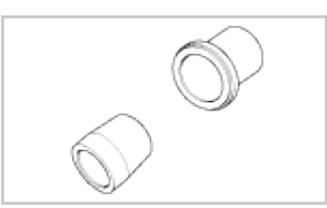
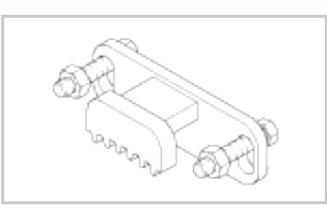
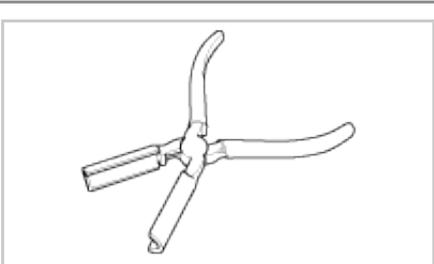
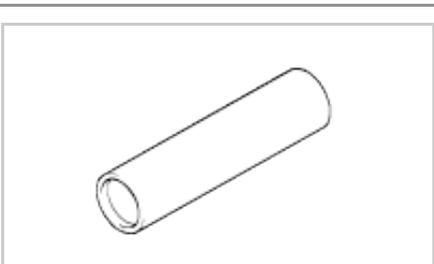
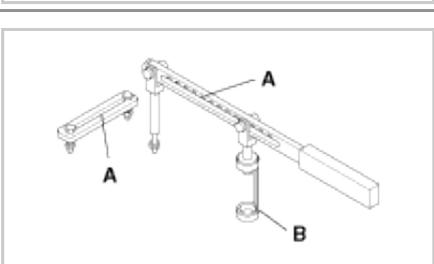
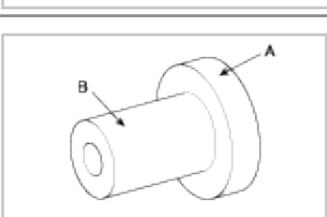


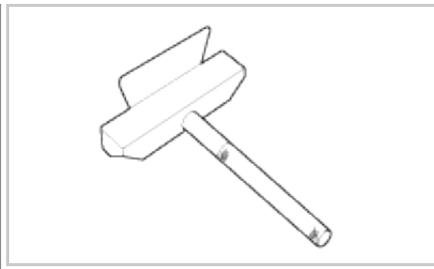
## **CHAPTER 2:**

# **Engine Mechanical System**

**SPECIAL SERVICE TOOLS**

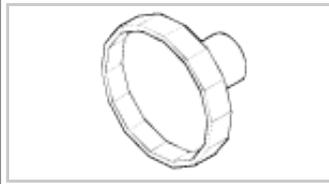
Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-3C100)		Installation of the front oil seal
Flywheel stopper (09231-3C300)		Removal and installation of the flywheel and crankshaft pulley.
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method
Valve stem seal remover (09222-29000)		Remover of the valve stem seal
Valve stem seal remover (09222-3C100)		Installation of the valve stem seal
Valve spring compressor & holder (09222-3K000) (09222-3C300)		Removal and installation of the intake or exhaust valve A : 09222-3K000 B : 09222-3C300 (holder)
Crankshaft rear oil seal installer (09231-3C200) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09231-3C200 B : 09231-H1100

Oil pan remover  
(09215-3C000)



Removal of oil pan

Oil filter wrench  
(09263-3C100)



Removal and installation of the oil filter housing cover

**TROUBLESHOOTING**

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or improperly installed engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as required.
	Worn crankshaft thrust bearings	Replace the crankshaft and bearings as required.
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and valve lifters.
Engine misfire with coolant consumption.	a. Malfunctioning cylinder head gasket and/or cranking or other damage to the cylinder head and engine block cooling system. b. Coolant consumption may or may not cause the engine to overheat.	a. Inspect the cylinder head and engine block for damage to the coolant passages and/or a malfunctioning head gasket. b. Repair or replace as required.
Engine misfire with excessive oil consumption.	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	a. Inspect the cylinder for a loss of compression. b. Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity.	a. Drain the oil. b. Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	a. Inspect the thrust bearing and crankshaft. b. 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.	a. Inspect the camshaft lobes. b. 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	Low oil pressure.	Repair or required.

noise, regardless of engine speed.	Loose or damaged drive plate.	Repair or replace the drive plate.
	Damaged oil pan, contacting the oil pump screen.	a. Inspect the oil pan. b. Inspect the oil pump screen. c. Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	a. Inspect the oil pump screen. b. Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	a. Inspect the piston, piston pin and cylinder bore. b. Repair as required.
	Excessive piston pin-to-piston clearance.	a. Inspect the piston, piston pin and the connecting rod. b. Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair as required. a. The connecting rod bearings. b. The connecting rods. c. The crankshaft pin journals.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. a. The crankshaft bearings. b. The crankshaft main journals. c. The cylinder block.
	Incorrect piston, piston pin and connecting rod installation	a. Verify the piston pins and connecting rods are installed correctly. b. 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 : a. The connecting rod bearings. b. The connecting rods. c. The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. a. The crankshaft bearings. b. The crankshaft main journals. c. The cylinder block.
Engine will not crank- crankshaft will not rotate.	Hydraulically locked cylinder. a. Coolant/antifreeze in cylinder. b. Oil in cylinder. c. Fuel in cylinder.	a. Remove spark plugs and check for fluid. b. Inspect for broken head gasket. c. Inspect for cracked engine block or cylinder head. d. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain and/or timing chain gears.	a. Inspect timing chain and gears. b. Repair as required.
	Material in cylinder. a. Broken valve b. Piston material c. Foreign material	a. Inspect cylinder for damaged components and/or foreign materials. b. Repair or replace as required.

Seized crankshaft or connecting rod bearings.	a. Inspect crankshaft and connecting rod bearing. b. Repair as required.
Bent or broken connecting rod.	a. Inspect connecting rods. b. Repair as required.
Broken crankshaft.	a. Inspect crankshaft. b. Repair as required.

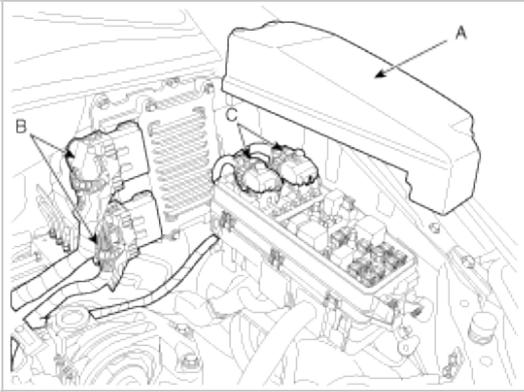


## Compression pressure inspection

### NOTICE

If there is a lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

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



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

### NOTICE

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

Repeat steps 1) through 3) for each cylinder.

### NOTICE

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

Compression pressure: 1,176.79kPa (12.0kgf/cm<sup>2</sup>, 170.68psi) - 200 ~ 250rpm  
 Minimum pressure: 1,029.69kPa (10.5kgf/cm<sup>2</sup>, 149.34psi)  
 Difference between cylinders: 98.07kPa (1.0kgf/cm<sup>2</sup>, 14.22psi)

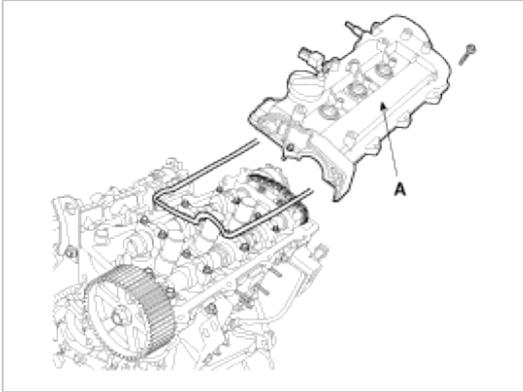
- (4) If the compression pressure in 1 or more cylinders is lower than the specification above, pour a small amount of engine oil into the cylinder through the spark plug hole, repeat the steps (1) through (3) for the cylinder and measure the pressure again.
  - a. If adding oil increases the pressure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

## VALVE CLEARANCE INSPECTION AND ADJUSTMENT

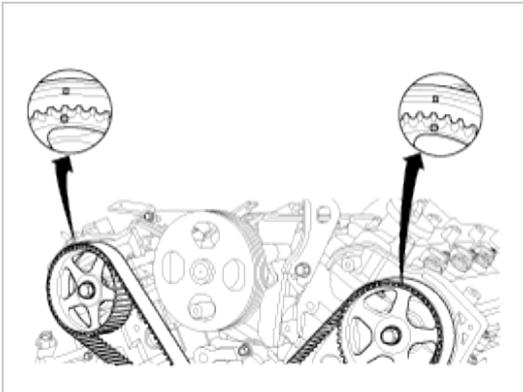
### NOTICE

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

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



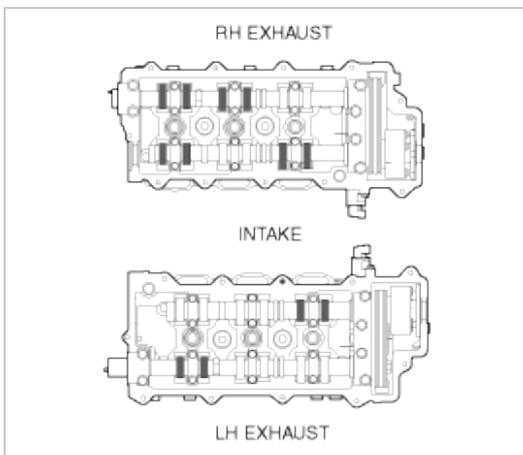
5. Set the piston of the No.1 cylinder to TDC(Top Dead Center) position.
  - (1) Turn the crankshaft pulley clockwise and align its groove with the timing mark "T" of the timing chain cover.
  - (2) Check that the timing marks of the camshaft sprocket are in straight line on that of the cylinder head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



### NOTICE

If not, turn the crankshaft one revolution clockwise.

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



Measurement method.

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

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Specification

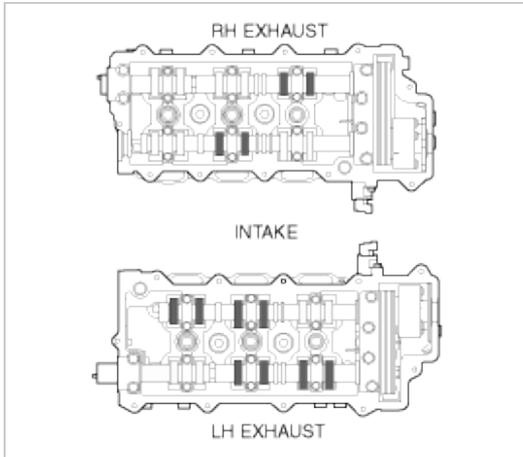
Limit (Engine coolant temperature : 20°C [68°F])

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

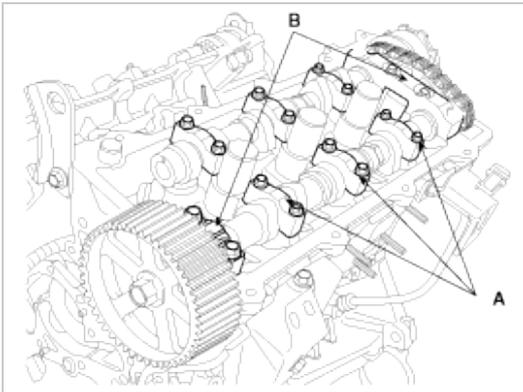
Exhaust : 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

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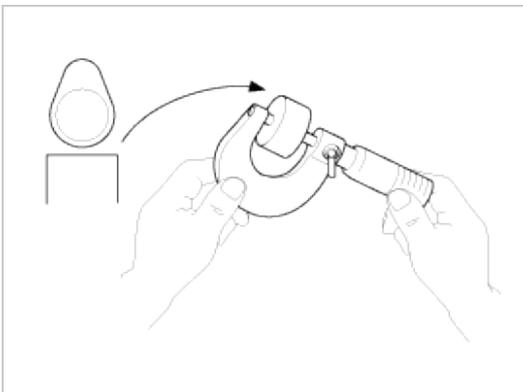
- (2) Turn the crankshaft pulley one revolution (360°) clockwise and align the groove with the timing mark "T" of the timing chain cover.
- (3) With the piston of the No.4 cylinder positioning at TDC, the valves which can be measured its clearance are as shown below.



