~ 0.70mm (0.0079 ~ 0.0276in)	
Piston pin			
Piston pin outer diameter		21.995 ~ 22.000mm (0.8659 ~ 0.8661in)	
Piston pin hole inner diameter		22.004 ~ 22.010mm (0.8663 ~ 0.8665in)	
Piston pin hole clearance		0.004 ~ 0.015mm (0.0002 ~ 0.0006in)	
Connecting rod small end hole inner diameter		22.007 ~ 22.018mm (0.8664 ~ 0.8668in)	
Connecting rod small end hole clearance		0.007 ~ 0.023mm (0.0003 ~ 0.0009in)	

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Connecting rod

Connecting rod big end inner diameter	55.000 ~ 55.018mm (2.1654 ~ 2.1661in)	
Connecting rod bearing oil clearance	0.018 ~ 0.036mm (0.0007 ~ 0.0014in)	
Side clearance	0.1 ~ 0.3mm (0.0039 ~ 0.0118in)	

Crankshaft

Main journal outer diameter	64.982 ~ 65.000mm (2.5583 ~ 2.5591in)	
Pin journal outer diameter	51.982 ~ 52.000mm (2.0465 ~ 2.0472in)	
Main bearing oil clearance	0.004 ~ 0.022mm (0.0002 ~ 0.0009in)	
End play	0.10 ~ 0.28mm (0.0039 ~ 0.0110in)	

Drive plate

Runout	0.25mm (0.0098in)	
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Oil pump

Relief valve opening pressure	530±49kPa (5.5±0.5kg/cm ² , 78.2±7psi)	
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Engine oil

Oil quantity	Total	7.5L (7.92US qt, 6.59lmp qt)	When replacing a short engine or a block assembly
	Oil pan	6.0L (6.34US qt, 5.27lmp qt)	
	Drain and refill	6.5L (6.86U.S.qts, 5.71lmp.qts)	Including oil filter
Oil grade	Recommendation (except Middle East)	5W-20/GF4&SM	If not available, refer to the recommended API of ILSAC classification and SAE viscosity number. .
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the " LUBRICATION SYSTEM "
Oil pressure (at 1,000 rpm)		156.91kPa (1.6kgf/cm ² , 22.76psi) or above	Oil temperature (oil pan): 110 ± 2 °C (230 ± 35.6°F)

Cooling system

Cooling method	Forced circulation with water pump	
	13.5L (14.27US qt,	

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Coolant quantity		11.88lmp qt)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±3.6°F)	
	Pull opening temperature	95°C (203°F)	
	Pull open lift	10mm (0.3937in) or more	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm ² , 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm ² , 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermistor type	
Resistance	20°C(68°F)	2.45±0.14 kohms	
	80°C(176°F)	0.3222 kohms	

Tightening Torques

TIGHTENING TORQUES SPECIFICATIONS

Item	Quantity	Nm	kgf.m	lb-ft
Cylinder head				
Cylinder head cover bolt (RH)	17	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head cover bolt (LH)	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head bolt (long bolt) (LH/RH)	20	(32.4~36.3) + (88°~92°) + (118°~122°)	(3.3~3.7) + (88°~92°) + (118°~122°)	(23.9~26.8) + (88°~92°) + (118°~122°)
Cylinder head bolt (flange bolt) (LH/RH)	4	32.4 ~ 36.3	3.3 ~ 3.7	23.9 ~ 26.8
Camshaft bearing cap bolt (LH/RH)	44	13.7 ~ 14.7	1.4 ~ 1.5	10.1 ~ 10.8
Pressure relief valve (LH/RH)	2	21.6 ~ 25.	2.2 ~ 2.6	15.9 ~ 18.8
Ignition coil bolt (LH/RH)	8	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Spark plug (LH/RH)	8	24.5 ~ 29.4	2.5 ~ 3.0	18.1 ~ 21.7
Oil control valve bolt (LH/RH)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV(oil control valve) filter (LH/RH)	2	53.9 ~ 63.7	5.5 ~ 6.5	39.8 ~ 47.0
CVVT assembly fixing bolt (LH/RH)	4	73.5 ~ 83.4	7.5 ~ 8.5	54.2 ~ 61.5
Water temperature sensor wiring bracket bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water temperature sensor	1	19.6 ~ 39.2	2.0 ~ 4.0	14.5 ~ 28.9
Oil pressure switch wiring bracket bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pressure switch	1	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Timing system				

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Timing chain lower cover bolt	14	23.5 ~ 27.5	2.4 ~ 2.8	17.4 ~ 20.3
Timing chain upper cover (LH/RH)	14	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Tensioner adapter bolt	3	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain tensioner arm bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain guide mounting bolt (LH/RH)	2	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Timing chain tensioner bolt (LH/RH)	2	78.5 ~ 88.3	8.0 ~ 9.0	57.9 ~ 65.1
Cam to cam guide bolt (LH/RH)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Crankshaft pulley bolt	1	392.3 ~ 402.1	40.0 ~ 41.0	289.3 ~ 296.6
Drive belt tensioner bolt	3	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Drive belt idler bolt	1	37.3 ~ 41.2	3.8 ~ 4.2	27.5 ~ 30.4
Alternator mounting bolt	2	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Alternator bracket bolt (10X50)	4	29.4 ~ 41.2	3.0 ~ 4.2	21.7 ~ 30.4
Alternator bracket bolt (8X40)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Cylinder block				
Drain plug	1	96.1 ~ 100.0	9.8 ~ 10.2	70.9 ~ 73.8
Piston oil jet	4	24.5 ~ 29.4	2.5 ~ 3.0	18.1 ~ 21.7
Connecting rod cap bolt	16	(22.6~26.5) + (98°~102°)	(2.3~2.7) + (98°~102°)	(16.6~19.5) + (98°~102°)
Lower crankcase assembly bolt (main bearing cap bolt)	20	(37.3~41.2) + (120°)	(3.8~4.2) + (120°)	(27.5~30.4) + (120°)
Lower crankcase assembly bolt (flange bolt)	15	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Cylinder block rear cover bolt	12	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder block bank cover bolt	12	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Drive plate bolt	8	98.1 ~ 107.9	10.0 ~ 11.0	72.3 ~ 79.6
Cooling system				
Water pump pulley bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water pump bolt	9	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Water temperature control assembly bolt	4	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water outlet fitting assembly bolt	2	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Water inlet pipe bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water outlet pipe bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Lubrication system				
Oil level gauge guide bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil filter & cooler assembly bolt	5	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Lower oil pan bolt	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Upper oil pan bolt	27	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Baffle plate bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump assembly bolt	4	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Oil pump sprocket bolt	1	21.6 ~ 25.5	2.2 ~ 2.6	15.9 ~ 18.8
Intake and exhaust system				

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Air cleaner assembly bolt	4	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Intake manifold module nut	10	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Exhaust manifold nut (LH/RH)	24	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.8
Exhaust manifold heat protector A bolt (LH/RH)	6	8.8 ~ 10.8	0.9 ~ 1.1	6.5 ~ 8.0
Exhaust manifold heat protector B bolt (LH/RH)	4	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Front muffler nut (LH/RH)	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Center muffler	4	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Main muffler (LH/RH)	4	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Engine mounting				
Engine mounting support bracket fixing bolt (LH/RH)	12	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Engine mounting insulator and engine mounting support bracket fixing bolt (LH/RH)	2	63.7 ~ 83.4	6.5 ~ 8.5	47.0 ~ 61.5
Engine mounting insulator and frame fixing bolt (LH/RH)	6	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transmission mounting insulator and transmission mounting bracket fixing nut	2	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
Transmission mounting bracket and frame fixing bolt	4	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0

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 engine to normal operating temperature(80~95°C(176-203°F)).
2. Remove the ignition coil connectors (A) and ignition coils (B).

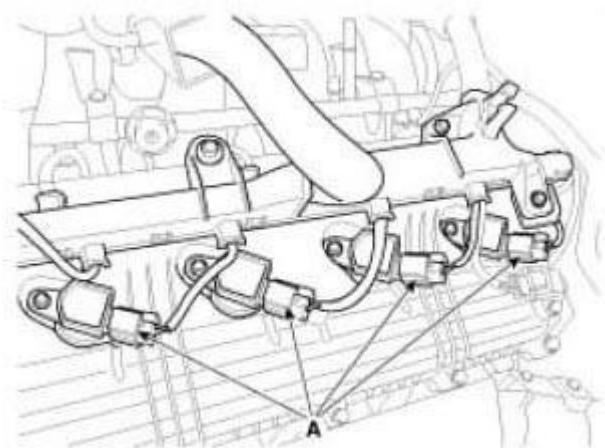


Fig. 1: Identifying Ignition Coil Connectors
Courtesy of HYUNDAI MOTOR CO.

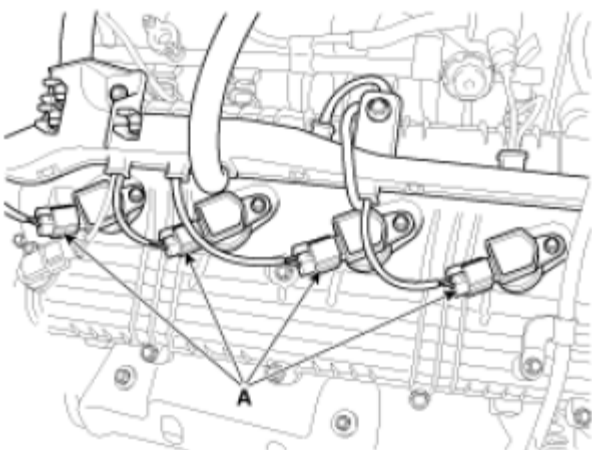


Fig. 2: Identifying Ignition Coil Connectors
Courtesy of HYUNDAI MOTOR CO.

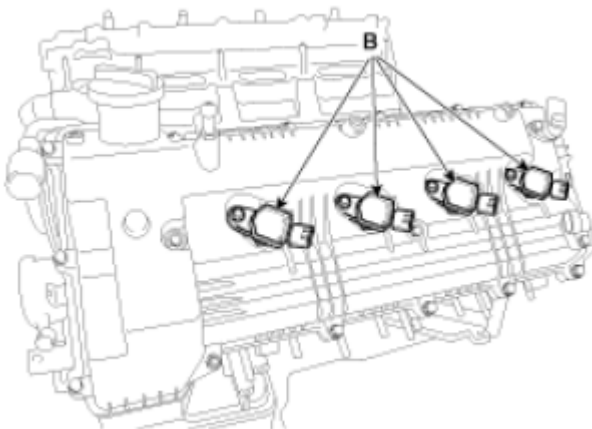


Fig. 3: Identifying Ignition Coils

Courtesy of HYUNDAI MOTOR CO.

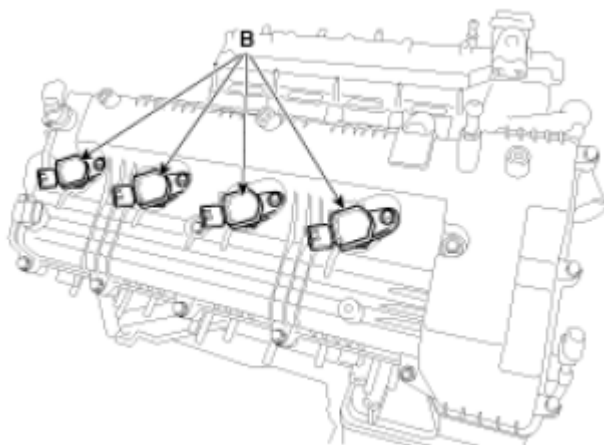


Fig. 4: Identifying Ignition Coils
Courtesy of HYUNDAI MOTOR CO.

3. Remove the spark plugs.

Using a 16mm plug wrench, remove the 8 spark plugs.

4. Check cylinder compression pressure.
 1. Insert a compression gauge into the spark plug hole.
 2. Fully open the throttle.
 3. Crank the engine over 7 times to measure compression pressure.

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

4. Repeat step 1) though 3) for each cylinder.

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

Compression pressure:

1,078kPa (11.0kg/cm² , 156psi)

Minimum pressure:

931kPa (9.5kg/cm² , 135psi)

Difference between each cylinder:

98kPa (1.0kg/cm² , 14psi) or less

5. If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat step 1) through 3) for cylinders with low compression.
 - A. If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
 - B. If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.
5. Reinstall the spark plugs.
6. Install the ignition coils and ignition connectors.

TROUBLESHOOTING

TROUBLESHOOTING CHART

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged 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.
	HLA sponge	Run the engine at 2500~3000rpm within 15 minutes. If it doesn't disappear, refer to CYLINDER HEAD ASSEMBLY in this group.
Engine misfire with coolant consumption.	- Faulty cylinder head gasket 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.	- Inspect the cylinder head 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	Inspect the cylinder for a loss of compression.

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	engine to misfire)	• Repair or replace as required.
Engine noise on start-up, 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 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.

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		• 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. • 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- crankshaft will not rotate.	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	• Remove spark plugs and check for fluid. • Inspect for broken head gasket. • Inspect for cracked engine block or cylinder head. • Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain sprockets.	• Inspect timing chain and sprockets. • Repair as required.
	Material in cylinder. • Broken valve	• Inspect cylinder for damaged components and/or foreign

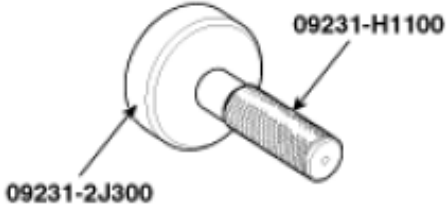
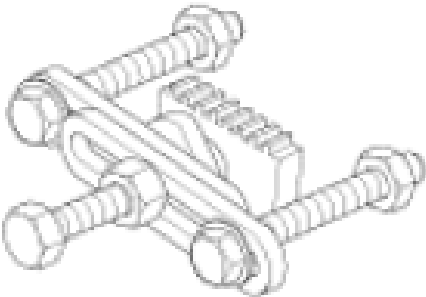
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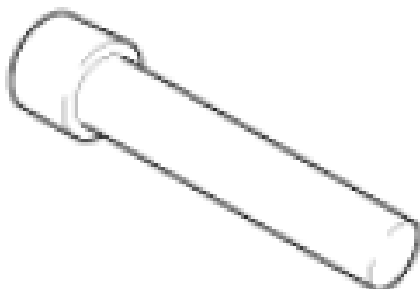
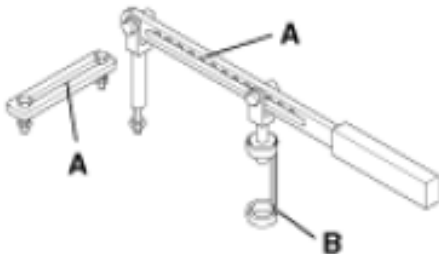
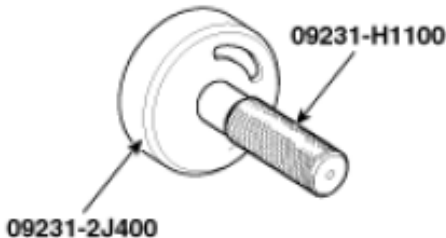
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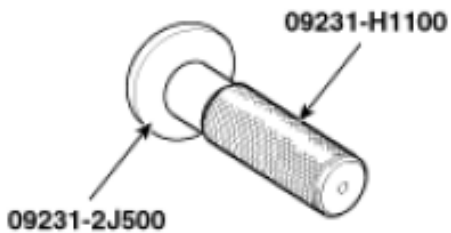
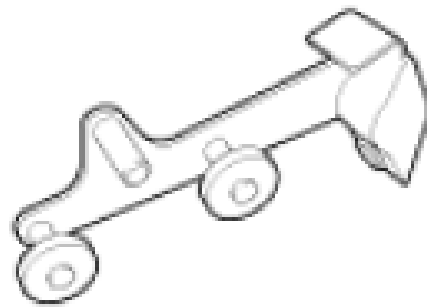
	• Piston material • Foreign material	materials. • Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	• Inspect crankshaft and connecting rod bearing. • Repair as required.
	Bent or broken connecting rod.	• Inspect connecting rods. • Repair as required.
	Broken crankshaft.	• Inspect crankshaft. • Repair as required.

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS DESCRIPTION CHART

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-2J300) (09231-H1100)		Installation of the front oil seal
Ring gear (09231-2B100)		Removal and installation of the crankshaft pulley
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method

		
Valve stem seal installer (09222-28200)		Installation of the valve stem 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 (09231-2J400) (09231-H1100)		Installation of the crankshaft rear oil seal
Oil pan remover (09215-3C000)		Removal of oil pan

		
Oil seal installer (09231-2J500) (09231-H1100)		Installation of the cylinder head cover oil seal & timing chain upper cover oil seal.
Timing chain locking tool (09231-2J600)		Holds the timing chain with timing chain guide & timing chain tensioner arm during installation.

2011 ENGINE

Cylinder Head Assembly - Equus

CYLINDER HEAD

COMPONENTS AND COMPONENTS LOCATION

Components

[RH]

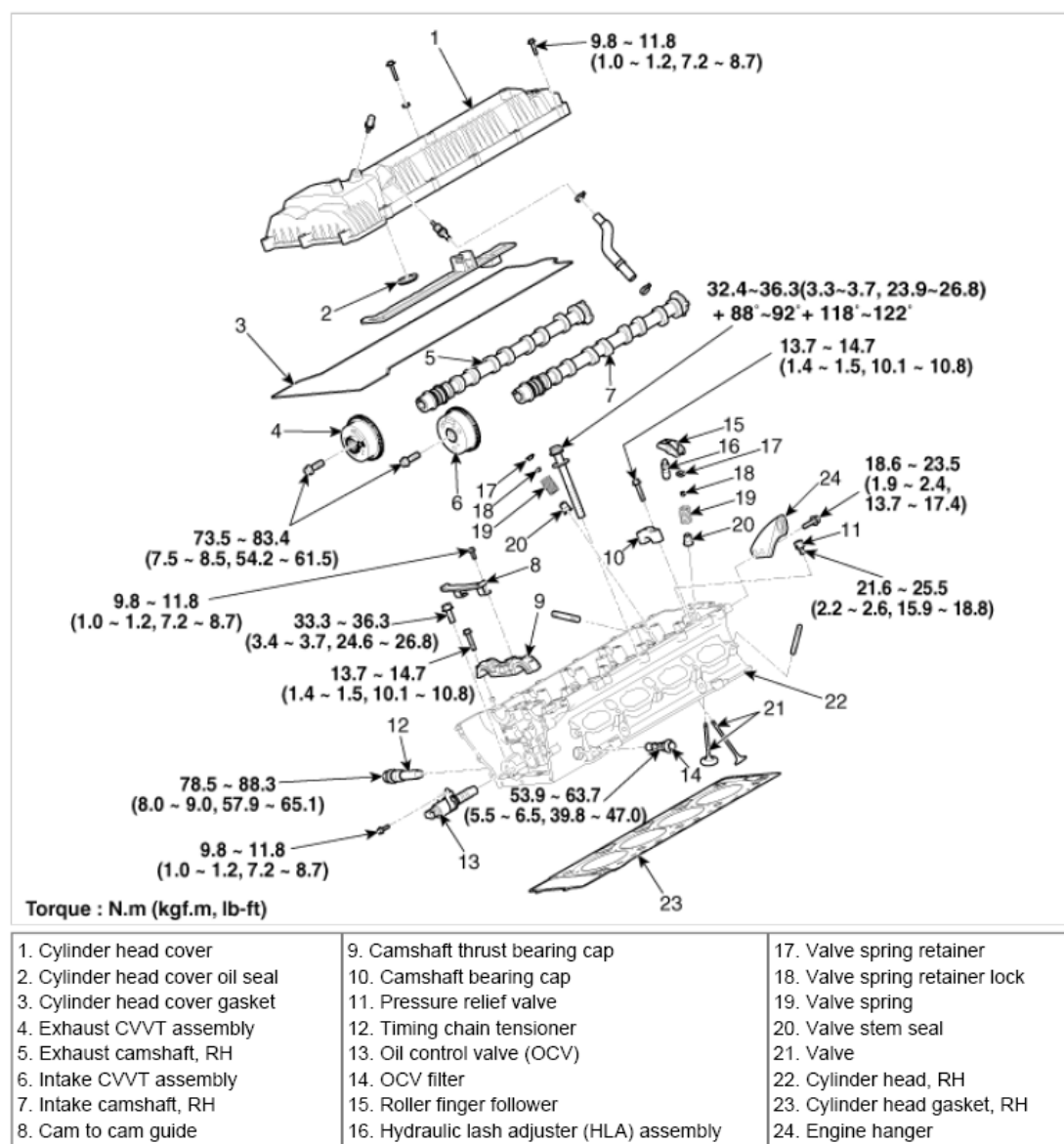


Fig. 1: Exploded View Of Cylinder Head With Torque Specifications (RH)
 Courtesy of HYUNDAI MOTOR CO.

[LH]

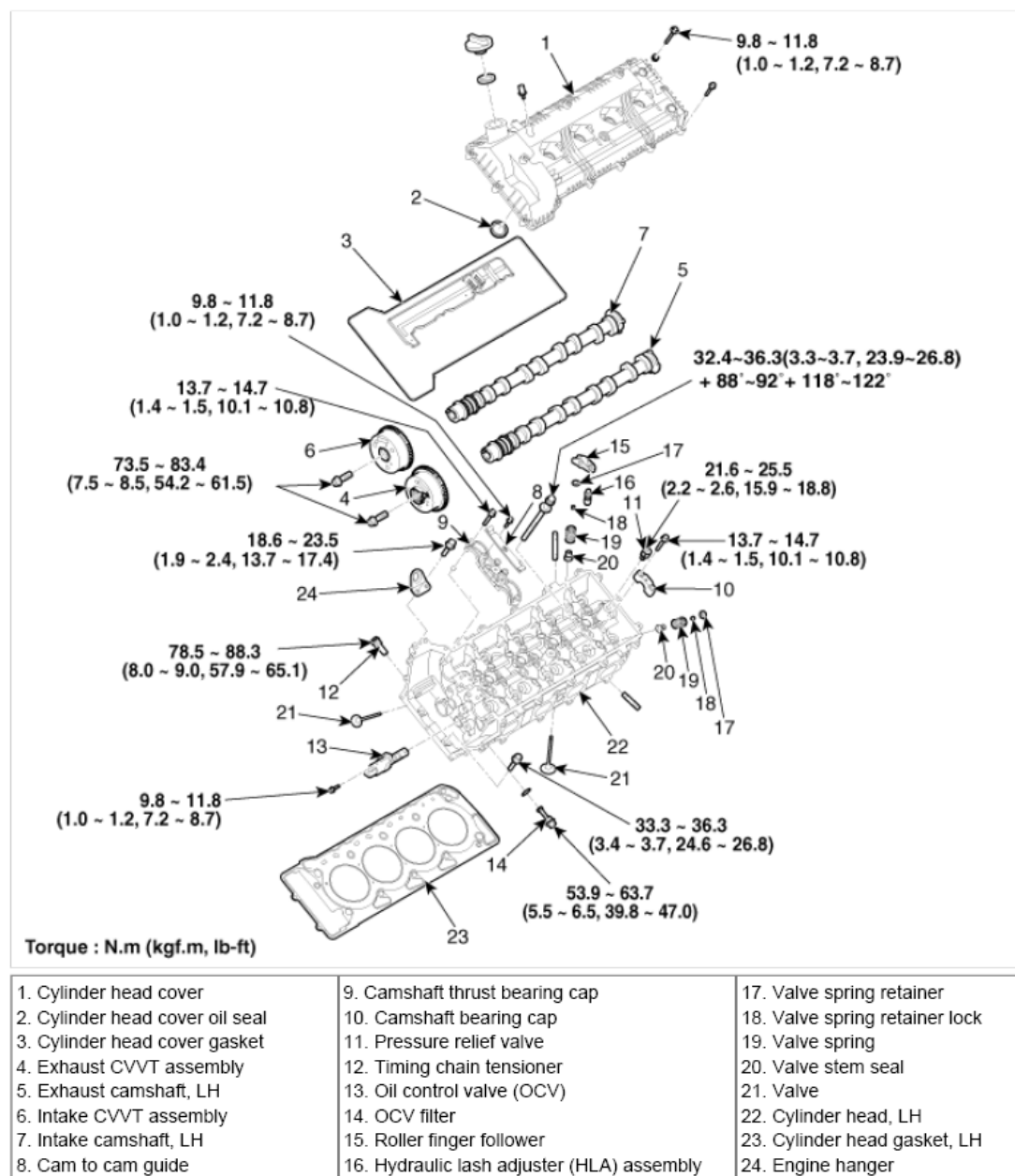


Fig. 2: Exploded View Of Cylinder Head With Torque Specifications (LH)
 Courtesy of HYUNDAI MOTOR CO.

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 operating 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 misconception.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

1. Disconnect the negative terminal (A) from the battery.

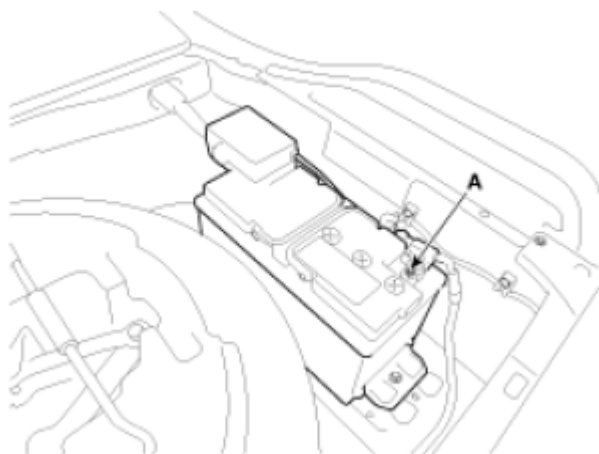


Fig. 3: Identifying Negative Terminal Of Battery
Courtesy of HYUNDAI MOTOR CO.

2. Remove the engine room cover (A), engine cover (B) and radiator grill upper cover (C).

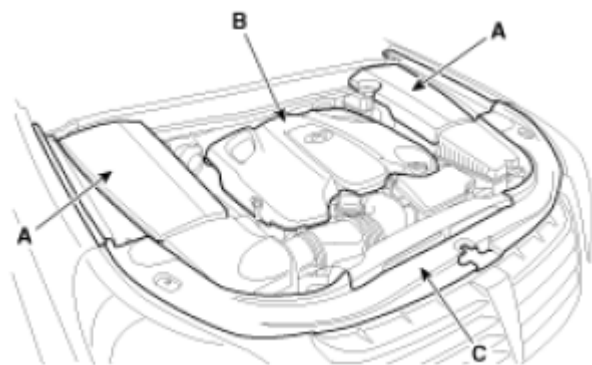


Fig. 4: Identifying Engine Room Cover, Engine Cover And Radiator Grill Upper Cover
Courtesy of HYUNDAI MOTOR CO.

3. Loosen the drain plug (A) and drain the engine coolant. Remove the radiator cap (B) to speed draining.

WARNING: Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

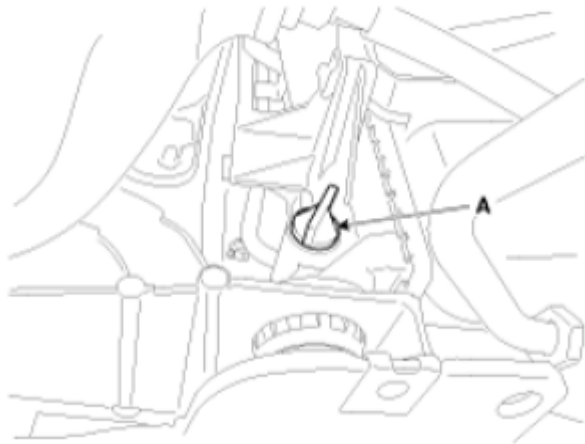


Fig. 5: Identifying Drain Plug
Courtesy of HYUNDAI MOTOR CO.

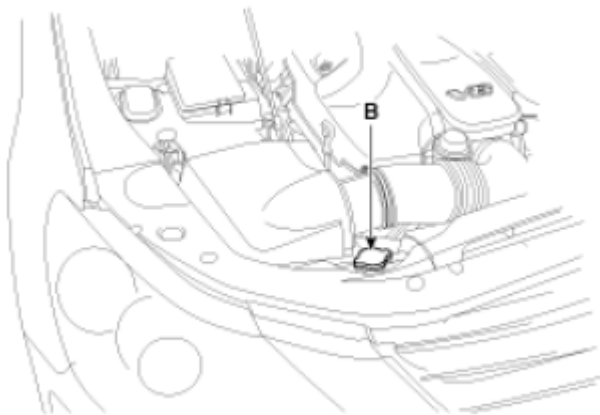


Fig. 6: Identifying Radiator Cap
Courtesy of HYUNDAI MOTOR CO.

4. Remove the air cleaner assembly.
 1. Remove the air duct (A).
 2. Disconnect the air flow sensor (AFS) connector (C).
 3. Disconnect the breather hose (B).
 4. Remove the resonator (F), the intake air hose (E) and air cleaner assembly (D).

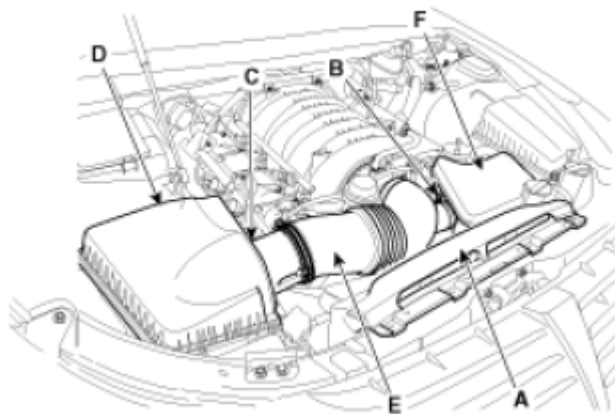


Fig. 7: Identifying Air Duct, Air Flow Sensor Connector, Breather Hose And Resonator
Courtesy of HYUNDAI MOTOR CO.

5. Disconnect the radiator upper hose (A) and lower hose (B).

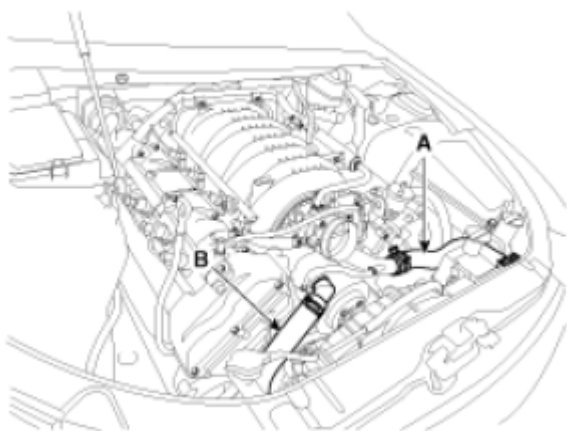


Fig. 8: Identifying Radiator Upper Hose And Lower Hose
Courtesy of HYUNDAI MOTOR CO.

6. Remove the fuel hose (A), the purge control solenoid valve (PCSV) hose (B) and the brake booster vacuum hose (C).

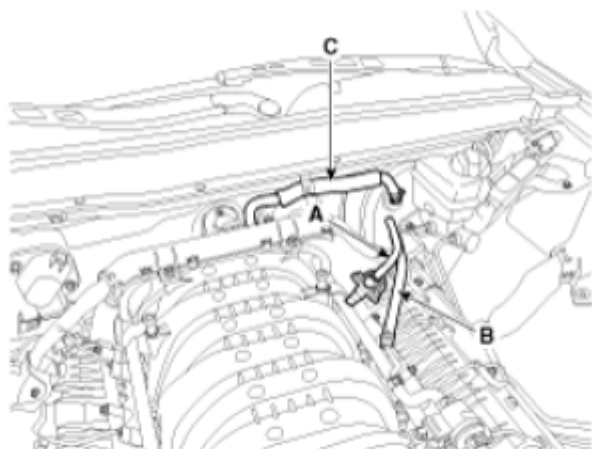


Fig. 9: Identifying Fuel Hose, Purge Control Solenoid Valve Hose And Brake Booster Vacuum Hose
Courtesy of HYUNDAI MOTOR CO.

7. Disconnect the heater hoses (A).

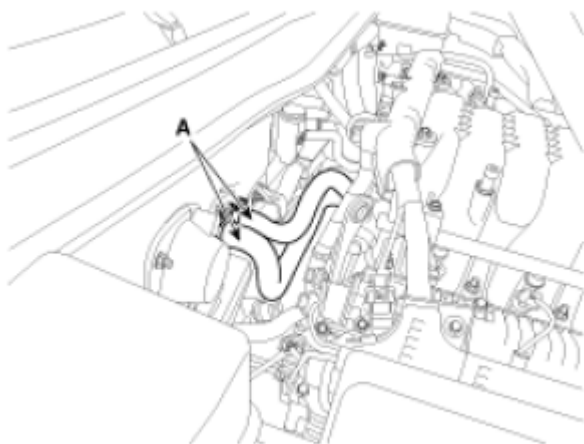


Fig. 10: Identifying Heater Hoses
Courtesy of HYUNDAI MOTOR CO.

8. Remove the radiator & cooling fan assembly from the vehicle. (Refer to **COOLING SYSTEM** in this group)
9. Turn the tensioner (B) clockwise and loosen, then remove the drive belt (A).

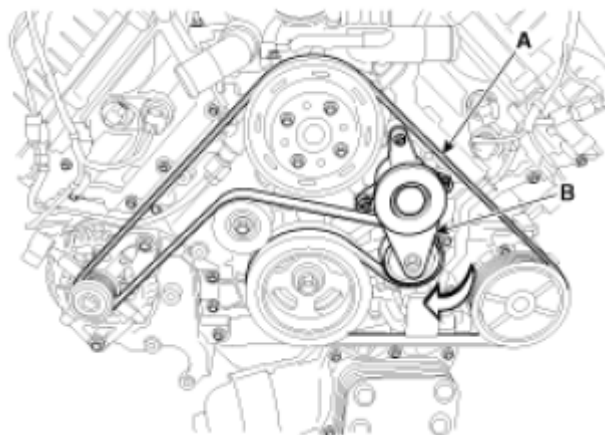


Fig. 11: Turning Tensioner Clockwise
Courtesy of HYUNDAI MOTOR CO.

10. Remove the drive belt tensioner (A).

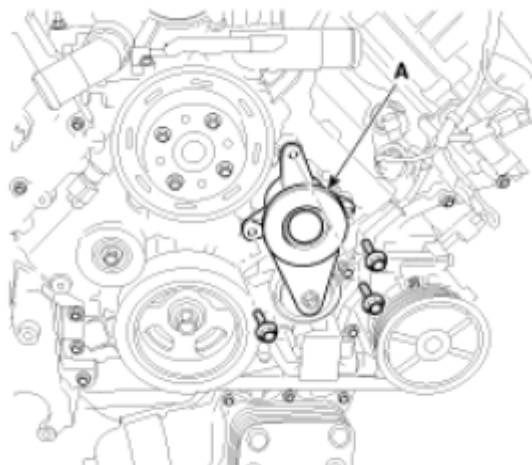


Fig. 12: Identifying Drive Belt Tensioner
Courtesy of HYUNDAI MOTOR CO.

11. Remove the engine wiring harness from the cylinder head.
 1. Disconnect the engine coolant temperature sensor (ECTS) connector (A) and the CVVT oil control valve (OCV) connectors (B).

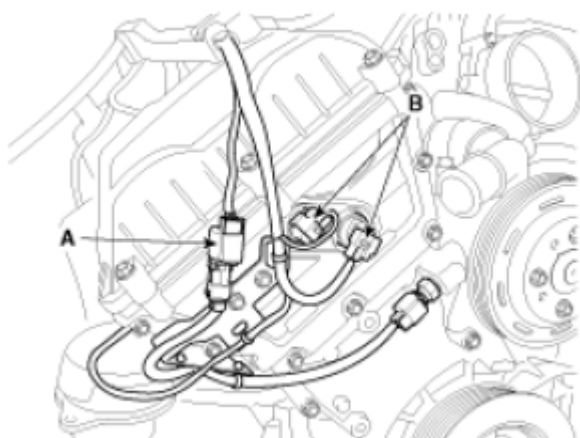


Fig. 13: Identifying Engine Coolant Temperature Sensor Connector And CVVT Oil Control Valve Connectors

Courtesy of HYUNDAI MOTOR CO.

2. Disconnect the alternator connector (A).

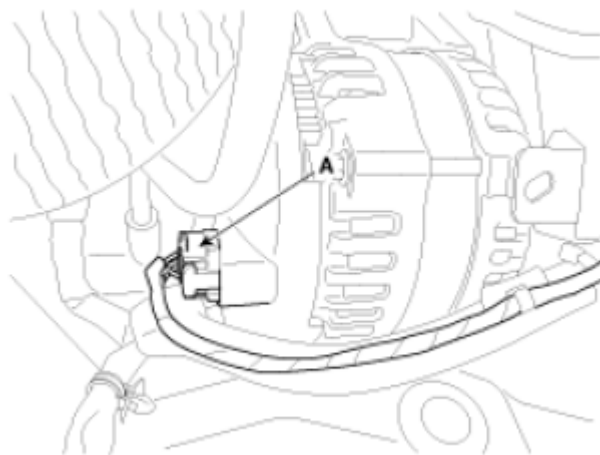


Fig. 14: Identifying Alternator Connector

Courtesy of HYUNDAI MOTOR CO.

3. Disconnect the ETC module connector (A).

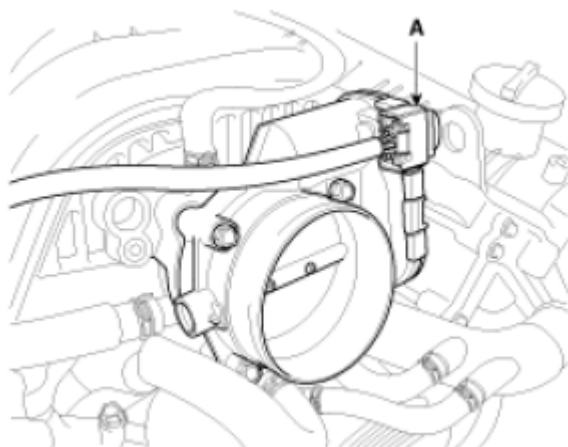


Fig. 15: Identifying ETC Module Connector
Courtesy of HYUNDAI MOTOR CO.

4. Disconnect the purge control solenoid valve (PCSV) connector (A) and the injector connectors (B).

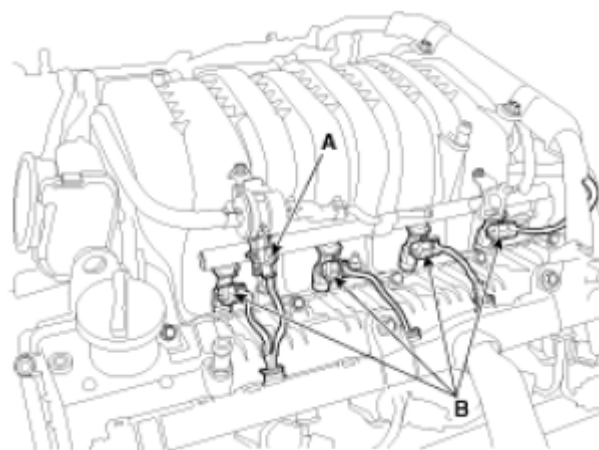


Fig. 16: Identifying Purge Control Solenoid Valve Connector And Injector Connectors
Courtesy of HYUNDAI MOTOR CO.

5. Disconnect the ignition coil connectors (A) and the wiring harness protector (B).

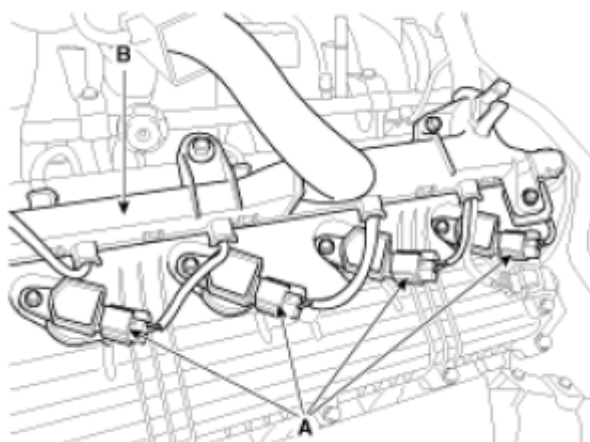


Fig. 17: Identifying Ignition Coil Connectors And Wiring Harness Protector
 Courtesy of HYUNDAI MOTOR CO.

6. Disconnect the knock sensor connectors (A), the camshaft position sensor (CMPS) connectors (B), the oxygen sensor (HO2S) connector (C), the condenser connector (D) and the ground line (E).

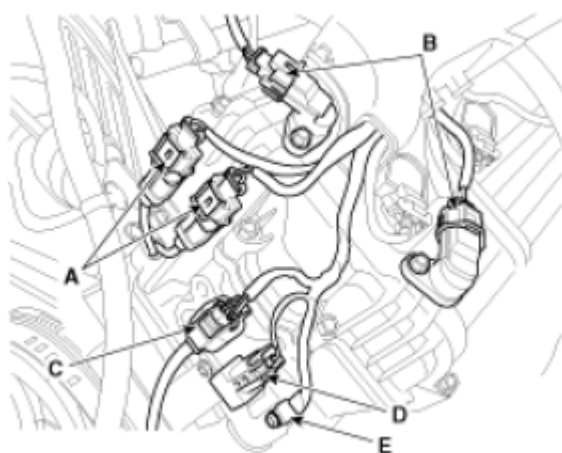


Fig. 18: Identifying Knock Sensor Connectors, Camshaft Position Sensor Connectors, Oxygen Sensor Connector, Condenser Connector And Ground Line
 Courtesy of HYUNDAI MOTOR CO.

7. Disconnect the variable intake system (VIS) solenoid valve connector (A) and the wiring harness protector (B).

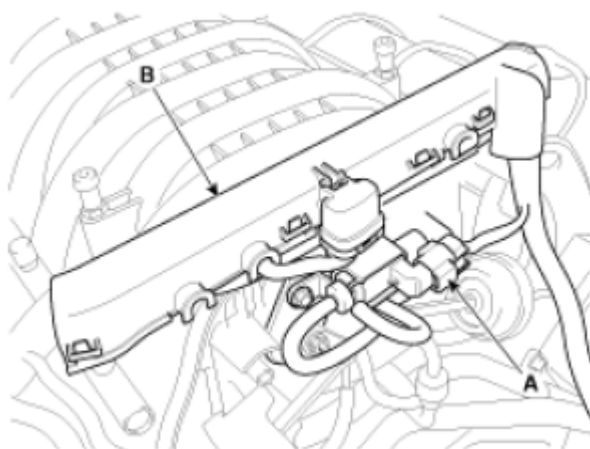


Fig. 19: Identifying Variable Intake System Solenoid Valve Connector And Wiring Harness Protector

Courtesy of HYUNDAI MOTOR CO.

8. Disconnect the knock sensor connectors (A), the camshaft position sensor (CMPS) connectors (B), the crankshaft position sensor (CKPS) connector (C), the oxygen sensor (HO2S) connector (D), condenser connector (E) and the ground line (F).