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



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



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

---

T : Thickness of removed tappet

A : Measured valve clearance

N : Thickness of new tappet

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

Exhaust :  $N = T + [A - 0.30\text{mm}(0.0118\text{in.})]$

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

**NOTICE**

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

(9) Place a new tappet on the cylinder head.

**NOTICE**

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

(10) Install the intake and exhaust camshafts.

(11) Install the bearing caps.

(12) Install the timing belt.

(13) Turn the crankshaft two revolutions in the operating direction (clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks(A).

(14) Recheck the valve clearance.

---

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

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

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

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## SPECIFICATION

Description		Specifications		Limit
General				
Type		V-type, DOHC		
Number of cylinders		6		
Bore		96mm(3.7795in.)		
Stroke		87.0mm(3.4252in.)		
Total displacement		3.778cc(230.55cu.in.)		
Compression ratio		10.4		
Firing order		1-2-3-4-5-6		
Valve timing				
Intake	Opens(ATDC)	10°		
	Closes(ABDC)	62°		
Exhaust	Opens(BBDC)	42°		
	Closes(ATDC)	6°		
Cylinder head				
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]		
Flatness of manifold mounting	Intake	Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in)/110x110]		
	Exhaust	Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in)/110x110]		
Camshaft				
Cam height	LH Camshaft	Intake	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
	RH Camshaft	Intake	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
Journal outer diameter	LH ,RHcamshaft	Intake	No.1: 27.964 ~ 27.980mm (1.1009 ~ 1.1016in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
		Exhaust	No.1: 27.964 ~ 27.980mm (1.1009 ~ 1.1016in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
Bearing oil clearance	LH ,RHcamshaft	Intake	No.1: 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
		Exhaust	No.1: 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
End play		0.02 ~ 0.18mm (0.0008 ~ 0.0071in.)		
Valve				
Valve length	Intake	105.27mm(4.1445in.)		
	Exhaust	105.50mm (4.1535in.)		
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)		
	Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)		

Face angle		45.25° ~ 45.75°	
Thickness of valvehead(margin)	Intake	1.56 ~ 1.86mm(0.06142 ~ 0.07323in.)	
	Exhaust	1.73 ~ 2.03mm(0.06811 ~ 0.07992in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)	0.07mm (0.00275in.)
	Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.09mm (0.00354in.)
Valve guide			
Inner diameter	Intake	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
	Exhaust	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Length	Intake	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
	Exhaust	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm(0.05118 ~ 0.05709in.)	
	Exhaust	1.35 ~ 1.65mm(0.05315 ~ 0.06496in.)	
Seat angle	Intake	44.75° ~ 45.20°	
	Exhaust	44.75° ~ 45.20°	
Valve spring			
Free length		43.86mm (1.7267in.)	
Load	19.3±0.8kg/34.0mm (42.7±1.8 lb/1.3386in.)		
	42.3±1.3kg/24.2mm (93.3±2.9 lb/0.9527in.)		
Out of squareness		Less than 1.5°	
MLA			
MLA outer diameter	Intake	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
	Exhaust	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
Cylinder head tappet bore inner diameter	Intake	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
	Exhaust	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
MLA to tappet bore clearance	Intake	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm(0.0027in.)
	Exhaust	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm(0.0027in.)
Valve clearance			
Intake		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)
Cylinder block			
Cylinder bore		96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Piston			
Piston outer diameter		95.96 ~ 95.99mm(3.7779 ~ 3.7791in.)	
Piston to cylinder clearance		0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)	
Ring groove width	No. 1 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	1.26mm (0.0496in.)
	No. 2 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	1.26mm (0.0496in.)
	Oil ring groove		2.05mm

	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	2.031mm (0.0807in.)
Piston ring			
Side clearance	No. 1 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	No. 2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)	0.2mm (0.008in.)
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)	0.6mm (0.0236in.)
	No. 2 ring	0.32 ~ 0.47mm (0.0126 ~ 0.0185in.)	0.7mm (0.0275in.)
	Oil ring	0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin			
Piston pin outer diameter		23.001 ~ 23.006mm (0.9055 ~ 0.9057in.)	
Piston pin hole inner diameter		23.016 ~ 23.021mm (0.9061 ~ 0.9063in.)	
Piston pin hole clearance		0.01 ~ 0.02mm (0.0039 ~ 0.0078in.)	
Connecting rod small end inner diameter		22.974 ~ 22.985mm (0.9045 ~ 0.9049in.)	
Connecting rod small end hole clearance		-0.032 ~ -0.016mm (-0.0012 ~ 0.0006in.)	
Connecting rod			
Connecting rod big end innerdiameter		58.000 ~ 58.018mm(2.2834 ~2.2842in.)	
Connecting rod bearing oil clearance		0.038 ~ 0.056mm (0.0015 ~ 0.0022in.)	
Side clearance		0.1 ~ 0.25mm (0.0039 ~ 0.0098in.)	
Crankshaft			
Main journal outer diameter		68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)	
Pin journal outer diameter		54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)	
Main bearing oil clearance		0.022 ~ 0.040mm (0.0008 ~ 0.0016in.)	
End play		0.10 ~ 0.28mm (0.0039 ~ 0.0110in.)	
Oil pump			
Relief valve opening pressure		450 ~ 550kPa (4.59 ~ 5.61kgf/cm <sup>2</sup> ,65.28 ~ 79.79psi)	
Engine oil			
Oil quantity (Total)		6.0 L (6.34 US qt, 5.27 Imp qt)	
Oil quantity (Oil pan)		5.5 L (5.81 US qt, 4.83 Imp qt)	
Oil quantity (Drain and refill including oil filter)		5.2 L (5.49 US qt, 4.57 Imp qt)	
Oil quality		ABOVE API SJ / SL or SAE 5W-20	
Oil pressure		130kPa(1.32kgf/cm <sup>2</sup> ,18.77psi) [at 1000rpm,110°C(230°F)]	
Cooling system			
Cooling method		Forced circulation with electrical fan	
Coolant quantity		8.6L(9.09U.S.qts,7.57Imp.qts)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±35.6°F)	
	Fully openedtemperature	95°C (203°F)	
	Full lift	10mm (0.3937in.)	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm <sup>2</sup> , 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm <sup>2</sup> , 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermister type	

Resistance	20°C (68°F)	2.31 ~ 2.59KΩ	
	80°C(176°F)	0.3222 KΩ	

## TIGHTENING TORQUE

Item	Quantity	Nm	kgf.m	lb-ft
Crankshaft pulley bolt	1	284.2 ~ 303.8	29.0 ~ 31.0	209.76 ~ 224.22
Timing chain cover bolt B	17	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Timing chain cover bolt C	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt D	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt E	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt F	2	24.50 ~ 26.46	2.5 ~ 2.7	18.08 ~ 19.53
Timing chain cover bolt G	4	21.56 ~ 23.52	2.2 ~ 2.4	15.91 ~ 17.36
Timing chain cover bolt H	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt I	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt J	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cam to cam guide bolt	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner nut	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain guide bolt	4	19.60 ~ 24.50	2.0 ~ 2.5	14.17 ~ 18.08
Oil pump chain cover bolt	3	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain tensioner bolt	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain guide bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain sprocket bolt	1	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Lower oil pan bolt	13	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Drive belt auto tensioner bolt(M12)	1	96.04 ~ 99.96	9.8 ~ 10.2	70.88 ~ 73.78
Drive belt auto tensioner bolt(M8)	1	17.64 ~ 21.56	1.8 ~ 2.2	13.02 ~ 15.91
Drive belt idler bolt	1	53.90 ~ 57.82	5.5 ~ 5.9	39.78 ~ 42.67
OCV(oil control valve) bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head bolt	16	39.2 + 120° + 90°	4.0 + 120° + 90°	28.93+ 120° + 90°
Cylinder head bolt	1	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
CVVT & exhaust cam sprocket bolt	4	64.68 ~ 76.44	6.6 ~ 7.8	47.74 ~ 56.42
Camshaft bearing cap bolt	32	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head cover bolt	38	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Connecting rod bearing bolt	12	19.60 + 90°	2.0 + 90°	14.46 + 90°
Main bearing cap inner bolt(M11)	8	49.00 + 90°	5.0 + 90°	36.16 + 90°
Main bearing cap outer bolt(M8)	8	19.60 + 120°	2.0 + 120°	14.46 + 120°
Main bearing cap side bolt(M8)	6	29.40 ~ 31.36	3.0 ~ 3.2	21.70 ~ 23.14
Oil drain cover bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Rear oil seal case bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Baffle plate bolt	12	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Upper oil pan bolt	16	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Knock sensor bolt	2	15.68 ~ 23.52	1.6 ~ 2.4	11.57 ~ 17.36
Drive plate bolt cap	8	71.54 ~ 75.46	7.3 ~ 7.7	52.80 ~ 55.69

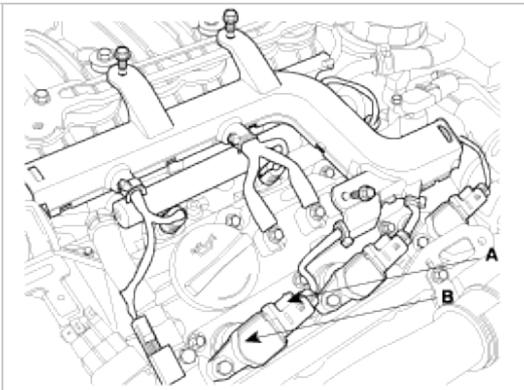
Oil filter cap		24.50	2.5	18.08
Oil drain bolt cap	1	34.30 ~ 44.10	3.5 ~ 4.5	25.31 ~ 32.55
Oil pump bolt	3	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Oil filter body bolt	10	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil filter body cover bolt	11	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water vent hose bolt(Timing chain cover bolt L)	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water pump bolt(Timing chain cover bolt K)	1	21.56 ~ 26.46	2.2 ~ 2.7	15.91 ~ 19.53
Water pump bolt	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water pump pulley bolt	4	7.84 ~ 9.80	0.8 ~ 1.0	5.78 ~ 7.23
Water temp. control nut	4	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Water temp. control bolt	2	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Water inlet pipe bolt	3	16.66 ~ 19.60	1.7 ~ 2.0	12.30 ~ 14.47
Air vent pipe bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Intake manifold bolt	6	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Intake manifold nut	2	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Surge tank bolt (M8 × 25)	3	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Surge tank bolt (M6 × 106)	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Surge tank nut	1	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Breather pipe bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Surge tank bracket bolt rear (M10 × 18 )	2	27.44 ~ 31.36	2.8 ~ 3.2	20.25 ~ 23.14
Surge tank bracket bolt front (M8 × 16)	2	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
ETC bracket bolt	2	15.68 ~ 25.48	1.6 ~ 2.6	11.57 ~ 18.80
Exhaust manifold nut	16	39.20 ~ 44.10	4.0 ~ 4.5	28.93 ~ 32.55
Heat proctor bolt	8	3.9 ~ 5.9	0.4 ~ 0.6	2.89 ~ 4.34
Front muffler	2	39.20 ~ 58.80	4.0 ~ 6.0	28.93 ~ 43.40

## COMPRESSION

### NOTICE

If there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. Warm up and stop engine.  
Allow the engine to warm up to normal operating temperature.
2. Remove the surge tank.
3. Remove the ignition coil connectors(A) and ignition coils(B).



4. Remove the spark plugs.  
Using a 16mm plug wrench, remove the 6 spark plugs.

5. Check cylinder compression pressure.
  - (1) Insert a compression gauge into the spark plug hole.
  - (2) Fully open the throttle.
  - (3) After 7 times of cranking the engine, measure the compression pressure.

**NOTICE**

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

Repeat steps 1) through 3) for each cylinder.

**NOTICE**

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

---

Compression pressure :  
1,225kPa (12.5kgf/cm<sup>2</sup>, 177psi) - 200 ~ 250rpm  
Minimum pressure :  
1,078kPa (11.0kgf/cm<sup>2</sup>, 156psi)

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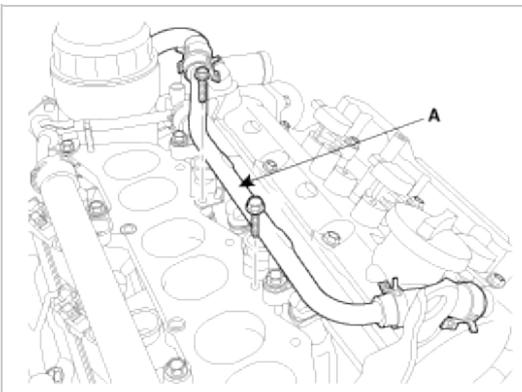
- (4) If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (a) through (c) for cylinders with low compression.
  - a. If adding oil helps the compression, it is likely that the piston rings and/or cylinder 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.
6. Reinstall the spark plugs.
7. Install the ignition coil and ignition coil connectors.
8. Install the surge tank.

## VALVE CLEARANCE INSPECTION AND ADJUSTMENT

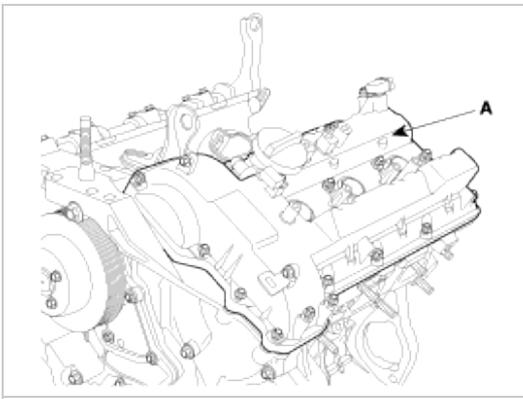
**NOTICE**

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C) and cylinder head is installed on the cylinder block.

1. Remove the engine cover.
2. Remove air cleaner assembly.
3. Remove the surge tank.
4. Remove the cylinder head cover.
  - (1) Disconnect the ignition coil connector and remove the ignition coil.
  - (2) Disconnect the breather pipe assembly(A) from the cylinder head cover.

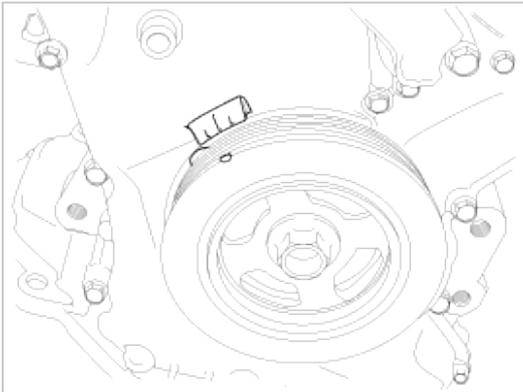


- (3) Loosen the cylinder head cover bolts and then remove the cover(A) and gasket.



5. Set No.1 cylinder to TDC/compression.

(1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.

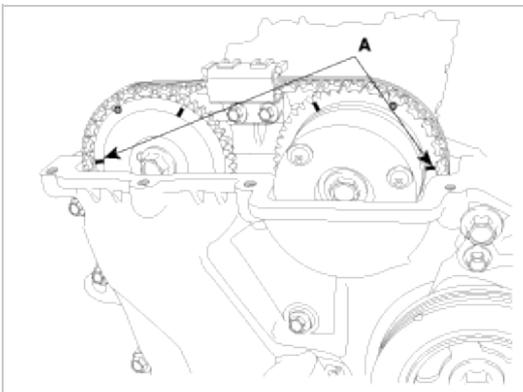


(2) Check that the mark(A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.

If not, turn the crankshaft one revolution (360°)

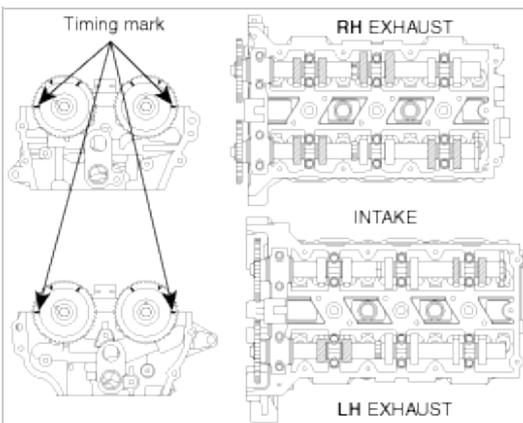
**NOTICE**

Do not rotate engine counterclockwise



6. Inspect the valve clearance.

(1) Check only the valve indicated as shown. [No. 1 cylinder : TDC/Compression] measure the valve clearance.



Measurement method.

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

Valve clearance

Specification

Engine coolant temperature : 20°C [68°F]

Limit

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

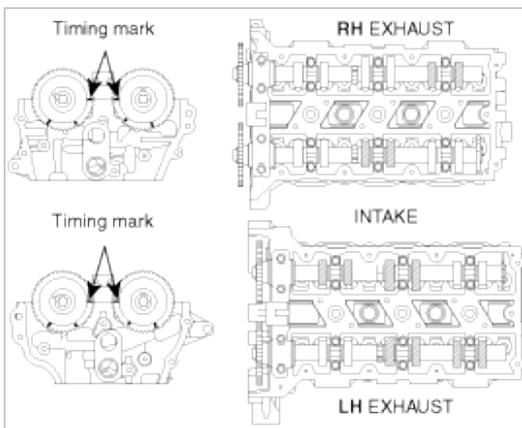
Exhaust : 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

- (2) Turn the crankshaft pulley one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.

**NOTICE**

Do not rotate engine counterclockwise

- (3) Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearance. (Refer to procedure step1))

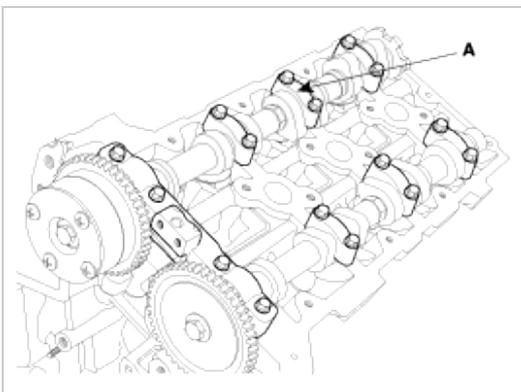


- 7. Adjust the intake and exhaust valve clearance.
  - (1) Set the No.1 cylinder to the TDC/compression.
  - (2) Remove the timing chain.

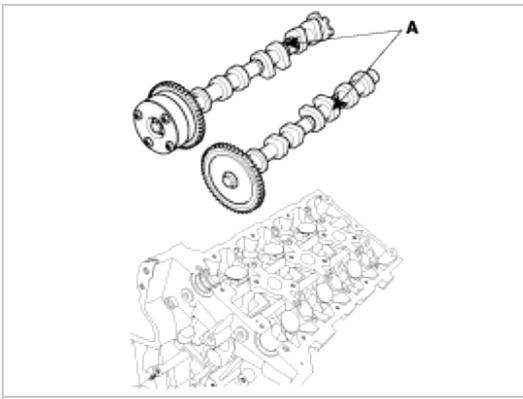
**NOTICE**

Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC(Top Dead Center) can be erased.

- (3) Remove the camshaft bearing caps(A).

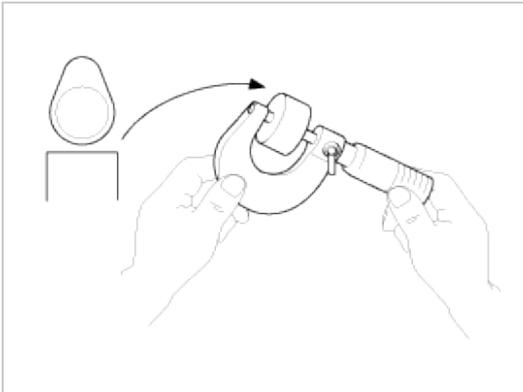


- (4) Remove the camshaft assembly(A).



(5) Remove MLAs.

(6) Measure the thickness of the removed tappet using a micrometer.



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

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

T : Thickness of removed tappet

A : Measured valve clearance

N : Thickness of new tappet

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

Exhaust :  $N = T + [A - 0.30\text{mm}(0.0118\text{in.})]$

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

**NOTICE**

Shims are available in 41size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.600mm (0.1417in.)

(9) Place a new tappet on the cylinder head.

**NOTICE**

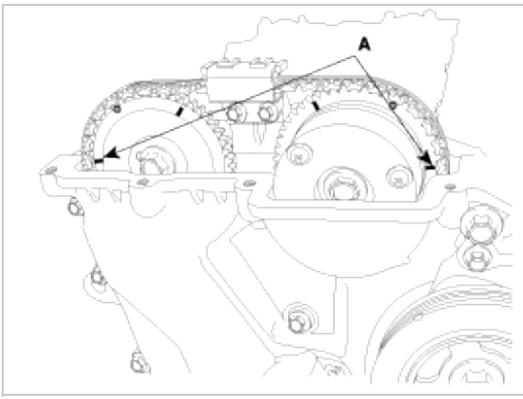
Applying engine oil at the selected tappet on the periphery and top surface.

(10) Install the intake and exhaust camshaft.

(11) Install the bearing caps

(12) Install the timing chain.

(13) Turn the crankshaft two turns in the operating direction(clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks(A).



(14) Recheck the valve clearance.

---

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

[Specification]

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

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

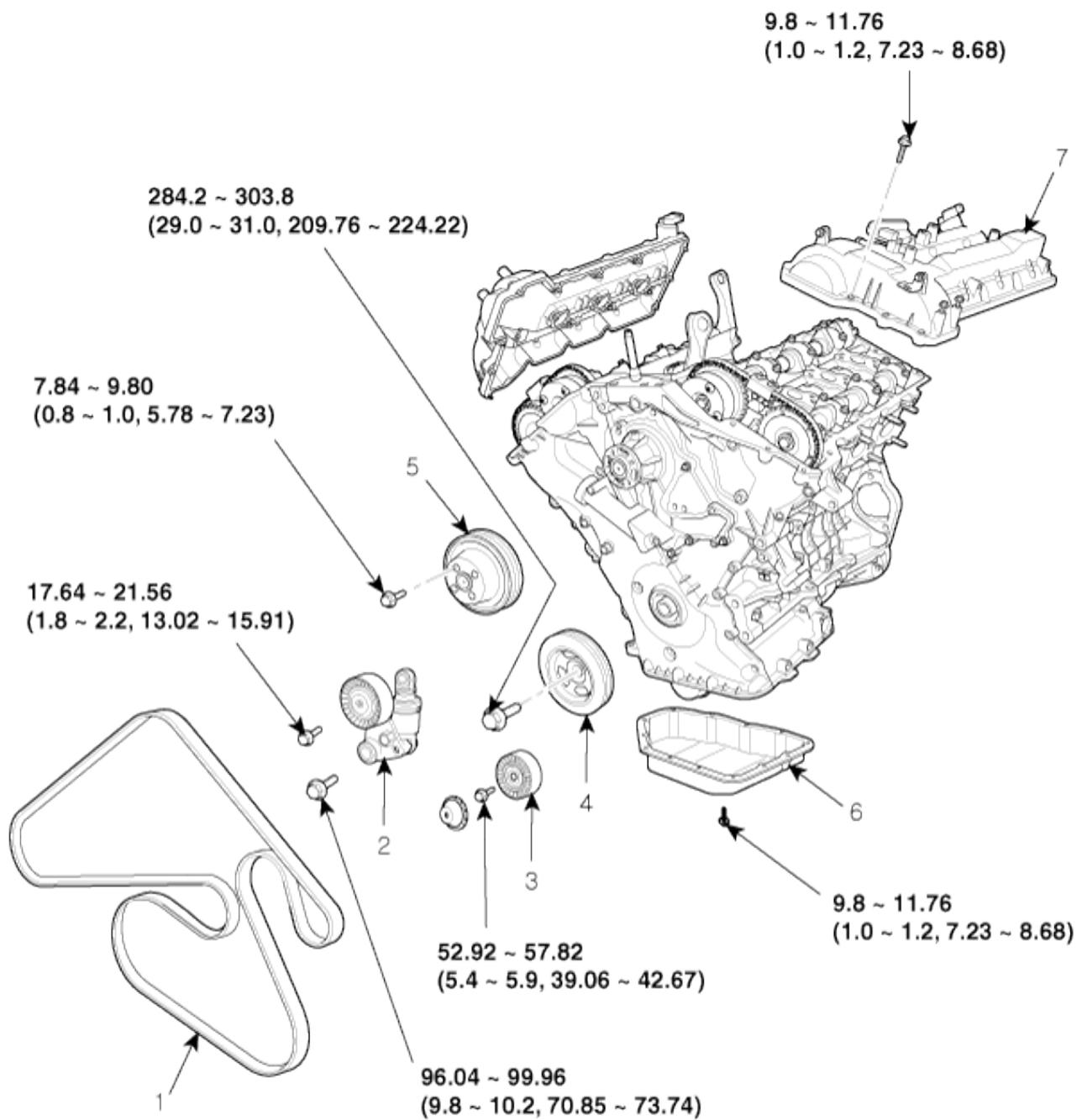
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**Timing system**