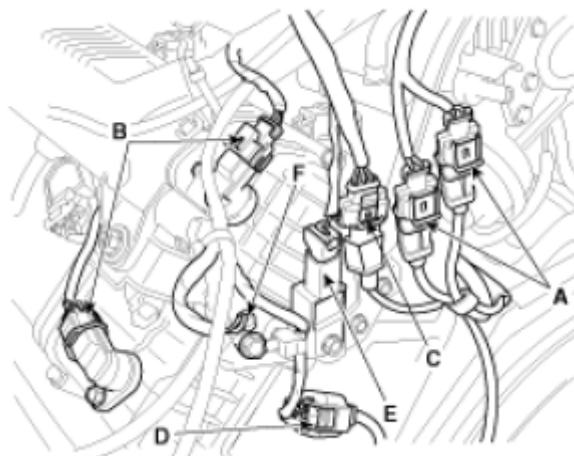


Fig. 20: Identifying Knock Sensor, Camshaft Position Sensor, Crankshaft Position Sensor, Oxygen Sensor, Condenser Connectors And Ground Line
Courtesy of HYUNDAI MOTOR CO.

9. Disconnect the injector connectors (A).

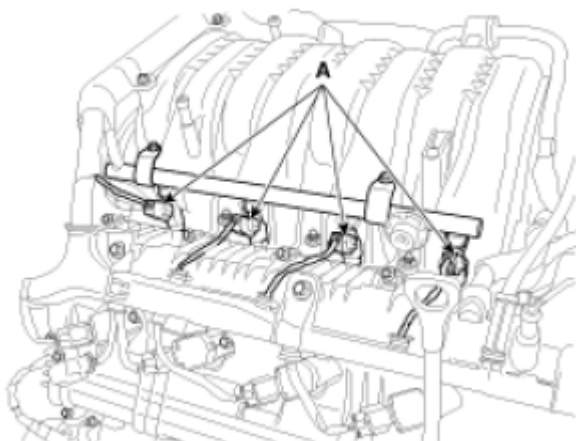


Fig. 21: Identifying Injector Connectors
Courtesy of HYUNDAI MOTOR CO.

10. Disconnect the ignition coil connectors (A) and the wiring harness protector (B).

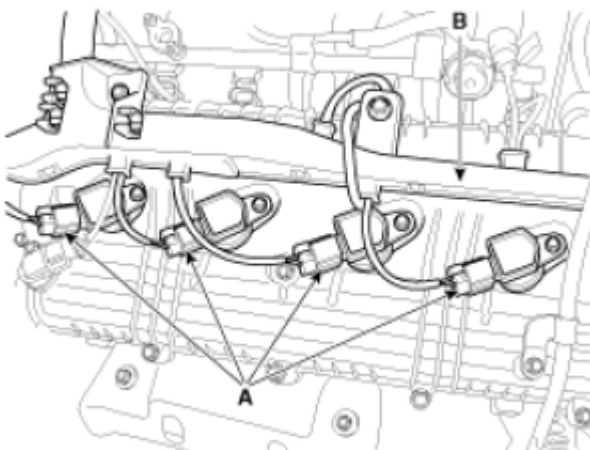


Fig. 22: Identifying Ignition Coil Connectors And Wiring Harness Protector
Courtesy of HYUNDAI MOTOR CO.

11. Disconnect the oil pressure switch (OPS) connector (A), the CVVT oil control valve (OCV) connectors (B) and the air conditioner compressor switch connector (C).

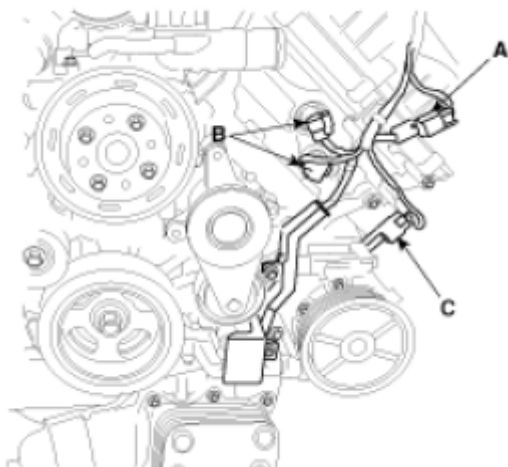


Fig. 23: Identifying Oil Pressure Switch Connector, CVVT Oil Control Valve Connectors And Air Conditioner Compressor Switch Connector
Courtesy of HYUNDAI MOTOR CO.

12. Remove the oil level gauge (A).

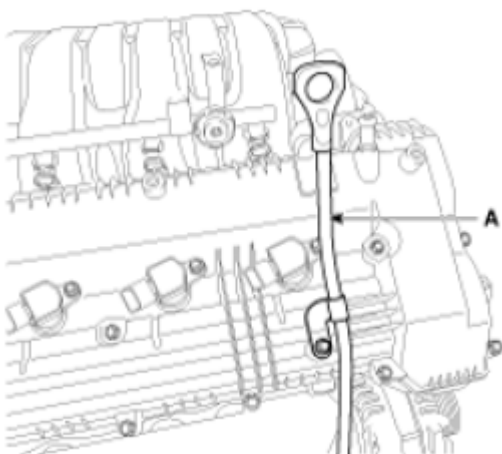


Fig. 24: Identifying Oil Level Gauge
Courtesy of HYUNDAI MOTOR CO.

13. Remove the oxygen sensor (HO2S) connector bracket (A).

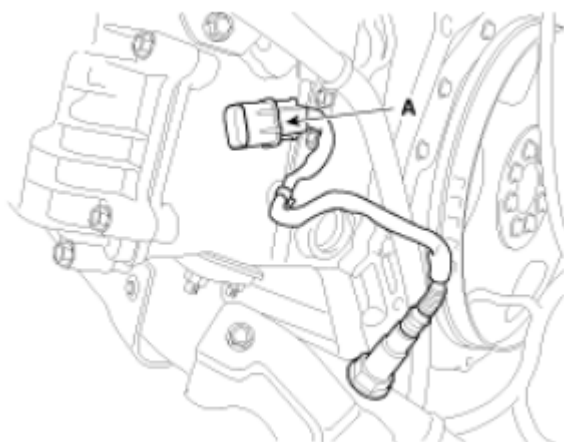


Fig. 25: Identifying Oxygen Sensor Connector Bracket
Courtesy of HYUNDAI MOTOR CO.

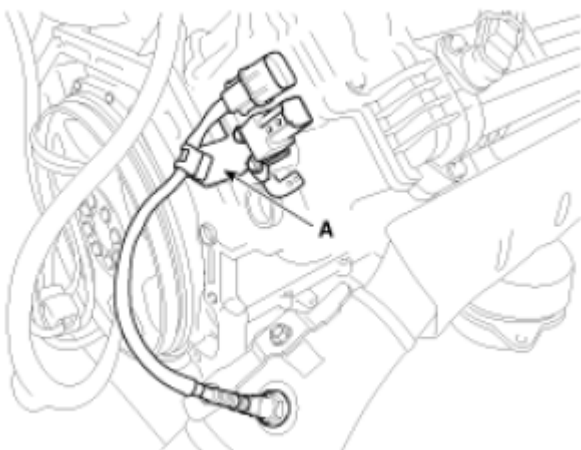


Fig. 26: Identifying Oxygen Sensor Connector Bracket
Courtesy of HYUNDAI MOTOR CO.

14. Disconnect the PCV hose (A), the PCSV hose (B) and the water hoses (C) from the intake manifold module.

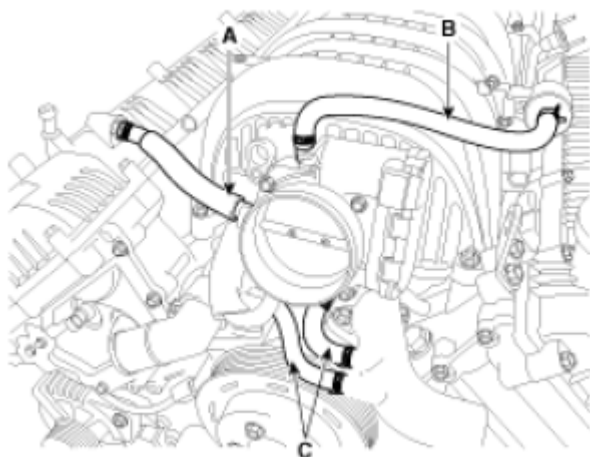


Fig. 27: Identifying PCV Hose, PCSV Hose And Water Hoses
Courtesy of HYUNDAI MOTOR CO.

15. Remove the intake manifold module (A).

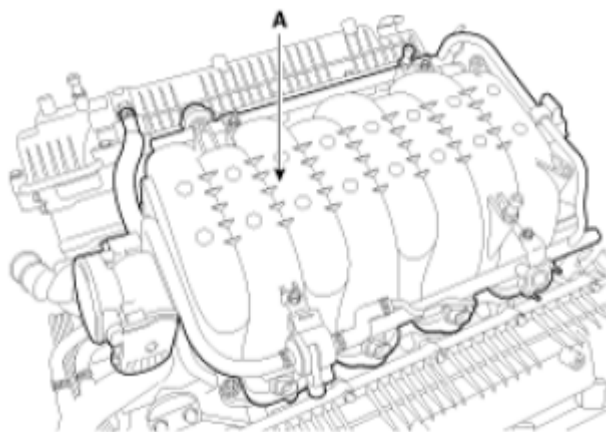


Fig. 28: Identifying Intake Manifold Module
Courtesy of HYUNDAI MOTOR CO.

16. Remove the knock sensors (A) and then remove the wiring assembly bracket (B).

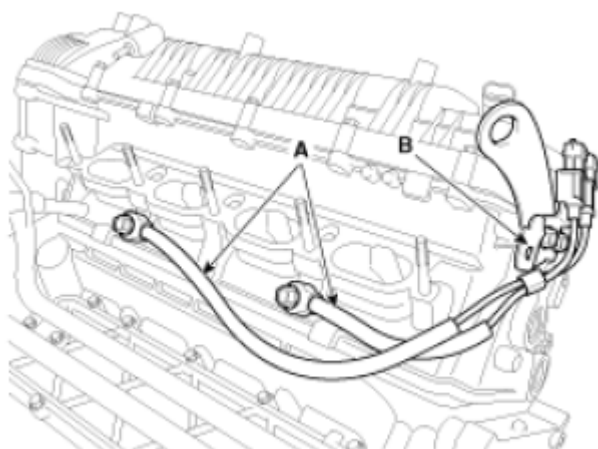


Fig. 29: Identifying Knock Sensors And Wiring Assembly Bracket
Courtesy of HYUNDAI MOTOR CO.

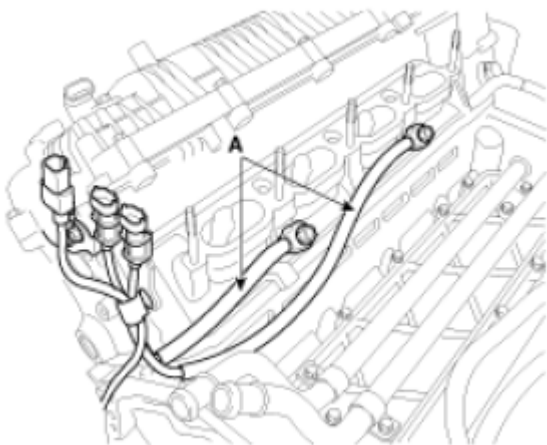


Fig. 30: Identifying Knock Sensors
Courtesy of HYUNDAI MOTOR CO.

17. Remove the water hose (A).

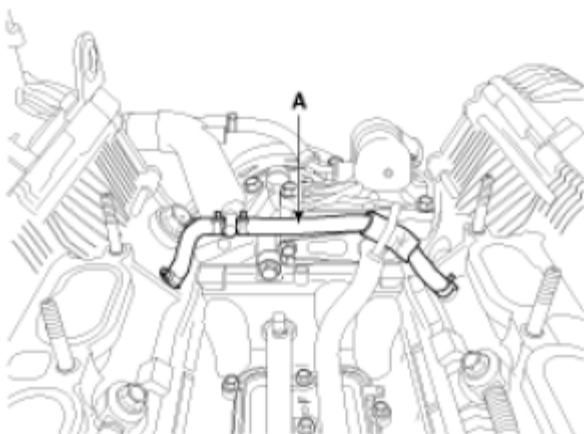


Fig. 31: Identifying Water Hose
Courtesy of HYUNDAI MOTOR CO.

18. Remove the ignition coils (A).

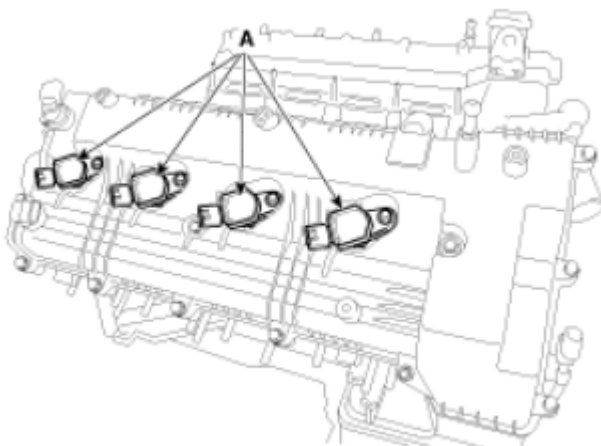


Fig. 32: Identifying (BANK 1) Ignition Coils #1, #3, #5, & #7
Courtesy of HYUNDAI MOTOR CO.

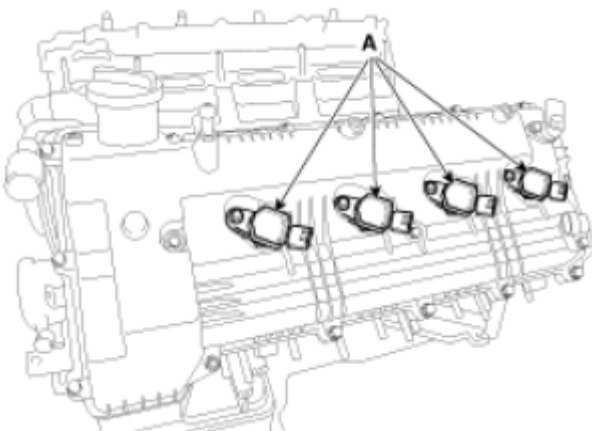


Fig. 33: Identifying (BANK 2) Ignition Coils #2, #4, #6, & #8
Courtesy of HYUNDAI MOTOR CO.

19. Remove the cylinder head cover (A).

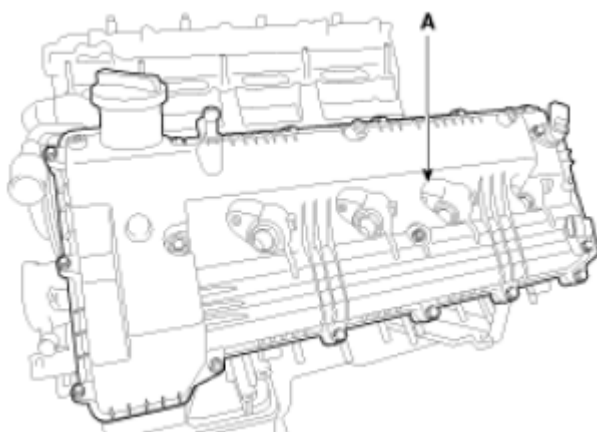


Fig. 34: Identifying Cylinder Head Cover
Courtesy of HYUNDAI MOTOR CO.

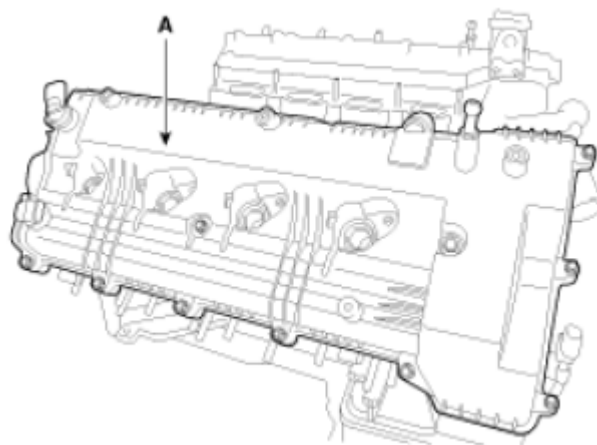


Fig. 35: Identifying Cylinder Head Cover
Courtesy of HYUNDAI MOTOR CO.

20. Remove the cylinder head cover gasket (A) and oil seal (B).

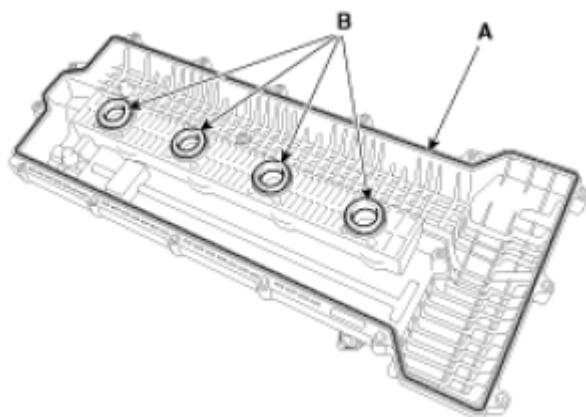


Fig. 36: Identifying Cylinder Head Cover Gasket And Oil Seal
Courtesy of HYUNDAI MOTOR CO.

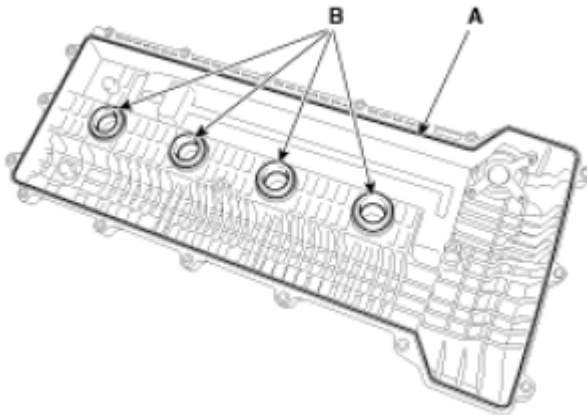


Fig. 37: Identifying Cylinder Head Cover Gasket And Oil Seal
Courtesy of HYUNDAI MOTOR CO.

21. Remove the oil pressure switch (OPS) wiring assembly and bracket (A).

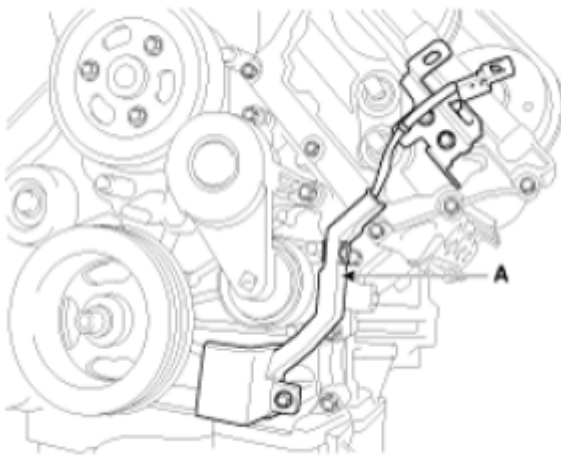


Fig. 38: Identifying Oil Pressure Switch Wiring Assembly And Bracket
Courtesy of HYUNDAI MOTOR CO.

22. Remove the engine coolant temperature sensor (ECTS) wiring assembly and bracket (A).

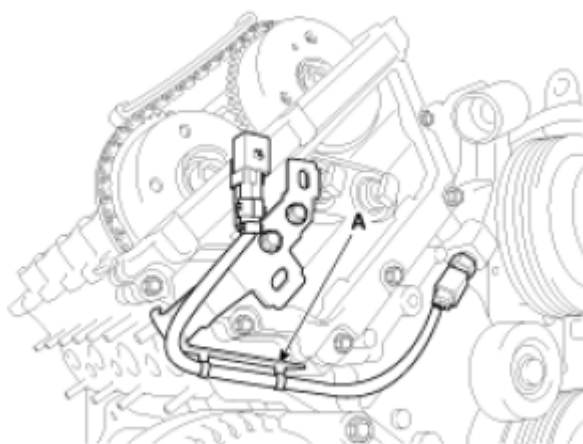


Fig. 39: Identifying Engine Coolant Temperature Sensor Wiring Assembly And Bracket
Courtesy of HYUNDAI MOTOR CO.

23. Remove the exhaust manifold heat protector (A).

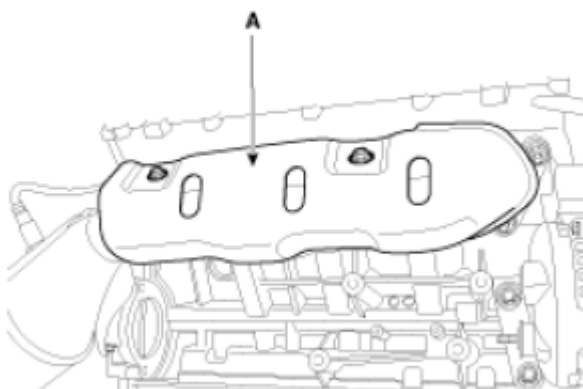


Fig. 40: Identifying Exhaust Manifold Heat Protector
Courtesy of HYUNDAI MOTOR CO.

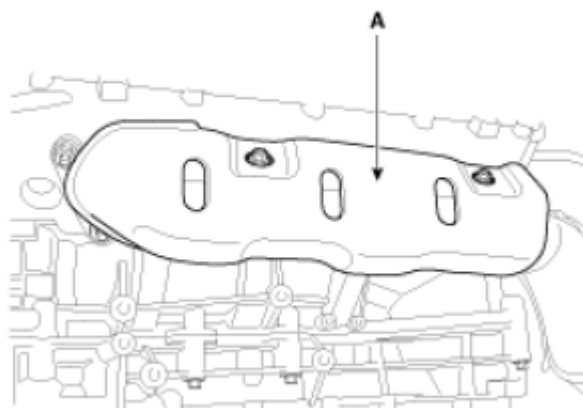


Fig. 41: Identifying Exhaust Manifold Heat Protector
Courtesy of HYUNDAI MOTOR CO.

24. Remove the exhaust manifold (A). (Refer to **INTAKE AND EXHAUST SYSTEM** in this group)

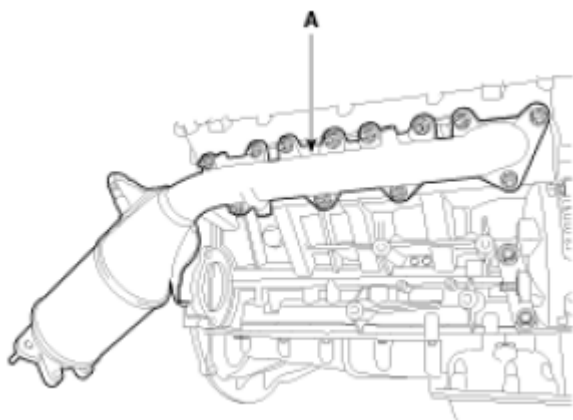


Fig. 42: Identifying Exhaust Manifold
Courtesy of HYUNDAI MOTOR CO.

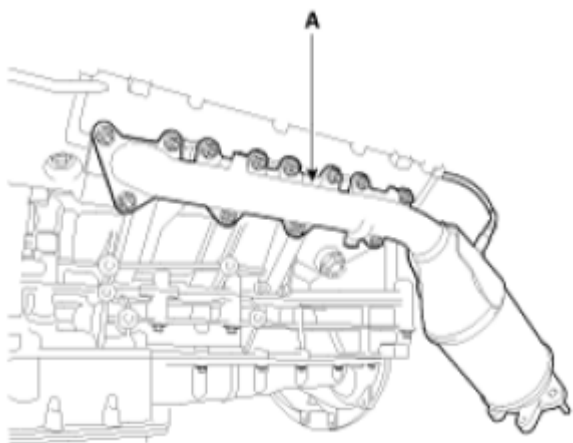


Fig. 43: Identifying Exhaust Manifold
Courtesy of HYUNDAI MOTOR CO.

25. Remove the timing chain upper cover (A).

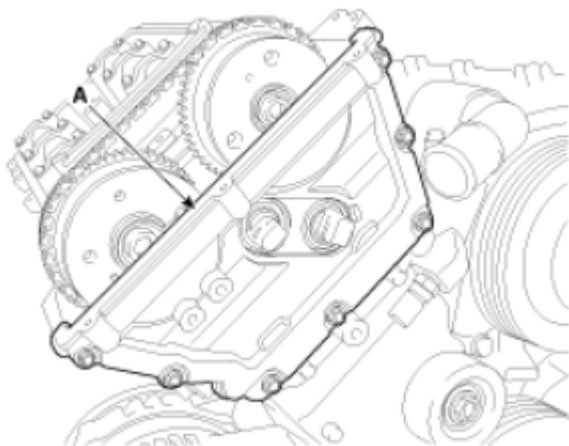


Fig. 44: Identifying Timing Chain Upper Cover
Courtesy of HYUNDAI MOTOR CO.

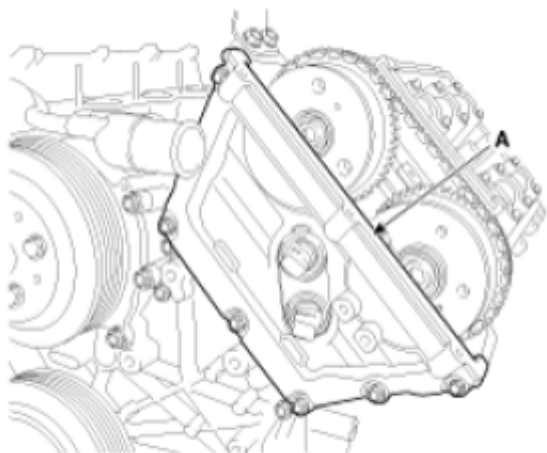


Fig. 45: Identifying Timing Chain Upper Cover
Courtesy of HYUNDAI MOTOR CO.

26. Remove the timing chain upper cover oil seal (A).

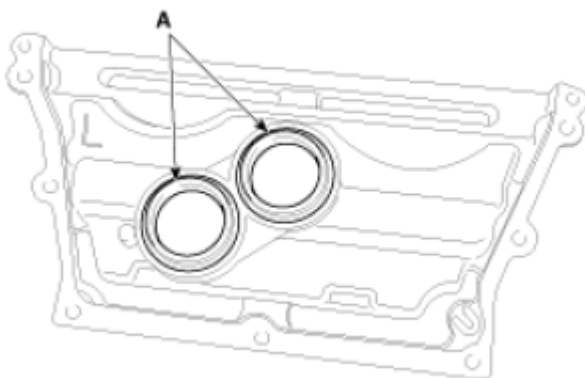


Fig. 46: Identifying Timing Chain Upper Cover Oil Seal

Courtesy of HYUNDAI MOTOR CO.

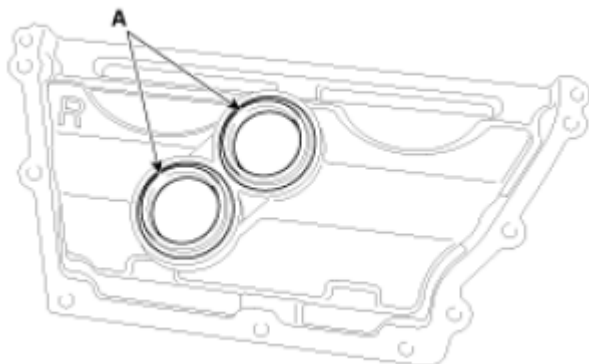


Fig. 47: Identifying Timing Chain Upper Cover Oil Seal
Courtesy of HYUNDAI MOTOR CO.

27. Remove the oil control valve (OCV) (A).

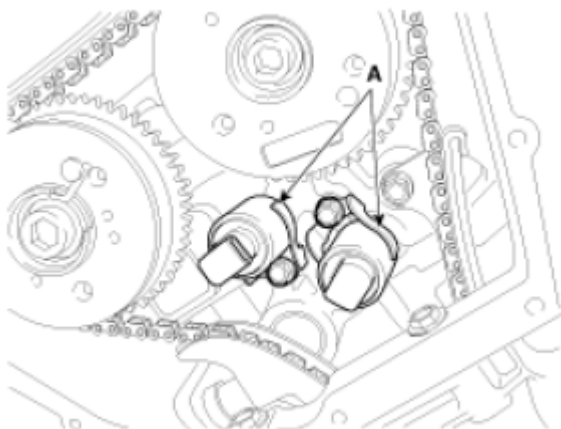


Fig. 48: Identifying Oil Control Valve
Courtesy of HYUNDAI MOTOR CO.

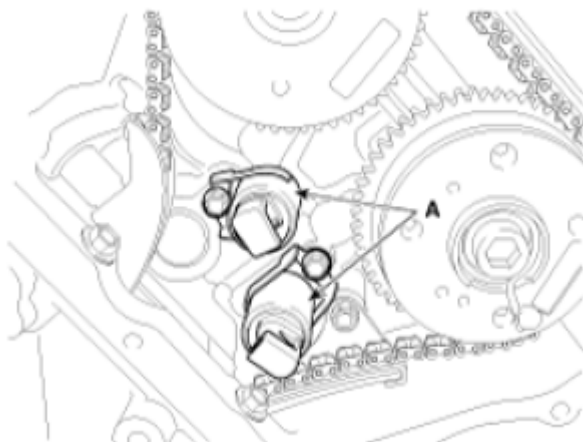


Fig. 49: Identifying Oil Control Valve
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Do not reuse the OCV when dropped.
- Keep the OCV clean.
- Do not hold the OCV sleeve (A) during servicing.
- When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.

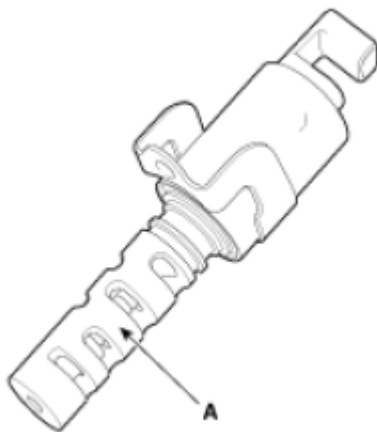


Fig. 50: Identifying OCV Sleeve
Courtesy of HYUNDAI MOTOR CO.

28. Remove the cam to cam guide (A).

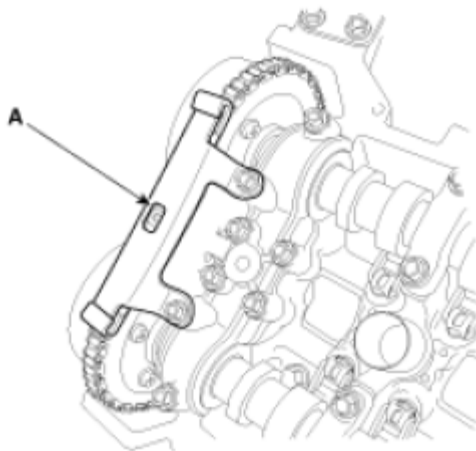


Fig. 51: Identifying Cam Guide
Courtesy of HYUNDAI MOTOR CO.

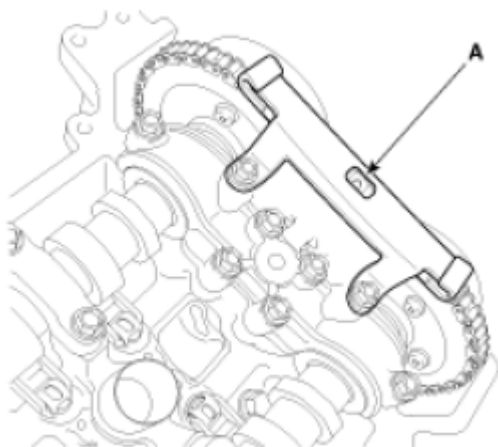


Fig. 52: Identifying Cam Guide
Courtesy of HYUNDAI MOTOR CO.

29. Align the timing mark of CVVT sprocket.

[RH]

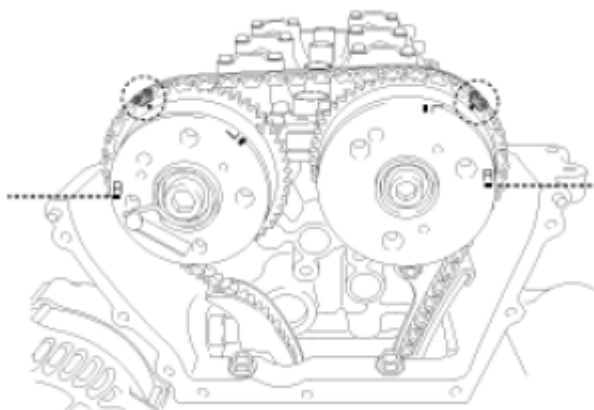


Fig. 53: Identifying Timing Mark Of CVVT Sprocket (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

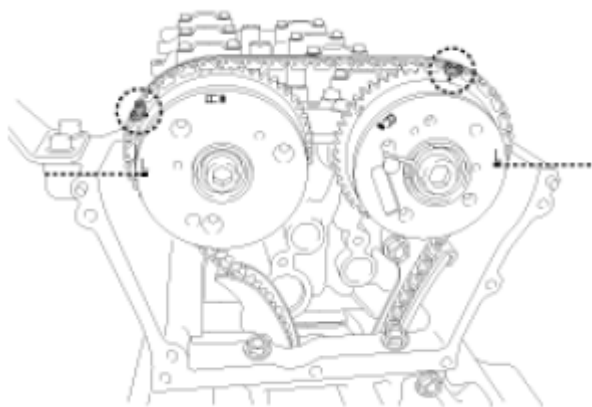


Fig. 54: Identifying Timing Mark Of CVVT Sprocket (LH)
Courtesy of HYUNDAI MOTOR CO.

NOTE: In case that the timing system has been completely disassembled, the timing chain can be installed with all of chain installation mark of the sprocket and timing marked chain links aligned without additional marking. However, during on-vehicle repair (for cylinder head assembly, timing chain tensioner, CVVT, camshaft, HLA or etc.), when it is not necessary to remove the timing chain completely, mark the timing chain links corresponding to the chain installation marks on the sprocket with an indication mark with a suitable marking paint pen when the No. 1 piston is at TDC position because it is very difficult to align all of the chain installation mark of the sprocket and the timing marked chain links.

30. Remove the alternator (A).

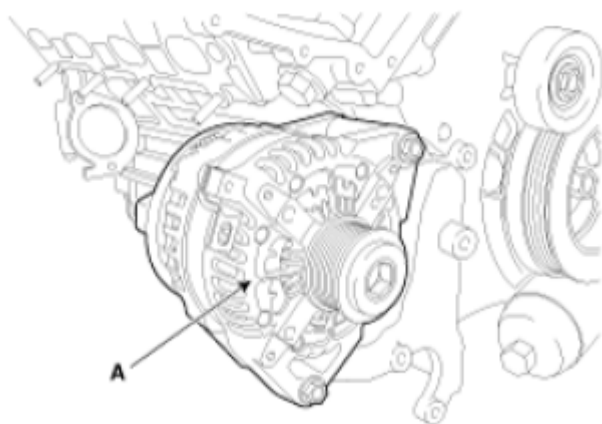


Fig. 55: Identifying Alternator
Courtesy of HYUNDAI MOTOR CO.

31. Remove the water outlet pipe (A) and the water inlet pipe (B).

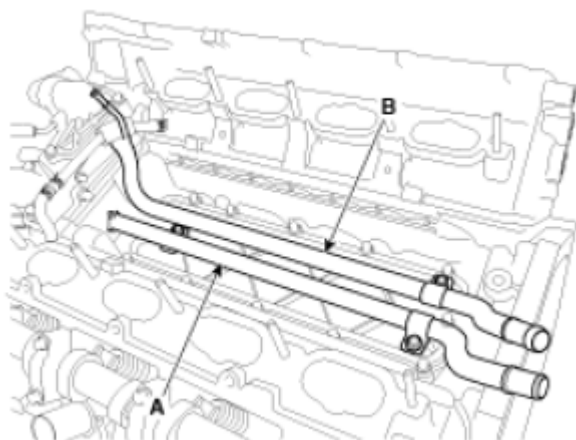


Fig. 56: Identifying Water Outlet Pipe And Water Inlet Pipe
Courtesy of HYUNDAI MOTOR CO.

NOTE: Remove the drain plug (A) and drain the engine coolant.

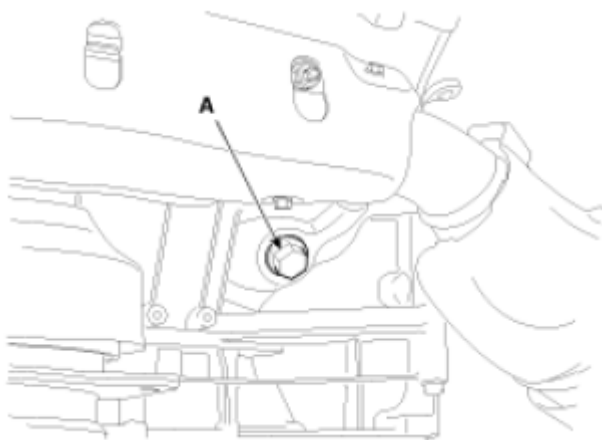


Fig. 57: Identifying Drain Plug
Courtesy of HYUNDAI MOTOR CO.

32. Remove the water temperature control assembly (A) and the water outlet fitting assembly (B).

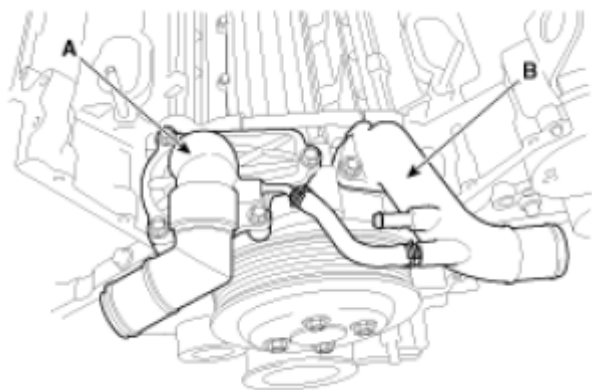


Fig. 58: Identifying Water Temperature Control Assembly And Water Outlet Fitting Assembly
 Courtesy of HYUNDAI MOTOR CO.

33. Remove the timing chain tensioner (A) and chain guide fixing bolt (B).



Fig. 59: Identifying Timing Chain Tensioner And Chain Guide Fixing Bolt
 Courtesy of HYUNDAI MOTOR CO.

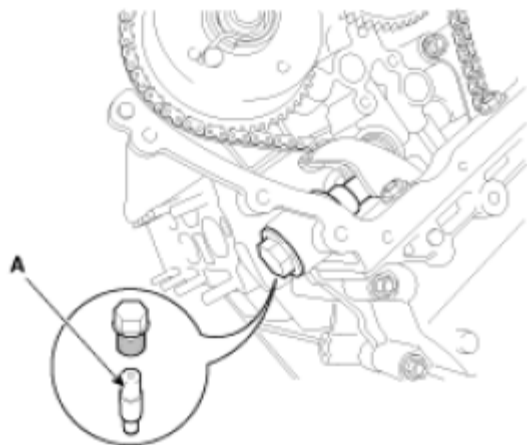


Fig. 60: Identifying Timing Chain Tensioner And Chain Guide Fixing Bolt
 Courtesy of HYUNDAI MOTOR CO.

34. Remove the camshaft bearing caps (A) and the camshaft thrust bearing cap (B).

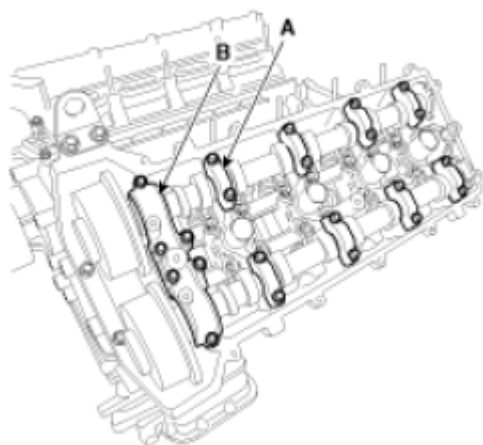


Fig. 61: Identifying Camshaft Bearing Caps And Camshaft Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

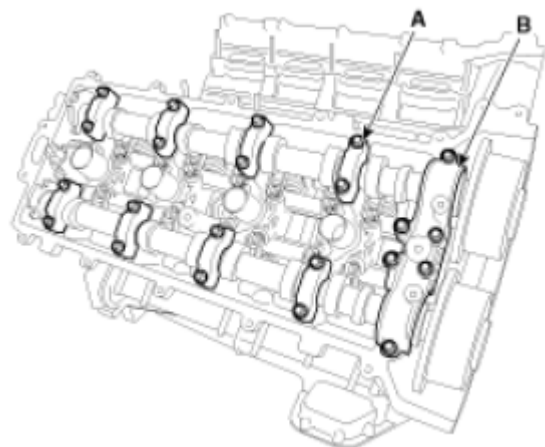


Fig. 62: Identifying Camshaft Bearing Caps And Camshaft Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

35. Remove the camshaft and CVVT assembly (A).

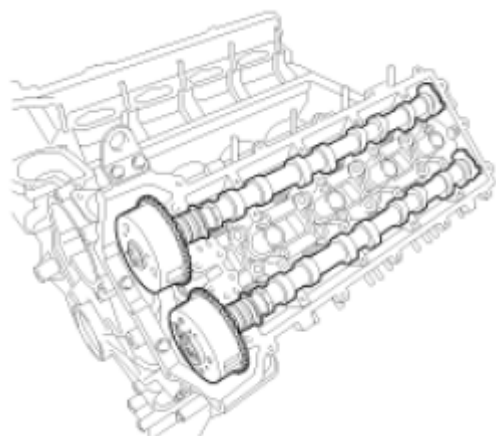


Fig. 63: Identifying Camshaft And CVVT Assembly
Courtesy of HYUNDAI MOTOR CO.

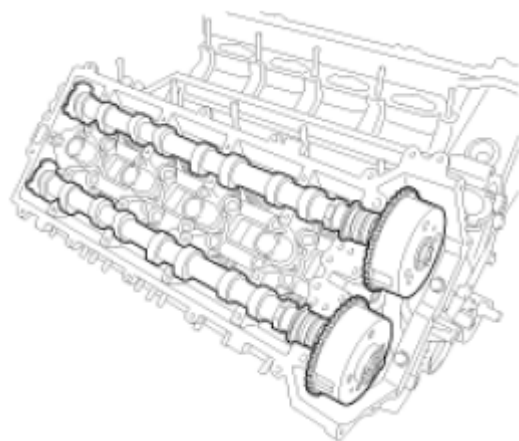


Fig. 64: Identifying Camshaft And CVVT Assembly
Courtesy of HYUNDAI MOTOR CO.

36. Remove the roller finger follower and the hydraulic lash adjuster (HLA) assembly (A).

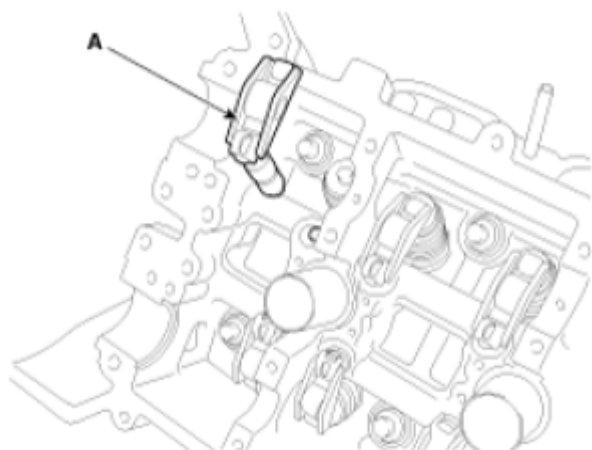


Fig. 65: Identifying Roller Finger Follower And Hydraulic Lash Adjuster Assembly
Courtesy of HYUNDAI MOTOR CO.