**Timing belt**



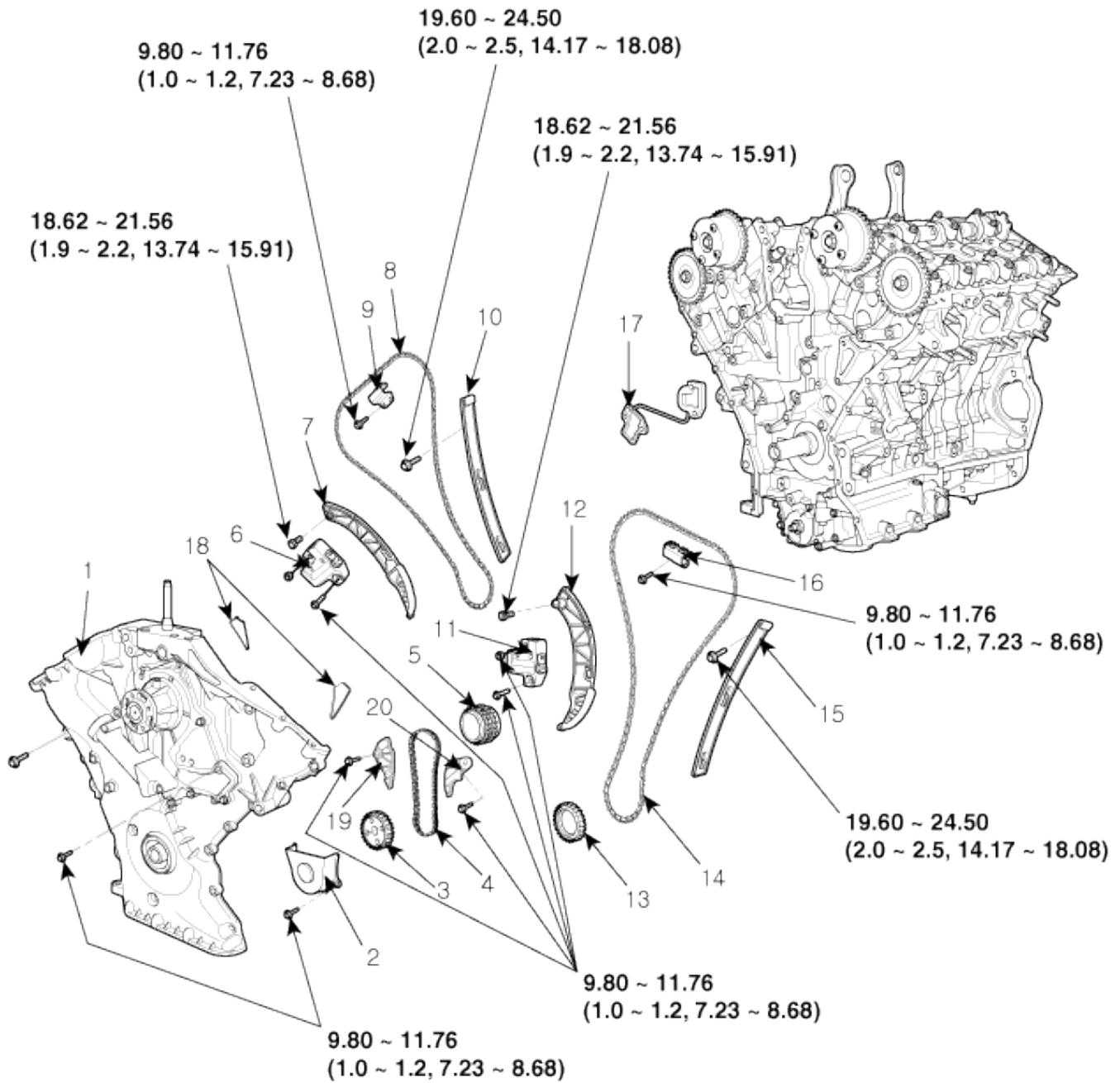
## COMPONENT



**TORQUE : N.m (kgf.m, lb-ft)**

1. Drive belt
2. Drive belt tensioner
3. Idler
4. Damper pulley

5. Water pump pulley
6. Oil pan
7. Cylinder head cover



**TORQUE : N.m (kgf.m, lb-ft)**

- |                                |                                 |                                 |
|--------------------------------|---------------------------------|---------------------------------|
| 1. Timing chain cover          | 8. Timing chain                 | 15. Timing chain guide          |
| 2. Oil pump chain cover        | 9. Cam to cam guide             | 16. Cam to cam guide            |
| 3. Oil pump sprocket           | 10. Timing chain guide          | 17. Tensioner adapter           |
| 4. Oil pump chain              | 11. Timing chain auto tensioner | 18. Gasket                      |
| 5. Crankshaft sprocket         | 12. Timing chain tensioner arm  | 19. Oil pump chain guide        |
| 6. Timing chain auto tensioner | 13. Crankshaft sprocket         | 20. Oil pump tensioner assembly |
| 7. Timing chain tensioner arm  | 14. Timing chain                |                                 |



## REMOVAL

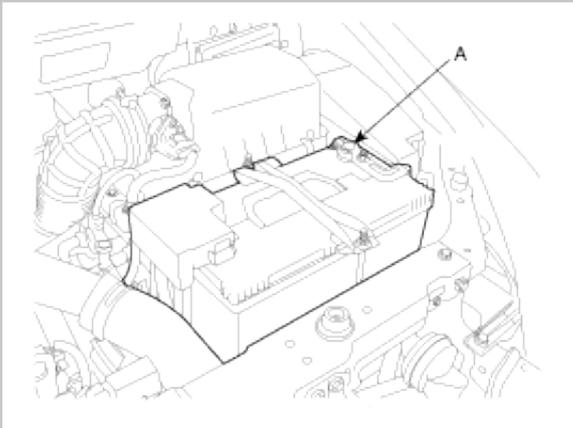
### CAUTION

- a. Use fender covers to avoid damaging painted surfaces.
- b. To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

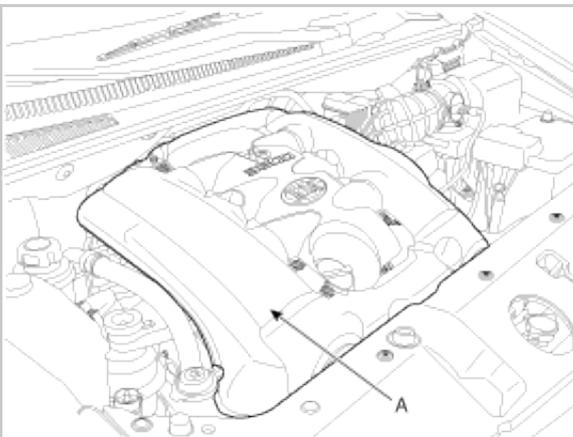
### NOTICE

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

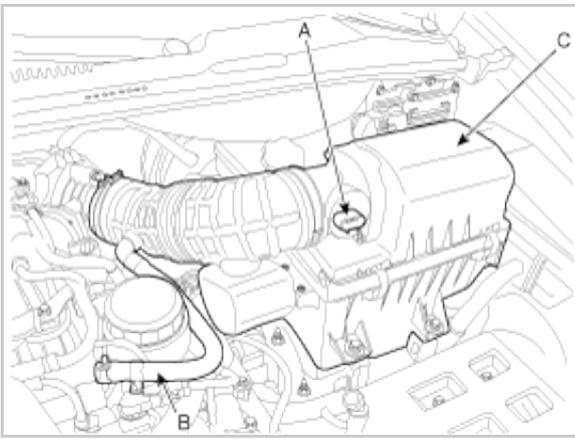
1. Disconnect the battery negative cable (A).



2. Remove the engine cover (A).

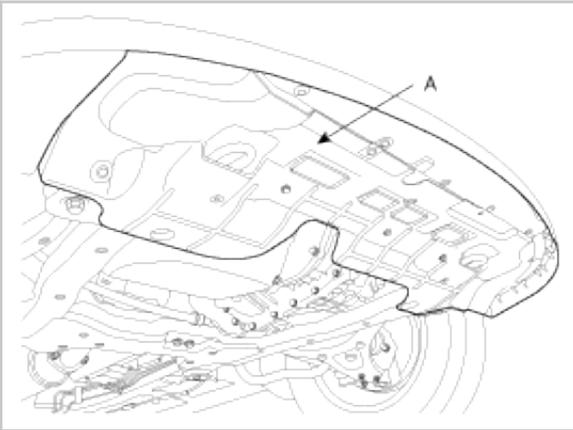


3. Remove the intake air hose and air cleaner assembly.
  - (1) Disconnect the MAF sensor connector (A).
  - (2) Disconnect the breather hose (B) from air intake hose.
  - (3) Remove the intake air hose and air cleaner assembly(C).



4. Remove the RH front wheel.

5. Remove the under cover (A).



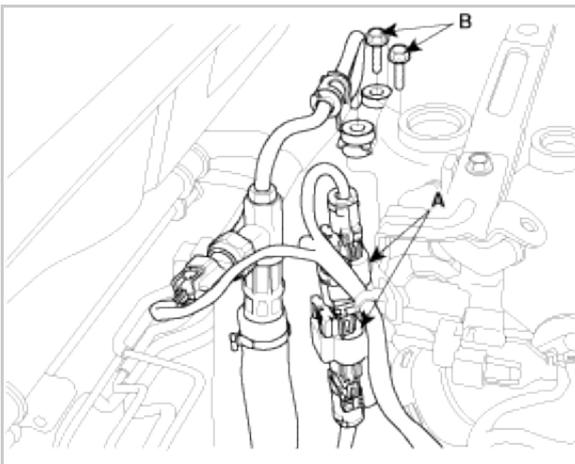
6. Remove the side cover.

7. Loosen the drain plug and drain the engine coolant.

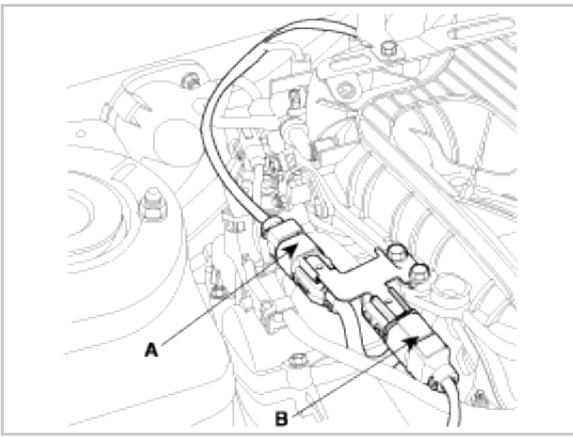
8. Drain the engine oil.

9. Remove the surge tank.

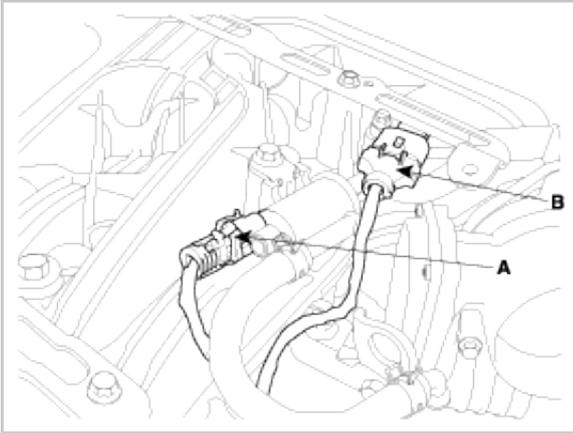
(1) Disconnect the RH oxygen sensor connector (A) and loosen the power steering hose mounting bolts (B).