37. Remove the cylinder head (A).

1. Uniformly loosen and remove the cylinder head bolts, in several passes, in the sequence shown.

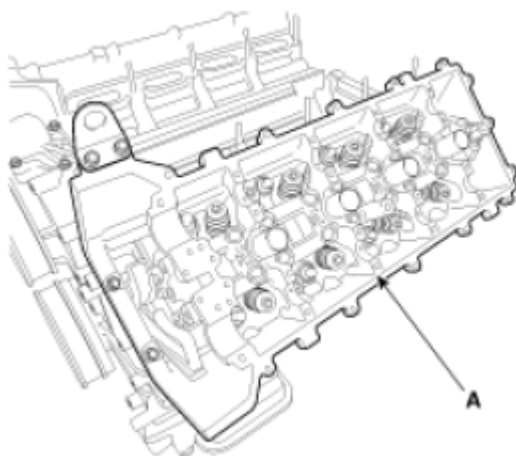


Fig. 66: Identifying Cylinder Head
Courtesy of HYUNDAI MOTOR CO.

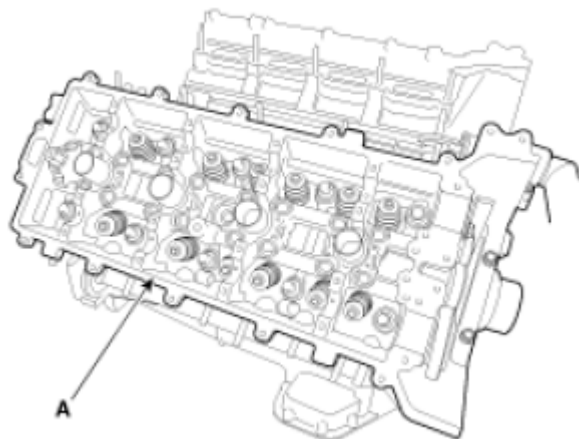


Fig. 67: Identifying Cylinder Head
Courtesy of HYUNDAI MOTOR CO.

NOTE: Head warpage or cracking could result from removing bolts in an incorrect order.

[RH]

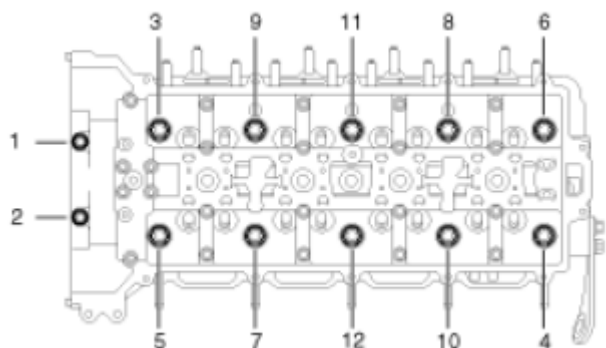


Fig. 68: Identifying Bolts Removal Sequence (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

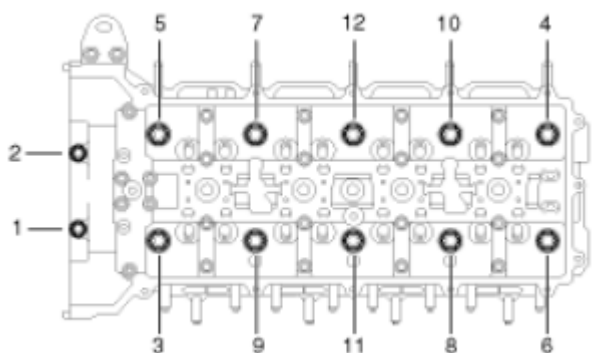


Fig. 69: Identifying Bolts Removal Sequence (LH)
Courtesy of HYUNDAI MOTOR CO.

(2) Lift the cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.

NOTE: Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

38. Remove the cylinder head gasket (A).

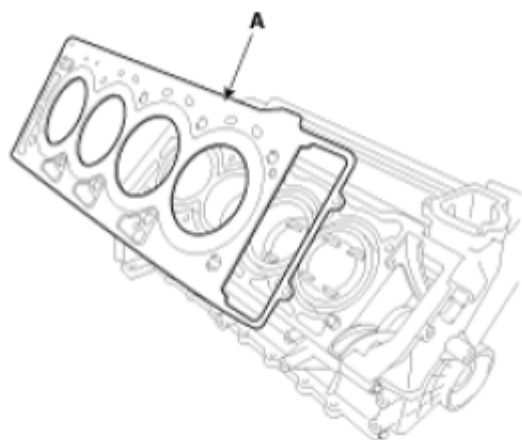


Fig. 70: Identifying Cylinder Head Gasket
Courtesy of HYUNDAI MOTOR CO.

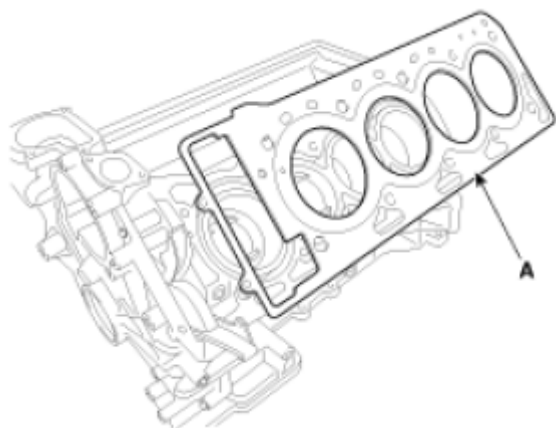


Fig. 71: Identifying Cylinder Head Gasket
Courtesy of HYUNDAI MOTOR CO.

Disassembly

1. Remove the roller finger follower and the hydraulic lash adjuster (HLA) assembly (A).

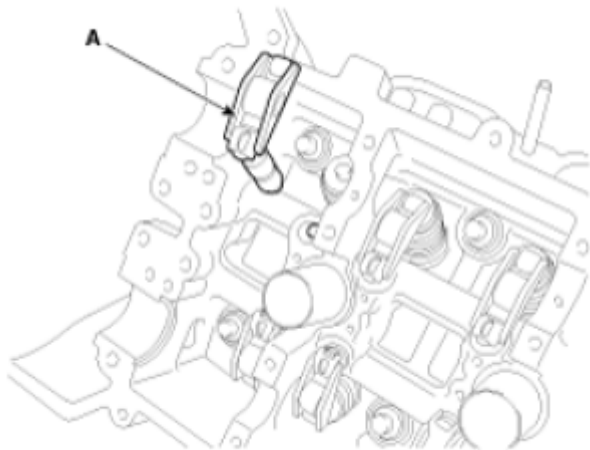


Fig. 72: Identifying Roller Finger Follower And Hydraulic Lash Adjuster Assembly
Courtesy of HYUNDAI MOTOR CO.

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

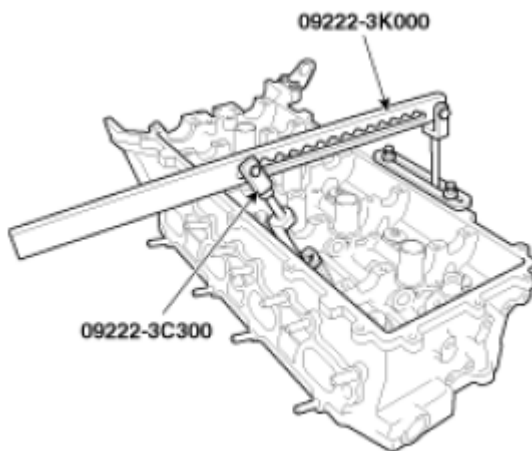


Fig. 73: Removing Retainer Lock Using SSR (09222-3K000, 09222-3C300)
Courtesy of HYUNDAI MOTOR CO.

2. Remove the spring retainer.
3. Remove the valve spring.
4. Remove the valve.
5. Remove the valve stem seal.

NOTE: Do not reuse old valve stem seals.

3. Remove the OCV filter.

[RH]

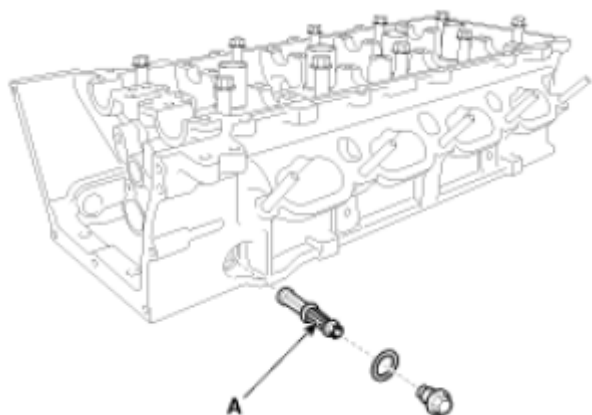


Fig. 74: Identifying OCV Filter (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

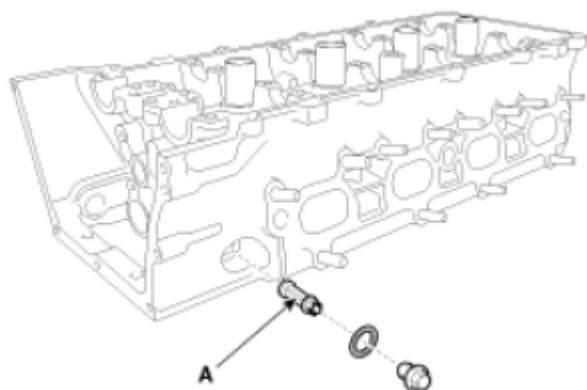


Fig. 75: Identifying OCV Filter (LH)
Courtesy of HYUNDAI MOTOR CO.

4. Remove the pressure relief valve.

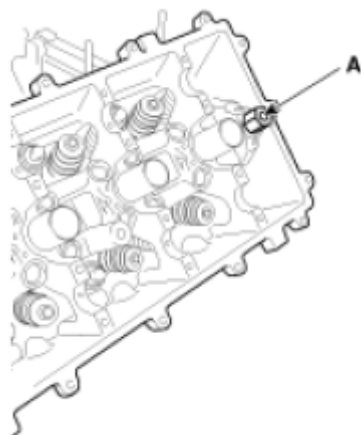


Fig. 76: Identifying Pressure Relief Valve
Courtesy of HYUNDAI MOTOR CO.

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: Less than 0.05mm(0.002in)

[Less than 0.02mm(0.0008in)/100x100]

Flatness of manifold gasket surface

Standard: Less than 0.1mm(0.004in)

[Less than 0.03mm(0.0012in)/110x110]

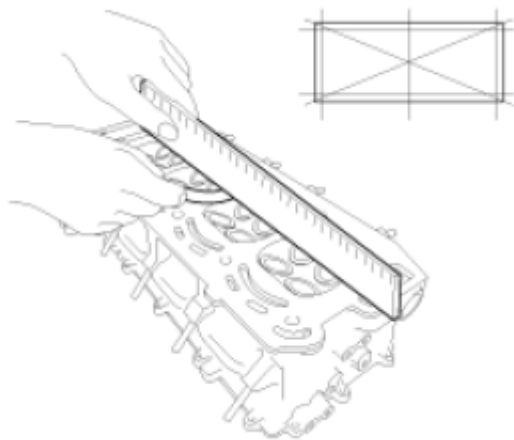


Fig. 77: Measuring Surface Contacting Cylinder Block And Manifolds For Warpage Using Feeler Gauge And Straight Edge
Courtesy of HYUNDAI MOTOR CO.

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 I.D.

Intake/Exhaust:

6.000 ~ 6.012mm (0.2362 ~ 0.2367in)

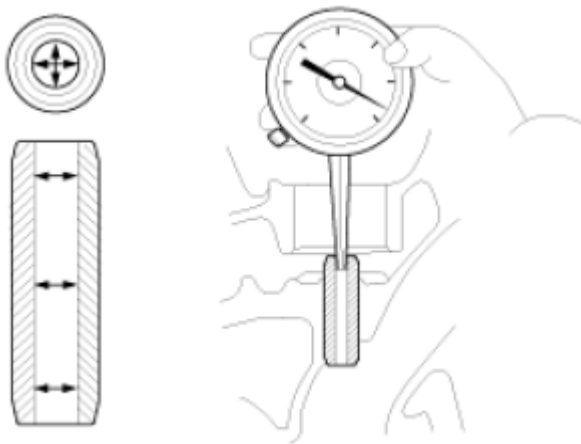


Fig. 78: Measuring Inside Diameter Of Valve Guide Using Caliper Gauge
Courtesy of HYUNDAI MOTOR CO.

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

Valve stem O.D.

Intake: 5.965 ~ 5.980mm (0.2348 ~ 0.2354in)

Exhaust: 5.958 ~ 5.970mm (0.2346 ~ 0.2350in)

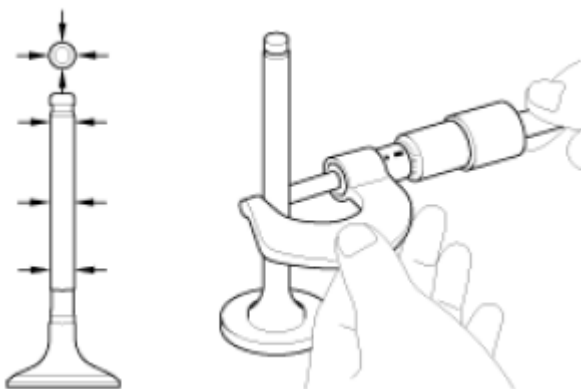


Fig. 79: Measuring Diameter Of Valve Stem Using Micrometer
Courtesy of HYUNDAI MOTOR CO.

3. Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

Valve stem-to-guide clearance

Intake: 0.020 ~ 0.047mm (0.0008 ~ 0.0018in)

Exhaust: 0.030 ~ 0.054mm (0.0012 ~ 0.0021in)

2. Inspect valves.

1. Check the valve is ground to the correct valve face angle.

Valve face angle:

Intake/Exhaust: 45.25° ~ 45.75°

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 minimum, replace the valve.

Margin

Intake: 1.2mm (0.0472in)

Exhaust: 1.2mm (0.0472in)

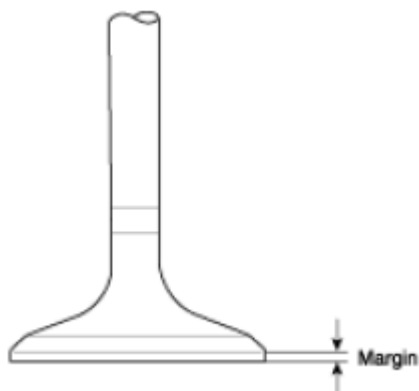


Fig. 80: Checking Valve Head Margin Thickness
Courtesy of HYUNDAI MOTOR CO.

4. Check the valve length.

Length

Intake: 107.77mm (4.2429in)

Exhaust: 107.75mm (4.2421in)

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 and improper contact with the valve face. If the valve seat is worn, replace cylinder head.
 2. Check the valve guide for wear. If the valve guide is worn, replace cylinder head.

Valve seat contact width:

Intake: 1.15 ~ 1.45mm (0.0453 ~ 0.0571in)

Exhaust: 1.35 ~ 1.65mm (0.0531 ~ 0.0650in)

Valve seat angle:

Intake/Exhaust: 44.75° ~ 45.10°

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

Free height: 48.44mm (1.9070in)

Out-of-square: 1.5°

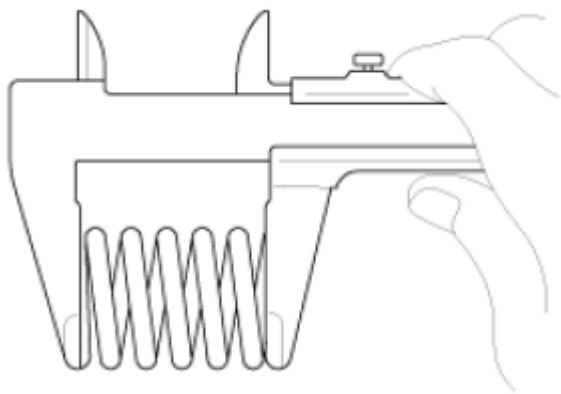


Fig. 81: Measuring Free Length Of Valve Spring Using Vernier Calipers
Courtesy of HYUNDAI MOTOR CO.

Camshaft

1. Inspect cam lobes.

Using a micrometer, measure the cam lobe height.

Cam height

Intake: 41.77329mm (1.6446in)

Exhaust: 41.55202mm (1.6359in)



Fig. 82: Identifying Measure Cam Lobe Height Using Micrometer
Courtesy of HYUNDAI MOTOR CO.

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

2. Inspect the 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.

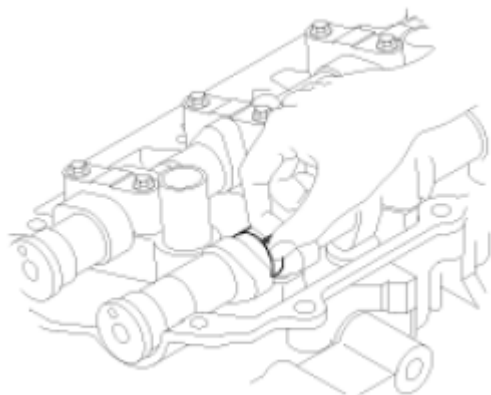


Fig. 83: Placing Camshafts On Cylinder Head
Courtesy of HYUNDAI MOTOR CO.

4. Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque:

1st step:

6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)

2nd step:

13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)

NOTE: Do not turn the camshaft.

[RH]

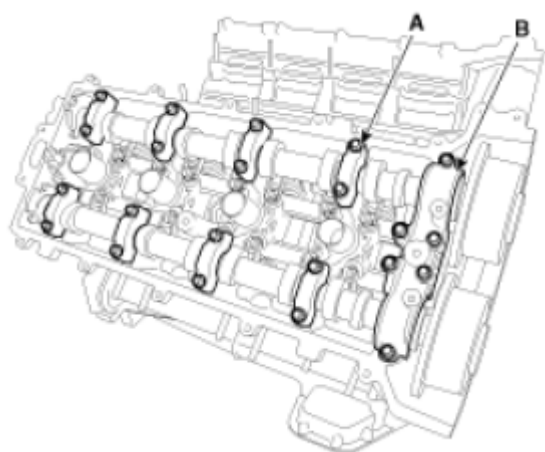


Fig. 84: Identifying Camshaft Bearing Caps And Camshaft Thrust Bearing Cap (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

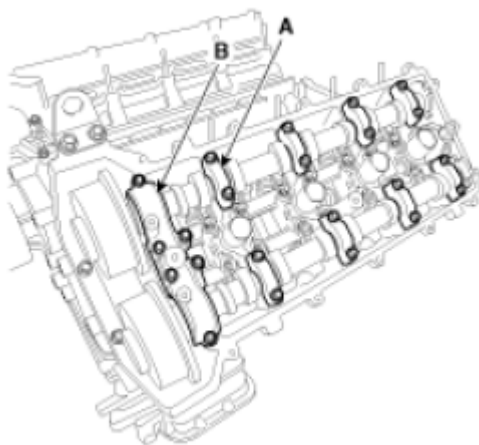


Fig. 85: Identifying Camshaft Bearing Caps And Camshaft Thrust Bearing Cap (LH)
Courtesy of HYUNDAI MOTOR CO.

- (5) Remove the bearing caps.
- (6) Measure the plastigage at its widest point.

Camshaft bearing oil clearance

Intake/Exhaust:

No. 1 journal:

0.025 ~ 0.057mm (0.0010 ~ 0.0022in)

No. 2, 3, 4, 5 journal:

0.020 ~ 0.057mm (0.0008 ~ 0.0022in)**Camshaft journal outer diameter**

Intake/Exhaust:

No. 1 journal:

35.964 ~ 35.980mm (1.4159 ~ 1.4165in)

No. 2, 3, 4, 5 journal:

25.964 ~ 25.980mm (1.0222 ~ 1.0228in)**Camshaft journal bore inner diameter**

Intake/Exhaust:

No. 1 journal:

36.005 ~ 36.021mm (1.4175 ~ 1.4181in)

No. 2, 3, 4, 5 journal:

26.000 ~ 26.021mm (1.0236 ~ 1.0244in)

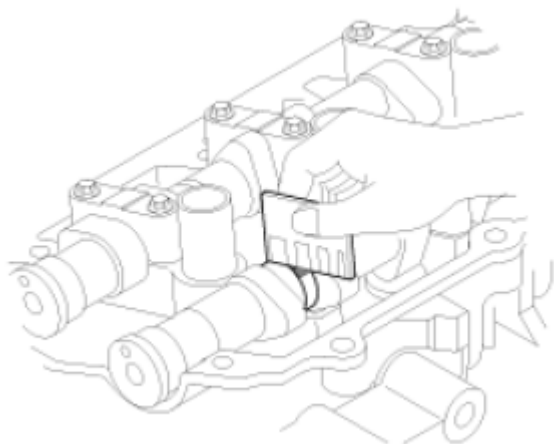


Fig. 86: Removing Bearing Caps
Courtesy of HYUNDAI MOTOR CO.

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

(7) Completely remove the plastigage.

(8) Remove the camshafts.

3. Inspect the camshaft end play.

1. Install the camshafts.
2. Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque:

1st step:

6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)

2nd step:

13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)

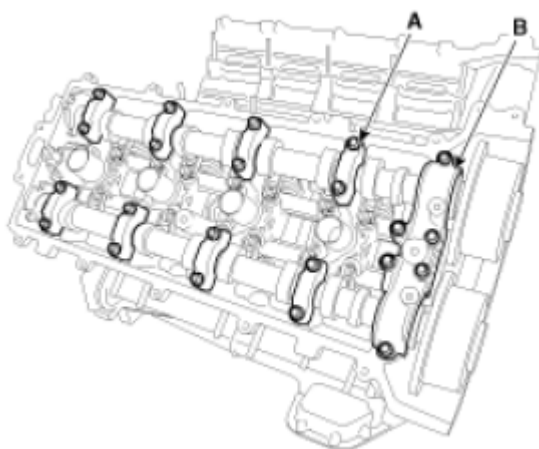


Fig. 87: Identifying Bearing Cap And Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

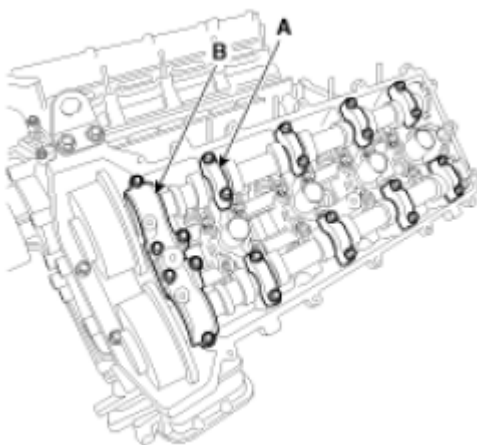


Fig. 88: Identifying Bearing Cap And Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

3. Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play:

0.12 ~ 0.22mm (0.0047 ~ 0.0086in)

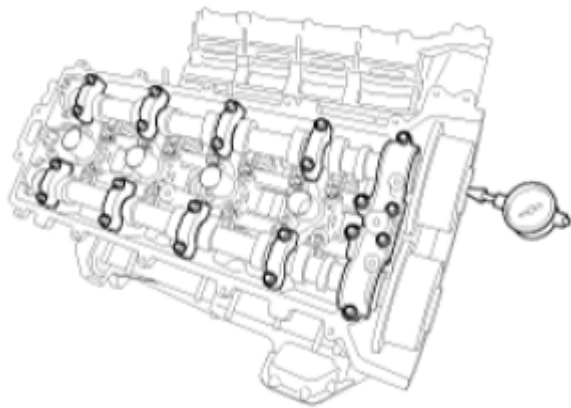


Fig. 89: Measuring End Play Using Dial Indicator
Courtesy of HYUNDAI MOTOR CO.

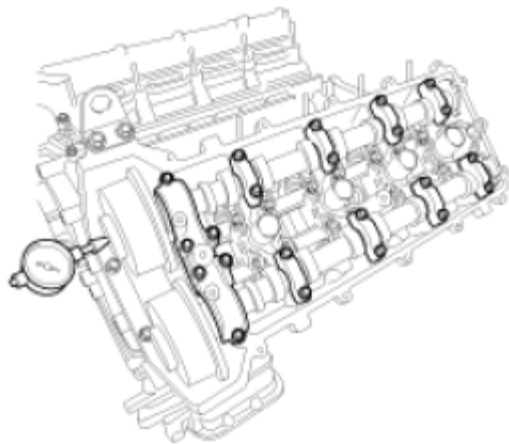


Fig. 90: Measuring End Play Using Dial Indicator
Courtesy of HYUNDAI MOTOR CO.

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

4. Remove the camshafts.

CVVT Assembly

1. Inspect the CVVT assembly.
 1. Check that the CVVT assembly will not turn.
 2. Ex-CVVT: Apply vinyl tape to the retard hole except the advanced hole indicated by the arrow in the illustration.

In-CVVT: Apply vinyl tape to the advance hole except the retard indicated by the arrow in the illustration.

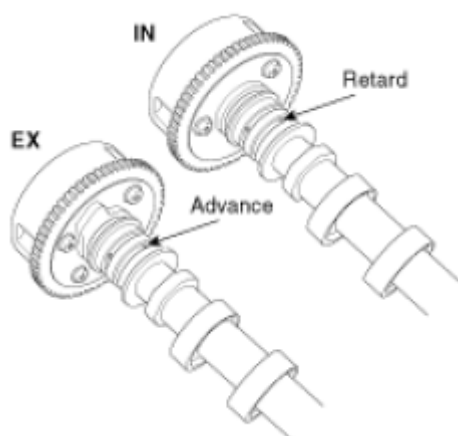


Fig. 91: Inspecting CVVT Assembly
Courtesy of HYUNDAI MOTOR CO.

3. Wrap tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm² , 21psi) to the port of the camshaft. (Perform this in order to release the lock pin for the maximum default angle locking.)

In-default: Max retard

Ex-default: Max advance

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

4. Under the condition of (2), turn the In-CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.

Depending on the air pressure, the In-CVVT assembly will turn to the advance side without applying force by hand.

Under the condition of (2), turn the Ex-CVVT assembly to the retard angle side (the arrow marked direction in the illustration) with your hand.

Depending on the air pressure, the Ex-CVVT assembly will turn to the retard side without applying force by hand.

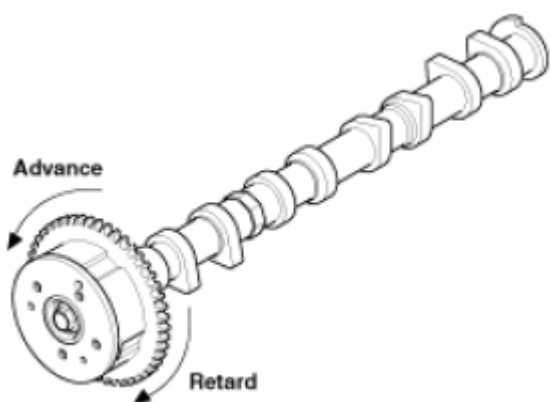


Fig. 92: Identifying CVVT Assembly Turning Directions
Courtesy of HYUNDAI MOTOR CO.

5. Except the position where the lock pin meets at the maximum default angle, let the CVVT assembly turn back and forth and check the movable range and that there is no interference.

Standard:

Movable smoothly in the range about 22.5°

6. Turn the In-CVVT assembly with your hand and lock it at the maximum retard angle position (clockwise).

Turn the Ex-CVVT assembly with your hand and lock it at the maximum advance angle position.

HLA (Hydraulic Lash Adjuster)

With the HLA filled with engine oil, hold A and press B by hand. If B moves, replace the HLA.

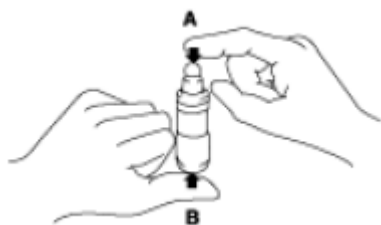


Fig. 93: Holding Hydraulic Lash Adjuster
Courtesy of HYUNDAI MOTOR CO.

POSSIBLE CAUSE ACTION REFERENCE CHART

Problem	Possible cause	Action
1. Temporary noise when starting a cold engine	Normal	This noise will disappear after the oil in the engine reaches the normal pressure.
2. Continuous noise when the	Oil leakage of the high pressure	

2011 Hyundai Equus Ultimate

2011 ENGINE Cylinder Head Assembly - Equus

engine is started after parking more than 48 hours.	chamber on the HLA, allowing air to get in.	
3. Continuous noise when the engine is first started after rebuilding cylinder head.	Insufficient oil in cylinder head oil gallery.	Noise will disappear within 15 minutes when engine runs at 2000-3000 rpm. If it doesn't disappear, refer to step 7 below.
4. Continuous noise when the engine is started after excessively cranking the engine by the starter motor or band.	Oil leakage of the high-pressure chamber in the HLA, allowing air to get in. Insufficient oil in the HLA.	
5. Continuous noise when the engine is running after changing the HLA.		CAUTION: Do not run engine at a speed higher than 3000 rpm, as this may damage the HLA.
6. Continuous noise during idle after high engine speed.	Engine oil level too high or too low.	Check oil level. Drain or add oil as necessary.
	Excessive amount of air in the oil at high engine speed.	Check oil supply system.
	Deteriorated oil.	Check oil quality. If deteriorated, replace with specified type.
7. Noise continues for more than 15 minutes.	Low oil pressure.	Check oil pressure and oil supply system of each part of engine.
	Faulty HLA.	Remove the cylinder head cover and press HLA down by hand. If it moves, replace the HLA. WARNING: Be careful as the HLA may be hot.

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 the OCV filter(A).

Tightening torque:

53.9 ~ 63.7Nm(5.5 ~ 6.5kgf.m, 39.8 ~ 47.0lb-ft)

[RH]

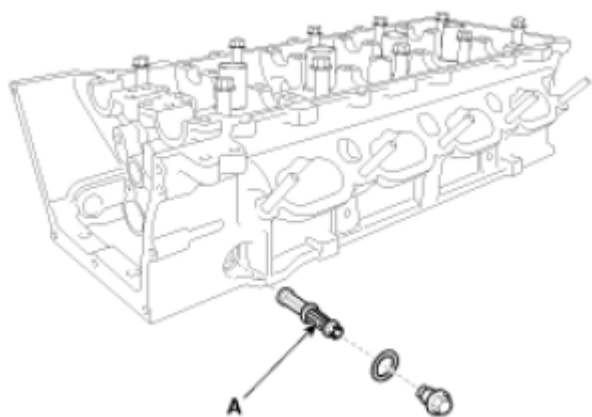


Fig. 94: Identifying OCV Filter (LH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

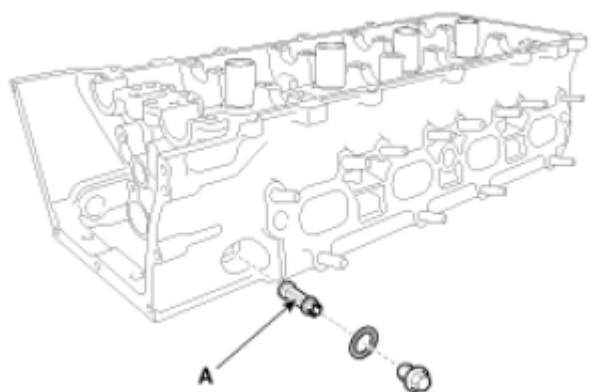


Fig. 95: Identifying OCV Filter (LH)
Courtesy of HYUNDAI MOTOR CO.

2. Install the valves.
 1. Using the SST(09222-28200), push in a new oil seal.

NOTE:

- Do not reuse old valve stem seals.
- Incorrect installation of the seal could result in oil leakage past the valve guides.

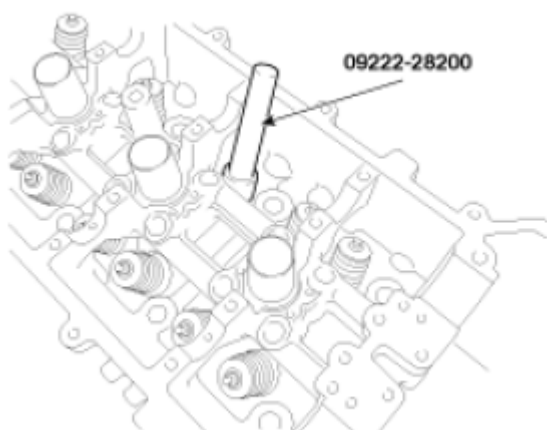


Fig. 96: Pushing New Oil Seal Using SST(09222-28200)
Courtesy of HYUNDAI MOTOR CO.

2. Install the valve, valve spring and spring retainer.

NOTE: Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then install the retainer.

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

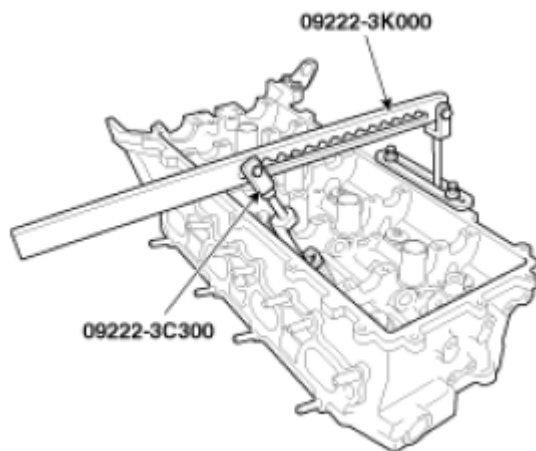


Fig. 97: Compressing Spring Using SST(09222 - 3K000, 09222-3C300)
Courtesy of HYUNDAI MOTOR CO.

4. Lightly tap the end of each valve stem two or three times with a soft hammer or the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.

Install the roller finger follower and the hydraulic lash adjuster assembly (A).

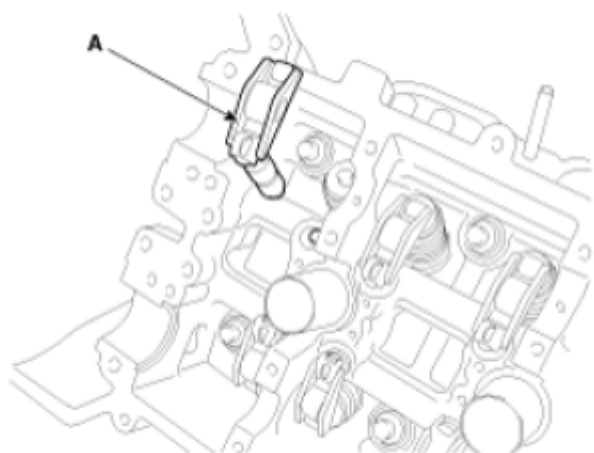


Fig. 98: Identifying Roller Finger Follower And Hydraulic Lash Adjuster Assembly
Courtesy of HYUNDAI MOTOR CO.

1. Until installing HLA shall be held upright so that engine oil in HLA should not spill and assured that dust does not adhere to HLA.
2. HLA shall be inserted tenderly to the cylinder head not to spill engine oil from HLA. In case of spilling, air vent shall be done in accordance with the air bent procedure.

NOTE: **Stroke HLA in engine oil 4~5 times by pushing its cap while pushing the ball down slightly by hard steel wire.**
(Take care not to severely push hard steel wire down since ball is several grams.)

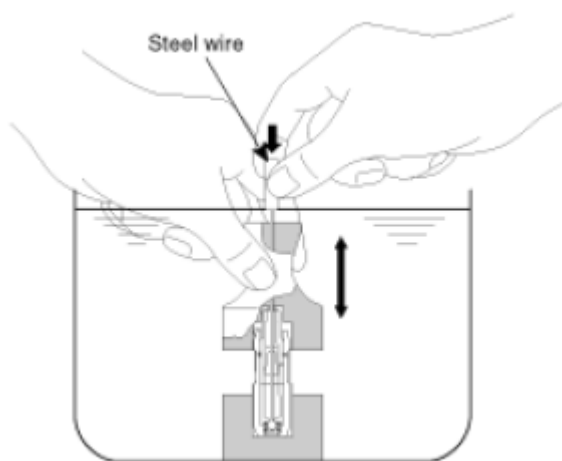


Fig. 99: Pushing Ball Down Slightly Using Hard Steel Wire
Courtesy of HYUNDAI MOTOR CO.

Install the pressure relief valve.

Tightening torque:

21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

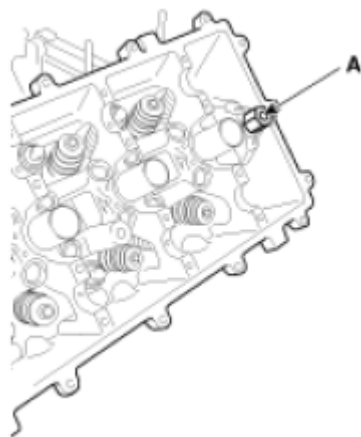


Fig. 100: Identifying Pressure Relief Valve
Courtesy of HYUNDAI MOTOR CO.

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, set the No. 1 piston at TDC.

1. Install the cylinder head gasket (A).

1. The sealant locations on cylinder head gasket, cylinder block and timing chain lower case must be free of engine oil and etc.
2. Before assembling the cylinder head gasket, the liquid sealant LT5900H or equivalent should be applied on the gap between cylinder block and timing chain lower case.

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

NOTE: Refer to below illustration to apply the sealant.

Bead width:

3.5 ~ 4.5 mm (0.1378 ~ 0.1772 in)

Sealant locations:

1.5 ~ 2.5mm (0.0591 ~ 0.0984 in)

from timing chain lower case inner surface

Recommended sealant: Liquid sealant LT5900H or equivalent

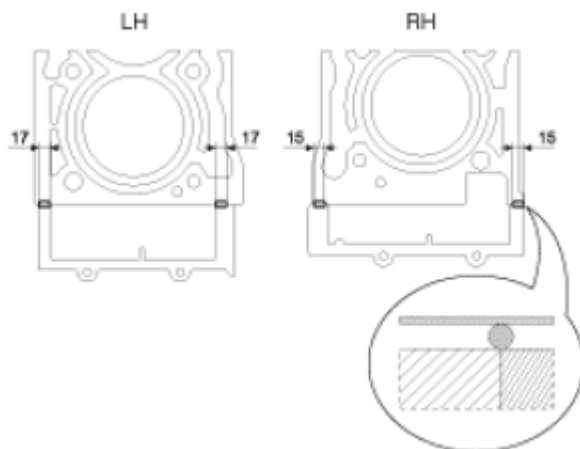


Fig. 101: Identifying Sealant Applying Area
Courtesy of HYUNDAI MOTOR CO.

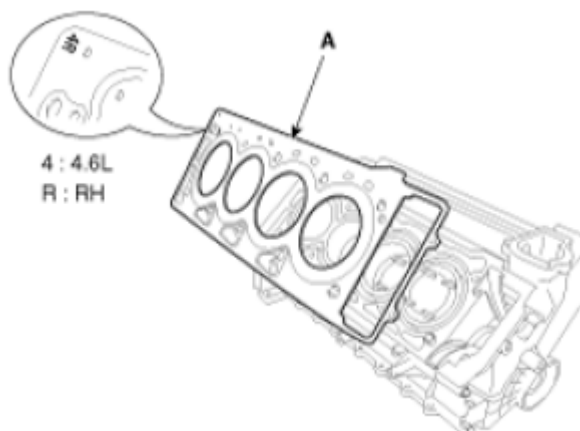


Fig. 102: Identifying Cylinder Head Gasket
Courtesy of HYUNDAI MOTOR CO.

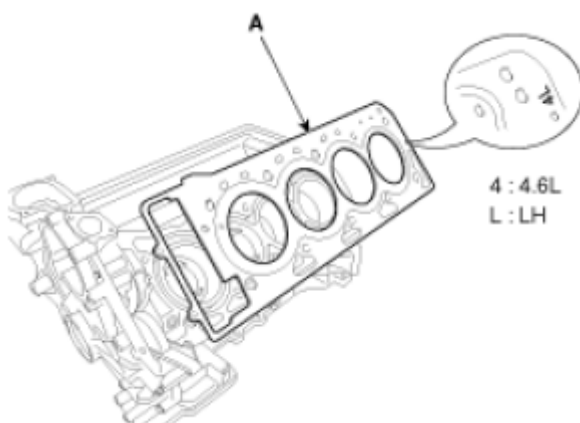


Fig. 103: Identifying Cylinder Head Gasket
Courtesy of HYUNDAI MOTOR CO.

3. Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block.

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

NOTE: Be careful of the installation direction.

4. Install the cylinder head.

NOTE: Wipe away any excess liquid sealant that may appear after assembling cylinder heads.

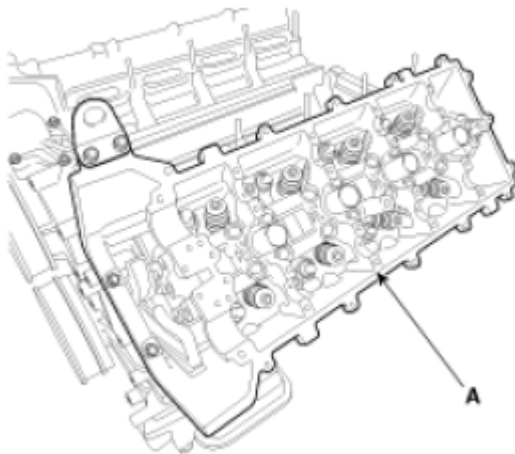


Fig. 104: Identifying Cylinder Head
Courtesy of HYUNDAI MOTOR CO.

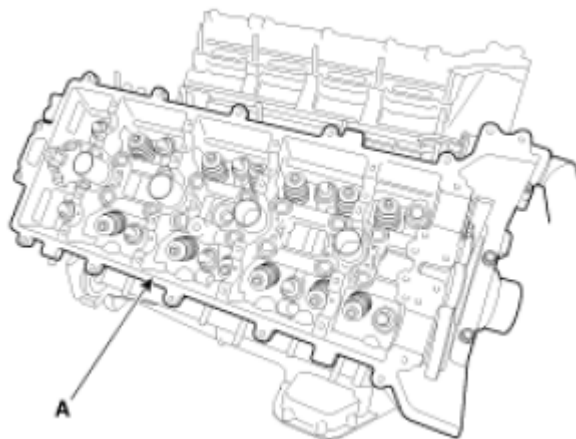


Fig. 105: Identifying Cylinder Head
Courtesy of HYUNDAI MOTOR CO.

2. Install the cylinder head bolts.

1. Do not apply engine oil on the cylinder head bolts.
2. Using SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque:

Cylinder head bolts (1~10):

32.4~36.3N.m(3.3~ 3.7kgf.m, 23.9~26.8lb-ft) +

88°~92°+ 118°~122°

Flange bolts (11~12):

33.3 ~ 36.3N.m(3.4 ~ 3.7kgf.m, 24.6 ~ 26.8lb-ft)

NOTE: Always use new cylinder head bolts.

[RH]

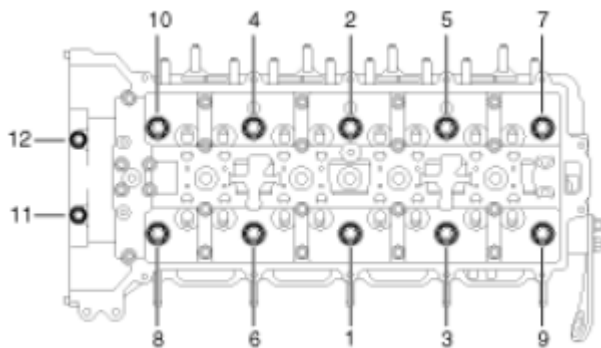


Fig. 106: Identifying Cylinder Head Bolts Tightening Sequence (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH]

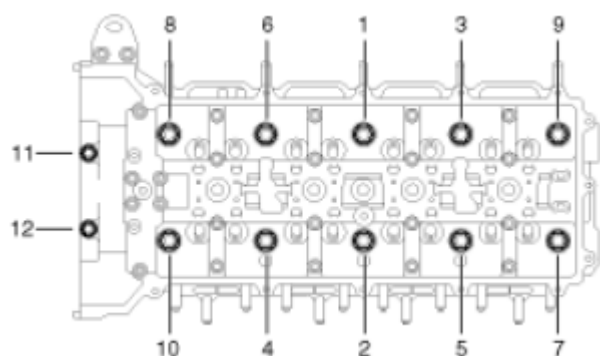


Fig. 107: Identifying Cylinder Head Bolts Tightening Sequence (LH)
Courtesy of HYUNDAI MOTOR CO.

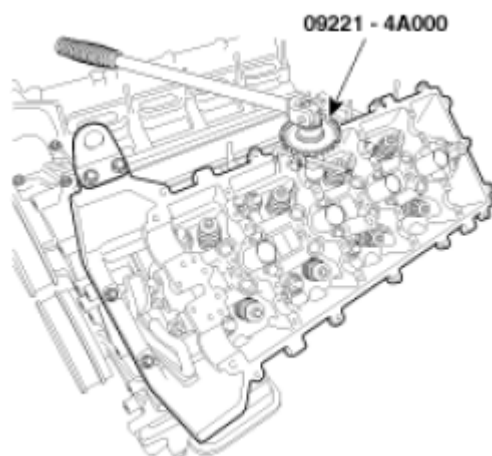


Fig. 108: Tightening Cylinder Head Bolts Using SST(09221-4A000)
Courtesy of HYUNDAI MOTOR CO.

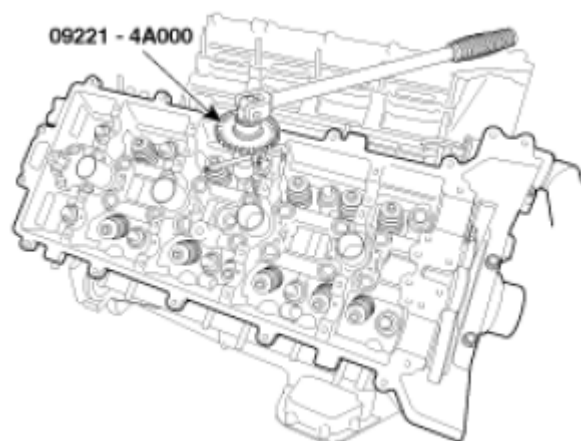


Fig. 109: Tightening Cylinder Plate Washers Using SST(09221-4A000)
Courtesy of HYUNDAI MOTOR CO.

3. Assemble the CVVT and camshaft assembly.

Tightening torque:

73.5 ~ 83.4N.m(7.5 ~ 8.5kgf.m, 54.2 ~ 61.5lb-ft)

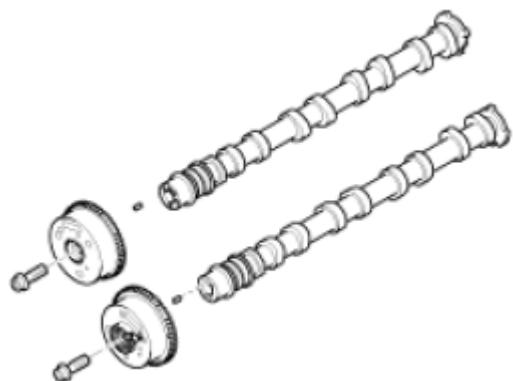


Fig. 110: Identifying CVVT And Camshaft Assembly
Courtesy of HYUNDAI MOTOR CO.

- A. Assemble the camshaft to the dowel pin of CVVT assembly. At this time, attend not to be assembled to oil hole of camshaft.
- B. Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt to the CVVT assembly.
- C. Do not rotate the CVVT assembly when the camshaft is assembled to the dowel pin of CVVT assembly.

Install the roller finger follower and the hydraulic lash adjuster (HLA) assembly (A).

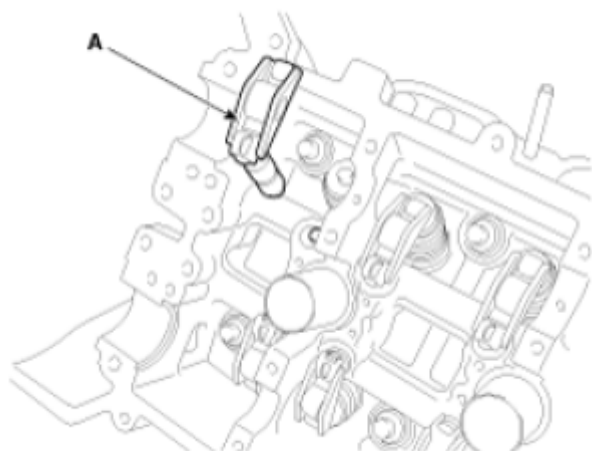


Fig. 111: Identifying Roller Finger Follower And Hydraulic Lash Adjuster Assembly
Courtesy of HYUNDAI MOTOR CO.

Install the LH/RH CVVT and camshaft assembly (A).

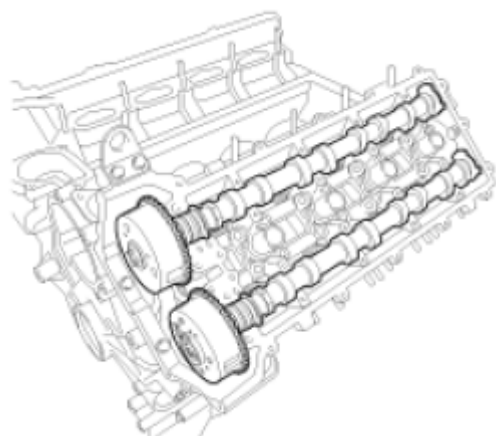


Fig. 112: Identifying Camshaft And CVVT Assembly
Courtesy of HYUNDAI MOTOR CO.

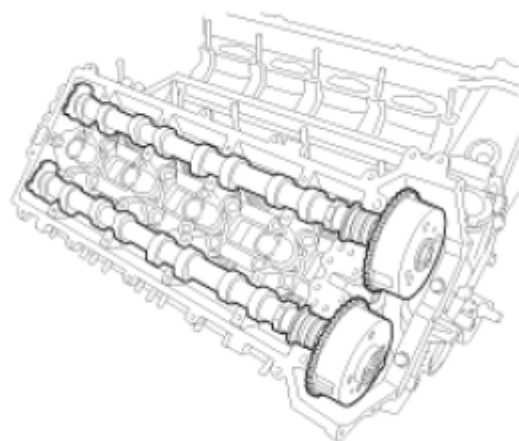


Fig. 113: Identifying Camshaft And CVVT Assembly
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Apply a light coat of engine oil on camshaft journals.
- Assemble the timing mark of CVVT to the same level of cylinder head top surface.
- Make sure the right, left bank, intake, exhaust side camshaft are correct before assembling.
- Turn the crankshaft to set the No. 1 piston at TDC position.

Install the timing chain to the CVVT sprocket.

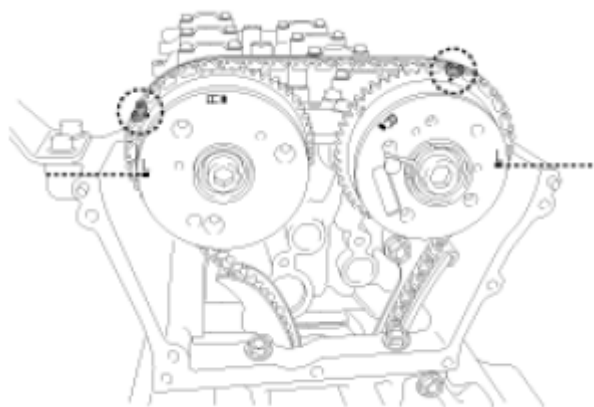


Fig. 114: Identifying Timing Mark Of CVVT Sprocket (LH)
Courtesy of HYUNDAI MOTOR CO.

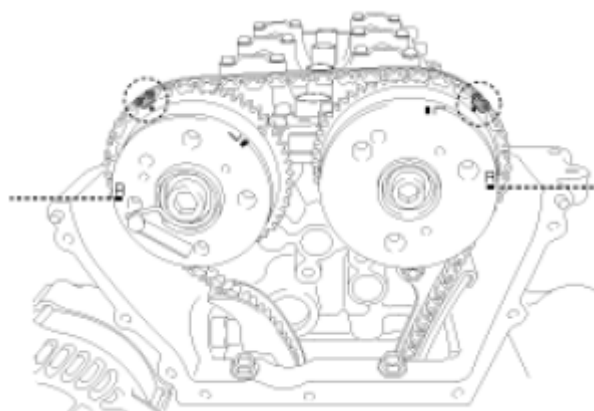


Fig. 115: Identifying Timing Mark Of CVVT Sprocket (RH)
Courtesy of HYUNDAI MOTOR CO.

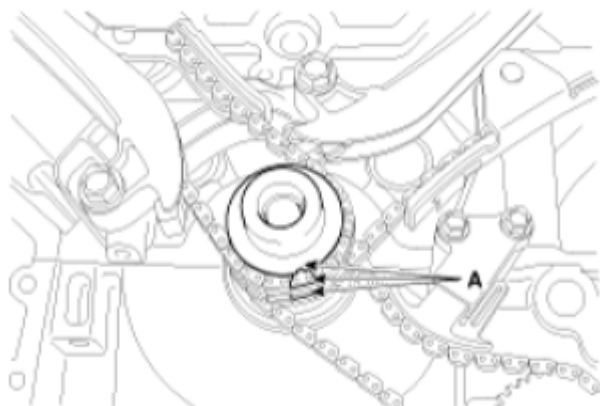


Fig. 116: Identifying Chain Installation Mark
Courtesy of HYUNDAI MOTOR CO.

NOTE: • Make sure the crankshaft is at TDC position.

- Align the chain installation mark (A) of the crankshaft sprocket and the timing mark (A) of the chain link, and then install the chain.

NOTE: In case of marking the timing chain links corresponding to the chain installation marks on the sprocket with an identification for on-vehicle repair (for cylinder head assembly, timing chain tensioner, CVVT, camshaft, HLA or etc.), align all of the chain installation mark of the sprocket and the timing marked chain links for reassembly.

NOTE: To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket --> Timing chain guide --> Exhaust CVVT sprocket --> Intake CVVT sprocket. (LH Bank)
Crankshaft sprocket --> Timing chain guide --> Intake CVVT sprocket --> Exhaust CVVT sprocket. (RH Bank)
When reassembling the timing chain, make sure all of the chain installation mark of the sprocket and the timing marked chain links are aligned.

Install the camshaft bearing caps and the camshaft thrust bearing cap.

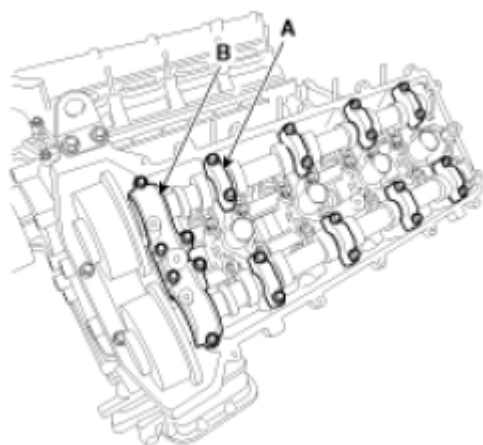


Fig. 117: Identifying Bearing Cap And Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

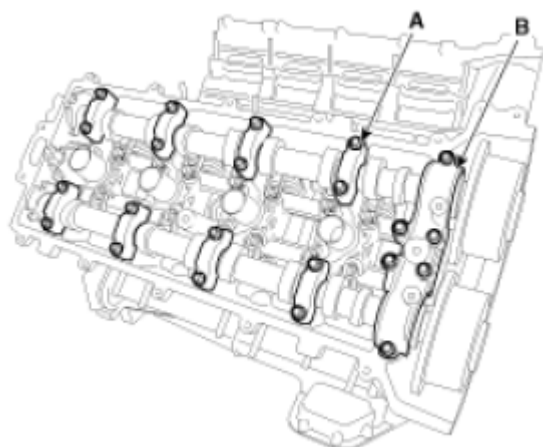


Fig. 118: Identifying Bearing Cap And Thrust Bearing Cap
Courtesy of HYUNDAI MOTOR CO.

Tighten the bolts in order to below sequence.

Tightening torque:

1st step:

6.9 ~ 7.8N.m (0.7 ~ 0.8kgf.m, 5.1 ~ 5.8lb-ft)

2nd step:

13.7 ~ 14.7N.m (1.4 ~ 1.5kgf.m, 10.1 ~ 10.8lb-ft)

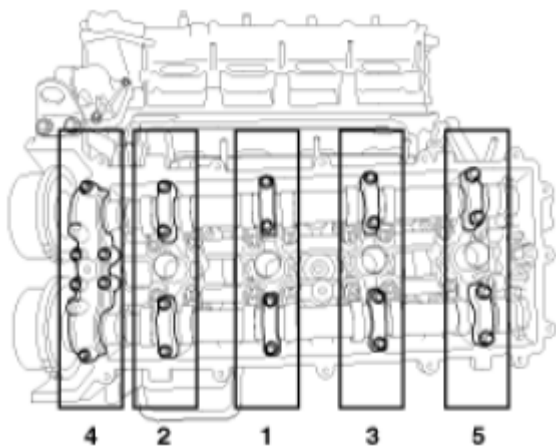


Fig. 119: Identifying Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

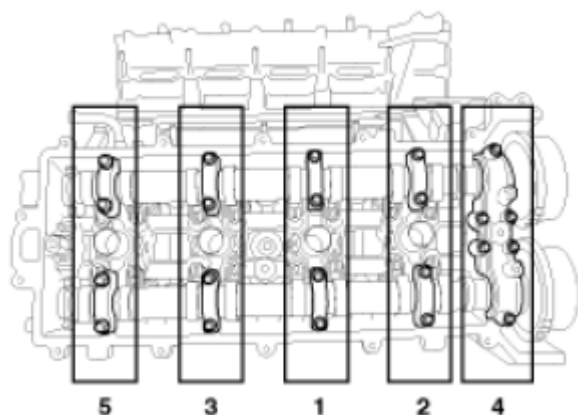
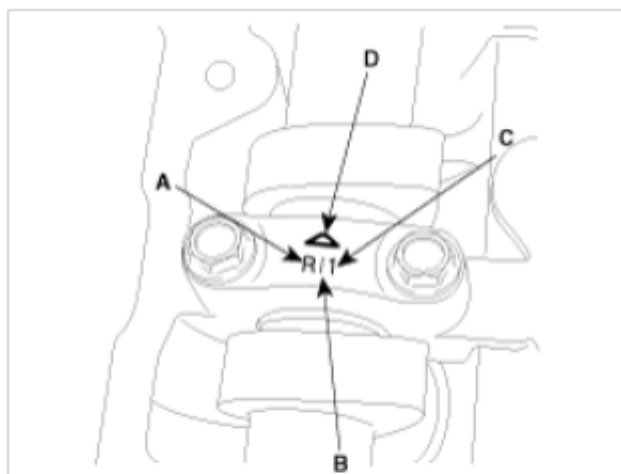


Fig. 120: Identifying Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

NOTE: Be careful the right, left bank, intake, exhaust side before assembling.



A : L(LH),R(RH)
B : I(Intake), E(Exhaust)
C : Journal number
D : Front mark

Fig. 121: Identifying Journal Number And Front Mark
Courtesy of HYUNDAI MOTOR CO.

CAUTION: Be sure to install the thrust bearing cap and bearing cap bolts in the correct position and facing direction.

Install the cam to cam guide (A).

Tightening torque:

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

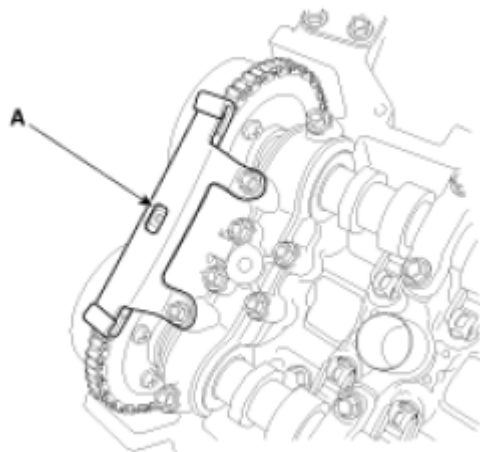


Fig. 122: Identifying Cam Guide
Courtesy of HYUNDAI MOTOR CO.

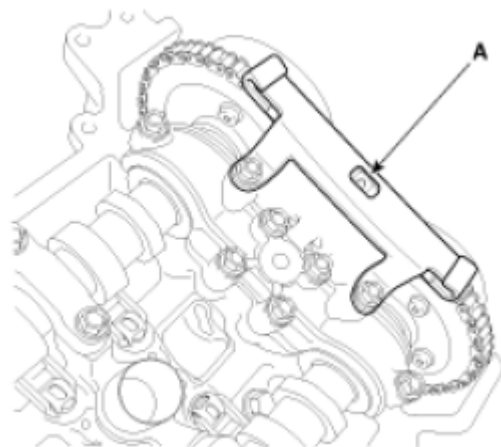


Fig. 123: Identifying Cam Guide
Courtesy of HYUNDAI MOTOR CO.

Install the LH timing chain guide bolt (B) and then the LH timing chain tensioner (A).

1. Install the timing chain tensioner & plug bolt in the hole on the cylinder head by hand.
2. Tighten the plug bolt with the specified torque while pressing the timing chain on the LH intake CVVT.

Tightening torque:

Timing chain guide bolt:

21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

Timing chain tensioner plug bolt:

78.5 ~ 88.3N.m(8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

NOTE:

1. Do not reuse the timing chain tensioner.
2. Make sure the timing chain tensioner is at compressed transport position state.
3. Install the timing chain tensioner with the oil hole facing the plug bolt.

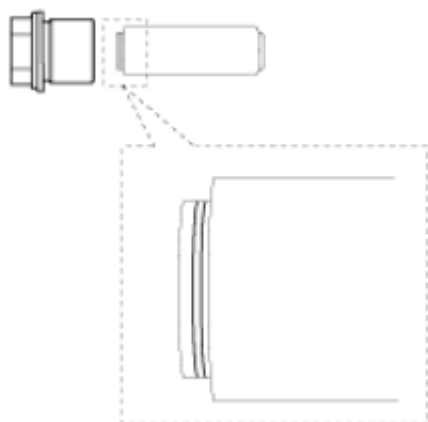


Fig. 124: Identifying Timing Chain Tensioner Installation Position
 Courtesy of HYUNDAI MOTOR CO.

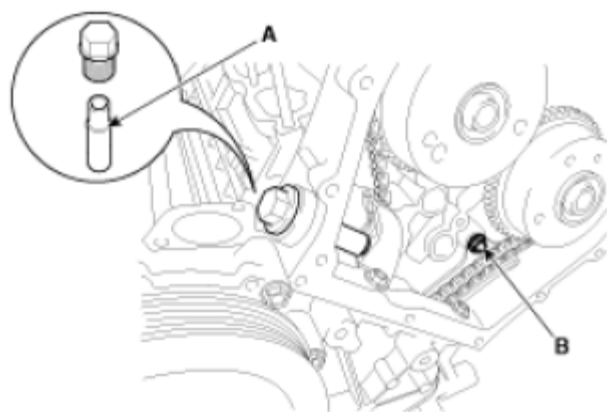


Fig. 125: Identifying Timing Chain Tensioner And Chain Guide Fixing Bolt
 Courtesy of HYUNDAI MOTOR CO.

Install the RH timing chain guide bolt (B) and then the RH timing chain tensioner (A).

1. Install the timing chain tensioner & plug bolt in the hole on the cylinder head by hand.
2. Tighten the plug bolt with the specified torque while pressing the timing chain on the RH intake CVVT.

Tightening torque:

Timing chain guide bolt:

21.6 ~ 25.5Nm (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

Timing chain tensioner plug bolt:

78.5 ~ 88.3N.m(8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

NOTE:

1. Do not reuse the timing chain tensioner.
2. Make sure the timing chain tensioner is at compressed transport position state.
3. Install the timing chain tensioner with the oil hole facing the plug bolt.

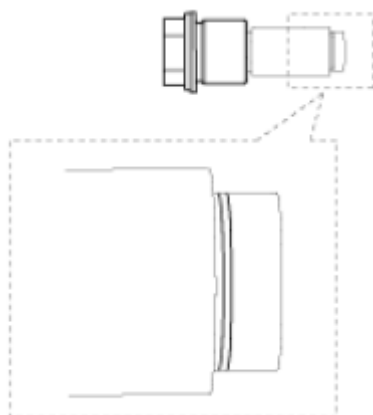


Fig. 126: Identifying Timing Chain Tensioner Installation Position
Courtesy of HYUNDAI MOTOR CO.

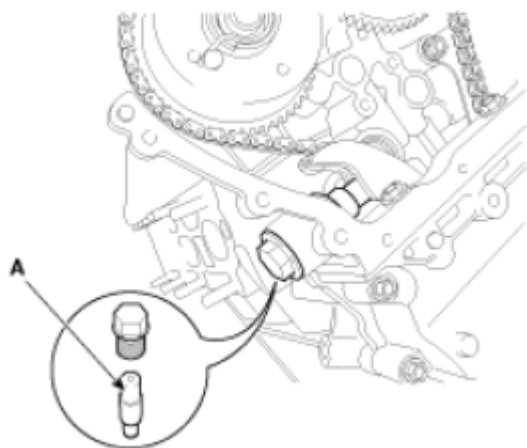


Fig. 127: Identifying Timing Chain Tensioner And Chain Guide Fixing Bolt
Courtesy of HYUNDAI MOTOR CO.

Set tension of the timing chain tensioner.

1. LH Bank

- A. Press the timing chain on the LH intake CVVT by hand with the timing mark "L" on the LH intake and exhaust CVVT and the LH cylinder head upper surface aligned.

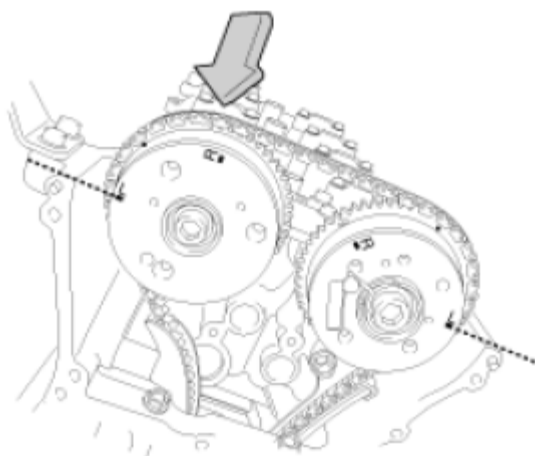


Fig. 128: Identifying Timing Chain Tensioner
Courtesy of HYUNDAI MOTOR CO.

- B. To set tension of the timing chain tensioner, push the timing chain tensioner arm outward with a force about 150N (15.3kgf, 33.7lbf).

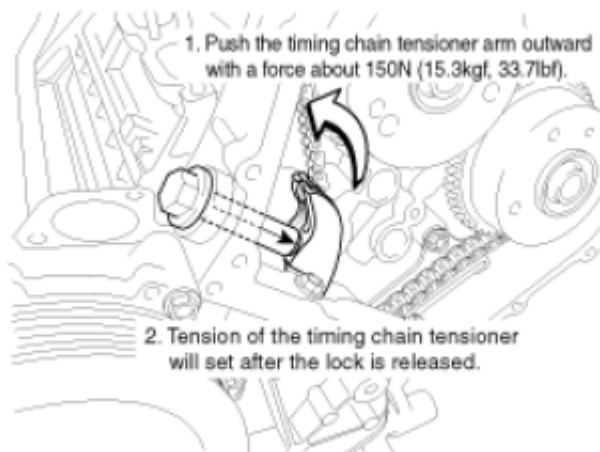


Fig. 129: Pushing Timing Chain Tensioner Arm Outward
Courtesy of HYUNDAI MOTOR CO.

- C. To check the tension of the timing chain tensioner, push the timing chain tensioner arm outward strongly. The distance between the cylinder head surface and end of tensioner plunger should be about 20mm (0.79inch).

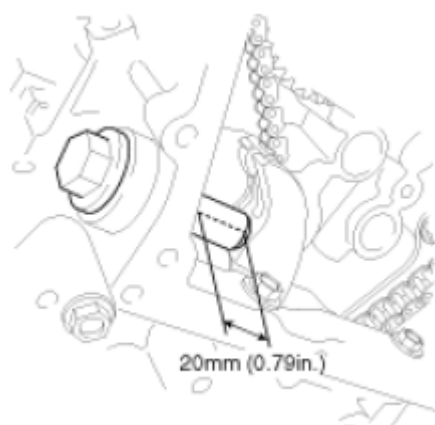


Fig. 130: Identifying Distance Between Cylinder Head Surface And End Of Tensioner Plunger

Courtesy of HYUNDAI MOTOR CO.

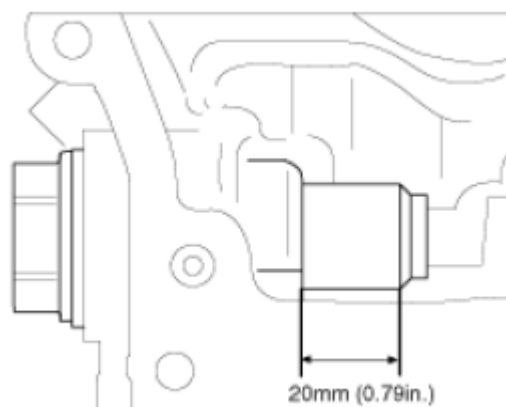


Fig. 131: Identifying Distance Between Cylinder Head Surface And End Of Tensioner Plunger

Courtesy of HYUNDAI MOTOR CO.

2. RH Bank

- A. To align the timing mark "R" on the RH intake and exhaust CVVT and the RH cylinder head upper surface, turn the exhaust CVVT about 20° counterclockwise while pressing the timing chain on the intake CVVT by hand with all of the chain installation mark of the sprocket and the timing marked chain links aligned.

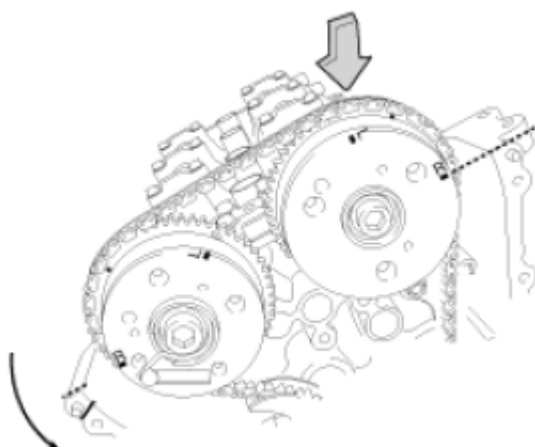


Fig. 132: Turning Exhaust CVVT 20 Degree Counterclockwise
 Courtesy of HYUNDAI MOTOR CO.

- B. To set tension of the timing chain tensioner, push the timing chain tensioner arm outward with a force about 150N (15.3kgf, 33.7lbf).

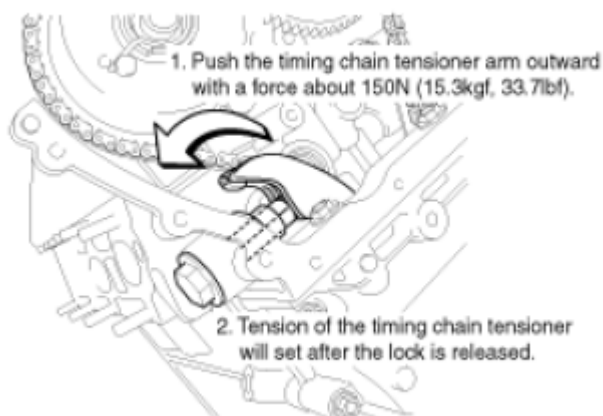


Fig. 133: Pushing Timing Chain Tensioner Arm Outward
 Courtesy of HYUNDAI MOTOR CO.

- C. To check the tension of the timing chain tensioner, push the timing chain tensioner arm outward strongly. The distance between the tensioner body and end of tensioner plunger should be about 3.5mm (0.14inch).

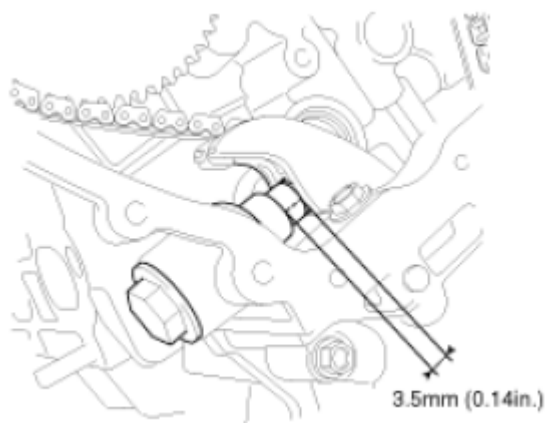


Fig. 134: Identifying Distance Between Tensioner Body And End Of Tensioner Plunger
 Courtesy of HYUNDAI MOTOR CO.

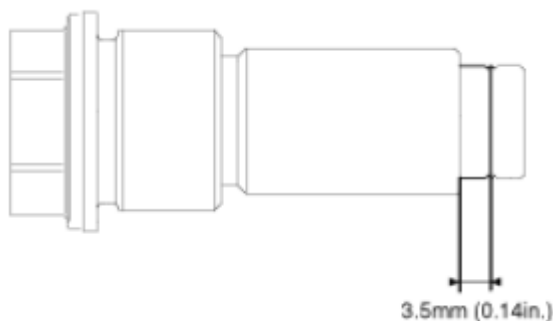


Fig. 135: Identifying Distance Between Tensioner Body And End Of Tensioner Plunger
 Courtesy of HYUNDAI MOTOR CO.

3. After setting tension of the LH, RH timing chain tensioner, check timing again.
 - A. Make sure the chain installation mark of the sprocket and the timing marked chain links are aligned.
 - B. Rotate the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing marks on the LH, RH intake and exhaust CVVT and the RH cylinder head upper surfaces are aligned.

After rotating the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.

NOTE: Always turn the crankshaft clockwise.
 Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

Install the water temperature control assembly (A) and the water outlet fitting assembly (B) with new O-ring and new gasket.

Tightening torque:

16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)

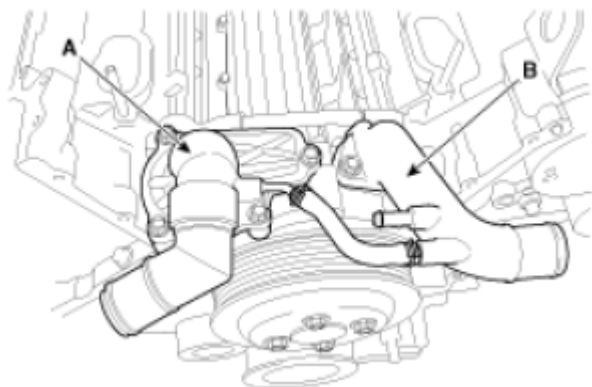


Fig. 136: Identifying Water Temperature Control Assembly And Water Outlet Fitting Assembly
Courtesy of HYUNDAI MOTOR CO.

Install the water outlet pipe (A) and the water inlet pipe (B).

Tightening torque:

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

NOTE:

- Use new O-rings when reassembling.
- Never apply sort of oil on O-ring and O-ring groove of pipe end.
- O-ring must be free from scratching damage.
- Make clean the contact face before assembly.
- Insert pipe after to be wetting O-ring or inside of attaching hole by water or antifreeze.

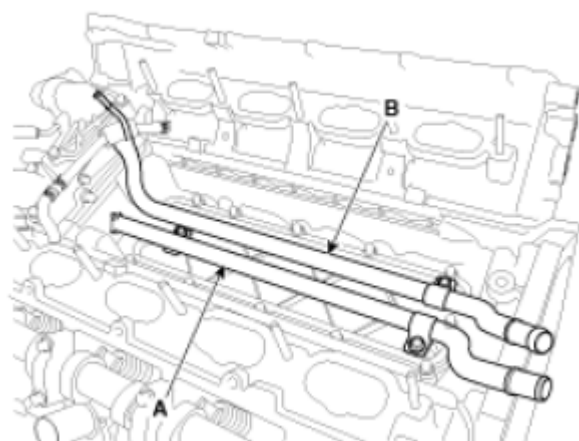


Fig. 137: Identifying Water Outlet Pipe And Water Inlet Pipe
Courtesy of HYUNDAI MOTOR CO.

NOTE: Install the drain plug (A).

Tightening torque:

96.1~100.0N.m(9.8~10.2kgf.m,70.9~73.8lb-ft)

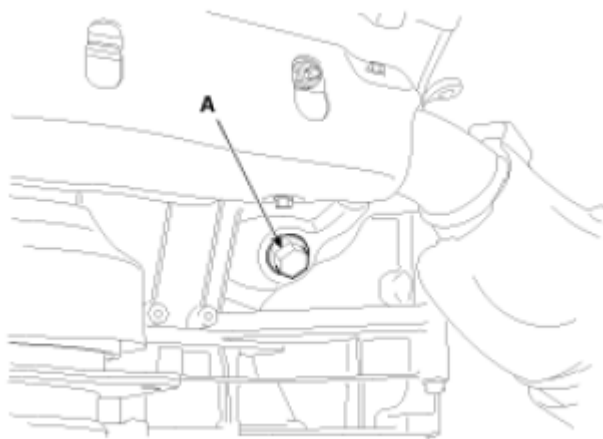


Fig. 138: Identifying Drain Plug
Courtesy of HYUNDAI MOTOR CO.

Install the alternator (A).

Tightening torque:

29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)

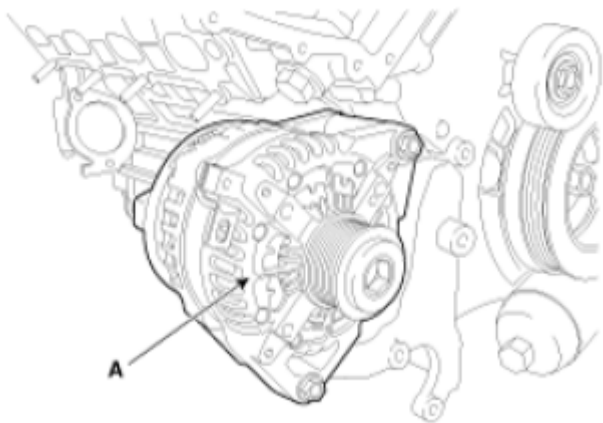


Fig. 139: Identifying Alternator
Courtesy of HYUNDAI MOTOR CO.

Install the oil control valve (OCV) (A).

Tightening torque:

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

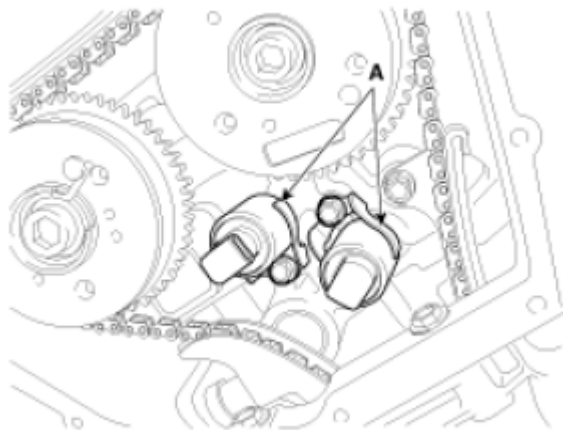


Fig. 140: Identifying Oil Control Valve
Courtesy of HYUNDAI MOTOR CO.

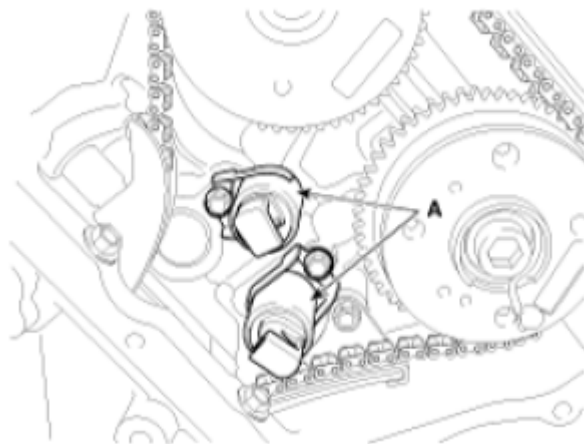


Fig. 141: Identifying Oil Control Valve
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Do not reuse the OCV when dropped.
- Keep the OCV clean.
- Do not hold the OCV sleeve (A) during servicing.
- When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.

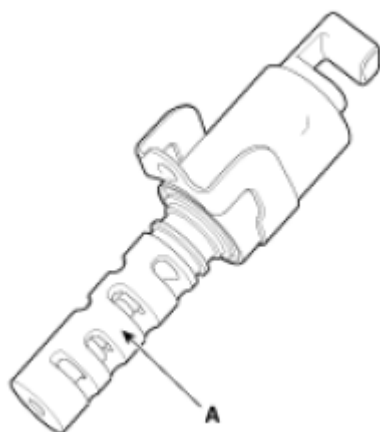


Fig. 142: Identifying OCV Sleeve
 Courtesy of HYUNDAI MOTOR CO.

Use the SST (09231-2J500, 09231-H1100) install the timing chain upper cover oil seal (A).

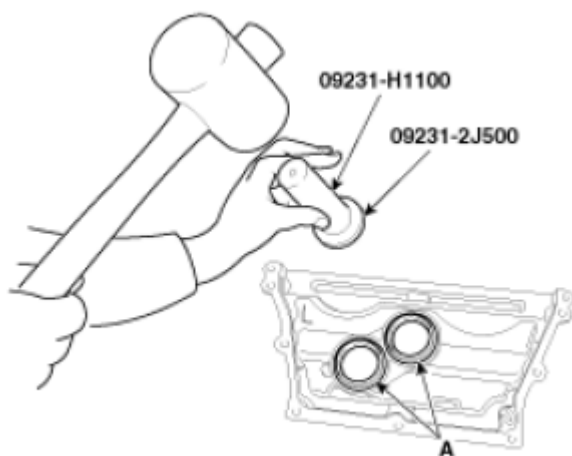


Fig. 143: Installing Timing Chain Upper Cover Oil Seal Using SST (09231-2J500, 09231-H1100)
 Courtesy of HYUNDAI MOTOR CO.

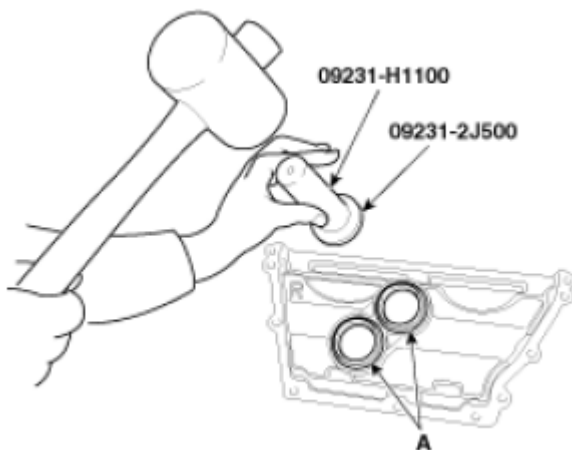


Fig. 144: Installing Timing Chain Upper Cover Oil Seal Using SST (09231-2J500, 09231-H1100)
Courtesy of HYUNDAI MOTOR CO.

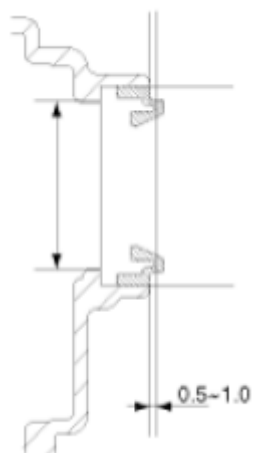


Fig. 145: Identifying Timing Chain Upper Cover Dimensions
Courtesy of HYUNDAI MOTOR CO.

Apply sealant to the timing chain upper cover.

1. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
2. Before assembling the timing chain upper cover, the liquid sealant LT5900H or equivalent should be applied on upper cover.

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

Bead width: $\varnothing 2.5 \pm 0.5\text{mm}$ ($0.1 \pm 0.002\text{in}$)

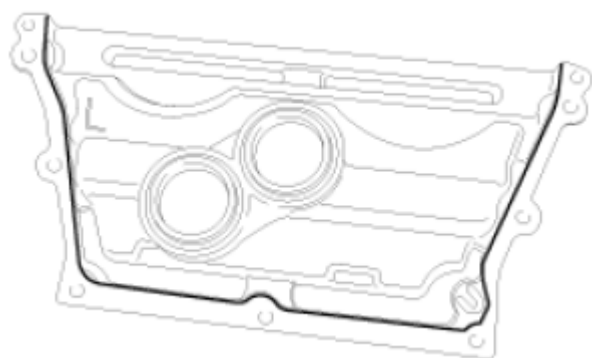


Fig. 146: Identifying Timing Chain Upper Cover Liquid Sealant Applying Area
Courtesy of HYUNDAI MOTOR CO.

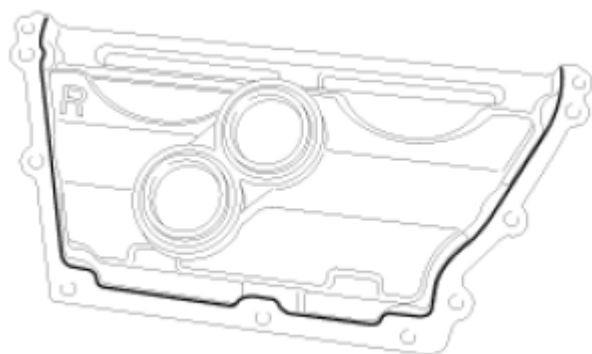


Fig. 147: Identifying Timing Chain Upper Cover Liquid Sealant Applying Area
Courtesy of HYUNDAI MOTOR CO.

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 upper cover.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

Install the timing chain upper cover (A).

Tightening torque:

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

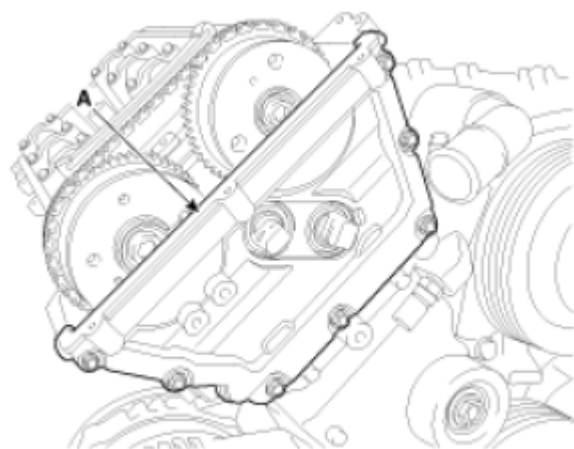


Fig. 148: Identifying Timing Chain Upper Cover
Courtesy of HYUNDAI MOTOR CO.

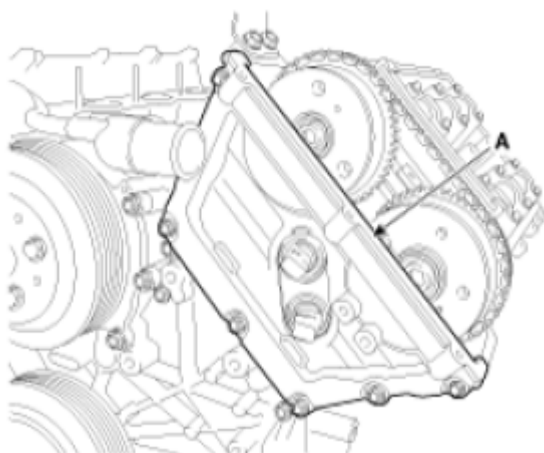


Fig. 149: Identifying Timing Chain Upper Cover
Courtesy of HYUNDAI MOTOR CO.