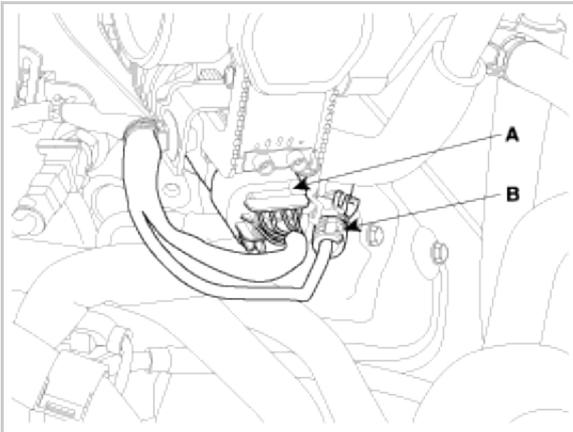
(2) Disconnect the RH injector connector (A) and ignition coil connector (B).



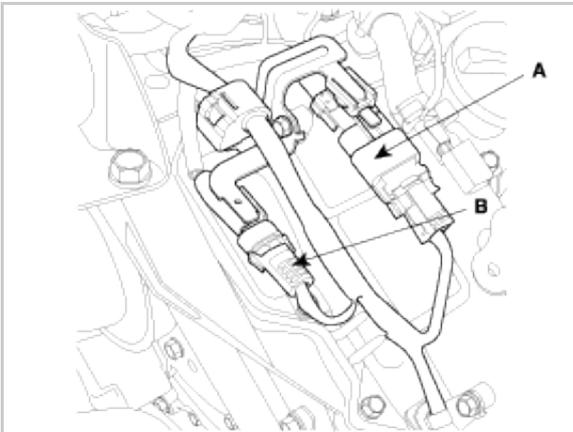
(3) Disconnect the PCSV connector (A), MAP sensor connector (B) and PCSV hose.



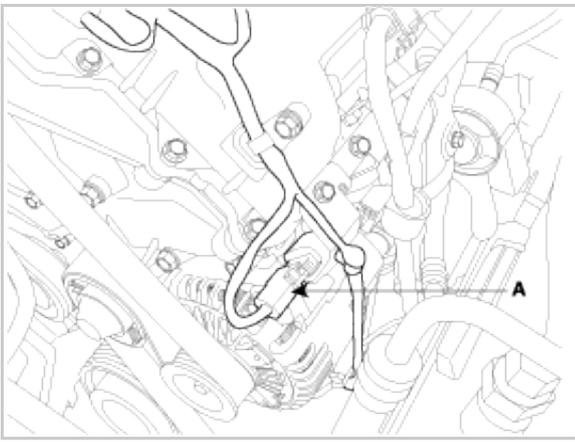
(4) Disconnect the ETC connector (A) and knock sensor connector (B).



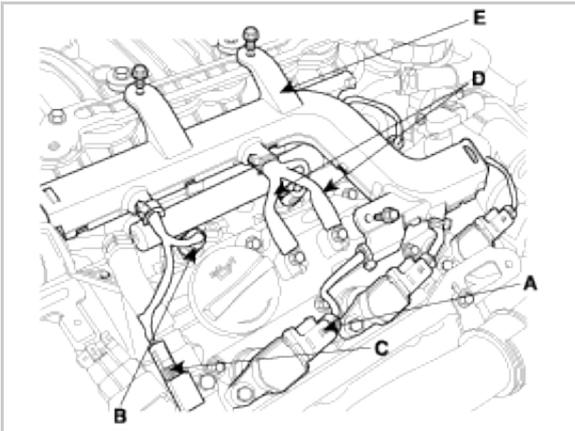
(5) Disconnect the OCV connector (A) and knock sensor connector (B).



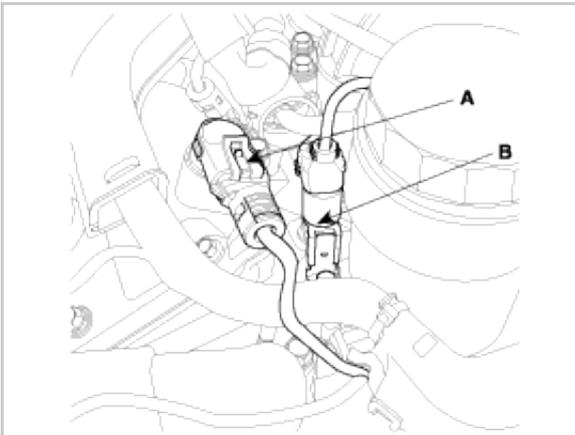
(6) Disconnect the LH front oxygen sensor connector (A).



(7) Disconnect the LH ignition coil connector (A), injector connector (B), condenser connector (C) and ground (D), and remove the wiring harness protector (E).



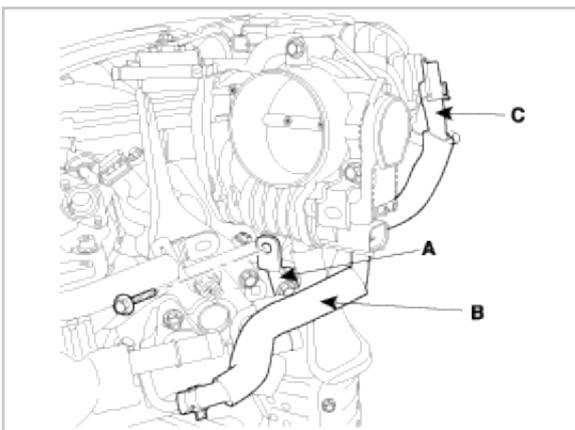
(8) Disconnect the LH CMPS (A) and oil pressure switch connector (B).



(9) Remove the ETC bracket (A).

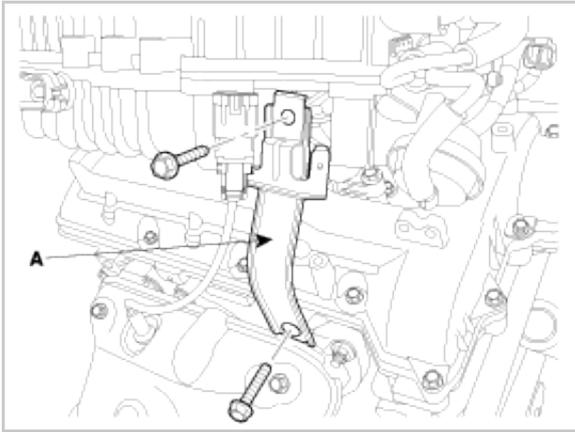
(10) Disconnect the water hoses (B) from ETC.

(11) Disconnect the PCV hose (C).

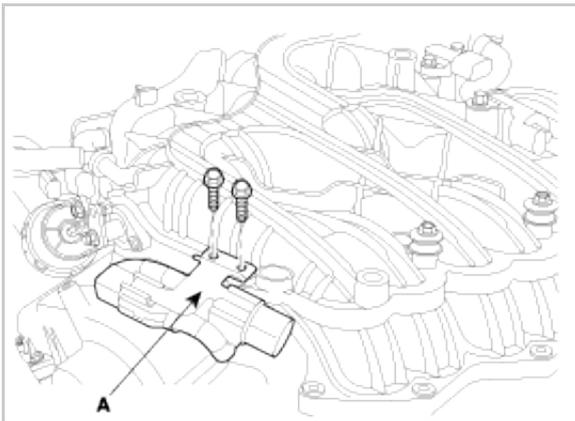


(12) Disconnect the brake vacuum hose.

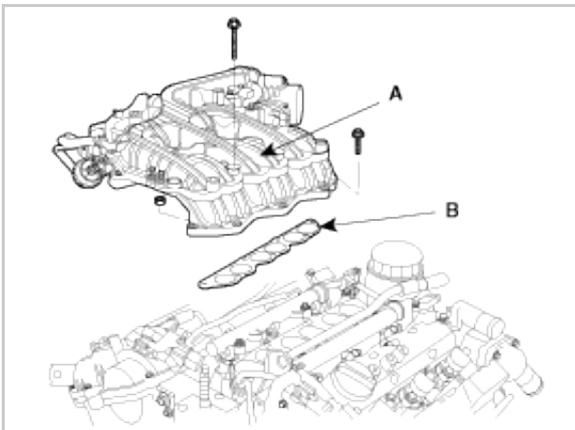
(13) Remove the surge tank stay (A).



(14) Remove the connector bracket (A) from surge tank.



(15) Remove the surge tank (A).

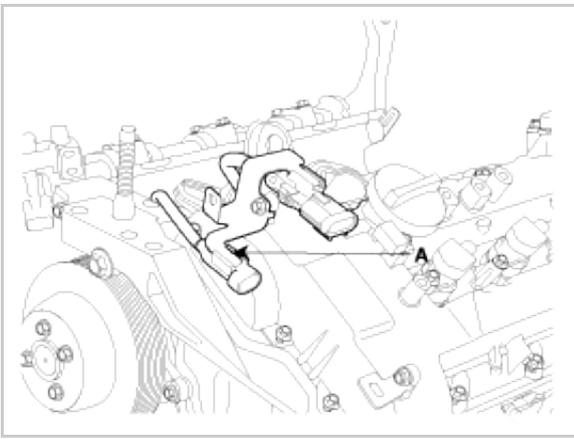


### NOTICE

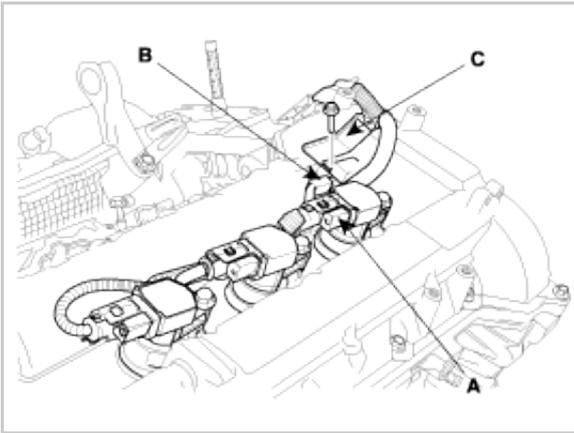
Cover the inlet of intake manifold with a clean woven stuff or vinyl cover to prevent foreign materials from entering.

10. Remove the cylinder head cover.

(1) Remove the connector bracket (A) from LH cylinder head cover.

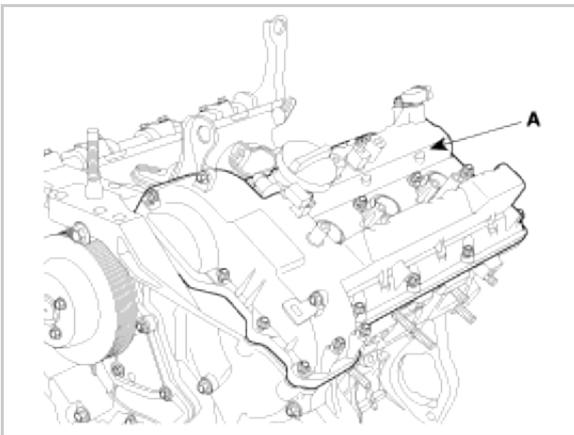


(2) Disconnect the RH ignition coil connector (A), condenser connector (B) and remove the wiring bracket (C).

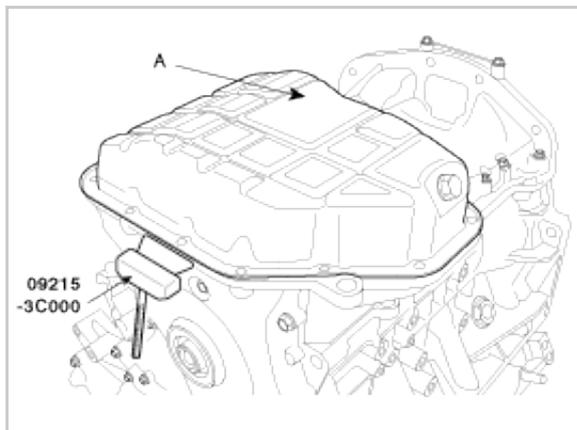


(3) Remove the LH, RH ignition coil.