Install the exhaust manifold (A) by tightening the nuts as following method. (Refer to **INTAKE AND EXHAUST SYSTEM** in this group)

Tightening torque:

49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.8lb-ft)

NOTE: The "TOP" mark of the gasket must be face the exhaust manifold.

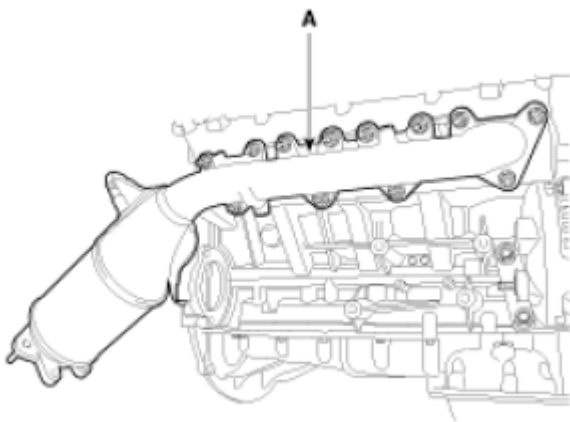


Fig. 150: Identifying Exhaust Manifold
Courtesy of HYUNDAI MOTOR CO.

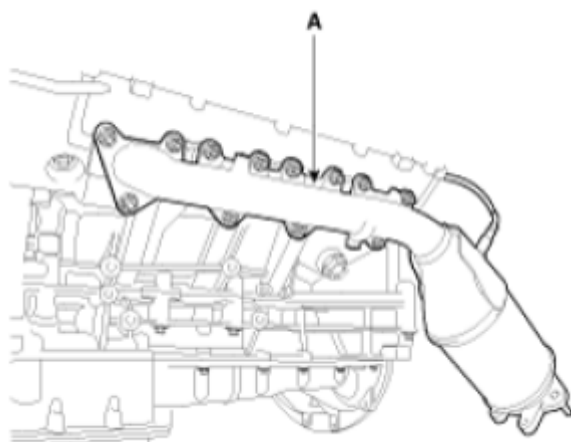


Fig. 151: Identifying Exhaust Manifold
Courtesy of HYUNDAI MOTOR CO.

NOTE: Tighten the exhaust manifold nuts as following method.

[RH]

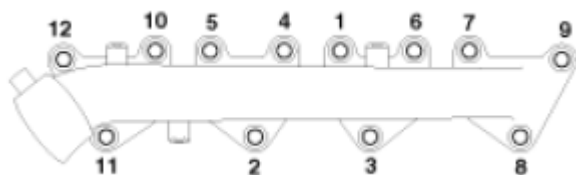


Fig. 152: Identifying Exhaust Manifold Nuts Tightening Sequence (RH)
Courtesy of HYUNDAI MOTOR CO.

[LH] - With engine assembly removal

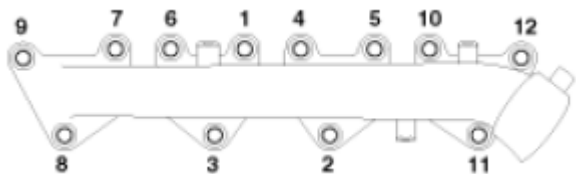


Fig. 153: Identifying Exhaust Manifold Nuts Tightening Sequence (LH)- With Engine Assembly Removal
Courtesy of HYUNDAI MOTOR CO.

[LH] - Without engine assembly removal

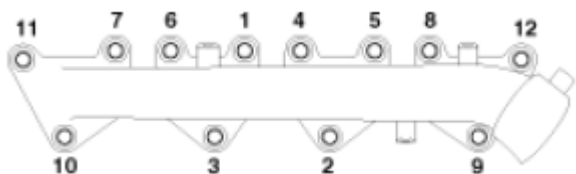


Fig. 154: Identifying Exhaust Manifold Nuts Tightening Sequence (LH)- Without Engine Assembly Removal
Courtesy of HYUNDAI MOTOR CO.

21. Install the exhaust manifold heat protector (A).

Tightening torque:

8.8 ~ 10.8 N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 8.0lb-ft)

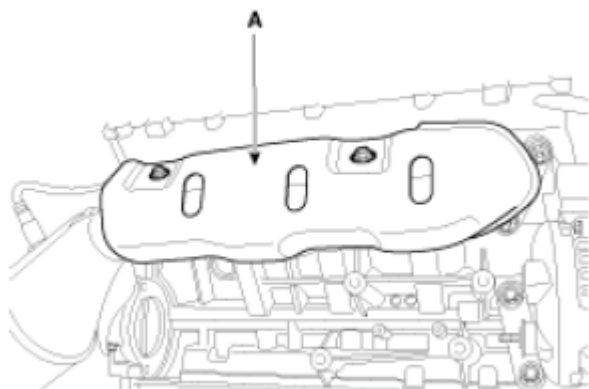


Fig. 155: Identifying Exhaust Manifold Heat Protector
Courtesy of HYUNDAI MOTOR CO.

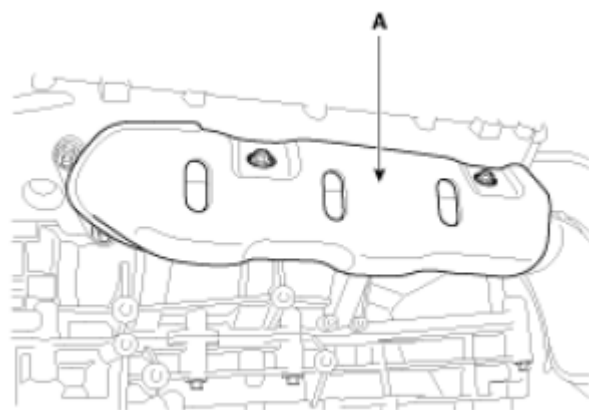


Fig. 156: Identifying Exhaust Manifold Heat Protector
Courtesy of HYUNDAI MOTOR CO.

22. Install the engine coolant temperature sensor (ECTS) wiring assembly and bracket (A).

Tightening torque:

Wiring bracket bolts:

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

Engine coolant temperature sensor:

19.6 ~ 39.2Nm (2.0 ~ 4.0kgf.m, 14.5 ~ 28.9lb-ft)

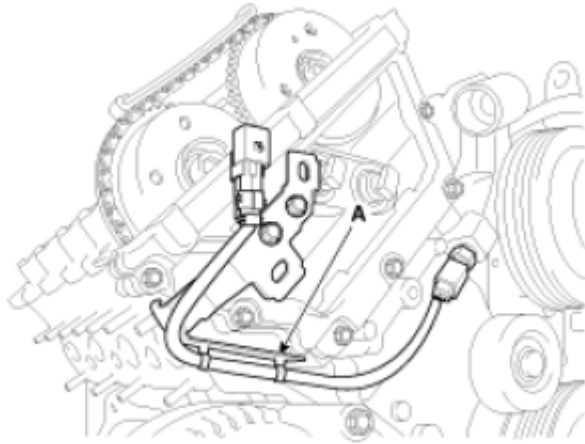


Fig. 157: Identifying Engine Coolant Temperature Sensor Wiring Assembly And Bracket
Courtesy of HYUNDAI MOTOR CO.

23. Install the oil pressure switch (OPS) wiring assembly and bracket (A).

Tightening torque:

Wiring bracket bolts:

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

Oil pressure switch:

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

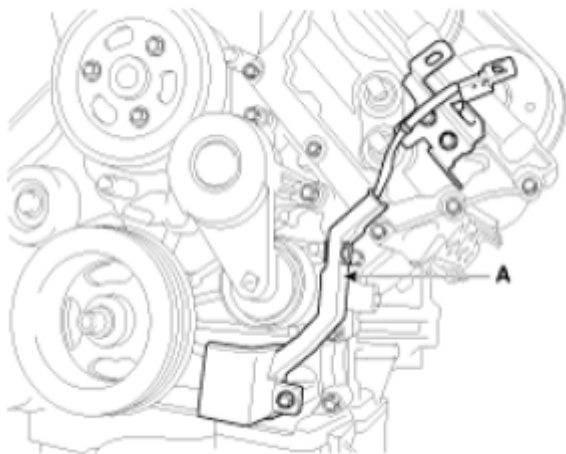


Fig. 158: Identifying Oil Pressure Switch Wiring Assembly And Bracket

Courtesy of HYUNDAI MOTOR CO.

24. Use the SST (09231-2J500, 09231-H1100), install the oil seal (B) and the gasket (A).

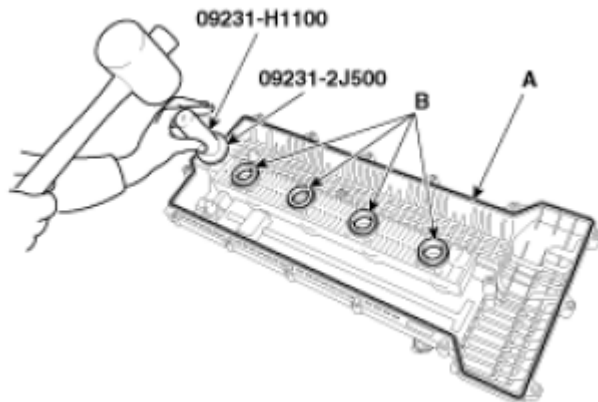


Fig. 159: Installing Oil Seal And Gasket Using SST (09231-2J500, 09231-H1100)
Courtesy of HYUNDAI MOTOR CO.

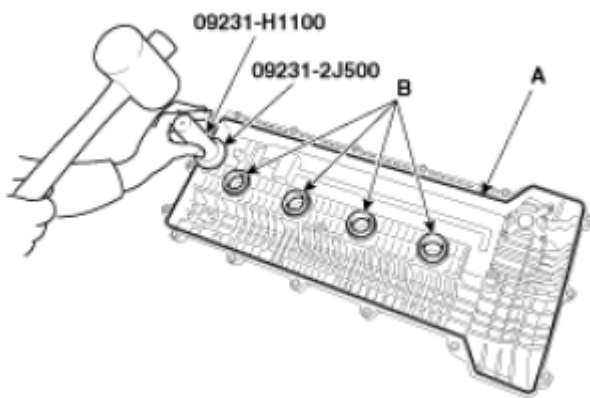


Fig. 160: Installing Oil Seal And Gasket Using SST (09231-2J500, 09231-H1100)
Courtesy of HYUNDAI MOTOR CO.

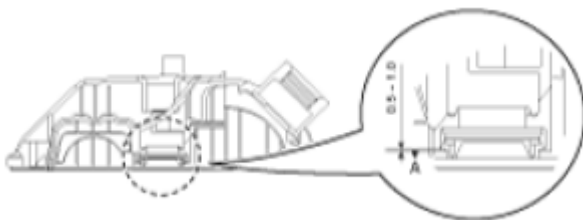


Fig. 161: Identifying Oil Seal And Gasket Dimensions
Courtesy of HYUNDAI MOTOR CO.

25. Install the cylinder head cover.

1. The sealant locations on cylinder head and timing chain upper case must be free of engine oil and etc.

2. Before assembling the cylinder head cover, the liquid sealant LT5900H or equivalent should be applied on the gap between cylinder head and timing chain upper case.

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

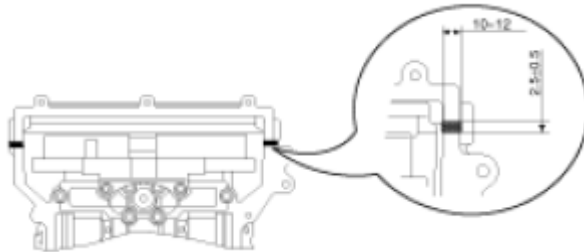


Fig. 162: Identifying Gap Dimension Between Cylinder Head And Timing Chain Upper Case
Courtesy of HYUNDAI MOTOR CO.

3. Install the cylinder head cover (A).

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

Tightening torque:

1st step: 4.9 ~ 5.9N.m (0.5 ~ 0.6kgf.m, 3.6 ~ 4.3lb-ft)

2nd step: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

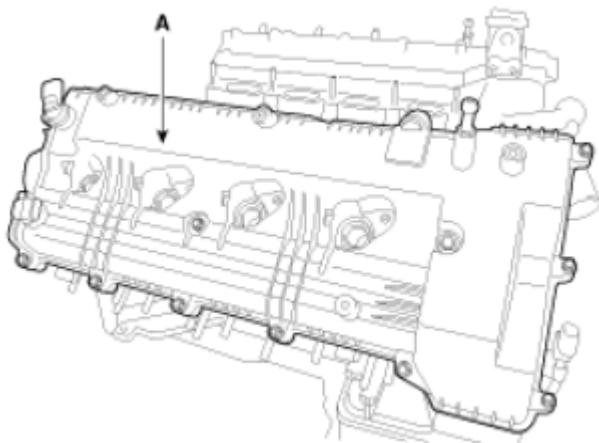


Fig. 163: Identifying Cylinder Head Cover
Courtesy of HYUNDAI MOTOR CO.

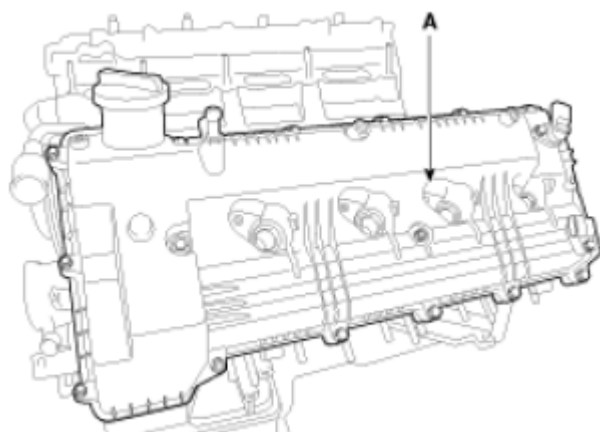


Fig. 164: Identifying Cylinder Head Cover
 Courtesy of HYUNDAI MOTOR CO.

NOTE: Tighten the cylinder head cover bolts as following method.

[RH]

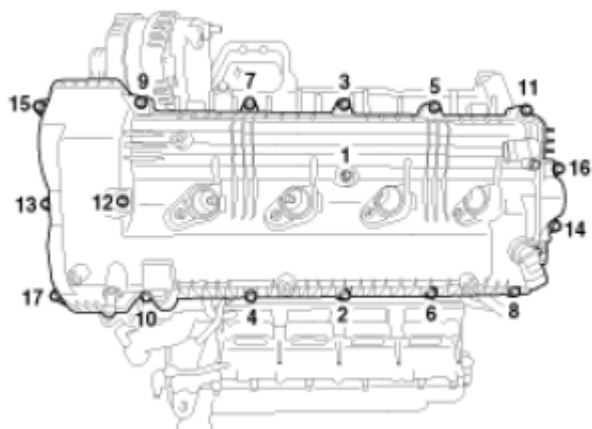


Fig. 165: Identifying Cylinder Head Cover Bolts Tightening Sequence (RH)
 Courtesy of HYUNDAI MOTOR CO.

[LH]

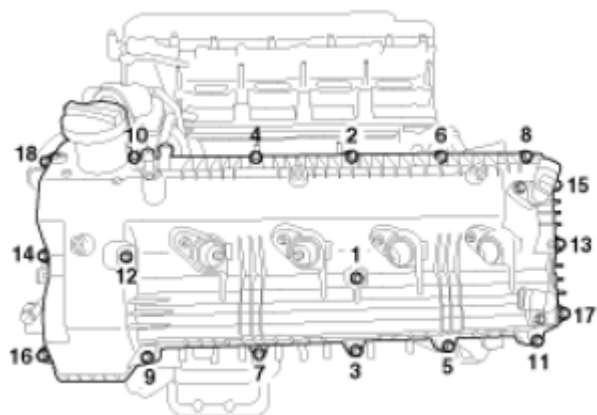


Fig. 166: Identifying Cylinder Head Cover Bolts Tightening Sequence (LH)
Courtesy of HYUNDAI MOTOR CO.

26. Install the ignition coils (A).

Tightening torque:

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

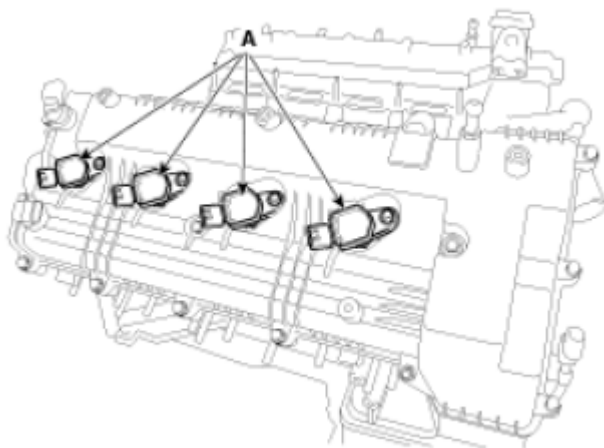


Fig. 167: Identifying (BANK 1) Ignition Coils #1, #3, #5, & #7
Courtesy of HYUNDAI MOTOR CO.

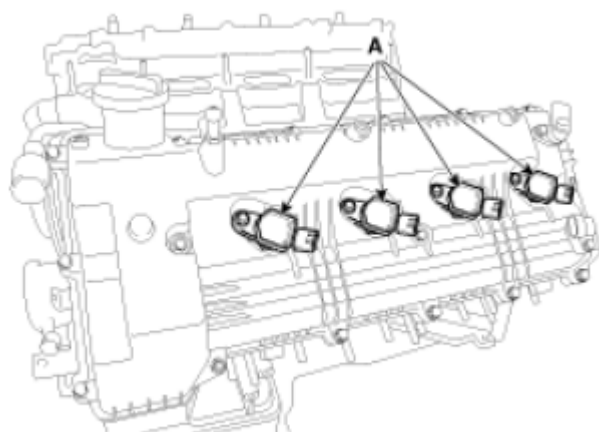


Fig. 168: Identifying (BANK 2) Ignition Coils #2, #4, #6, & #8
Courtesy of HYUNDAI MOTOR CO.

27. Reconnect the water hose (A).

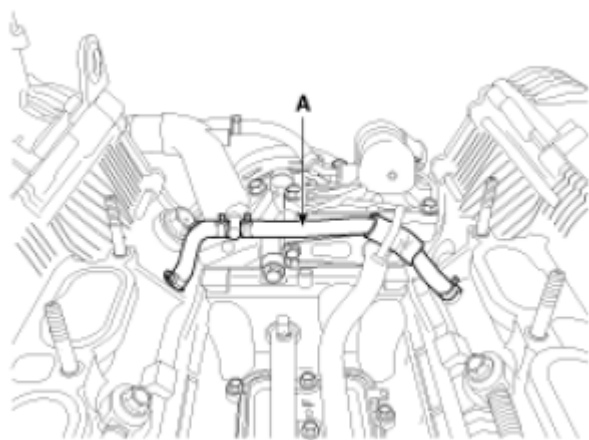


Fig. 169: Identifying Water Hose
Courtesy of HYUNDAI MOTOR CO.

28. Install the knock sensors (A) and wiring assembly bracket (B).

Tightening torque:

64.7 ~ 76.5N.m (6.6 ~ 7.8kgf.m, 47.7 ~ 56.4lb-ft)

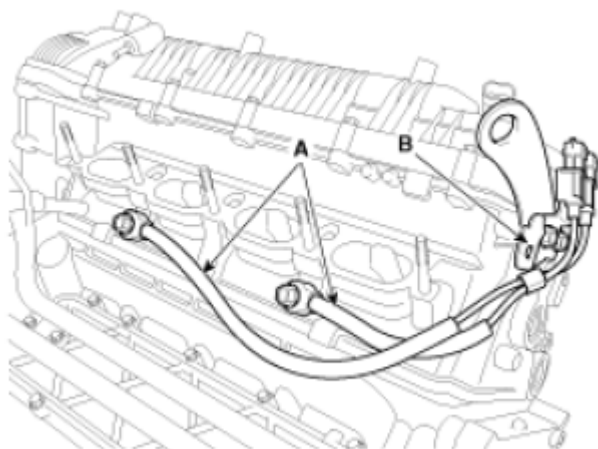


Fig. 170: Identifying Knock Sensors And Wiring Assembly Bracket
Courtesy of HYUNDAI MOTOR CO.

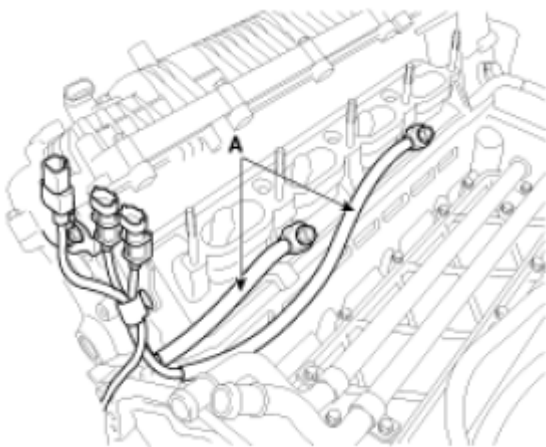


Fig. 171: Identifying Knock Sensors
Courtesy of HYUNDAI MOTOR CO.

29. Install the intake manifold module (A) by tightening the nuts as following method.

Tightening torque:

1st step:

4.9 ~ 7.8N.m (0.5 ~ 0.8kgf.m, 3.6 ~ 5.8lb-ft)

2nd step:

19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)

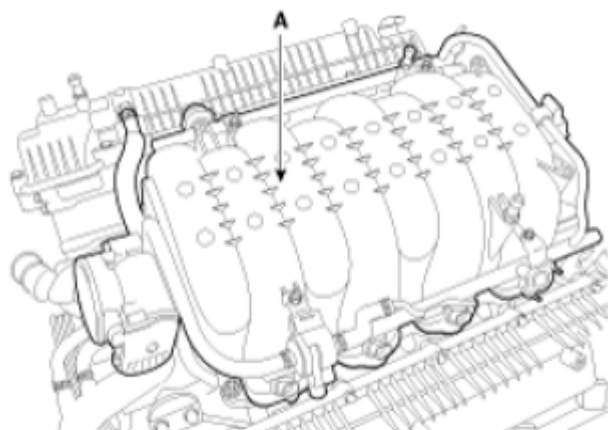


Fig. 172: Identifying Intake Manifold Module
Courtesy of HYUNDAI MOTOR CO.

NOTE: Tighten the intake manifold nuts as following method.

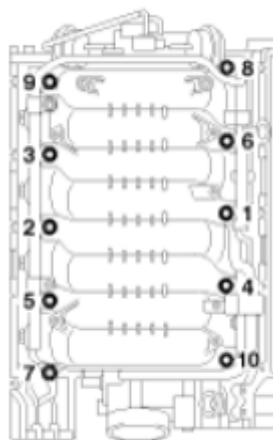


Fig. 173: Identifying Intake Manifold Nuts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

30. Reconnect the PCV hose (A), the PCSV hose (B) and water hoses (C) to the intake manifold module.

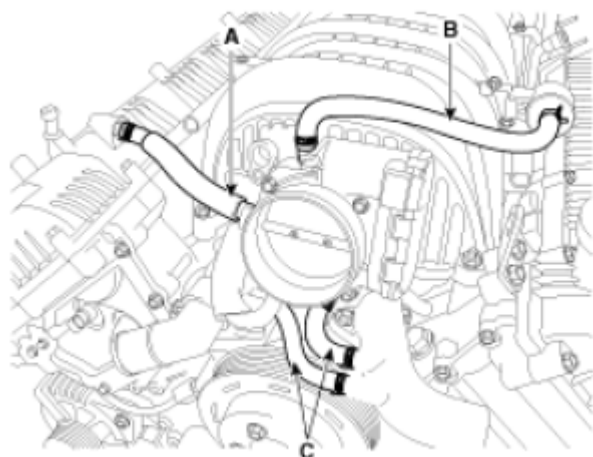


Fig. 174: Identifying PCV Hose, PCSV Hose And Water Hoses
Courtesy of HYUNDAI MOTOR CO.

31. Install the oxygen sensor (HO2S) connector bracket (A).

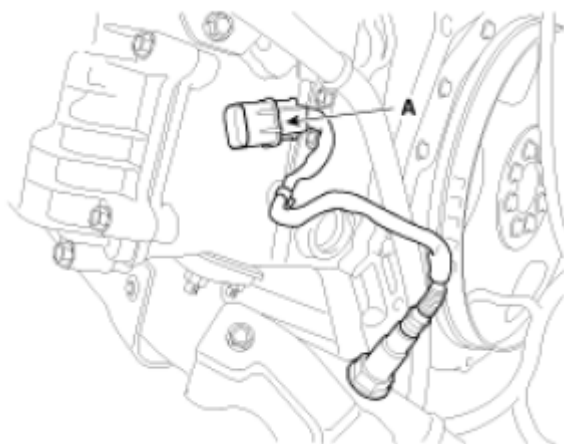


Fig. 175: Identifying Oxygen Sensor Connector Bracket
Courtesy of HYUNDAI MOTOR CO.

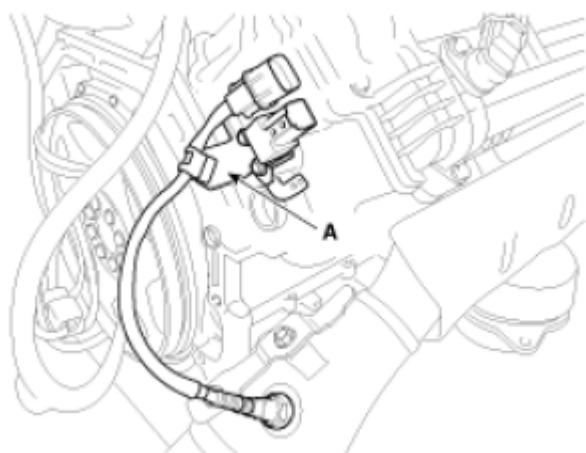


Fig. 176: Identifying Oxygen Sensor Connector Bracket
Courtesy of HYUNDAI MOTOR CO.

32. Install the oil level gauge (A).

Tightening torque:

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

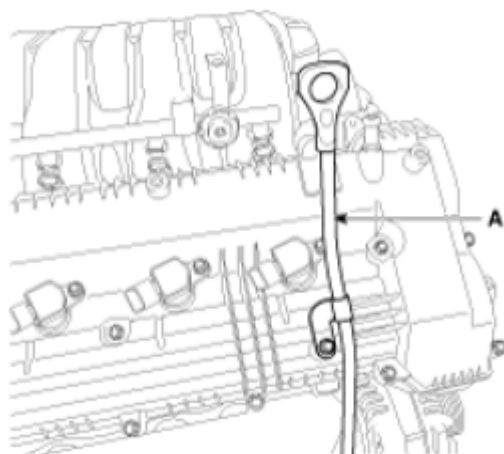


Fig. 177: Identifying Oil Level Gauge
Courtesy of HYUNDAI MOTOR CO.

33. Install the engine wiring harness to the cylinder head.

1. Reconnect the engine coolant temperature sensor (ECTS) connector (A) and the CVVT oil control valve (OCV) connectors (B).

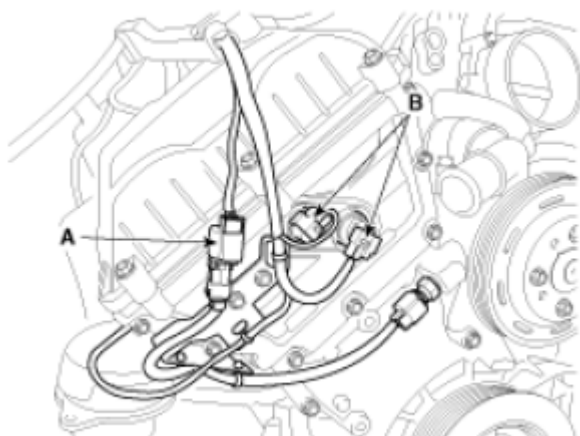


Fig. 178: Identifying Engine Coolant Temperature Sensor Connector And CVVT Oil Control Valve Connectors

Courtesy of HYUNDAI MOTOR CO.

2. Reconnect the alternator connector (A).

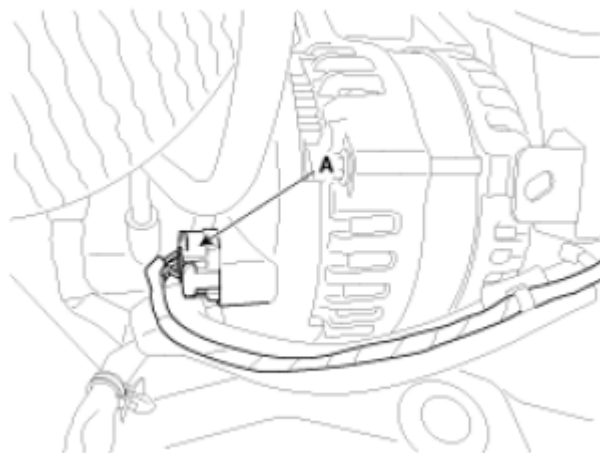


Fig. 179: Identifying Alternator Connector

Courtesy of HYUNDAI MOTOR CO.

3. Reconnect the ETC module connector (A).

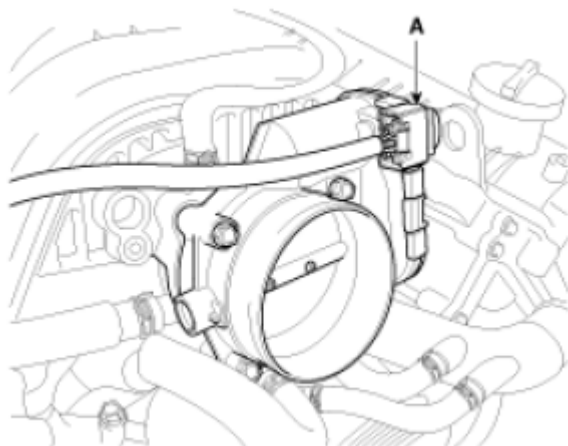


Fig. 180: Identifying ETC Module Connector
Courtesy of HYUNDAI MOTOR CO.

4. Reconnect the purge control solenoid valve (PCSV) connector (A) and the injector connectors (B).

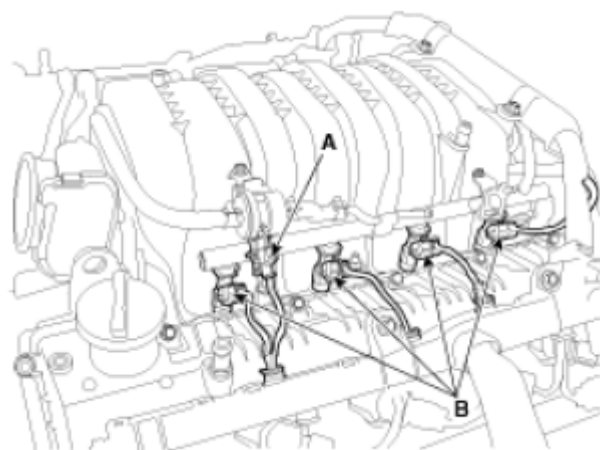


Fig. 181: Identifying Purge Control Solenoid Valve Connector And Injector Connectors
Courtesy of HYUNDAI MOTOR CO.

5. Reconnect the ignition coil connectors (A) and the wiring harness protector (B).

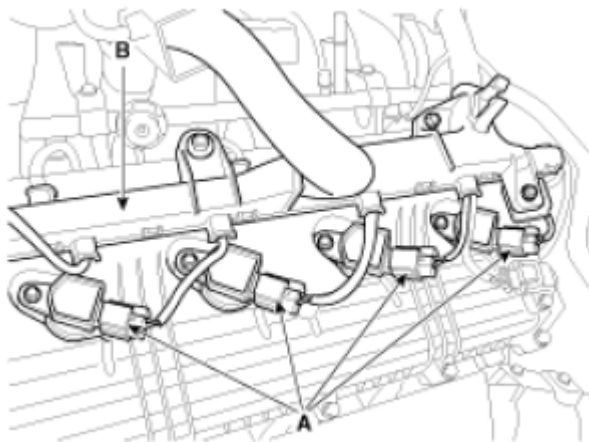


Fig. 182: Identifying Ignition Coil Connectors And Wiring Harness Protector
Courtesy of HYUNDAI MOTOR CO.

6. Reconnect the knock sensor connectors (A), the camshaft position sensor (CMPS) connectors (B), the oxygen sensor (HO2S) connector (C), the condenser connector (D) and the ground line (E).

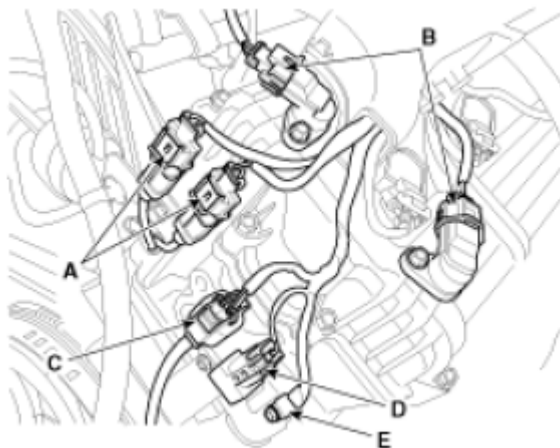


Fig. 183: Identifying Knock Sensor Connectors, Camshaft Position Sensor Connectors, Oxygen Sensor Connector, Condenser Connector And Ground Line
Courtesy of HYUNDAI MOTOR CO.

7. Reconnect the variable intake system (VIS) solenoid valve connector (A) and the wiring harness protector (B).

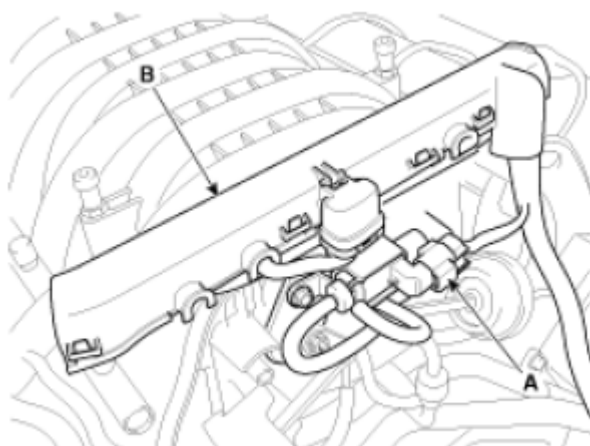


Fig. 184: Identifying Variable Intake System Solenoid Valve Connector And Wiring Harness Protector
 Courtesy of HYUNDAI MOTOR CO.

8. Reconnect the knock sensor connectors (A), the camshaft position sensor (CMPS) connectors (B), the crankshaft position sensor (CKPS) connector (C), the oxygen sensor (HO2S) connector (D), the condenser connector (E) and the ground line (F).

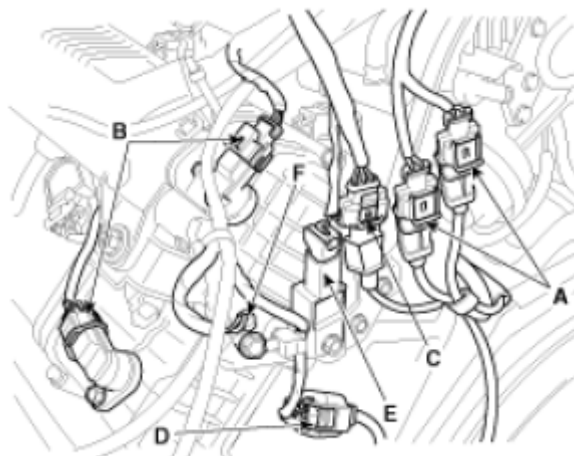


Fig. 185: Identifying Knock Sensor, Camshaft Position Sensor, Crankshaft Position Sensor, Oxygen Sensor, Condenser Connectors And Ground Line
 Courtesy of HYUNDAI MOTOR CO.

9. Reconnect the injector connectors (A).

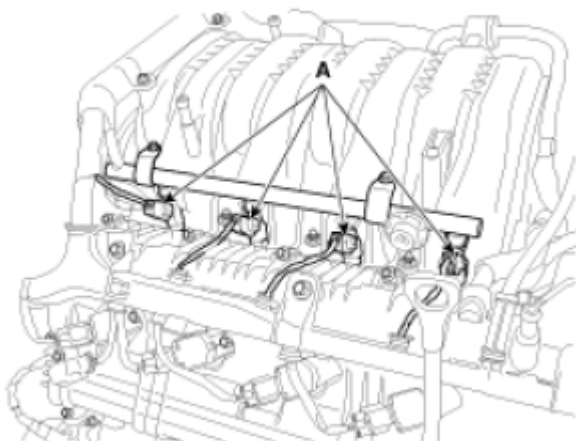


Fig. 186: Identifying Injector Connectors
Courtesy of HYUNDAI MOTOR CO.

10. Reconnect the ignition coil connectors (A) and the wiring harness protector (B).

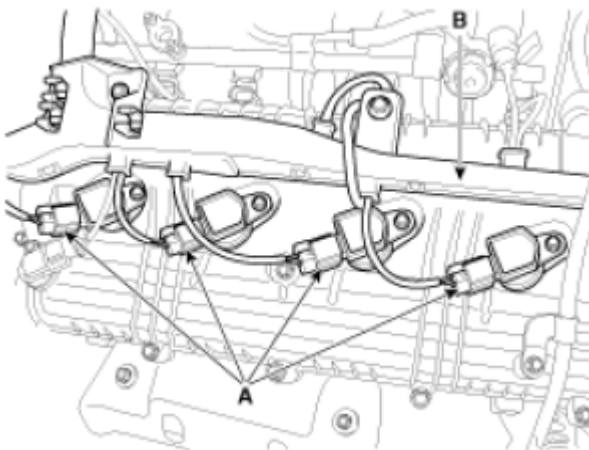


Fig. 187: Identifying Ignition Coil Connectors And Wiring Harness Protector
Courtesy of HYUNDAI MOTOR CO.

11. Reconnect the oil pressure switch (OPS) connector (A), the CVVT oil control valve (OCV) connectors (B) and the air conditioner compressor switch connector (C).

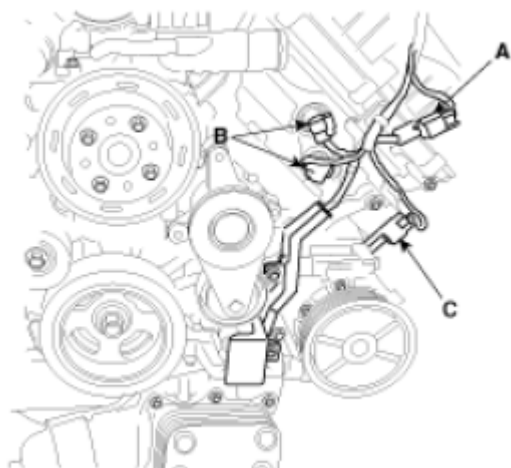


Fig. 188: Identifying Oil Pressure Switch Connector, CVVT Oil Control Valve Connectors And Air Conditioner Compressor Switch Connector
Courtesy of HYUNDAI MOTOR CO.

34. Install the drive belt tensioner (A).

Tightening torque:

19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

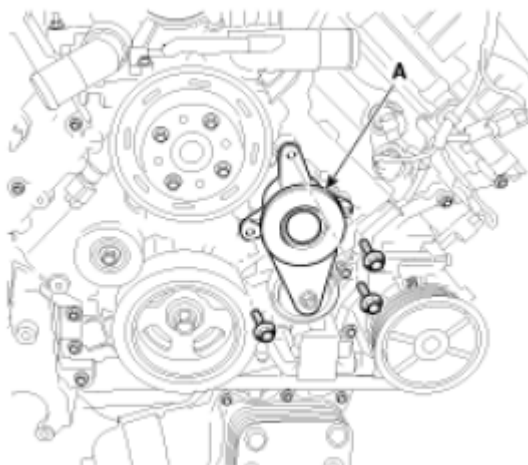


Fig. 189: Identifying Drive Belt Tensioner
Courtesy of HYUNDAI MOTOR CO.

35. Turn the tensioner (B) clockwise and loosen, then install the drive belt (A).

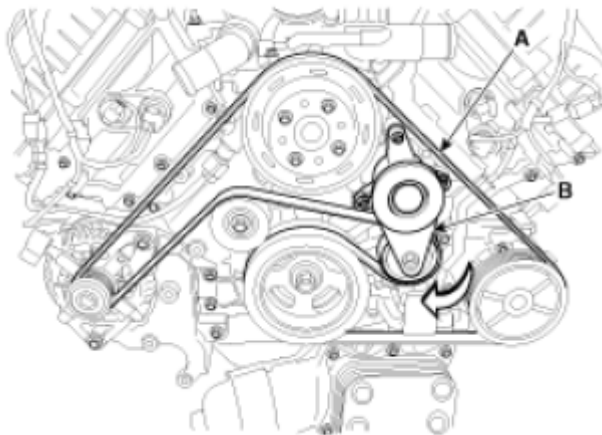


Fig. 190: Turning Tensioner Clockwise
 Courtesy of HYUNDAI MOTOR CO.

36. Install the radiator & cooling fan assembly. (Refer to **COOLING SYSTEM** in this group)
37. Connect the heater hoses (A),

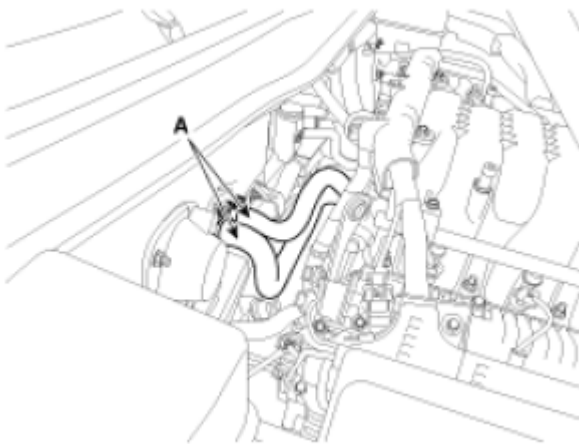


Fig. 191: Identifying Heater Hoses
 Courtesy of HYUNDAI MOTOR CO.

38. Connect the fuel hose (A), the purge control solenoid valve (PCSV) hose (B) and the brake booster vacuum hose (C).

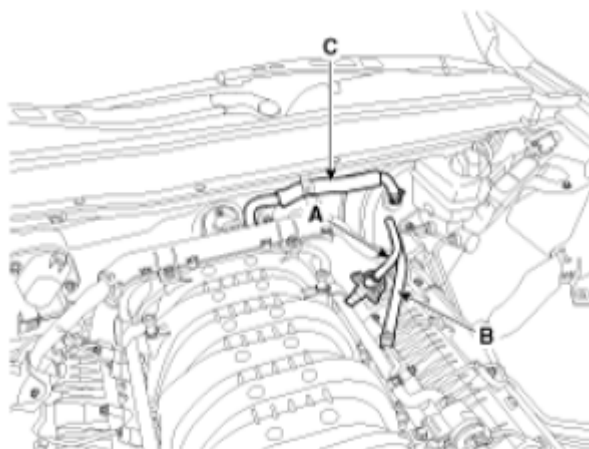


Fig. 192: Identifying Fuel Hose, Purge Control Solenoid Valve Hose And Brake Booster Vacuum Hose

Courtesy of HYUNDAI MOTOR CO.