(4) Remove the LH, RH cylinder head cover (A).



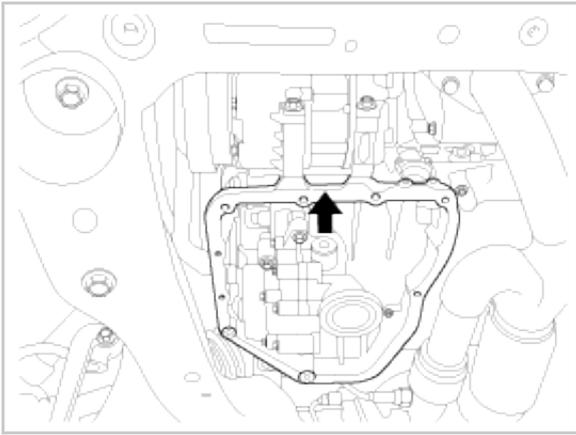
11. Using SST (09215-3C000) remove lower oil pan (A).



**NOTICE**

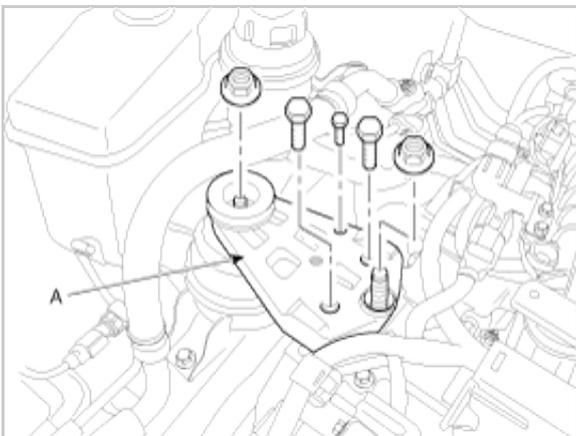
Be careful not to damage the contact surfaces of upper oil pan and lower oil pan.

12. Set a jack to the upper oil pan.



13. Remove the coolant reservoir tank.

14. Remove the engine mounting bracket (A).

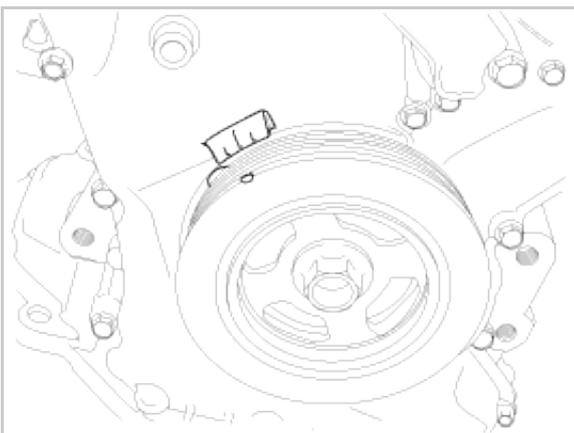


15. Set No.1 cylinder to TDC/compression.

- (1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.

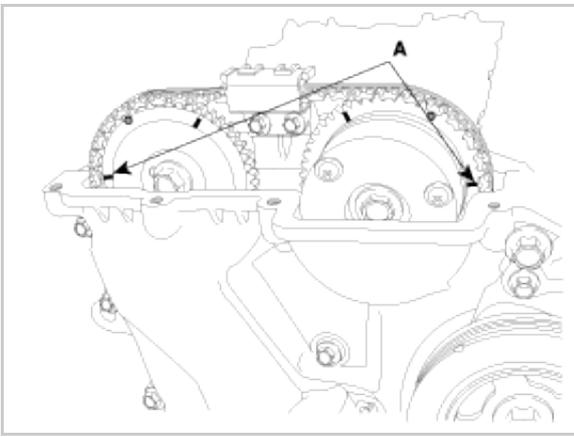
**NOTICE**

Do not rotate engine counterclockwise.



- (2) Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.

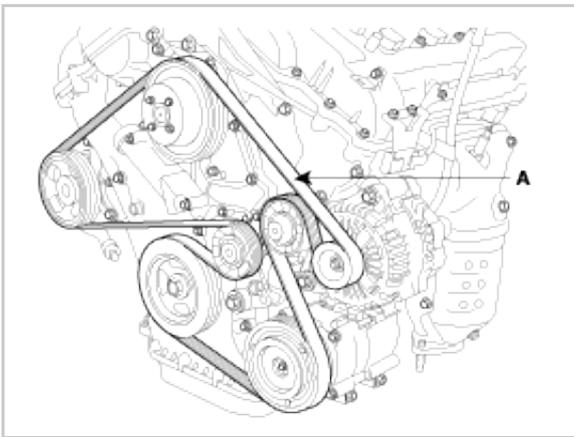
If not, turn the crankshaft one revolution (360°).



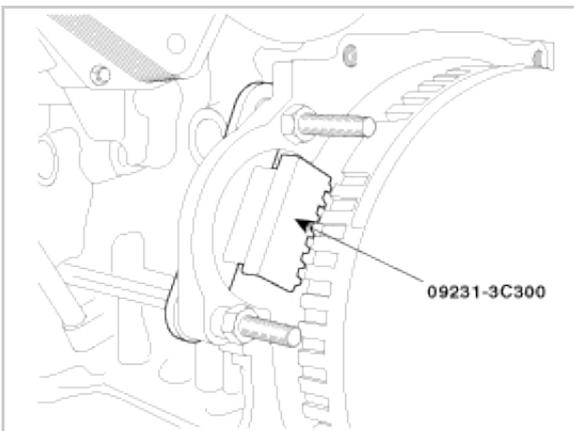
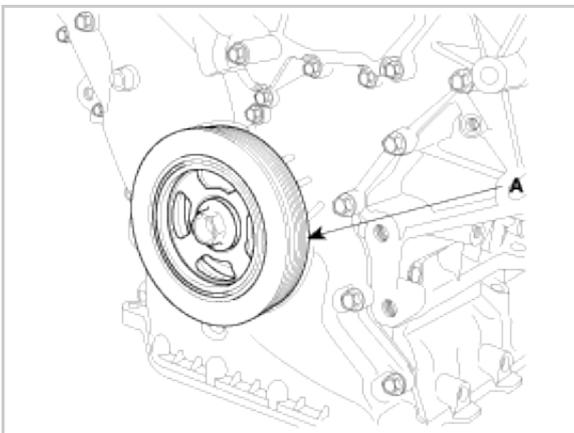
**NOTICE**

Do not rotate engine counterclockwise.

16. Remove the drive belt (A).

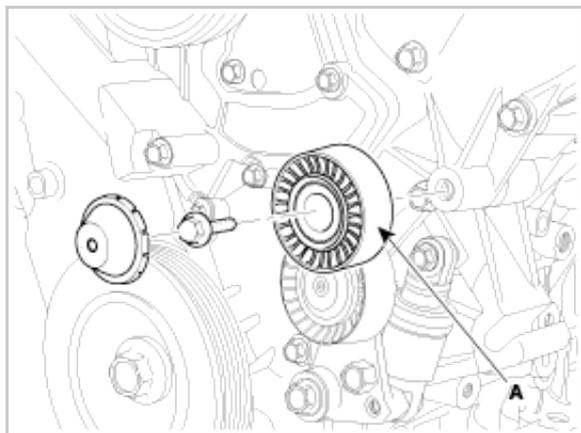


17. Using SST (09231-3C300) remove the crankshaft damper pulley (A).

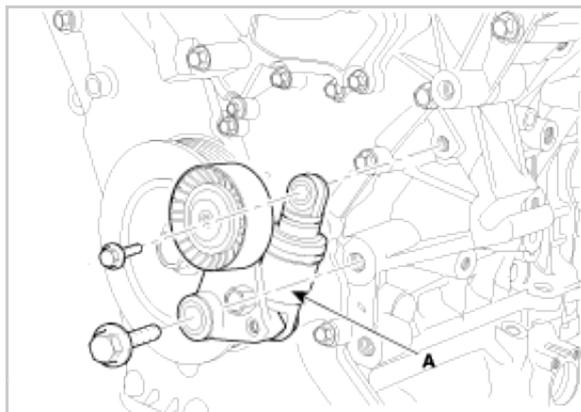


18. Lift up the engine assembly to using the jack.

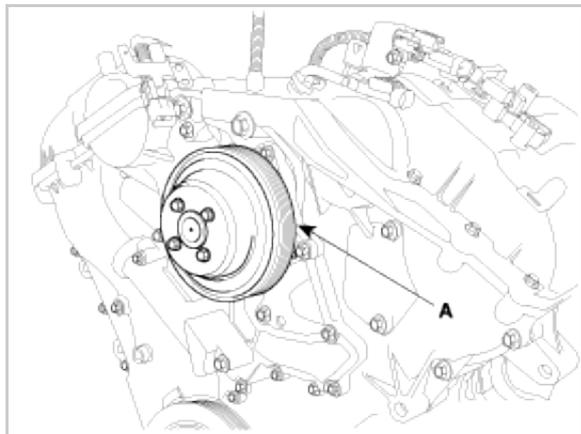
19. Remove the drive belt idler (A).



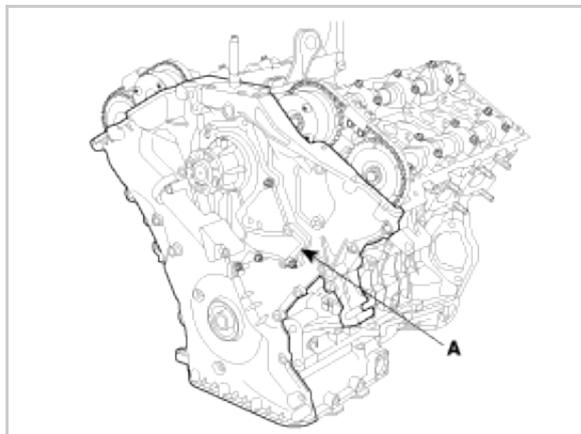
20. Remove the drive belt auto tensioner (A).



21. Remove the water pump pulley (A).



22. Remove the timing chain cover (A).

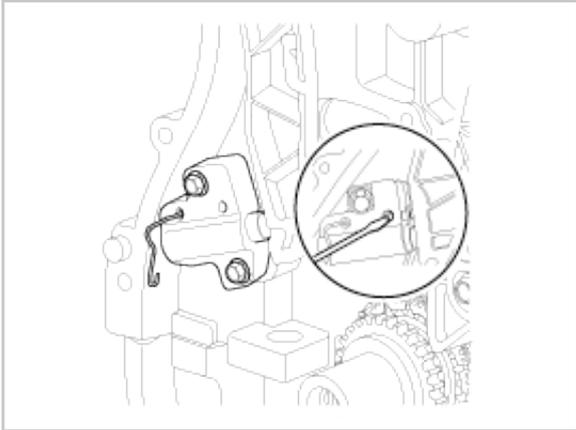


**NOTICE**

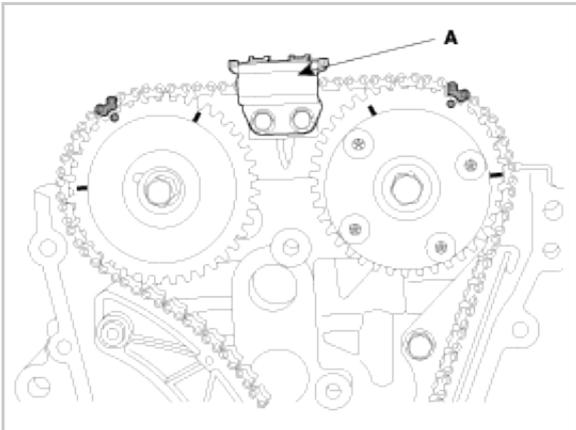
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.

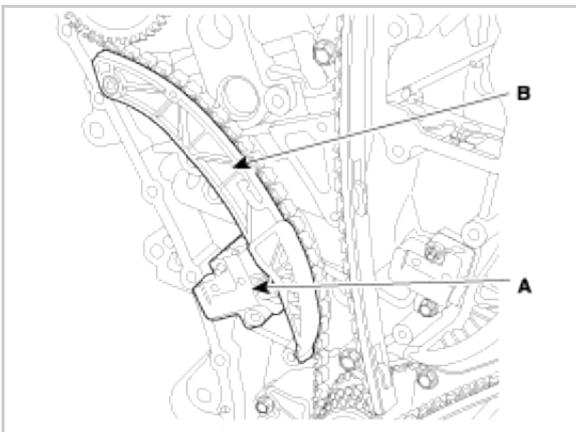
23. Install a set pin after compressing the timing chain tensioner.



24. Remove the RH cam-to-cam guide (A).

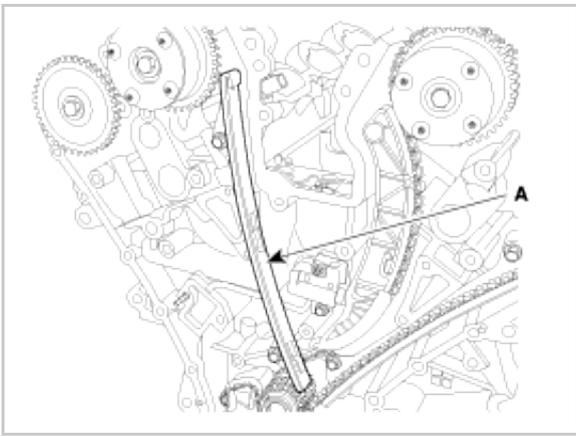


25. Remove the RH timing chain auto tensioner (A) and RH timing chain tensioner arm (B).

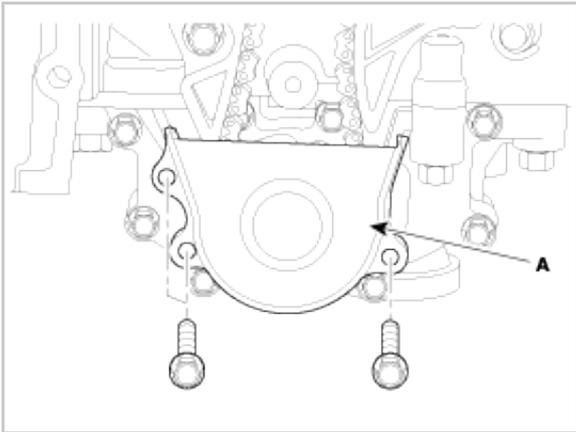


26. Remove the RH timing chain.

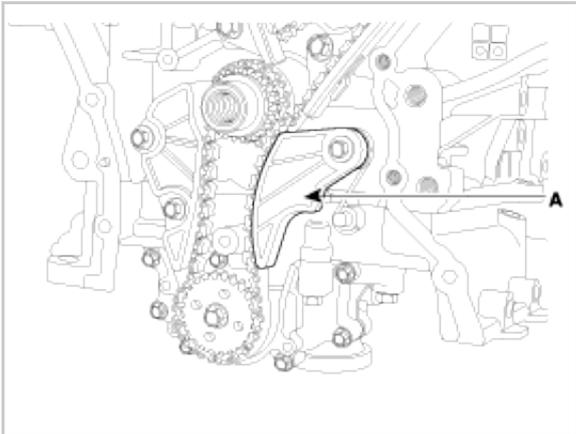
27. Remove the RH timing chain guide (A).



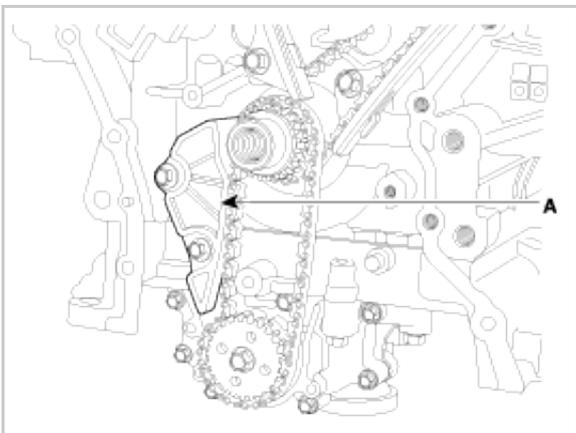
28. Remove the oil pump chain cover (A).



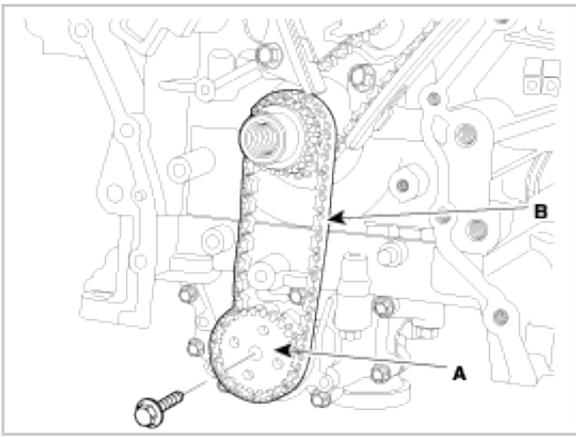
29. Remove the oil pump chain tensioner assembly (A).



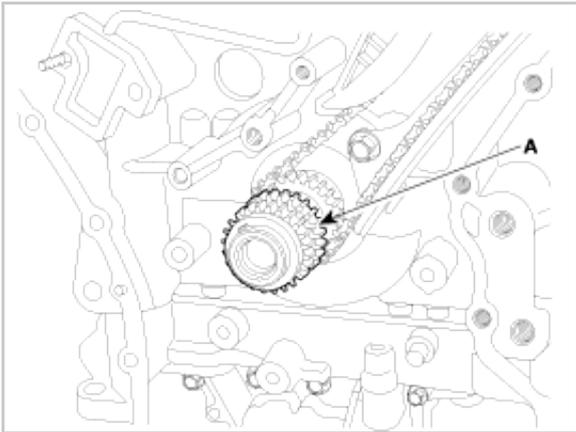
30. Remove the oil pump chain guide (A).



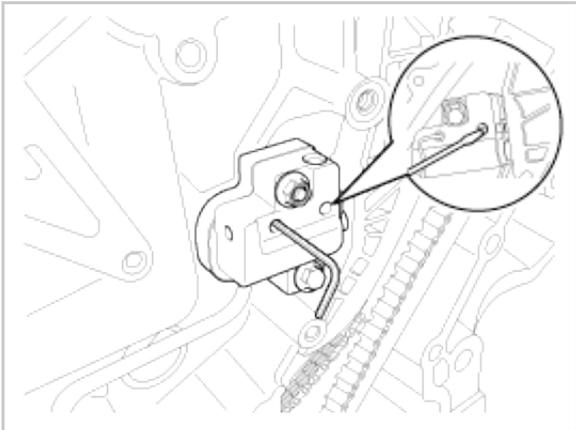
31. Remove the oil pump chain sprocket (A) and oil pump chain (B).



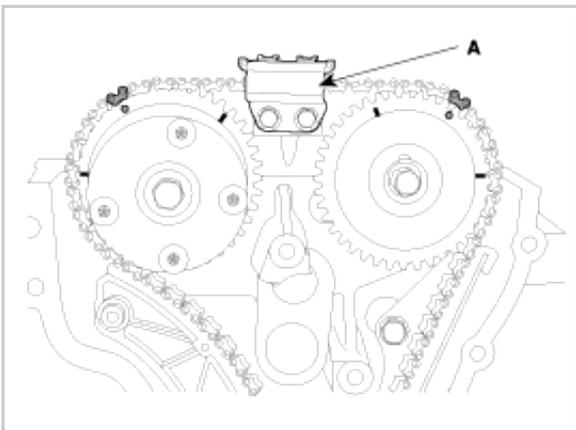
32. Remove the crankshaft sprocket (A) (Oil pump & RH camshaft drive).



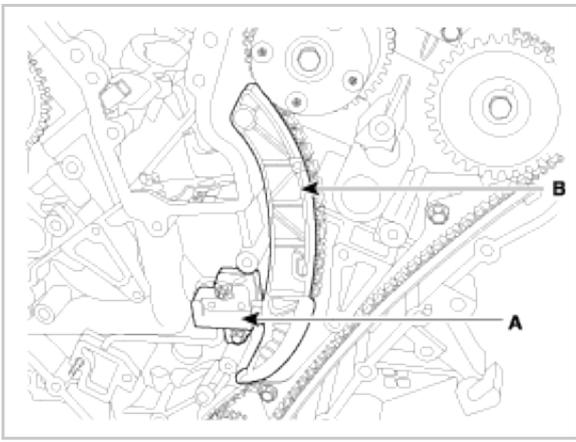
33. Install a set pin after compressing the LH timing chain tensioner.



34. Remove the LH cam-to-cam guide (A).

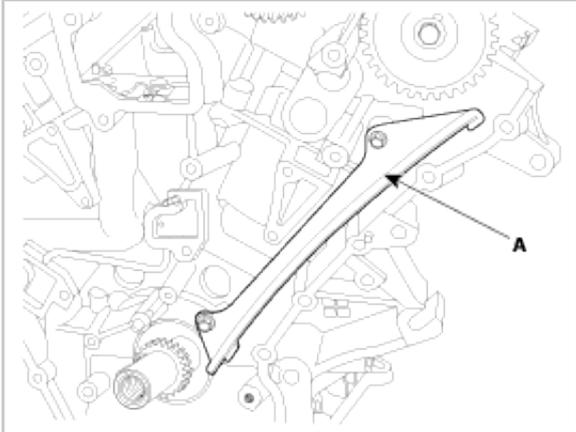


35. Remove the LH timing chain auto tensioner (A) and LH timing chain tensioner arm (B).

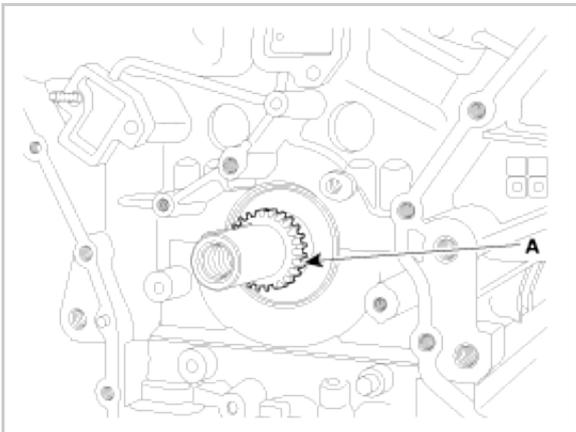


36. Remove the LH timing chain.

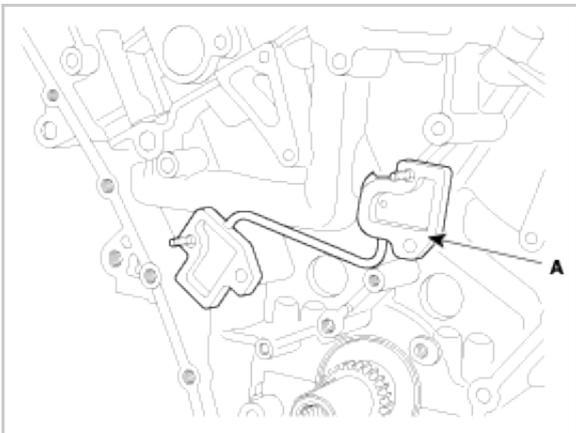
37. Remove the LH timing chain guide (A).