39. Connect the radiator upper hose (A) and lower hose (B).

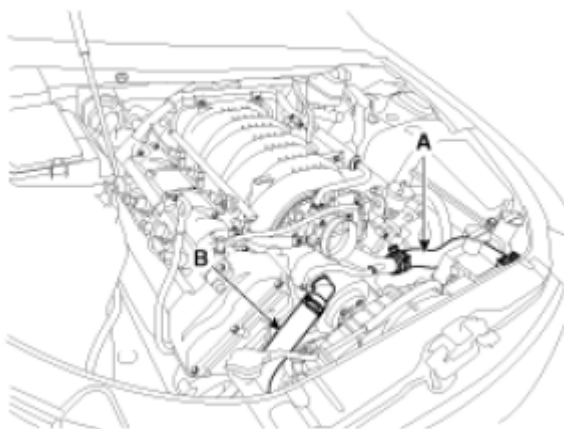


Fig. 193: Identifying Radiator Upper Hose And Lower Hose

Courtesy of HYUNDAI MOTOR CO.

40. Install the air cleaner assembly.

1. Install the resonator (F), the intake air hose (E) and air cleaner assembly (D).
2. Reconnect the breather hose (B).
3. Reconnect the air flow sensor (AFS) connector (C).
4. Install the air duct (A).

Tightening torque

Hose clamp bolt: 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)

Air cleaner assembly bolts: 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

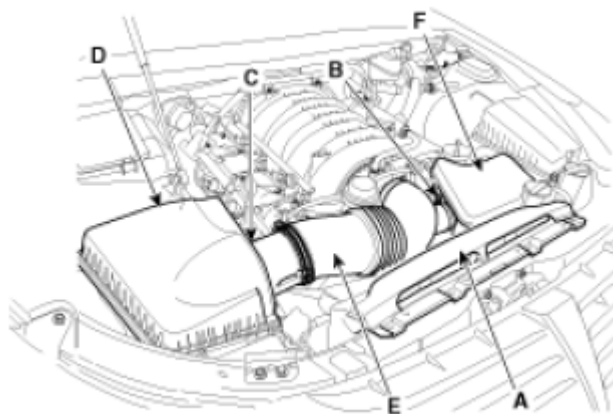


Fig. 194: Identifying Air Duct, Air Flow Sensor Connector, Breather Hose And Resonator

Courtesy of HYUNDAI MOTOR CO.

41. Install the engine room cover (A), the engine cover (B) and the radiator grill upper cover (C).

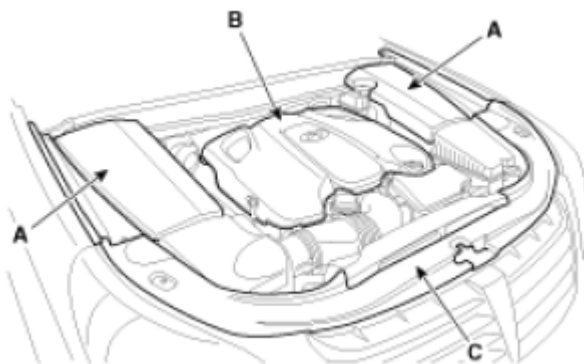


Fig. 195: Identifying Engine Room Cover, Engine Cover And Radiator Grill Upper Cover

Courtesy of HYUNDAI MOTOR CO.

42. Connect the battery negative terminal (A).

Tightening torque: 4.0~6.0N.m (0.4~0.6kgf.m, 3.0~4.4lb-ft)

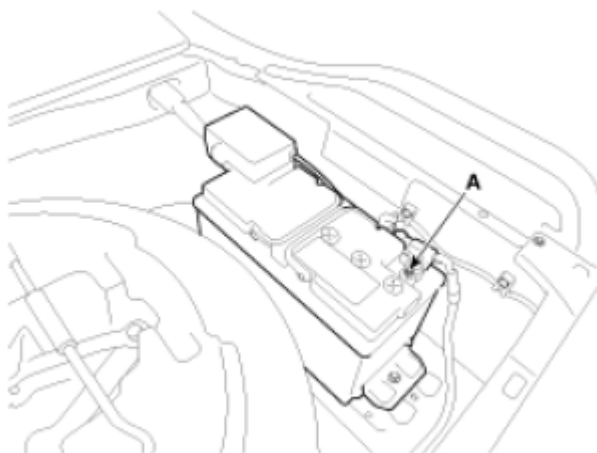


Fig. 196: Identifying Negative Terminal Of Battery
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper assemble them, and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
 - After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
 - Repeat this operation two or three times, and then check for fuel leakage at any point in the fuel lines.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
 - Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
 - Turn Off the engine and let it cool diwn. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
 - Put radiator cap on tightly, then run the engine again and check for leaks.

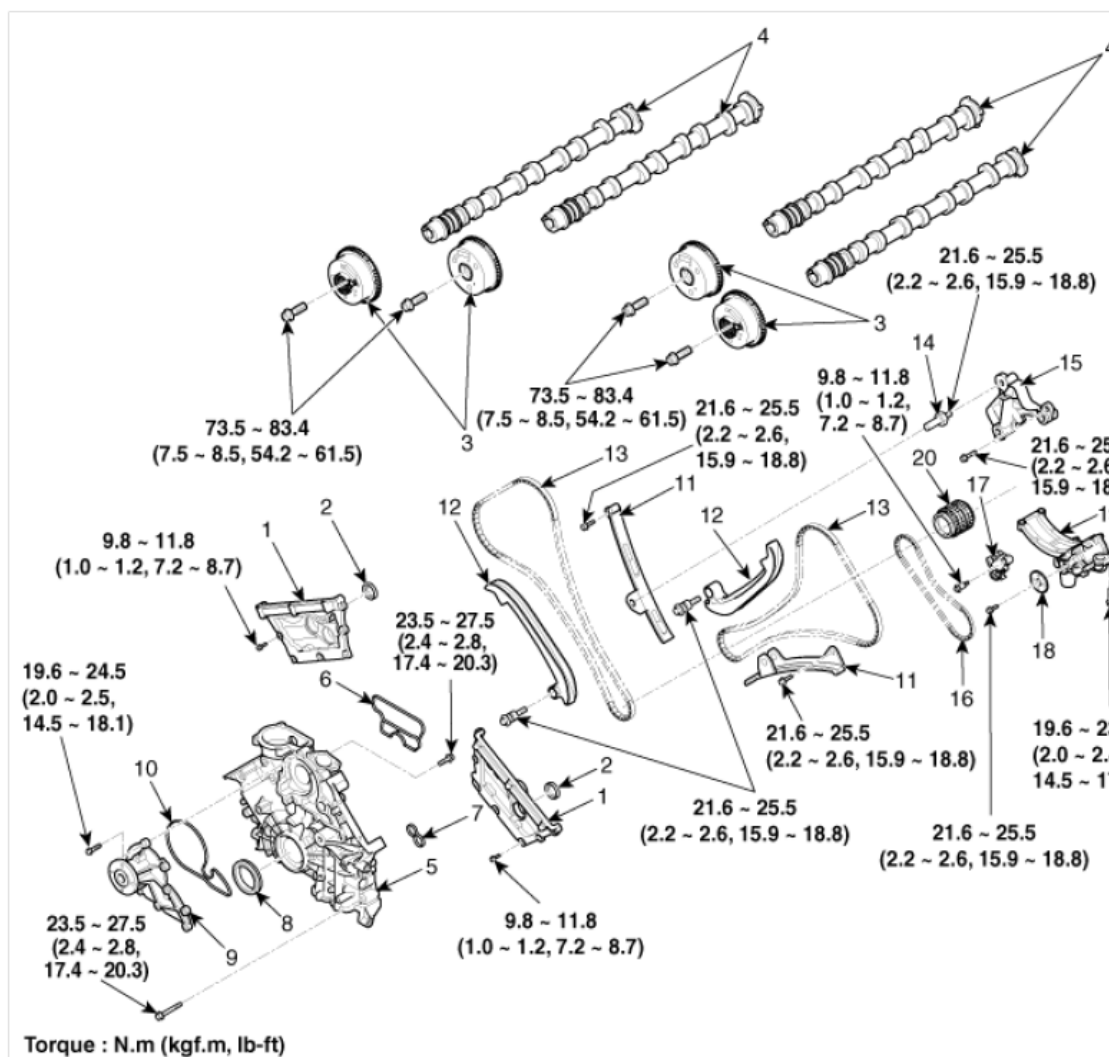
2011 ENGINE

Engine Timing System - Equus

TIMING CHAIN

COMPONENTS AND COMPONENTS LOCATION

Components



1. Timing chain upper cover	8. Timing chain lower cover oil seal	15. Tensioner adapter
2. Timing chain upper cover oil seal	9. Water pump	16. Oil pump chain
3. CVVT assembly	10. Water pump gasket	17. Oil pump chain tensioner
4. Camshaft	11. Timing chain guide	18. Oil pump sprocket
5. Timing chain lower cover	12. Timing chain tensioner arm	19. Oil pump assembly
6. Timing chain lower cover gasket(#1)	13. Timing chain	20. Crankshaft sprocket
7. Timing chain lower cover gasket(#2)	14. Timing chain guide bolt	

Fig. 1: Exploded View Of Timing System

Courtesy of HYUNDAI MOTOR CO.

REPAIR PROCEDURES

Removal

Engine removal is required for this procedure.

CAUTION:

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.
- 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 misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

1. Remove the engine and transmission assembly from the vehicle. (Refer to ENGINE AND TRANSMISSION ASSEMBLY in this group)
2. Remove the cylinder head assembly. (Refer to CYLINDER HEAD ASSEMBLY in this group)
3. Remove the alternator (A).

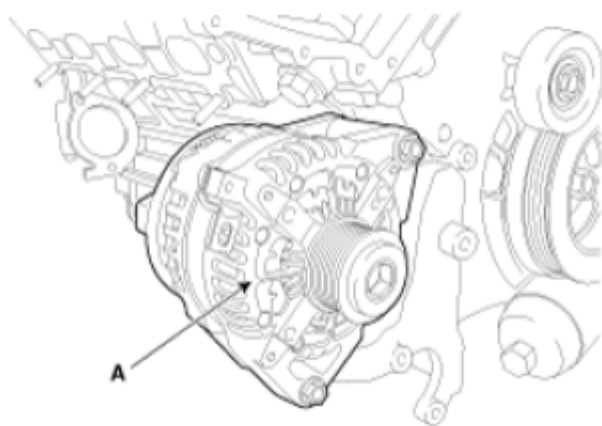


Fig. 2: Identifying Alternator

Courtesy of HYUNDAI MOTOR CO.

4. Remove the alternator bracket (A).

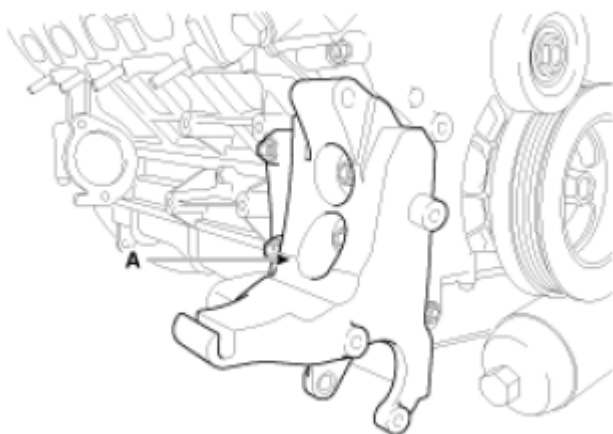


Fig. 3: Identifying Alternator Bracket
Courtesy of HYUNDAI MOTOR CO.

5. Remove the air conditioner compressor (A). (Refer to **REMOVAL**)

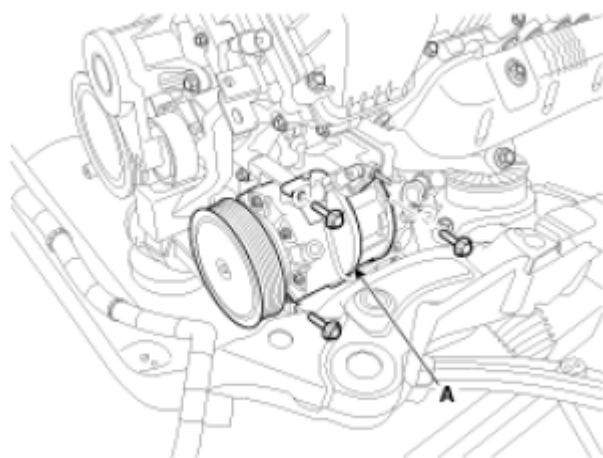


Fig. 4: Identifying Air Conditioner Compressor
Courtesy of HYUNDAI MOTOR CO.

6. Remove the drive belt idler (A).

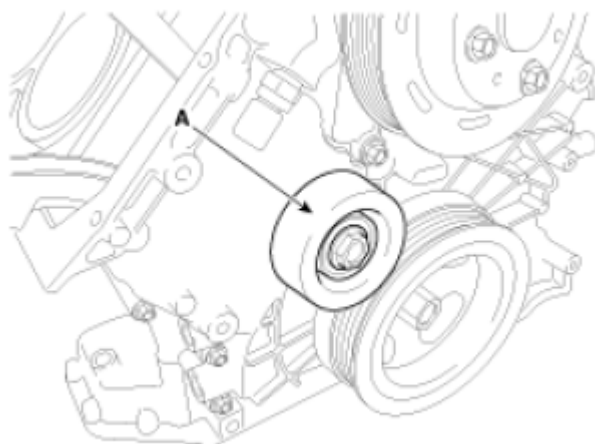


Fig. 5: Identifying Drive Belt Idler
Courtesy of HYUNDAI MOTOR CO.

7. Remove the drive belt tensioner (A).

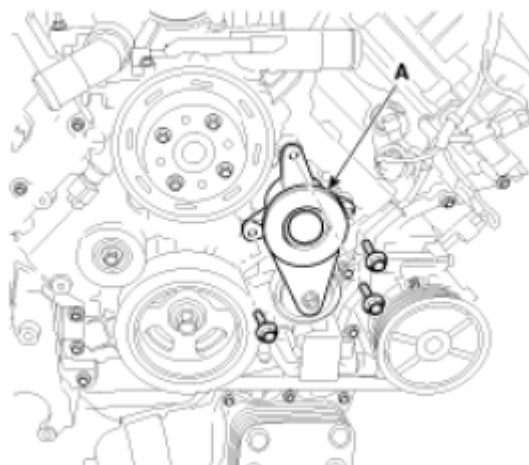


Fig. 6: Identifying Drive Belt Tensioner
Courtesy of HYUNDAI MOTOR CO.

8. Remove the water pump pulley (A).

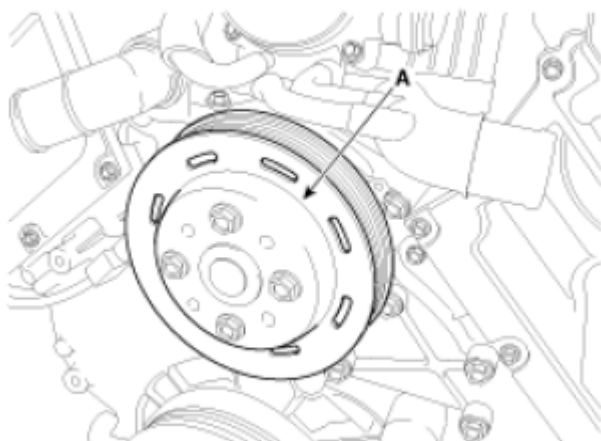


Fig. 7: Identifying Water Pump Pulley
Courtesy of HYUNDAI MOTOR CO.

9. Remove the oil filter & cooler assembly (B).

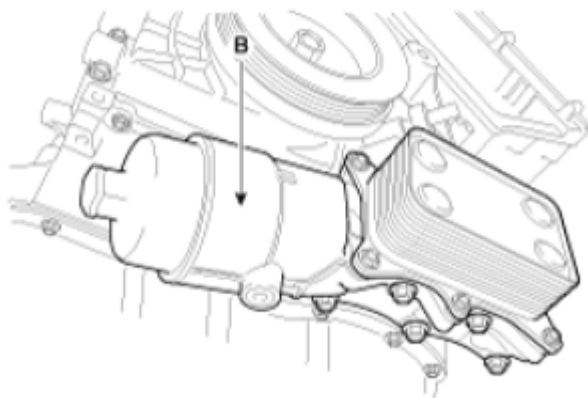


Fig. 8: Identifying Oil Filter & Cooler Assembly
Courtesy of HYUNDAI MOTOR CO.

10. Remove the lower oil pan(A).

Insert the blade of SST(09215-3C000) between the upper oil pan and the lower oil pan. Cut off applied sealer and remove the lower oil pan.

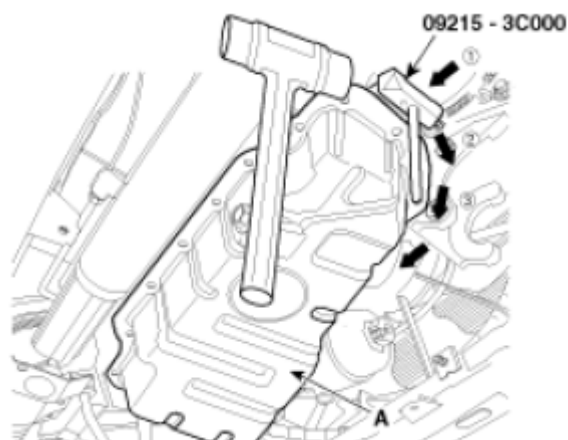


Fig. 9: Cutting Sealer To Remove Lower Oil Pan
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Insert the SST between the lower oil pan and the upper oil pan by tapping it with a plastic hammer in the direction of (1) arrow.
- After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the lower oil pan, remove it from the lower oil pan.
- Do not use the SST as a prybar. Hold the tool in position (on the gasket line) and tap in with a light hammer.
- Be careful not to damage the contact surfaces of Upper oil pan and lower oil pan.

11. Remove the upper oil pan (A).

Insert the blade of SST(09215-3C000) between the upper oil pan and the cylinder block. Cut off applied sealer and remove upper oil pan.

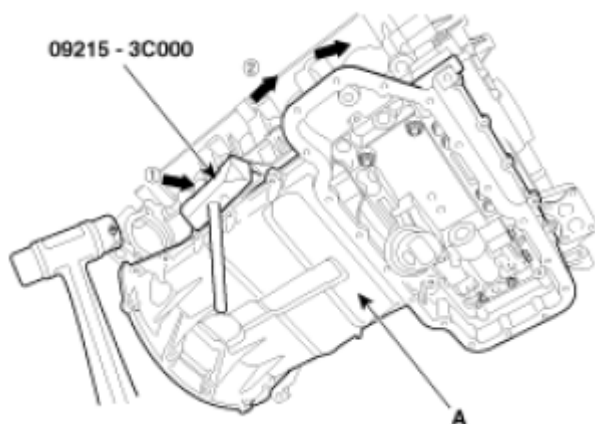


Fig. 10: Cutting Sealer To Remove Upper Oil Pan
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Insert the SST between the upper oil pan and the cylinder block by tapping it with a plastic hammer in the direction of (1) arrow.
- After tapping the SST with a plastic hammer along the direction of (2) arrow around more than 2/3 edge of the upper oil pan, remove it from the upper oil pan.
- Do not use the SST as a prybar. Hold the tool in position (on the gasket line) and tap in with a light hammer.
- Be careful not to damage the contact surfaces of Upper oil pan and cylinder block.

12. Remove the crankshaft pulley (A).

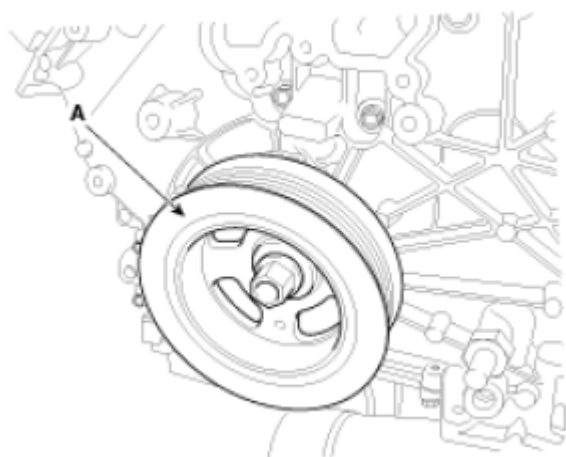


Fig. 11: Identifying Crankshaft Pulley

Courtesy of HYUNDAI MOTOR CO.

NOTE: Use the SST (ring gear stopper, 09231-2B100) to remove the crankshaft pulley bolt, after remove the starter.

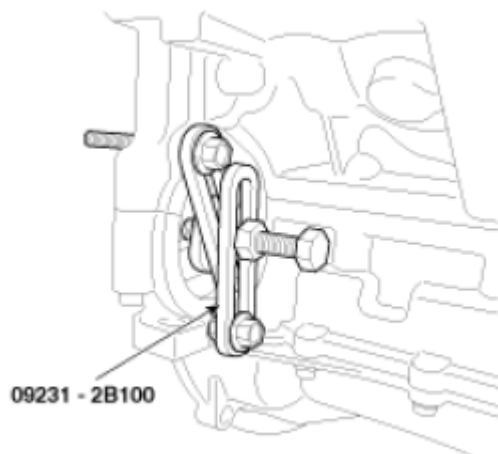


Fig. 12: Removing Crankshaft Pulley Bolt
Courtesy of HYUNDAI MOTOR CO.

13. Remove the front oil seal (A).

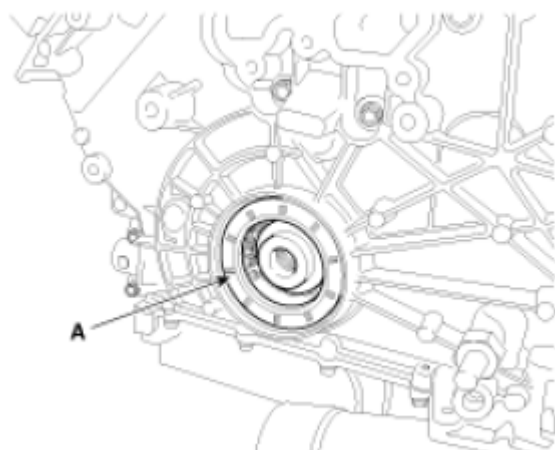


Fig. 13: Identifying Front Oil Seal
Courtesy of HYUNDAI MOTOR CO.

14. Remove the water pump (A).

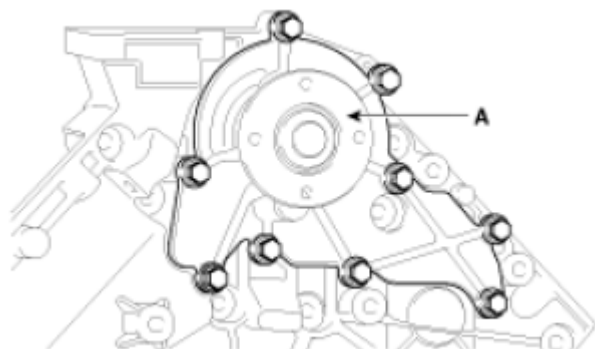


Fig. 14: Identifying Water Pump
Courtesy of HYUNDAI MOTOR CO.

15. Remove the water temperature control assembly (A).

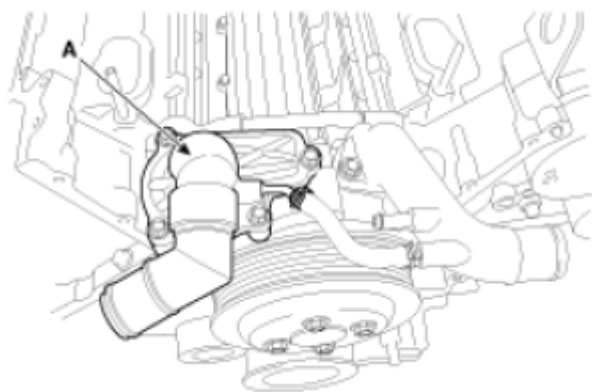


Fig. 15: Identifying Water Temperature Control Assembly
Courtesy of HYUNDAI MOTOR CO.

16. Remove the O-ring (A) from the water temperature control assembly.

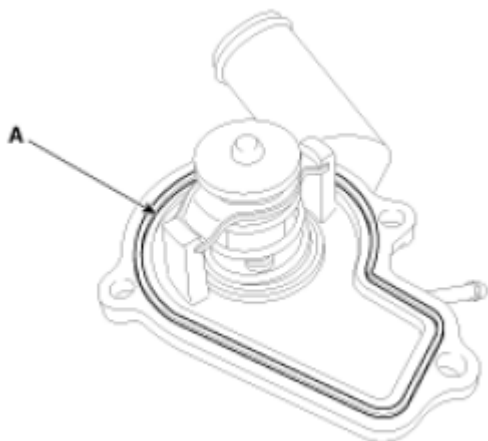


Fig. 16: Identifying O-Ring Of Water Temperature Control Assembly
Courtesy of HYUNDAI MOTOR CO.

17. Remove the timing chain lower cover (A).

[Front]

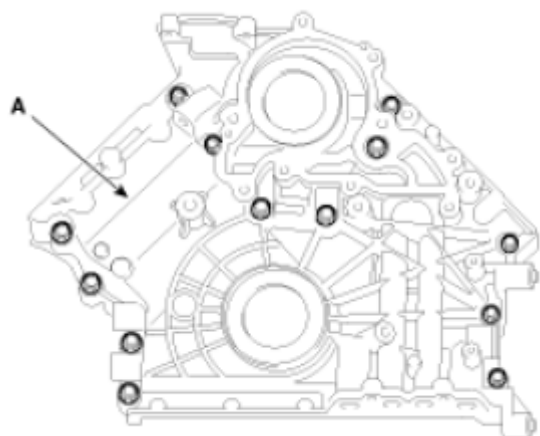


Fig. 17: Identifying Timing Chain Lower Cover (Front)
Courtesy of HYUNDAI MOTOR CO.

[Rear]

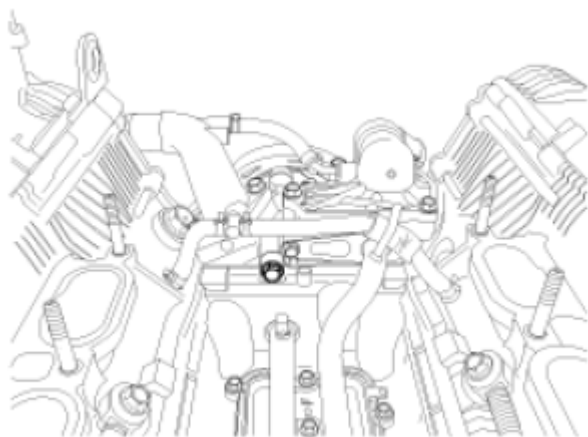


Fig. 18: Identifying Timing Chain Lower Cover (Rear)
Courtesy of HYUNDAI MOTOR CO.

18. Remove the O-ring (A) from the timing chain cover.

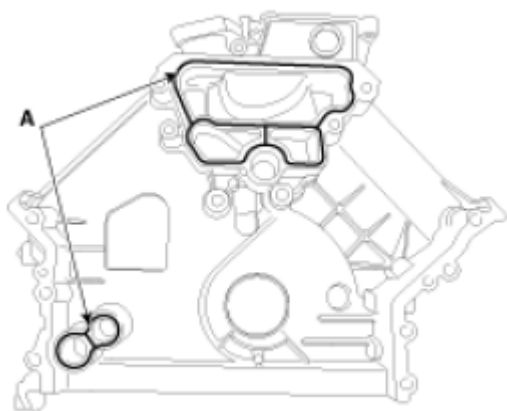


Fig. 19: Identifying O-Ring Of Timing Chain Cover
 Courtesy of HYUNDAI MOTOR CO.

19. Remove the timing chain tensioner arm (A) and the timing chain guide (B) and then remove the timing chain.

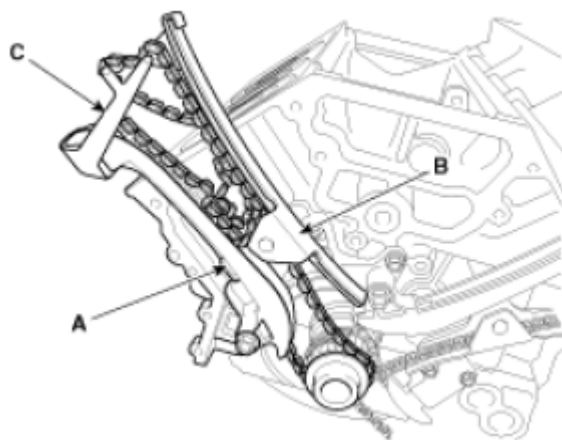


Fig. 20: Identifying Timing Chain Tensioner Arm
 Courtesy of HYUNDAI MOTOR CO.

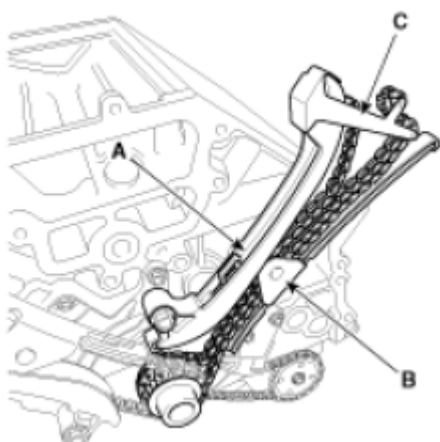


Fig. 21: Identifying Timing Chain Guide
Courtesy of HYUNDAI MOTOR CO.

20. Insert a set pin after compressing the oil pump chain tensioner (A) and then remove the oil pump sprocket (B) and chain (C).

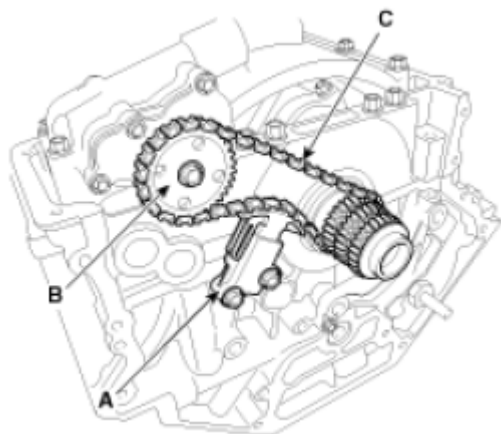


Fig. 22: Identifying Oil Pump Chain Tensioner, Oil Pump Sprocket And Chain
Courtesy of HYUNDAI MOTOR CO.

21. Remove the crankshaft sprocket (A) and friction plates (B).

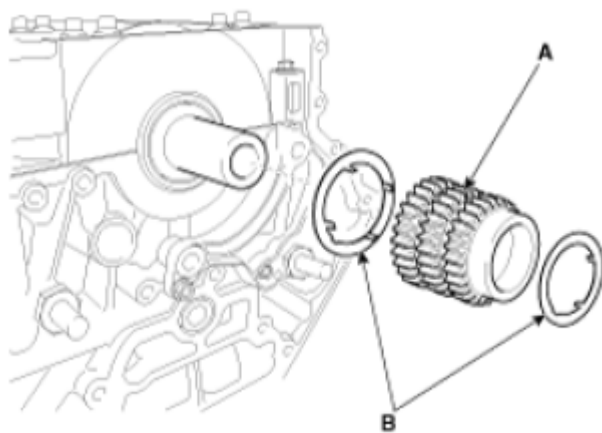


Fig. 23: Identifying Crankshaft Sprocket And Friction Plates
Courtesy of HYUNDAI MOTOR CO.

22. Remove the tensioner adapter (A) and the timing chain guide bolts (B).

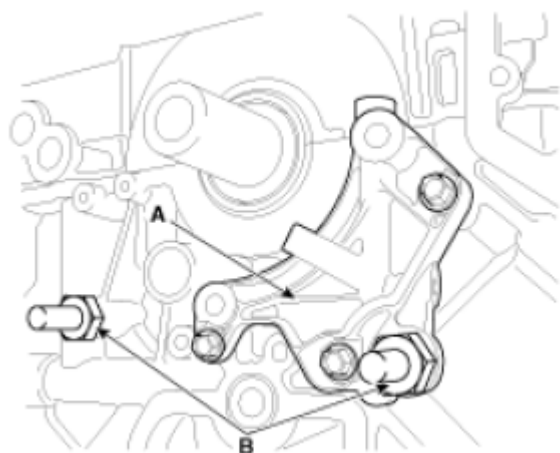


Fig. 24: Identifying Tensioner Adapter And Timing Chain Guide Bolts
Courtesy of HYUNDAI MOTOR CO.

Inspection

Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

1. Check the camshaft sprocket and crankshaft sprocket for abnormal wear, cracks, or damage. Replace as necessary.
2. Inspect the tensioner arm and chain guide for abnormal wear, cracks, or damage. Replace as necessary.
3. Check that the tensioner piston moves smoothly when the ratchet pawl is released with thin rod.

Installation

1. Install the tensioner adapter (A) and the timing chain guide bolts (B).

Tightening torque:

Tensioner adapter bolts:

21.6 ~ 25.5N.m (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

Timing chain guide bolts:

21.6 ~ 25.5N.m (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

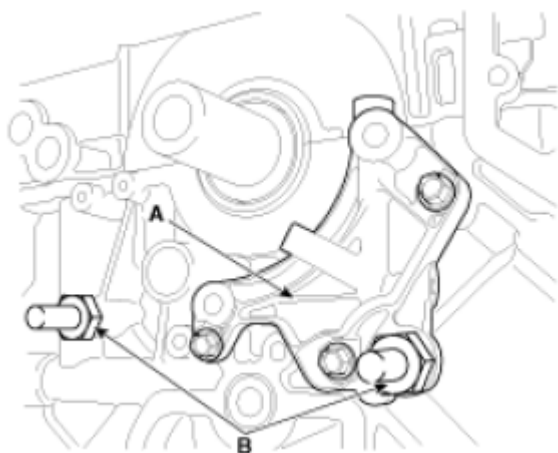


Fig. 25: Identifying Tensioner Adapter And Timing Chain Guide Bolts
Courtesy of HYUNDAI MOTOR CO.

2. Install the crankshaft sprocket (A) with the friction plates (B).

NOTE: Completely fix the four friction plate clips and the sprocket groove. Align the key-home of the friction plate with the key-home of the sprocket. Be careful for the clip not to be folded. The block is placed at bottom up before install the timing chain system and timing chain cover assembly.

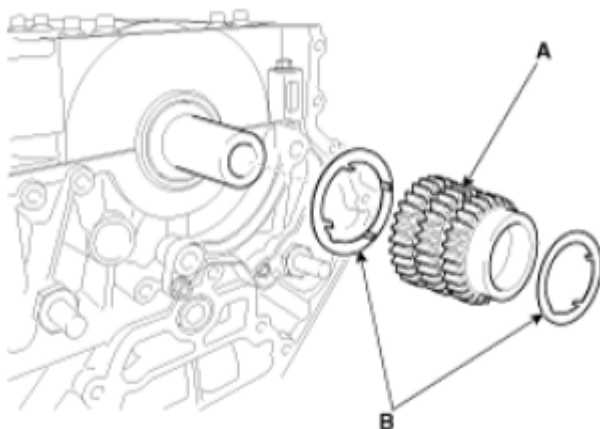


Fig. 26: Identifying Crankshaft Sprocket With Friction Plates
Courtesy of HYUNDAI MOTOR CO.

CAUTION: The mark of friction plate should be placed top. (Engine is placed bottom up)

3. Install the oil pump chain (C) with the oil pump sprocket (B) and oil pump chain tensioner (A).

Tightening torque:

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

B: 21.6 ~ 25.5N.m (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

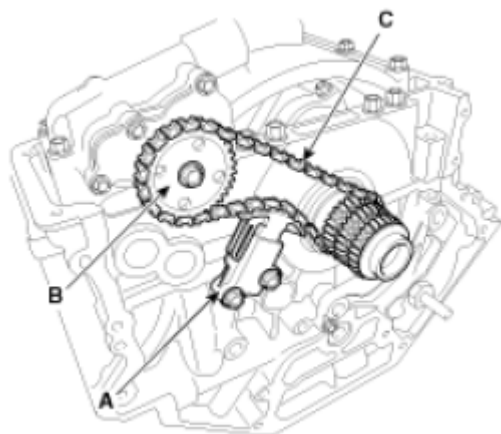


Fig. 27: Identifying Oil Pump Chain Tensioner, Oil Pump Sprocket And Oil Pump Chain
Courtesy of HYUNDAI MOTOR CO.

4. Install the timing chain with the timing chain tensioner arm (A), the timing chain guide (B) and the timing chain locking tool (SST: 09231-2J600) (C).

Tightening torque:

Timing chain tensioner arm bolts:

21.6 ~ 25.5N.m (2.2 ~ 2.6kgf.m, 15.9 ~ 18.8lb-ft)

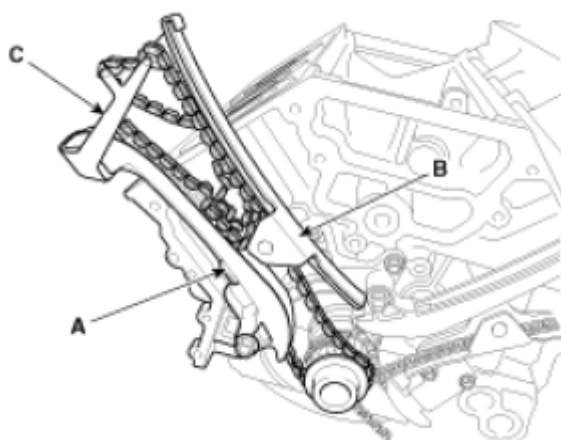


Fig. 28: Installing Timing Chain With Timing Chain Tensioner Arm (Right Side)
Courtesy of HYUNDAI MOTOR CO.

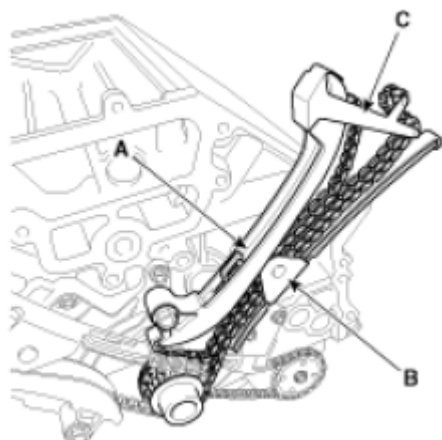


Fig. 29: Installing Timing Chain With Timing Chain Tensioner Arm (Left Side)
Courtesy of HYUNDAI MOTOR CO.

NOTE: Align the timing mark of the friction plate and crankshaft sprocket.

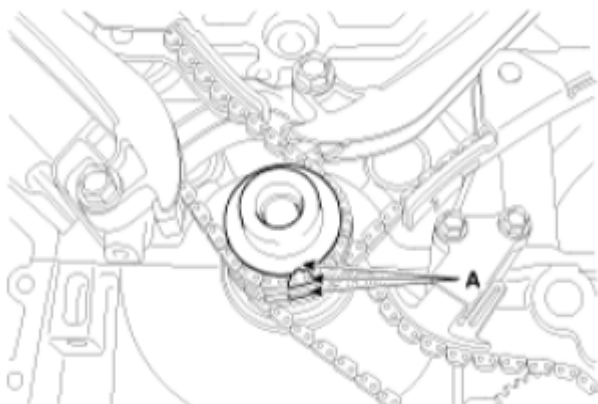


Fig. 30: Identifying Timing Mark Of Friction Plate And Crankshaft Sprocket
Courtesy of HYUNDAI MOTOR CO.

5. Install the timing chain lower cover.

NOTE: Assemble the timing chain lower cover with engine bottom up condition.

1. The sealant locations on chain lower cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and etc.
2. Install the new gasket (A) to the timing chain lower cover.

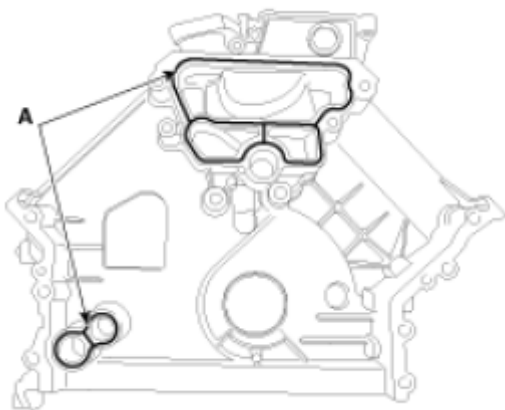


Fig. 31: Identifying Gasket
Courtesy of HYUNDAI MOTOR CO.

3. Apply liquid sealant LT 5900H or equivalent on timing chain lower cover. The part must be assembled within 5 minutes after sealant was applied.

Sealant should be applied in a continuous bead in each of the areas indicated below.

Bead width: $\varnothing 2.5 \pm 0.5\text{mm}$

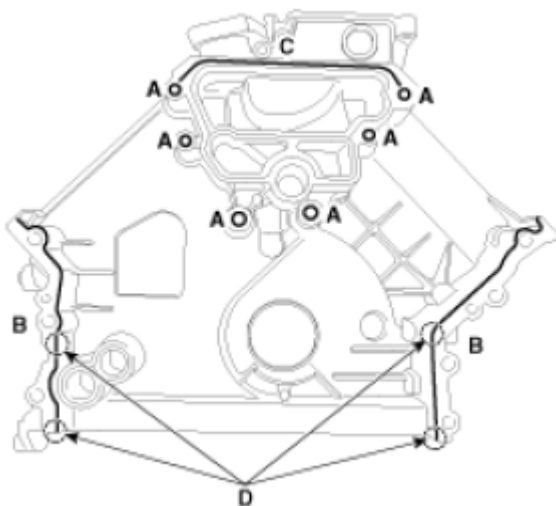


Fig. 32: Identifying Sealant Applying Area Of Timing Chain Lower Cover
Courtesy of HYUNDAI MOTOR CO.

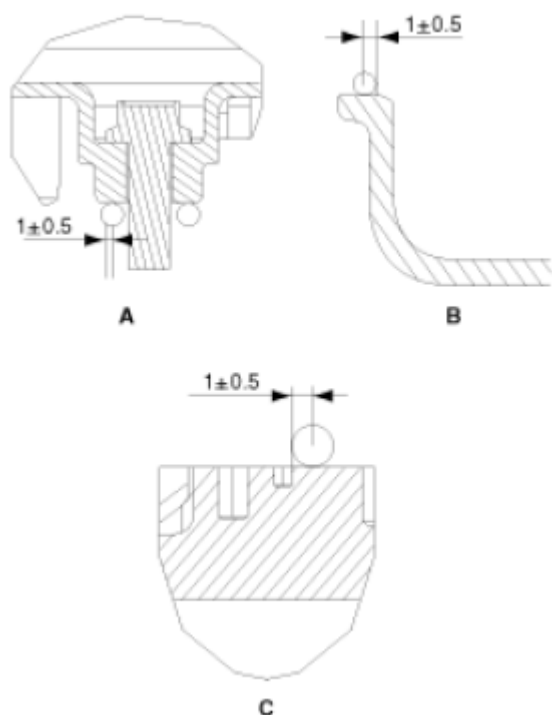


Fig. 33: Identifying Sealant Applying Areas
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- During timing chain lower cover installation, care not to take off applied sealant on the timing chain lower cover by contact with other parts.
 - Apply sealant in a 4.0 ± 0.5 mm wide spot for the 4 T-joints (D).
4. The dowel pins on the cylinder block and holes on the timing chain lower cover should be used as a reference in order to assemble the timing chain lower cover to be in exact position.

Tightening torque:

23.5 ~ 27.5N.m (2.4 ~ 2.8kgf.m, 17.4 ~ 20.3lb-ft)

[Front]

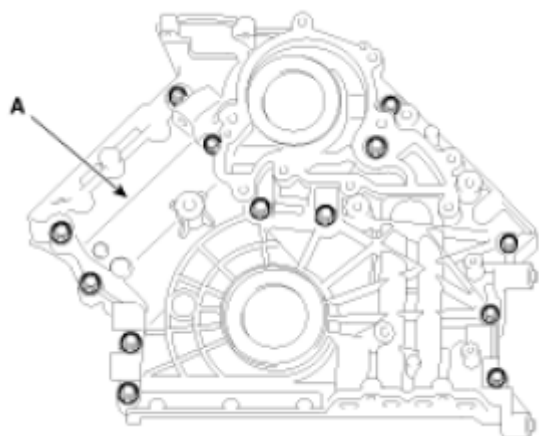


Fig. 34: Identifying Holes On Timing Chain Lower Cover (Front)
Courtesy of HYUNDAI MOTOR CO.

[Rear]

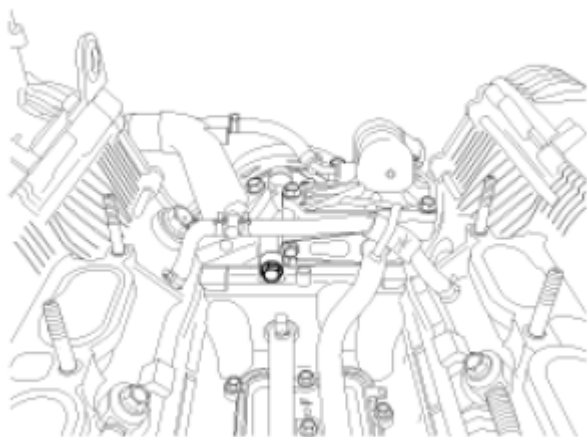


Fig. 35: Identifying Hole On Timing Chain Lower Cover (Rear)
Courtesy of HYUNDAI MOTOR CO.

5. Running the engine or performing a pressure test should not be performed within 30 minutes of assembly.
6. Install the cylinder head assembly. (Refer to CYLINDER HEAD ASSEMBLY in this group)

NOTE: Before install the cylinder head assembly, place the engine up right.

7. Install the camshaft assembly. (Refer to CYLINDER HEAD ASSEMBLY in this group)
8. Remove the SST from the timing chain guide and the timing chain tensioner arm.
9. Install the timing chain to the CVVT sprocket. (Refer to CYLINDER HEAD ASSEMBLY in this group)

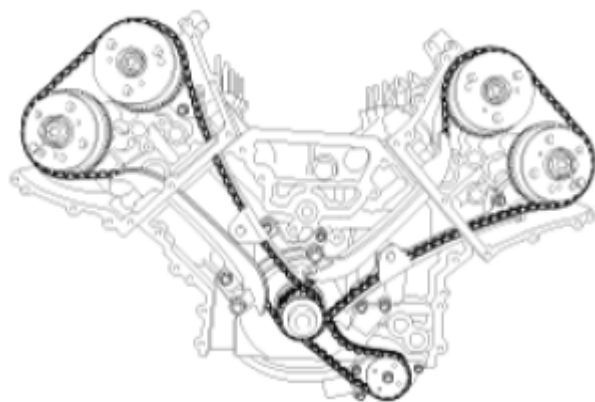


Fig. 36: Identifying Timing Chain On CVVT Sprocket
Courtesy of HYUNDAI MOTOR CO.

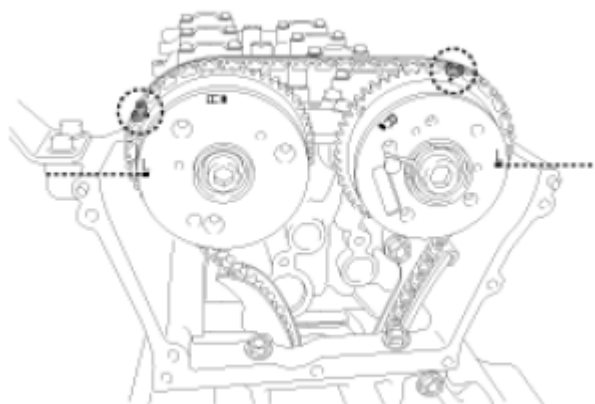


Fig. 37: Identifying Timing Marks Of Sprockets (1 Of 3)
Courtesy of HYUNDAI MOTOR CO.

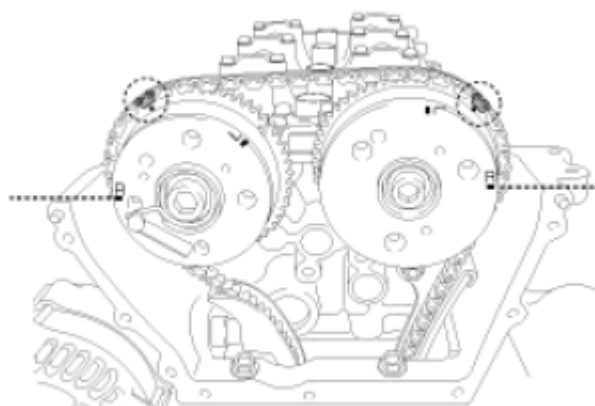


Fig. 38: Identifying Timing Marks Of Sprockets (2 Of 3)
Courtesy of HYUNDAI MOTOR CO.

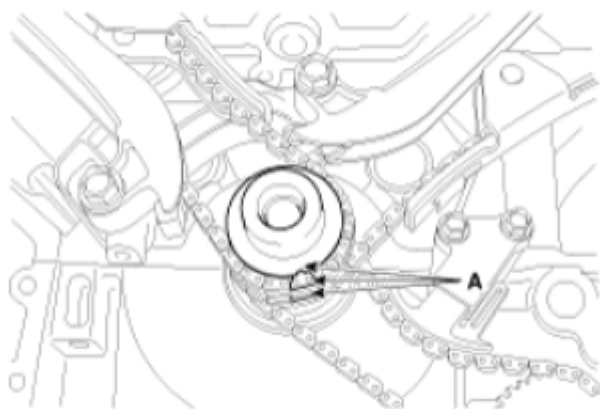


Fig. 39: Identifying Timing Marks Of Sprockets (3 Of 3)

Courtesy of HYUNDAI MOTOR CO.

NOTE: To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket --> Timing chain guide --> Exhaust CVVT sprocket --> Intake CVVT sprocket. (LH Bank)
Crankshaft sprocket --> Timing chain guide --> Intake CVVT sprocket --> Exhaust CVVT sprocket. (RH Bank)
The timing mark of each sprockets should be matched with timing mark (color link) of timing chain during installation.

10. Install the timing chain tensioner. (Refer to CYLINDER HEAD ASSEMBLY in this group)

Tightening torque:

78.5 ~ 88.3N.m (8.0 ~ 9.0kgf.m, 57.9 ~ 65.1lb-ft)

11. After rotating the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.

NOTE: Always turn the crankshaft clockwise.
Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

12. Install the O-ring (A) to the water temperature control assembly.

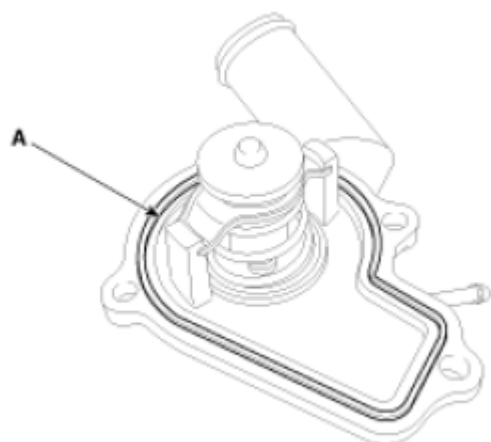


Fig. 40: Identifying O-Ring Of Water Temperature Control Assembly
Courtesy of HYUNDAI MOTOR CO.

13. Install the water temperature control assembly (A).

Tightening torque:

16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)



Fig. 41: Identifying Water Temperature Control Assembly
Courtesy of HYUNDAI MOTOR CO.

14. Install the water pump (A).

Tightening torque:

19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)

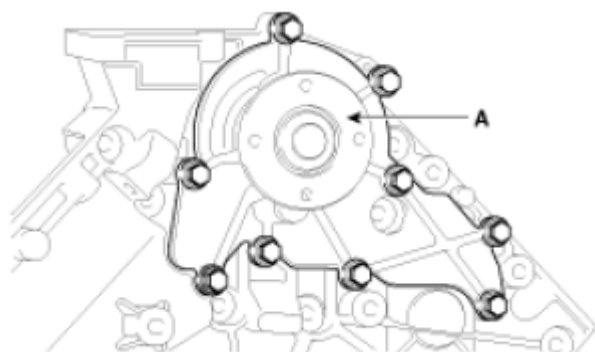


Fig. 42: Identifying Water Pump
Courtesy of HYUNDAI MOTOR CO.

15. Using SST(09231-2J300, 09231-H1100), Install the front oil seal (A).

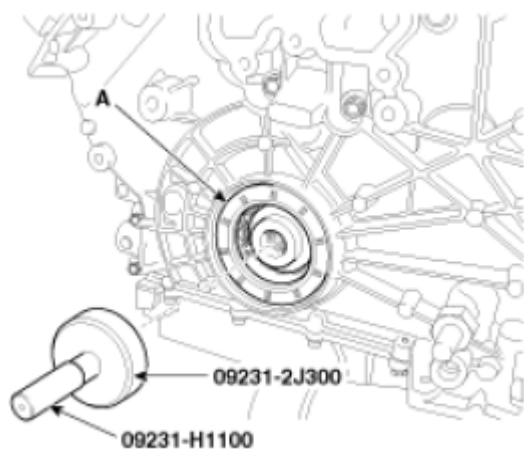


Fig. 43: Installing Front Oil Seal Using SST
Courtesy of HYUNDAI MOTOR CO.

16. Install the crankshaft pulley (A).

Tightening torque:

392.3~402.1N.m(40.0~41.0kgf.m,289.3~296.6lb-ft)

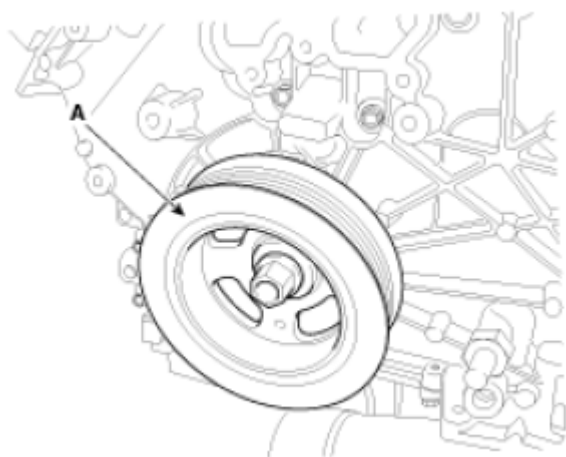


Fig. 44: Identifying Crankshaft Pulley
Courtesy of HYUNDAI MOTOR CO.

NOTE: Use the SST (ring gear stopper, 09231-2B100) to install the crankshaft pulley bolt, after remove the starter.

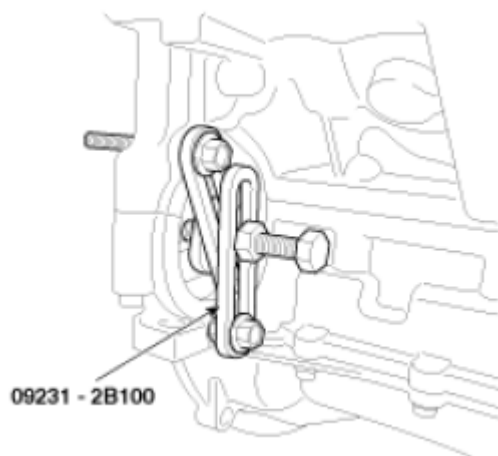


Fig. 45: Installing Crankshaft Pulley Bolt Using SST (Ring Gear Stopper, 09231-2B100)
Courtesy of HYUNDAI MOTOR CO.

17. Install the upper oil pan.

1. Using a gasket scraper, remove all the old gasket material from the gasket surfaces.
2. Before assembling the oil pan, the liquid sealant LT 5900H or equivalent should be applied on upper oil pan.

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

Bead width: 2.5mm (0.1in)

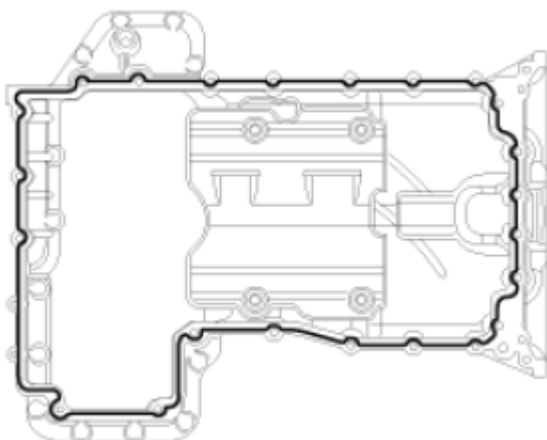


Fig. 46: Identifying Sealant Applying Area Of Upper Oil Pan
Courtesy of HYUNDAI MOTOR CO.

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 the upper oil pan.

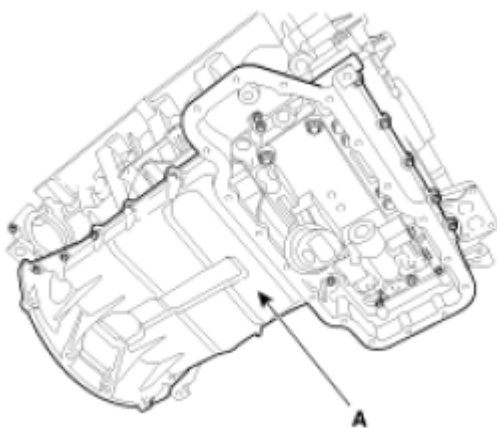


Fig. 47: Identifying Upper Oil Pan
Courtesy of HYUNDAI MOTOR CO.

Uniformly tighten the bolts in several passes.

Tightening torque:

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

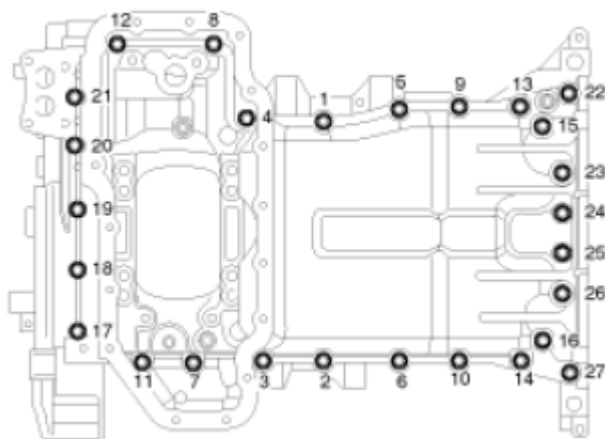


Fig. 48: Upper Oil Pan Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

18. Install the lower oil pan.

1. Using a gasket scraper, remove all the old gasket material from the gasket surfaces.
2. Before assembling the oil pan, the liquid sealant LT5900H or equivalent should be applied on lower oil pan.

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

Bead width: 2.5mm (0.1in)



Fig. 49: Identifying Sealant Applying Area Of Lower Oil Pan
Courtesy of HYUNDAI MOTOR CO.

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 the lower oil pan.

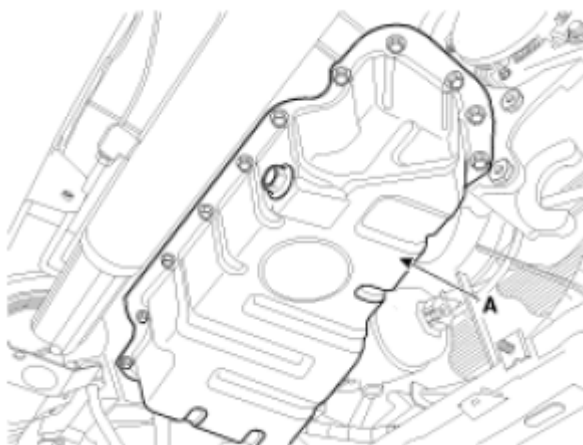


Fig. 50: Identifying Lower Oil Pan
Courtesy of HYUNDAI MOTOR CO.

Uniformly tighten the bolts in several passes.

Tightening torque:

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

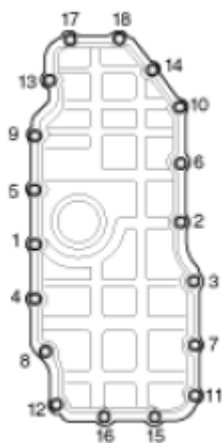


Fig. 51: Lower Oil Pan Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

19. Install the oil filter & cooler assembly (B).

Tightening torque:

19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

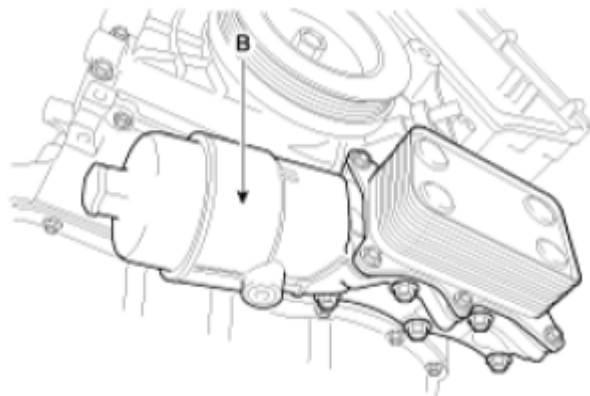


Fig. 52: Identifying Oil Filter & Cooler Assembly
Courtesy of HYUNDAI MOTOR CO.

20. Install the water pump pulley (A).

Tightening torque:

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

NOTE: Tighten each bolt gradually in a criss-cross pattern until the final tightening torque has been reached.

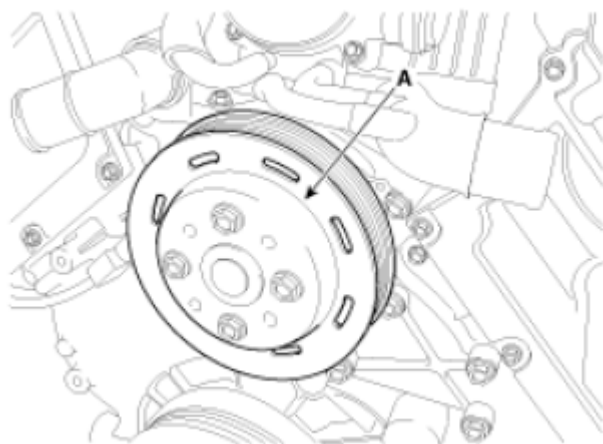


Fig. 53: Identifying Water Pump Pulley
Courtesy of HYUNDAI MOTOR CO.

21. Install the drive belt tensioner (A).

Tightening torque:

19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

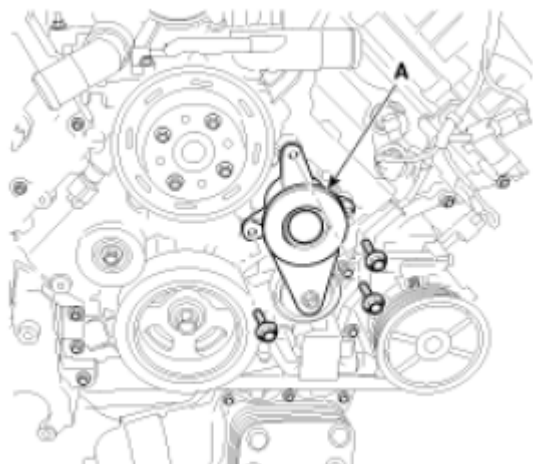


Fig. 54: Identifying Drive Belt Tensioner
Courtesy of HYUNDAI MOTOR CO.

22. Install the drive belt idler (A).

Tightening torque:

37.3 ~ 41.2N.m (3.8 ~ 4.2kgf.m, 27.5 ~ 30.4lb-ft)

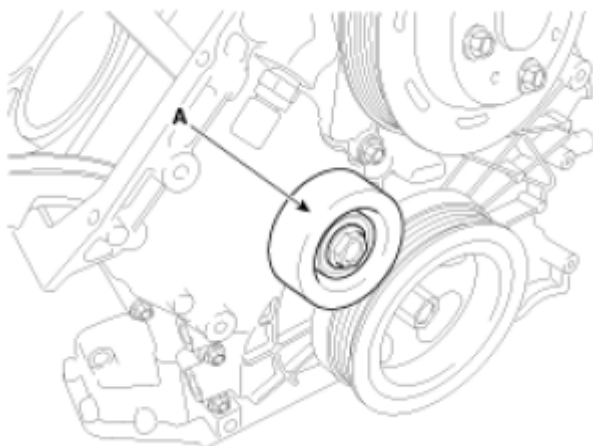


Fig. 55: Identifying Drive Belt Idler
Courtesy of HYUNDAI MOTOR CO.

23. Install the air conditioner compressor (A). (Refer to **INSTALLATION**)

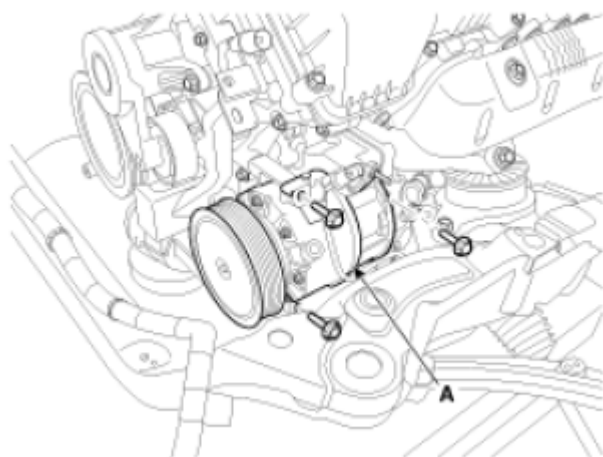


Fig. 56: Identifying Air Conditioner Compressor
Courtesy of HYUNDAI MOTOR CO.

24. Install the alternator bracket (A).

Tightening torque:

Bolts (B) 4EA:

29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)

Bolt (C) 1EA:

19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)

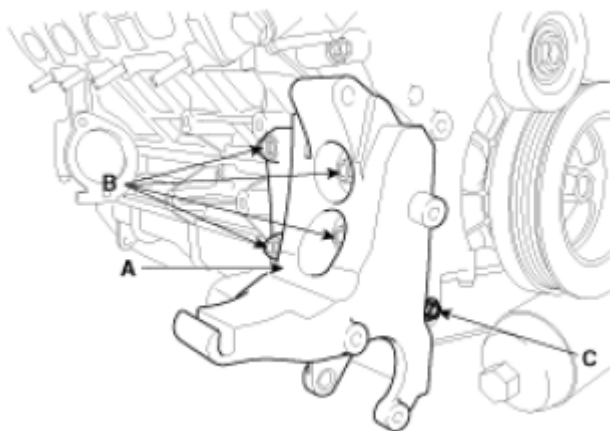


Fig. 57: Identifying Alternator Bracket
Courtesy of HYUNDAI MOTOR CO.

25. Install the alternator (A). (Refer to **INSTALL**)

Tightening torque:

29.4 ~ 41.2N.m (3.0 ~ 4.2kgf.m, 21.7 ~ 30.4lb-ft)

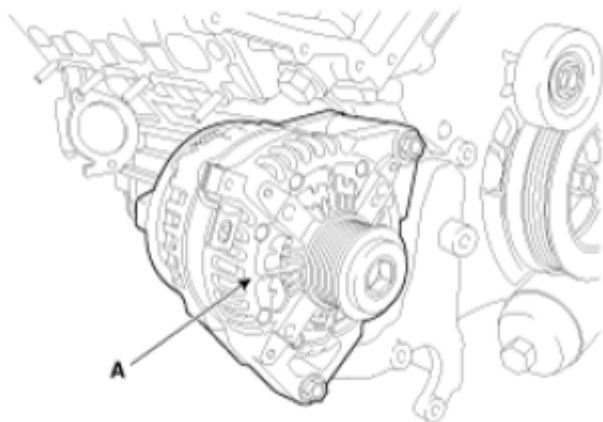


Fig. 58: Identifying Alternator
Courtesy of HYUNDAI MOTOR CO.

26. Install the removed parts. (Refer to **CYLINDER HEAD ASSEMBLY** installation procedure in this group)

2011 ENGINE

Engine Cylinder Block - Equus

CYLINDER BLOCK

COMPONENTS AND COMPONENTS LOCATION

Components

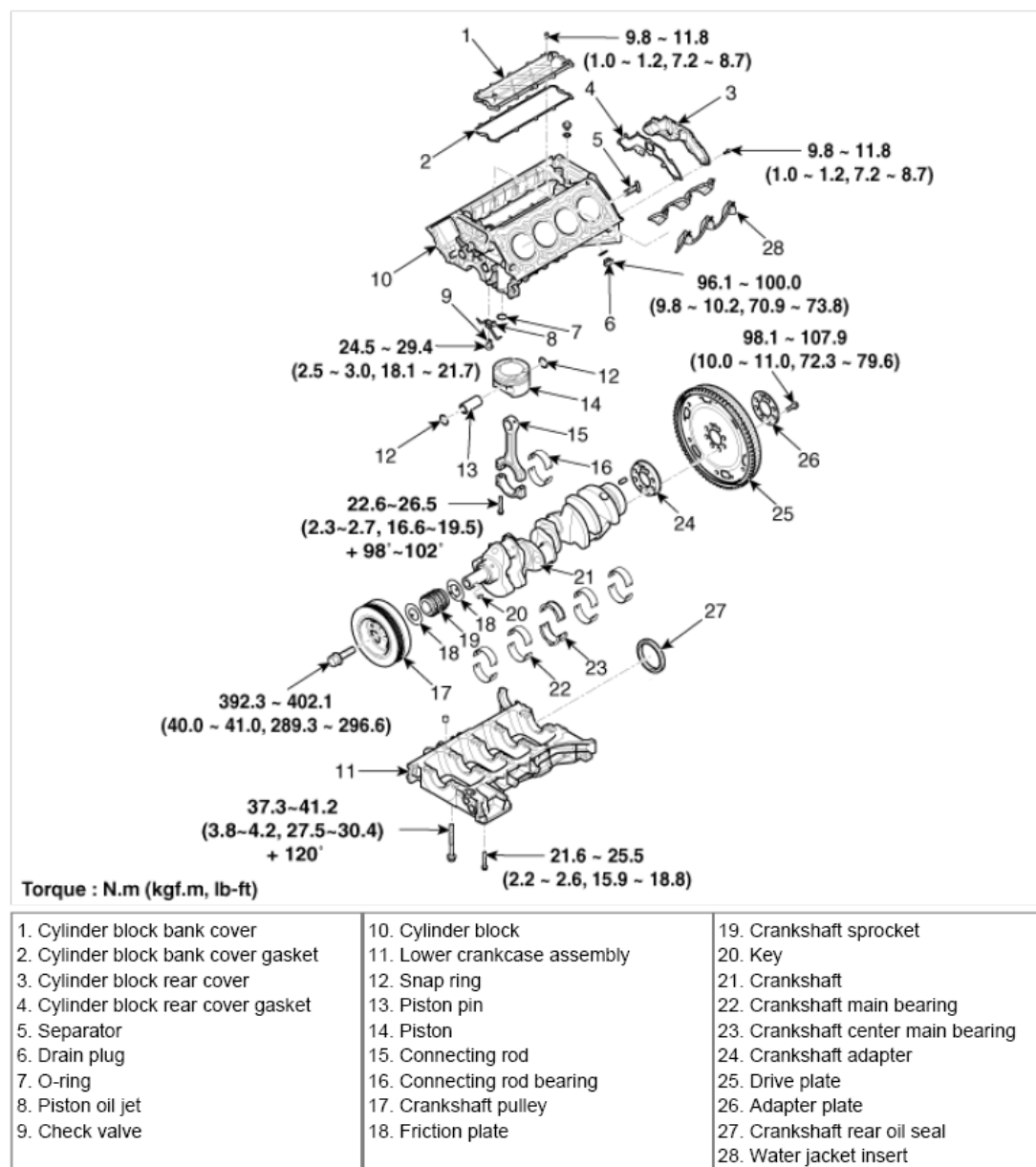


Fig. 1: Exploded View Of Cylinder Block With Torque Specifications
 Courtesy of HYUNDAI MOTOR CO.

REPAIR PROCEDURES

Disassembly

Engine removal is required for this procedure.

CAUTION:

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.
- 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 misconception.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

1. Remove the engine assembly from the vehicle. (Refer to ENGINE AND TRANSAXLE ASSEMBLY in this group)
2. Attach the engine to engine stand for disassembly.
3. Remove the intake manifold and exhaust manifold. (Refer to INTAKE AND EXHAUST SYSTEM in this group)
4. Remove the cylinder head. (Refer to CYLINDER HEAD in this group)
5. Remove the timing chain. (Refer to TIMING SYSTEM in this group)
6. Remove the engine coolant temperature control assembly. (Refer to COOLING SYSTEM in this group)
7. Remove the oil pump. (Refer to LUBRICATION SYSTEM in this group)
8. Remove the adapter plate (A) and the drive plate (B).

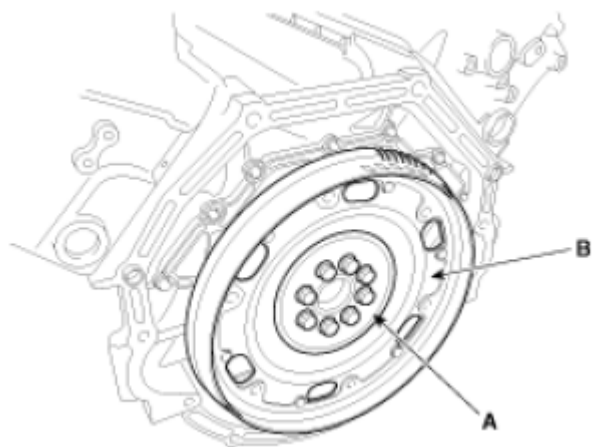


Fig. 2: Identifying Adapter Plate And Drive Plate
Courtesy of HYUNDAI MOTOR CO.

9. Remove the crankshaft adapter (A).

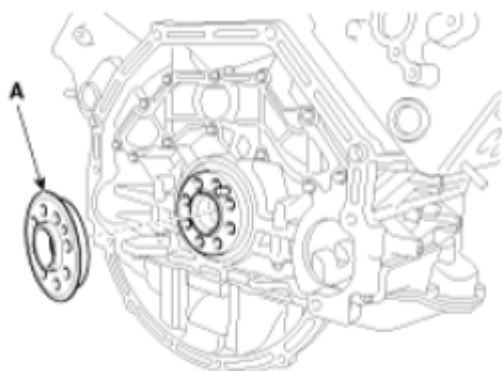


Fig. 3: Identifying Crankshaft Adapter
Courtesy of HYUNDAI MOTOR CO.

10. Remove the cylinder block rear cover (A).

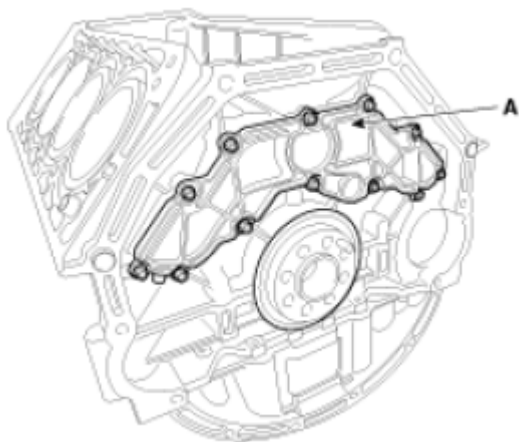


Fig. 4: Identifying Cylinder Block Rear Cover
Courtesy of HYUNDAI MOTOR CO.

11. Remove the separator (A) and the water jacket inserts (B).

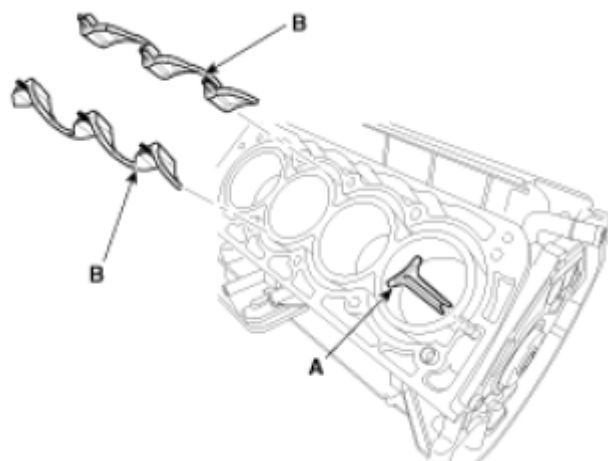


Fig. 5: Identifying Separator And Water Jacket Inserts
Courtesy of HYUNDAI MOTOR CO.

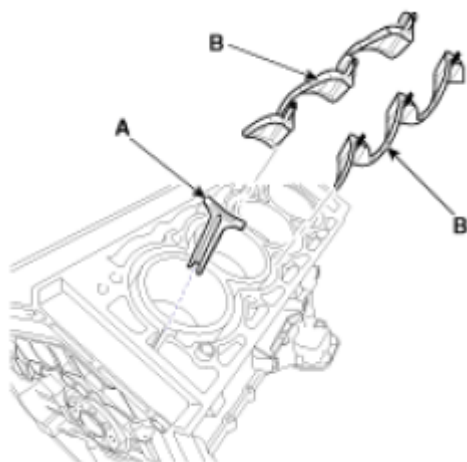


Fig. 6: Identifying Separator And Water Jacket Inserts
Courtesy of HYUNDAI MOTOR CO.

12. Remove the cylinder block bank cover (A) and the gasket (B).

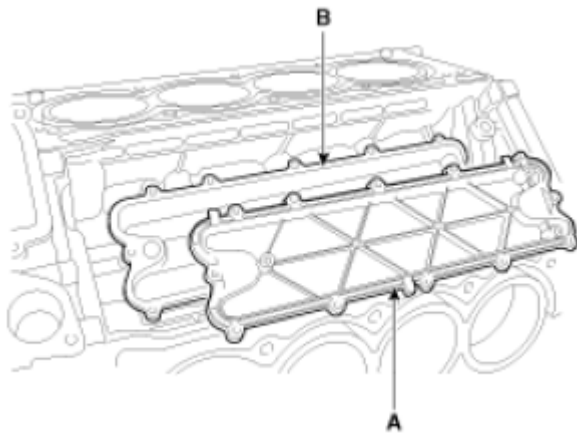


Fig. 7: Identifying Cylinder Block Bank Cover And Gasket
Courtesy of HYUNDAI MOTOR CO.

13. Check the connecting rod end play.
14. Check the connecting rod cap oil clearance.
15. Remove the piston and connecting rod assemblies.
 1. Using a ridge reamer, remove all the carbon from the top of the cylinder.
 2. Remove the connecting rod cap (A).

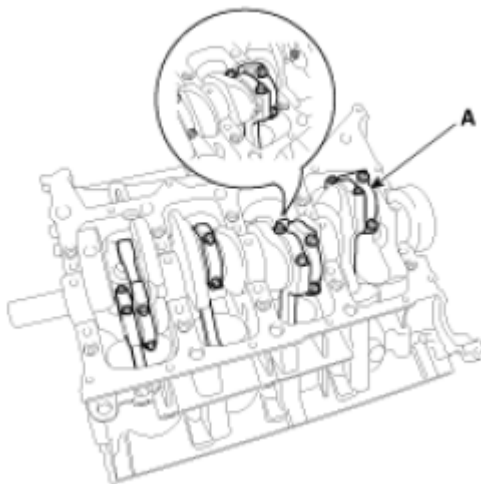


Fig. 8: Identifying Connecting Rod Cap
Courtesy of HYUNDAI MOTOR CO.

3. Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

NOTE:

- **Keep the bearings, connecting rod and cap together.**
- **Arrange the piston and connecting rod assemblies in the correct order.**

16. Check the main bearing oil clearance.
17. Check the crankshaft end play.
18. Remove the lower crankcase assembly (A).

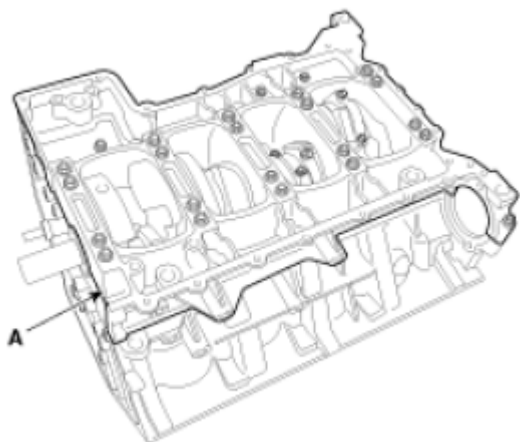


Fig. 9: Identifying Lower Crankcase Assembly
Courtesy of HYUNDAI MOTOR CO.

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

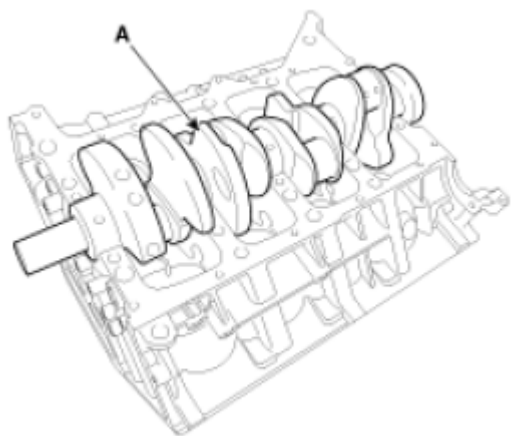


Fig. 10: Identifying Crankshaft
Courtesy of HYUNDAI MOTOR CO.

NOTE: Arrange the main bearings and center bearings in the correct order.

20. Check fit between piston and piston pin.

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

21. Remove the piston rings.

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

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

22. Disconnect connecting rod from piston.
 1. Remove the snap rings from piston.
 2. Remove the piston pin.
 3. Remove the connecting rod and the piston.

Inspection

Connecting Rod And Crankshaft

1. Check the connecting rod side clearance.

Using a feeler gauge, measure the side clearance between the connecting rod big-end.

Standard side clearance:

0.1 ~ 0.3mm (0.0039 ~ 0.0118in)

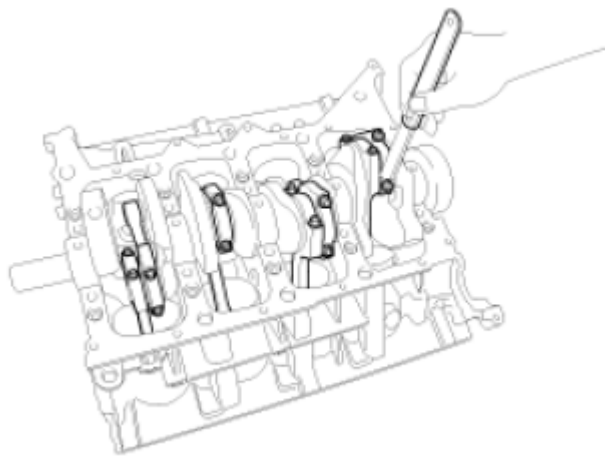


Fig. 11: Measuring Side Clearance Between Connecting Rod Big-End Using Feeler Gauge
Courtesy of HYUNDAI MOTOR CO.

1. If out-of-tolerance, install a new connecting rod.
 2. If still out-of-tolerance, replace the crankshaft.
2. Check the connecting rod bearing oil clearance.
 1. Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
 2. Remove 2 connecting rod cap bolts.
 3. Remove the connecting rod cap and bearing half.

4. Clean the crank pin and bearing.
5. Place plastigage across the crank pin.
6. Reinstall the bearing half and cap, and torque the bolts.

Tightening torque:

22.6~26.5Nm (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 98~102°

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

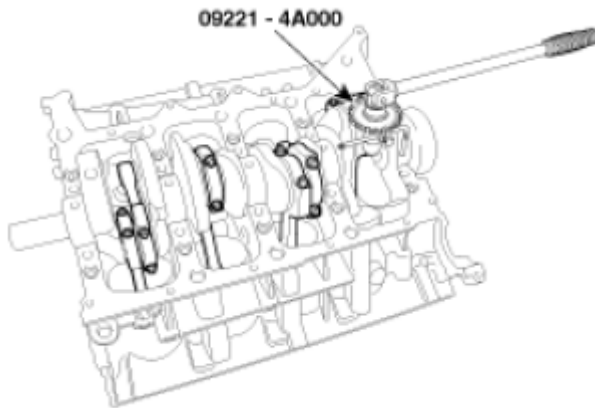


Fig. 12: Checking Connecting Rod Bearing Oil Clearance
Courtesy of HYUNDAI MOTOR CO.

7. Remove 2 bolts, connecting rod cap and bearing half.
8. Measure the plastigage at its widest point.

Standard oil clearance:

0.018 ~ 0.036mm (0.0007 ~ 0.0014in)

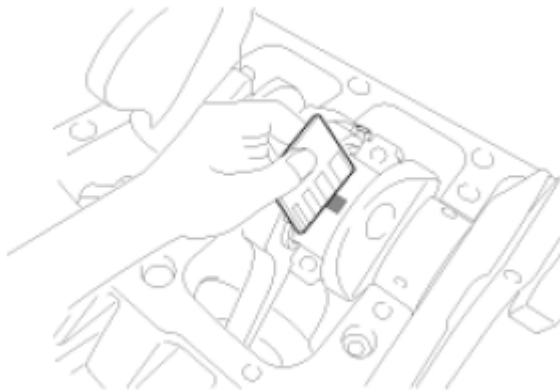


Fig. 13: Removing Bolts, Connecting Rod Cap And Bearing Half
Courtesy of HYUNDAI MOTOR CO.

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. 14: Identifying Connecting Rod Mark Location
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Connecting Rod

CONNECTING ROD SPECIFICATIONS CHART

Class	Mark	Connecting Rod Big-end Inner Diameter
a	A	55.000 ~ 55.006mm (2.1654 ~ 2.1656in)
b	B	55.006 ~ 55.012mm (2.1656 ~ 2.1658in)
c	C	55.012 ~ 55.018mm (2.1658 ~ 2.1661in)

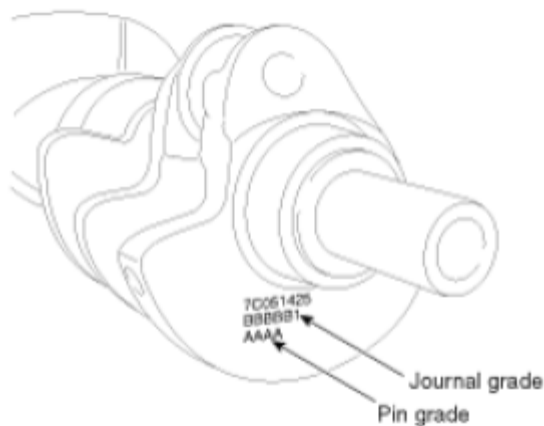
Crankshaft Pin Mark Location

Fig. 15: Identifying Journal Grade And Pin Grade
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Crankshaft Pin Journal**CRANKSHAFT PIN JOURNAL SPECIFICATIONS CHART**

Class	Mark	Crankshaft Pin Journal outer Diameter
I	A	51.994 ~ 52.000mm (2.0470 ~ 2.0472in)
II	B	51.988 ~ 51.994mm (2.0468 ~ 2.0470in)
III	C	51.982 ~ 51.988mm (2.0465 ~ 2.0468in)

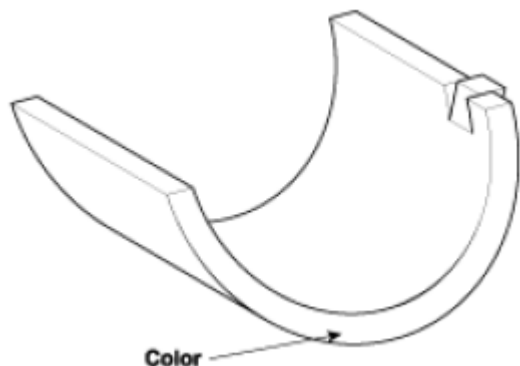
Connecting Rod Bearing Mark Location

Fig. 16: Identifying Connecting Rod Bearing Mark Location
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Connecting Rod Bearing

CONNECTING ROD BEARING SPECIFICATIONS CHART

Class	Color	Connecting Rod Bearing Thickness
A	Blue	1.500 ~ 1.503mm (0.0591 ~ 0.0592in)
B	Black	1.497 ~ 1.500mm (0.0589 ~ 0.0591in)
C	None	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 bearing by using selection table.

Connecting Rod Bearing Selection Table

CONNECTING ROD BEARING SELECTION REFERENCE CHART

Connecting Rod Bearing		Connecting Rod Mark		
		a(A)	b(B)	c(C)
Crank shaft pin journal mark	I(A)	E(Yellow)	D(Green)	C(None)
	II(B)	D(Green)	C(None)	B(Black)
	III(C)	C(None)	B(Black)	A(Blue)

3. Check the connecting rods.

- When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the projections (A) and the front mark (B) of the rod and the cap.

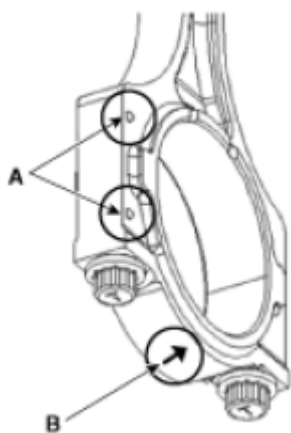


Fig. 17: Identifying Connecting Rod Projections And Front Mark
Courtesy of HYUNDAI MOTOR CO.

- Replace the connecting rod if it is damaged on the thrust faces at either end. Also if step wear or a

severely rough surface of the inside diameter of the small end is apparent, the rod must be replaced as well.

3. Using a connecting rod aligning tool, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

Allowable bend of connecting rod:

0.05mm/100mm (0.0020 in/3.94 in) or less

Allowable twist of connecting rod:

0.1mm/100mm (0.0039 in/3.94 in) or less

NOTE: **The unevenness between the rod and the cap is not allowed when assembling without the bearings.**

Check the crankshaft bearing oil clearance.

1. To check main bearing-to-journal oil clearance, remove the lower crankcase assembly 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 the lower crankcase assembly, and then torque the bolts.

Tightening torque:

Main bearing cap bolts (1~20)

37.3~41.2 N.m (3.8~4.2 kgf.m, 27.5~30.4 lb-ft) + 120°

Flange bolts (21~35)

21.6 ~ 25.5 N.m (2.2 ~ 2.6 kgf.m, 15.9 ~ 18.8 lb-ft)

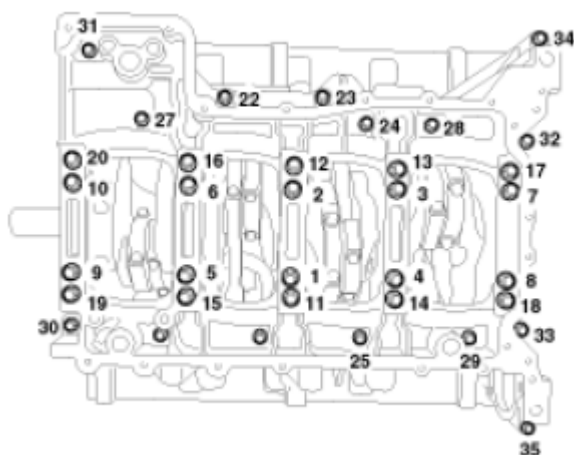


Fig. 18: Identifying Main Bearing Cap Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Do not turn the crankshaft.
- Use the SST (09221-4A000), install main bearing cap bolts.

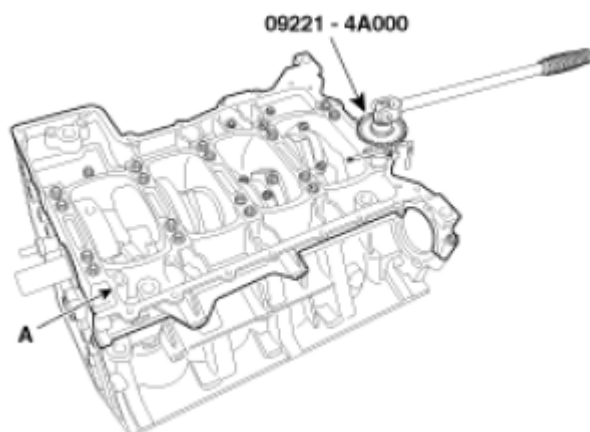


Fig. 19: Installing Main Bearing Cap Bolts Using SST
Courtesy of HYUNDAI MOTOR CO.

5. Remove the lower crankcase assembly and bearing again, and measure the widest part of the plastigage.

Standard oil clearance:

0.004 ~ 0.022mm (0.0002 ~ 0.0009in)

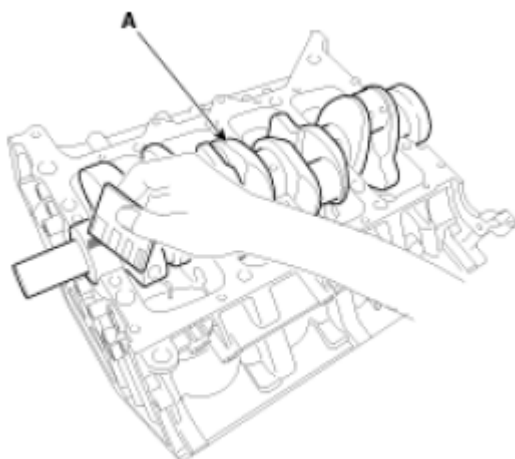


Fig. 20: Removing Lower Crankcase Assembly
Courtesy of HYUNDAI MOTOR CO.

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.

Cylinder block crankshaft journal bore mark location

Letters have been stamped on the block as a mark for the size of each of the 5 main journal bores.

Use them, and the numbers or bar stamped on the crank (marks for main journal size), to choose the correct bearings.

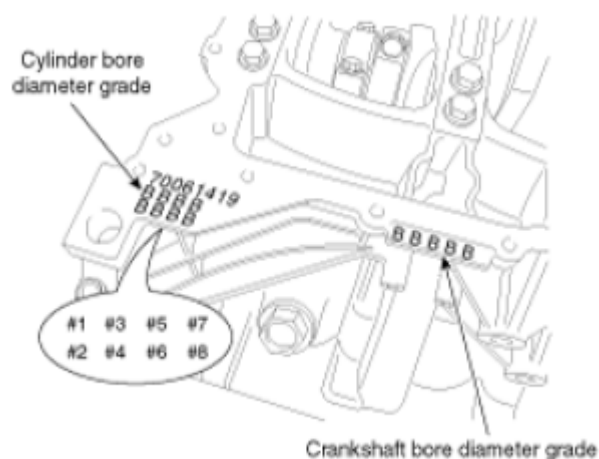


Fig. 21: Identifying Cylinder Bore Diameter Grade And Crankshaft Bore Diameter Grade
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Cylinder Block Crankshaft Journal Bore

CYLINDER BLOCK CRANKSHAFT JOURNAL BORE SPECIFICATIONS CHART

Class	Mark	Cylinder Block Crankshaft journal Bore Inner Diameter
a	A	70.000 ~ 70.006mm (2.7559 ~ 2.7561in)
b	B	70.006 ~ 70.012mm (2.7561 ~ 2.7564in)
c	C	70.012 ~ 70.018mm (2.7564 ~ 2.7566in)

Crankshaft Main Journal Mark Location

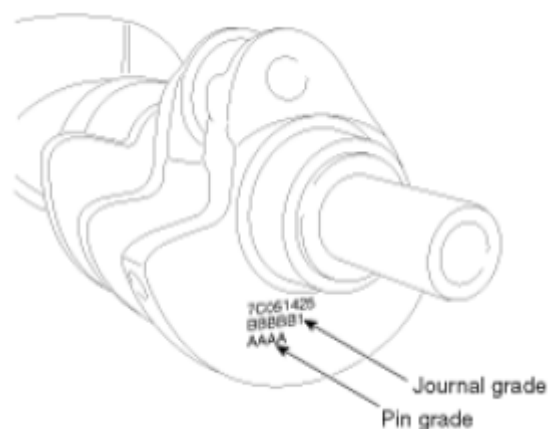


Fig. 22: Identifying Crankshaft Main Journal Mark Location
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Crankshaft Main Journal

CRANKSHAFT MAIN JOURNAL SPECIFICATIONS CHART

Class	Mark	Crankshaft Main Journal outer Diameter
I	A	64.994 ~ 65.000mm (2.5588 ~ 2.5591in)
II	B	64.988 ~ 64.994mm (2.5586 ~ 2.5588in)
III	C	64.982 ~ 64.988mm (2.5583 ~ 2.5586in)

Crankshaft Main Bearing Mark Location

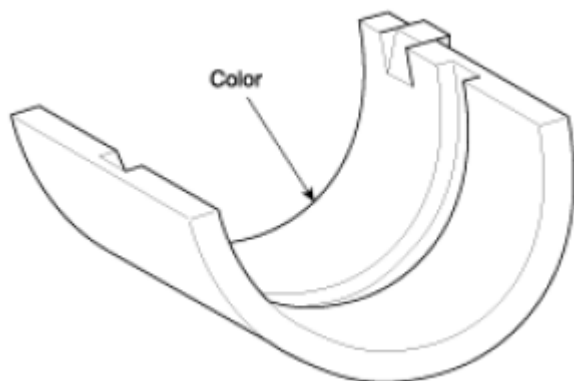


Fig. 23: Identifying Crankshaft Main Bearing Mark Location
Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Crankshaft Main Bearing

CRANKSHAFT MAIN BEARING SPECIFICATIONS CHART

Class	Color	Crankshaft Main Bearing Thickness
A	Blue	2.507 ~ 2.510mm (0.0987 ~ 0.0988in)
B	Black	2.504 ~ 2.507mm (0.0986 ~ 0.0987in)
C	None	2.501 ~ 2.504mm (0.0985 ~ 0.0986in)
D	Green	2.498 ~ 2.501mm (0.0983 ~ 0.0985in)
E	Yellow	2.495 ~ 2.498mm (0.0982 ~ 0.0983in)

(8) Select the bearing by using selection table.

Crankshaft Main Bearing Selection Table

CRANKSHAFT MAIN BEARING SELECTION CHART

--	--

Crankshaft Main Bearing		Cylinder Block Crankshaft Journal Bore Mark		
		A (a)	B (b)	C (c)
Crank shaft main journal mark	I(A)	E(Yellow)	D(Green)	C(None)
	II(B)	D(Green)	C(None)	B(Black)
	III(C)	C(None)	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:

0.10 ~ 0.28mm (0.0039 ~ 0.0110in)

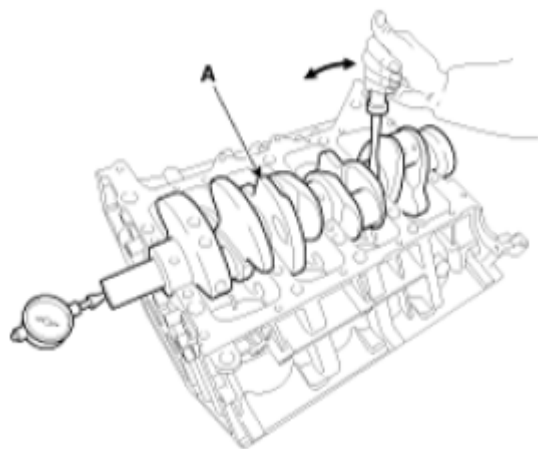


Fig. 24: Measuring Thrust Clearance Using Dial Indicator
Courtesy of HYUNDAI MOTOR CO.

If the end play is greater than maximum, replace the center bearings as a set.

Thrust bearing thickness (center bearing)

2.36 ~ 2.40mm (0.0929 ~ 0.0945in)

6. Inspect main journals and crank pins.

Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter:

64.982 ~ 65.000mm (2.5583 ~ 2.5591in)

Crank pin diameter:

51.982 ~ 52.000mm (2.0465 ~ 2.0472in)

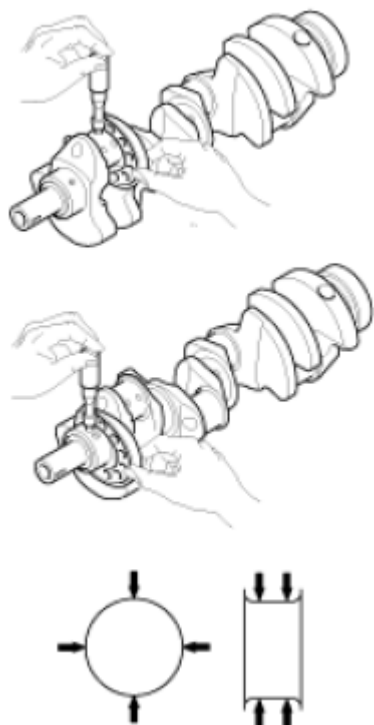


Fig. 25: Measuring Diameter Of Main Journal And Crank Pin Using Diameter
Courtesy of HYUNDAI MOTOR CO.

Cylinder Block

1. Remove the gasket material.

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

2. Clean the cylinder block.

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

3. Inspect the top surface of the 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: Less than 0.05mm(0.0020 in),

Less than 0.02mm(0.0008in)/150 x 150

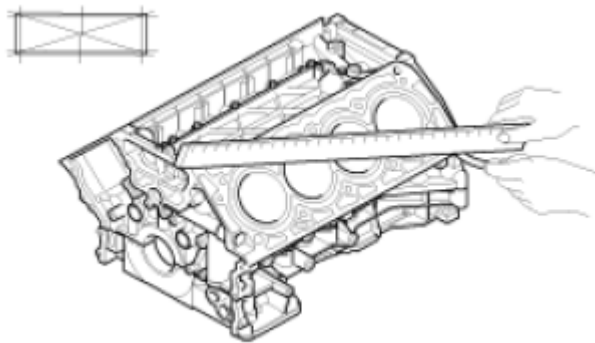


Fig. 26: Measuring Surface Contacting Cylinder Head Gasket Using Precision Straight Edge
Courtesy of HYUNDAI MOTOR CO.

4. Inspect cylinder bore diameter.

Visually check the cylinder for vertical scratches.

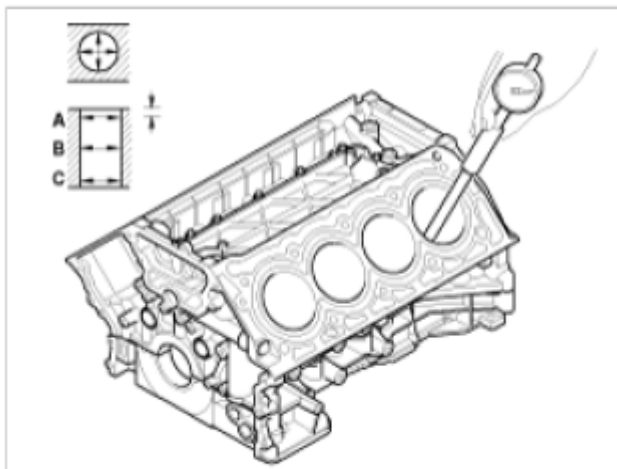
If deep scratches are present, replace the cylinder block

5. Inspect cylinder bore diameter.

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

Standard diameter

92.000 ~ 92.030mm (3.6220 ~ 3.6232in)



A: 15mm (0.5906in)

B: 62.5mm (2.4606in)

C: 110mm (4.3307in)

Fig. 27: Measuring Cylinder Bore Diameter At Position In Thrust And Axial Directions Using Cylinder Bore Gauge
 Courtesy of HYUNDAI MOTOR CO.

A: 15mm (0.5906in)

B: 62.5mm (2.4606in)

C: 110mm (4.3307in)

6. Check the cylinder bore size code on the cylinder block.

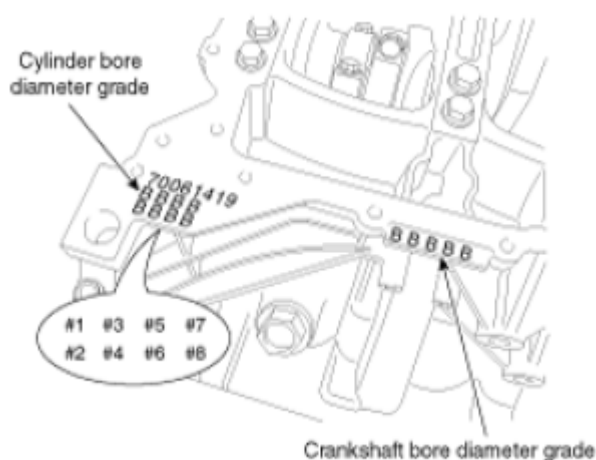


Fig. 28: Checking Cylinder Bore Size Code On Cylinder Block
 Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Cylinder Bore Size

CYLINDER BORE SIZE REFERENCE

Class	Size code	Cylinder Bore inner Diameter
A	A	92.000 ~ 92.010mm (3.6220 ~ 3.6224in)
B	B	92.010 ~ 92.020mm (3.6224 ~ 3.6228in)
C	C	92.020 ~ 92.030mm (3.6228 ~ 3.6232in)

7. Check the piston size code(A) and the front mark(B) on the piston top face.

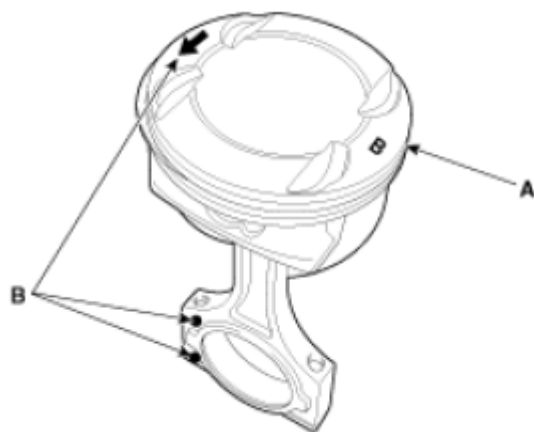


Fig. 29: Checking Piston Size Code And Front Mark
 Courtesy of HYUNDAI MOTOR CO.

Discrimination Of Piston Outer Diameter

PISTON OUTER DIAMETER SPECIFICATIONS CHART

Class	Size code	Piston Outer Diameter
A	A	91.945 ~ 91.955mm (3.6199 ~ 3.6203in)
B	B	91.955 ~ 91.965mm (3.6203 ~ 3.6207in)
C	C	91.965 ~ 91.975mm (3.6207 ~ 3.6211in)

8. Select the piston related to cylinder bore class.

Clearance: 0.045 ~ 0.065mm (0.0018 ~ 0.0026in)

Piston And Rings

1. Clean piston
 1. Using a gasket scraper, remove the carbon from the piston top.
 2. Using a groove cleaning tool, clean the piston ring grooves.
 3. Using solvent and a brush, thoroughly clean the piston.

NOTE: Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 15 mm (0.5906 in) from the bottom of the piston.

Standard diameter

91.945 ~ 91.975mm (3.6199 ~ 3.6211in)

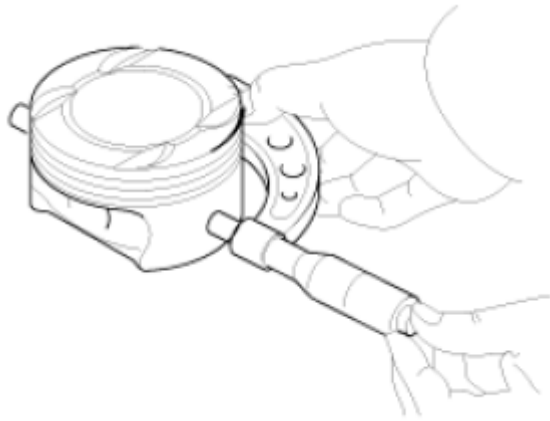


Fig. 30: Measuring Diameter Of Piston
Courtesy of HYUNDAI MOTOR CO.

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

Piston-to-cylinder clearance:

0.045 ~ 0.065mm (0.0018 ~ 0.0026in)

4. Inspect the piston ring side clearance.

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

Piston ring groove width

No. 1: 1.23 ~ 1.25mm (0.0484 ~ 0.0492in)

No. 2: 1.23 ~ 1.25mm (0.0484 ~ 0.0492in)

Oil ring: 2.01 ~ 2.03mm (0.0791 ~ 0.0799in)

Piston ring width

No. 1: 1.17 ~ 1.19mm (0.0461 ~ 0.0469in)

No. 2: 1.17 ~ 1.19mm (0.0461 ~ 0.0469in)

Oil ring: 1.88 ~ 1.95mm (0.0740 ~ 0.0768in)

Piston ring side clearance

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

No. 2: 0.04 ~ 0.08mm (0.0016 ~ 0.0031in)

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



Fig. 31: Measuring Clearance Between Piston Ring And Wall Of Ring Groove Using Feeler Gauge
Courtesy of HYUNDAI MOTOR CO.

If the clearance is greater than 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 against the wear limits. If the bore is over the service limit, the cylinder block must be replaced.

Piston ring end gap

No. 1: 0.17 ~ 0.32mm (0.0067 ~ 0.0126in)

No. 2: 0.37 ~ 0.52mm (0.0146 ~ 0.0205in)

Oil ring: 0.20 ~ 0.70mm (0.0079 ~ 0.0276in)

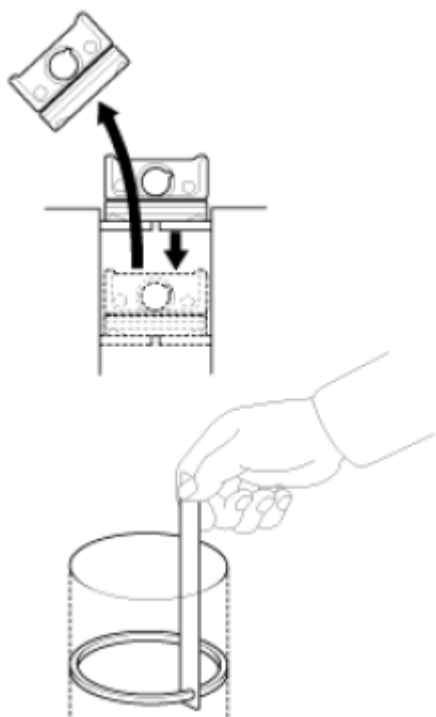


Fig. 32: Measuring Piston Ring End Gap
Courtesy of HYUNDAI MOTOR CO.

Piston Pins

1. Measure the diameter of the piston pin.

Piston pin outer diameter:

21.995 ~ 22.000mm (0.8659 ~ 0.8661in)

Piston pin hole inner diameter:

22.004 ~ 22.010mm (0.8663 ~ 0.8665in)

Connecting rod small end inner diameter:

22.007 ~ 22.018mm (0.8664 ~ 0.8668in)

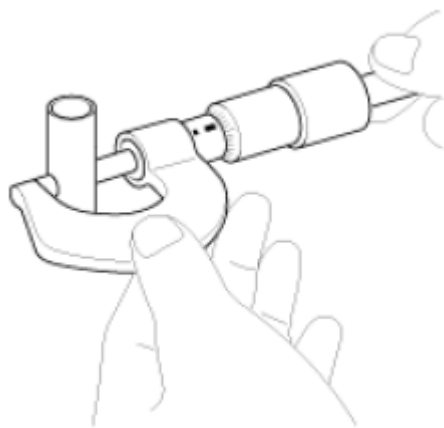


Fig. 33: Measuring Diameter Of Piston Pin
Courtesy of HYUNDAI MOTOR CO.

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

Piston pin-to-piston clearance:

0.004 ~ 0.015mm (0.0002 ~ 0.0006in)

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

Piston pin-to-connecting rod interference:

0.007 ~ 0.023mm (0.0003 ~ 0.0009in)

Reassembly

NOTE:

- Thoroughly clean all parts to be assembled.
- 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. Install the snap ring in one side of the piston pin hole.
 2. Align the piston front mark and the connecting rod front mark.

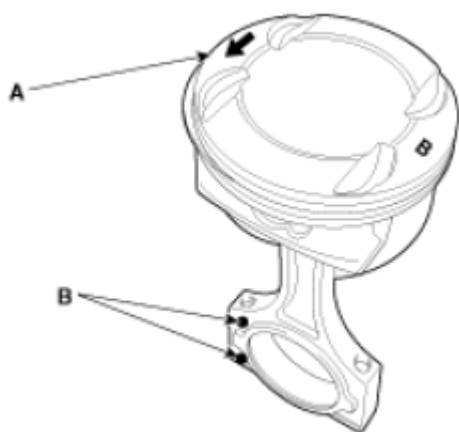


Fig. 34: Identifying Piston And Connecting Rod Front Mark
Courtesy of HYUNDAI MOTOR CO.

3. Insert the piston pin into the piston pin hole and the small end bore of connecting rod.
4. Install the snap ring in the other side after inserting the piston pin.

NOTE: Apply a sufficient amount of engine oil to outer surface of the piston, inner surface of piston pin hole and small end bore of the connecting rod before inserting the piston pin.

2. Install the 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. 35: Identifying Piston Installing Direction
Courtesy of HYUNDAI MOTOR CO.

3. Install the connecting rod bearings.
 1. Align the bearing claw with the groove of the connecting rod or connecting rod cap.

2. Install the bearings (A) in the connecting rod and connecting rod cap (B).

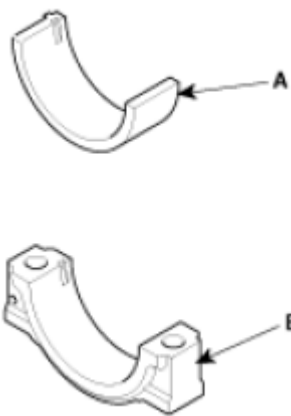


Fig. 36: Identifying Bearings And Connecting Rod Cap
Courtesy of HYUNDAI MOTOR CO.

4. Install the main bearings (A) (No. 1,2,4,5 journal) and the center bearings (B) (No. 3 journal).

NOTE: Upper bearings have an oil groove of oil holes; Lower bearings do not.

1. Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings.

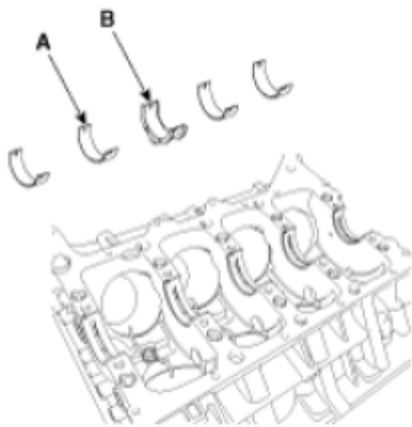


Fig. 37: Identifying Main Bearings And Center Bearings
Courtesy of HYUNDAI MOTOR CO.

2. Align the bearing claw with the claw groove of the lower crankcase and push in the 5 lower bearings.

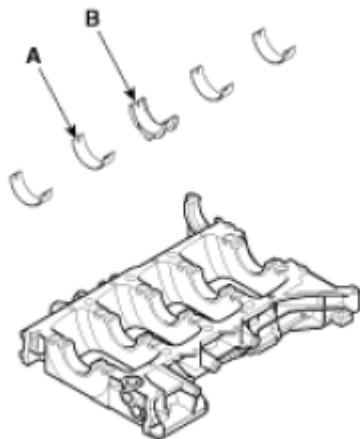


Fig. 38: Identifying Main Bearings And Center Bearings
Courtesy of HYUNDAI MOTOR CO.

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

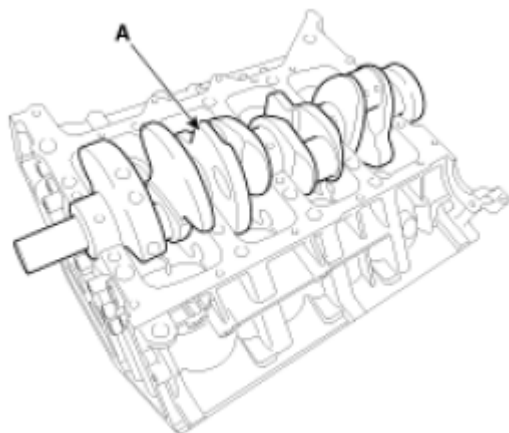


Fig. 39: Identifying Cylinder Block Crankshaft
Courtesy of HYUNDAI MOTOR CO.

6. Place the lower crankcase assembly on cylinder block.
 1. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
 2. Install the O-ring (A) to cylinder block.
 3. Before assembling the lower crankcase assembly, the liquid sealant LT 5900H or equivalent should be applied on cylinder block bottom.

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

Bead width: 2.5mm(0.1in)

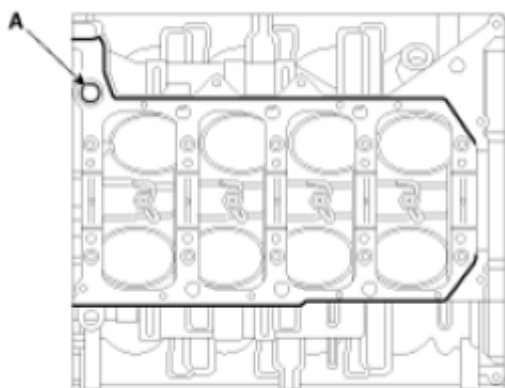


Fig. 40: Identifying Cylinder Block O-Ring
Courtesy of HYUNDAI MOTOR CO.

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 cylinder block.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

4. Install the lower crankcase assembly.
7. Install the lower crankcase assembly bolts.
 1. Install and uniformly tighten the lower crankcase assembly bolts, in several passes, in the sequence shown.

Tightening torque

Main bearing cap bolts (1~20)

37.3~41.2 N.m (3.8~4.2 kgf.m, 27.5~30.4 lb-ft) + 120°

Flange bolts (21~35)

21.6 ~ 25.5 N.m (2.2 ~ 2.6 kgf.m, 15.9 ~ 18.8 lb-ft)

NOTE:

- Always use new main bearing cap bolts.
- If any of the bearing cap bolts are broken or deformed, replace it.

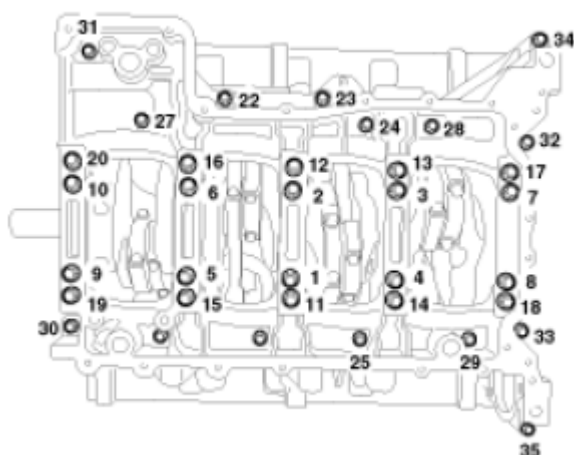


Fig. 41: Identifying Main Bearing Cap Bolts Tightening Sequence
Courtesy of HYUNDAI MOTOR CO.

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

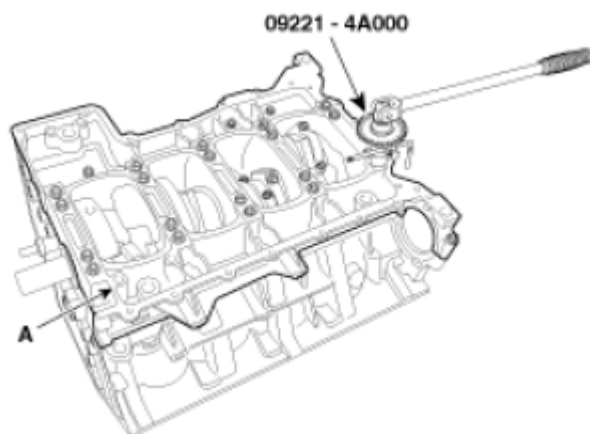


Fig. 42: Installing Bearing Cap Bolts Using SST(09221-4A000)
Courtesy of HYUNDAI MOTOR CO.

2. Check that the crankshaft turns smoothly.
8. Check crankshaft end play.
9. 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.
- The piston front mark (A) and the connecting rod front mark (B) must face the timing chain side of the engine.

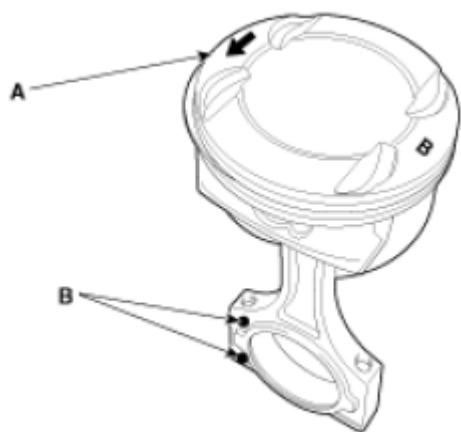


Fig. 43: Identifying Piston And Connecting Rod Front Mark
 Courtesy of HYUNDAI MOTOR CO.

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 after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.
3. Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque:

22.6~26.5N.m (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 98°~102°

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

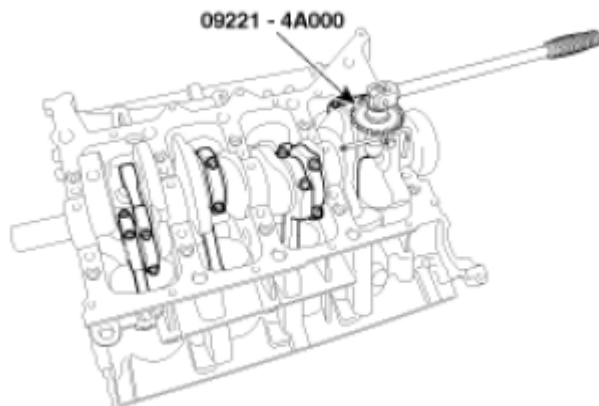


Fig. 44: Checking Connecting Rod Bearing Oil Clearance
 Courtesy of HYUNDAI MOTOR CO.

NOTE:

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

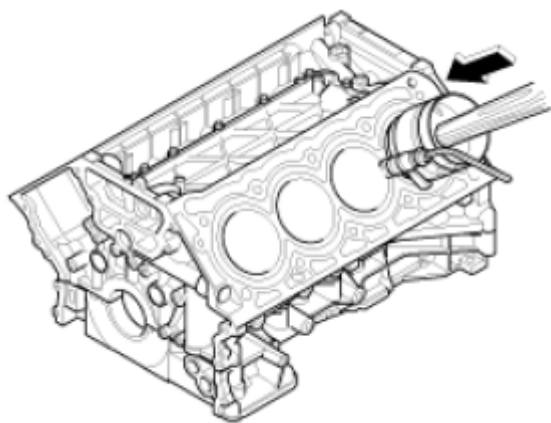


Fig. 45: Checking Connecting Rod End Play
Courtesy of HYUNDAI MOTOR CO.

10. Check the connecting rod end play.
11. Install the cylinder block rear cover (A) and a new gasket.

Tightening torque:

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

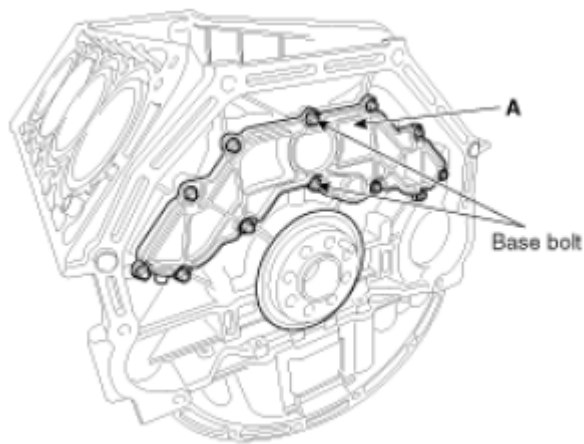


Fig. 46: Identifying Cylinder Block Rear Cover
Courtesy of HYUNDAI MOTOR CO.

NOTE: **Tighten the base bolts first and then tighten the other bolts.**

12. Install the crankshaft adapter plate (A).

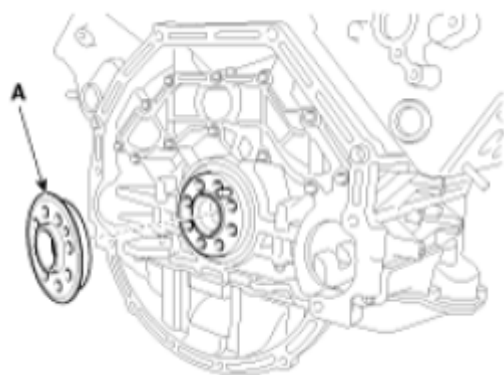


Fig. 47: Identifying Crankshaft Adapter
Courtesy of HYUNDAI MOTOR CO.

13. Using the SST(09231-2J400, 09231-H1100) and a plastic hammer, tap in a new oil seal (A) until SST surface is flush with the cylinder block.

At this time, the depth of the oil seal (A) from the cylinder block surface is 1mm(0.039in).

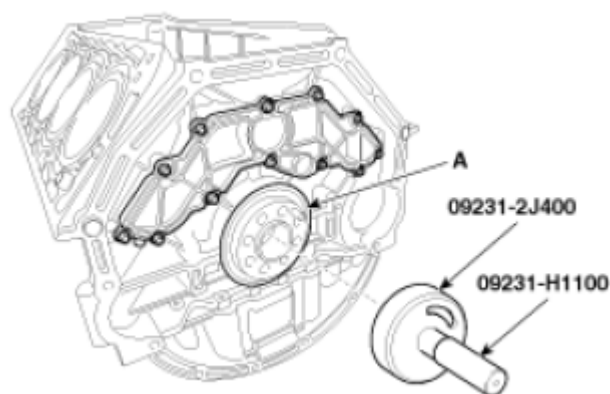


Fig. 48: Identifying Oil Seal, Special Tool And Plastic Hammer
Courtesy of HYUNDAI MOTOR CO.

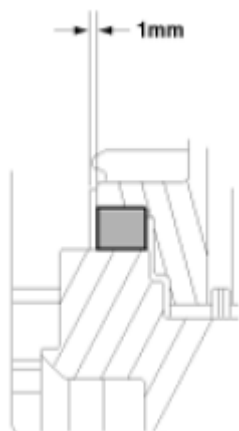


Fig. 49: Identifying Oil Seal Depth From Cylinder Block Surface
Courtesy of HYUNDAI MOTOR CO.

NOTE:

- Before assembling oil seal, the hardened sealant or injurious material located on the boundary area between cylinder block and lower crankcase must be removed.
- Apply engine oil to a new oil seal lip.
- When pressing oil seal, confirm to direction and take care not to damage oil seal.

14. Install the cylinder block bank cover (A) and a new gasket (B).

Tightening torque:

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

NOTE:

- The "F" mark of the gasket must be face the front of the engine.
- Tighten the base bolts first and then tighten the other bolts.

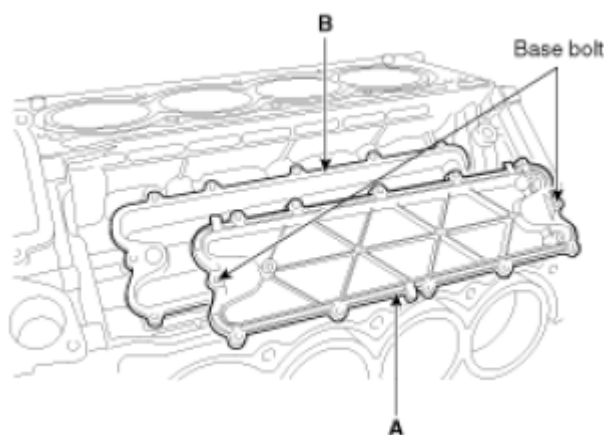


Fig. 50: Identifying Cylinder Block Bank Cover And New Gasket
Courtesy of HYUNDAI MOTOR CO.

15. Install the separator (A) and the water jacket inserts (B).

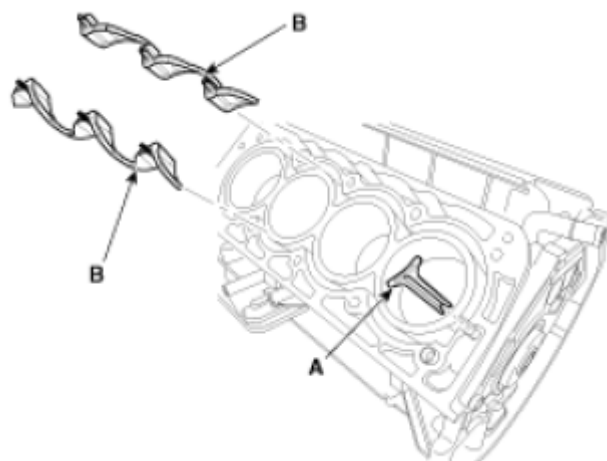


Fig. 51: Identifying Separator And Water Jacket Inserts
 Courtesy of HYUNDAI MOTOR CO.

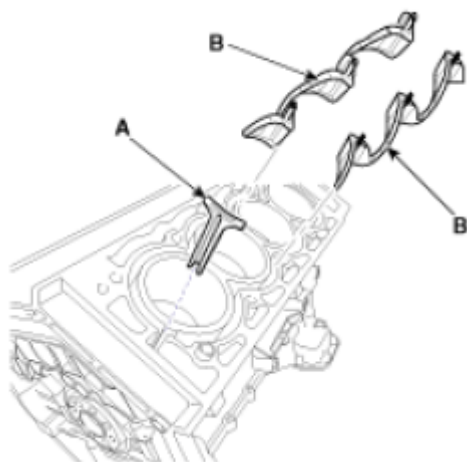


Fig. 52: Identifying Separator And Water Jacket Inserts
 Courtesy of HYUNDAI MOTOR CO.

NOTE: Insert the separator with the guide on the water jacket and the groove aligned.

16. Install the drive plate (B) and the adapter plate (A).

Tightening torque:

98.1~107.9N.m(10.0~11.0kgf.m,72.3~79.6lb-ft)

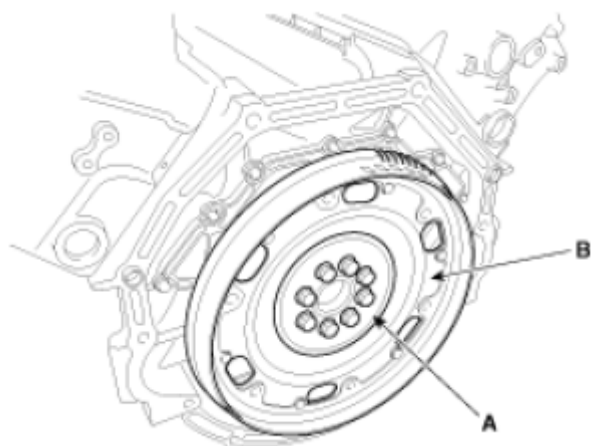


Fig. 53: Identifying Adapter Plate And Drive Plate
Courtesy of HYUNDAI MOTOR CO.

17. Install the oil pump. (Refer to **LUBRICATION SYSTEM** in this group)
18. Install the engine coolant temperature control assembly. (Refer to **COOLING SYSTEM** in this group)
19. Install the timing chain. (Refer to **TIMING SYSTEM** in this group)
20. Install the cylinder head. (Refer to **CYLINDER HEAD** in this group)
21. Install the intake manifold and exhaust manifold. (Refer to **INTAKE AND EXHAUST SYSTEM** in this group)
22. Remove the engine from engine stand.
23. Install the engine assembly to the vehicle. (Refer to **ENGINE AND TRANSMISSION ASSEMBLY** in this group)