38. Remove the crankshaft sprocket (A) (LH camshaft drive).



39. Remove the tensioner adapter assembly (A).

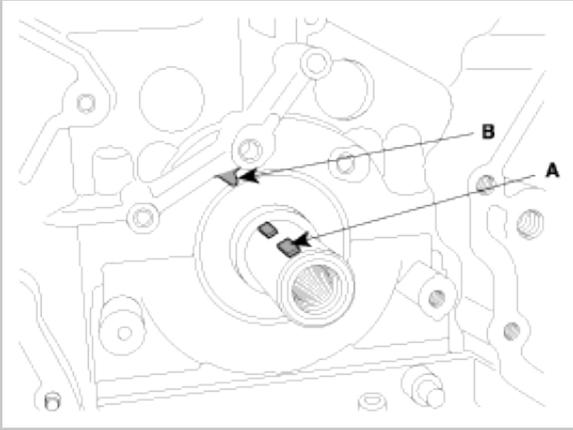


## Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

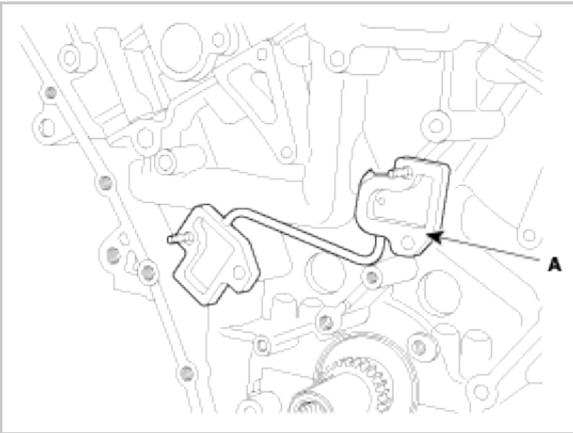
1. Check the camshaft sprocket and crankshaft sprocket for abnormal wear, cracks, or damage. Replace as necessary.
2. Inspect the tensioner arm and chain guide for abnormal wear, cracks, or damage. Replace as necessary.
3. Check that the tensioner piston moves smoothly when the ratchet pawl is released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

## INSTALLATION

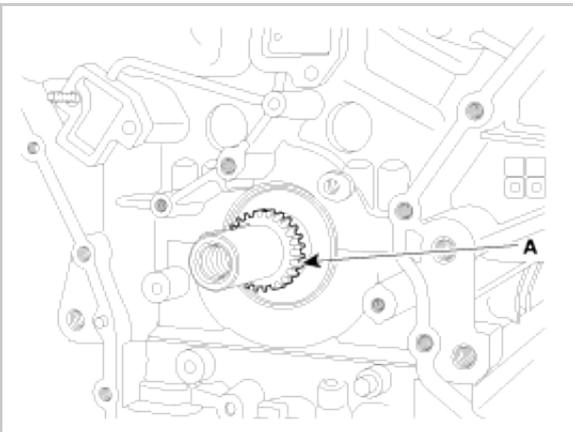
1. Install the jack to the upper oil pan.
2. The key (A) of crankshaft should be aligned with the timing mark (B) of timing chain cover. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



3. Install the tensioner adapter assembly (A).



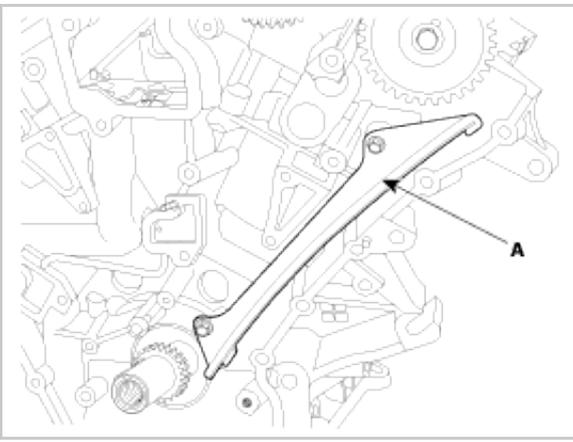
4. Install the crankshaft sprocket (A) (LH camshaft drive).



5. Install the LH timing chain guide (A).

Tightening torque :

19.60 ~ 24.50N.m(2.0 ~ 2.5kgf.m, 14.17 ~ 18.08lb-ft)

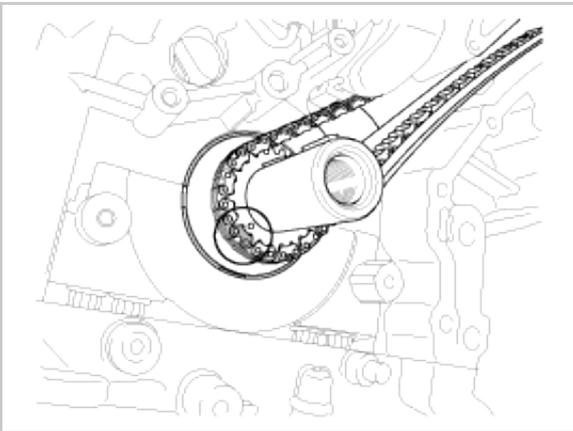
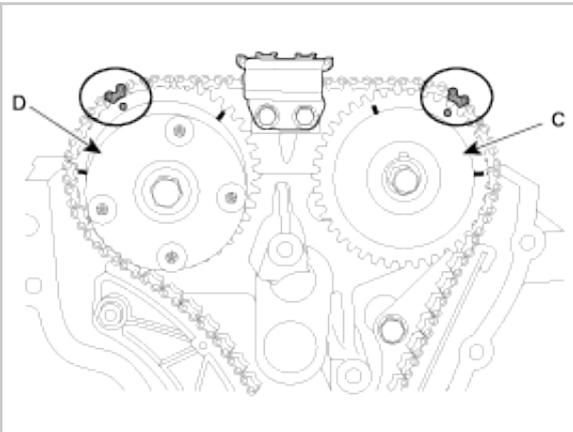


6. Install LH timing chain.

To install the timing chain with no slack between each shaft (cam, crank), follow the procedure below.

Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket(C) → Intake camshaft sprocket(D).

The timing mark of each sprocket should be matched with timing mark (color link) of timing chain at installing timing chain.



7. Install the LH timing chain tensioner arm(B).

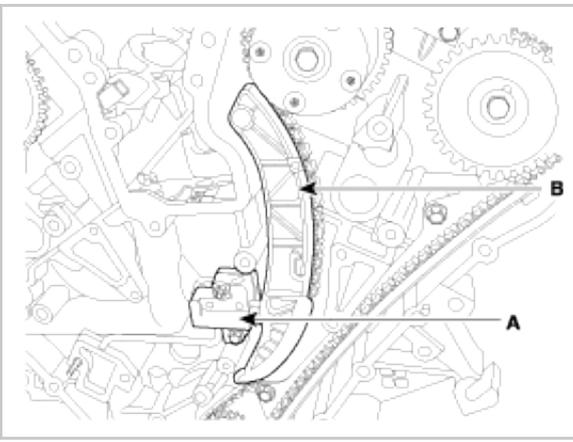
Tightening torque :

18.62 ~ 21.56N.m(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

8. Install the LH chain tensioner (A).

Tightening torque :

9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



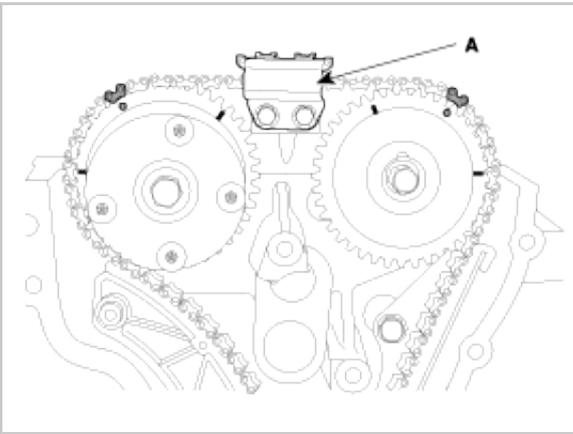
9. Install the LH cam-to-cam guide (A).

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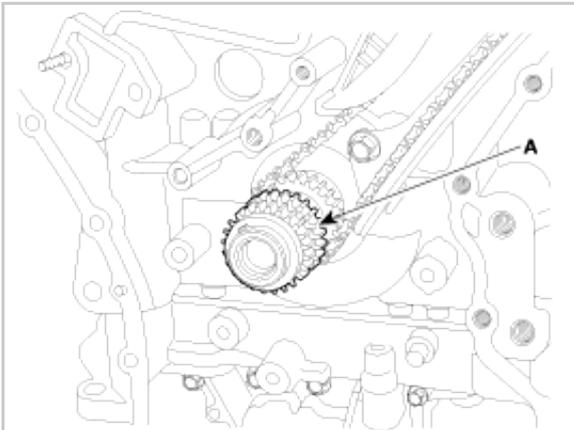
Tightening torque :

9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

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10. Install the crankshaft sprocket (A) (Oil pump & RH camshaft drive).



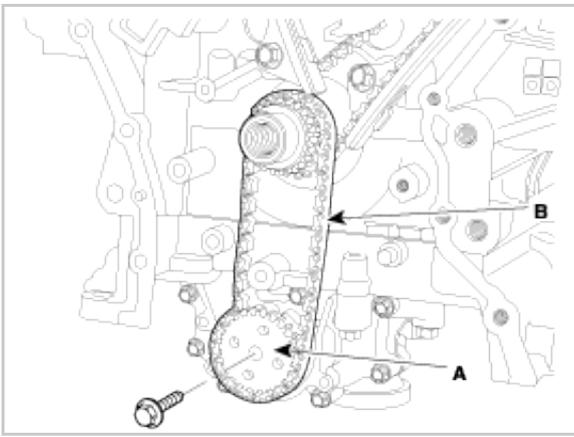
11. Install the oil pump chain (B) and oil pump sprocket (A).

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Tightening torque :

18.62 ~ 21.56N.m(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

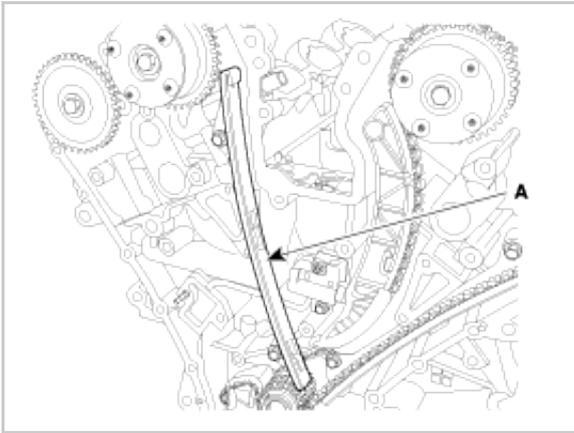
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12. Install the RH timing chain guide (A).

Tightening torque :

19.60 ~ 24.50N.m(2.0 ~ 2.5kgf.m, 14.17 ~ 18.08lb-ft)

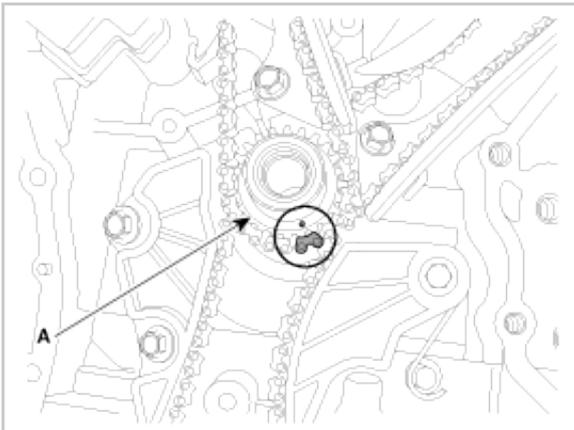


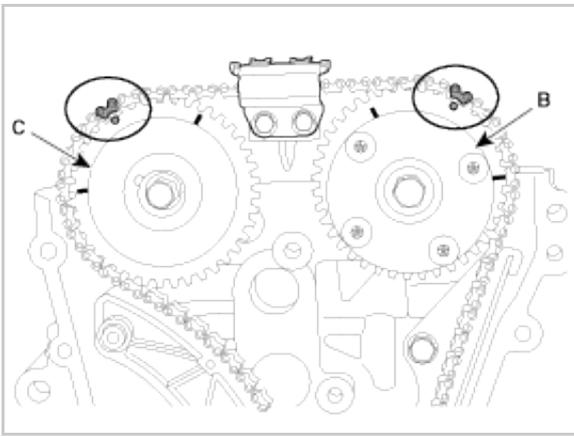
13. Install the RH timing chain.

To install the timing chain with no slack between each shaft (cam, crank), follow the procedure below.

Crankshaft sprocket (A) → Intake camshaft sprocket (B) → Exhaust camshaft sprocket (C).

The timing mark of each sprocket should be matched with timing mark (color link) of timing chain at installing timing chain.





14. Install the RH timing chain tensioner arm (B).

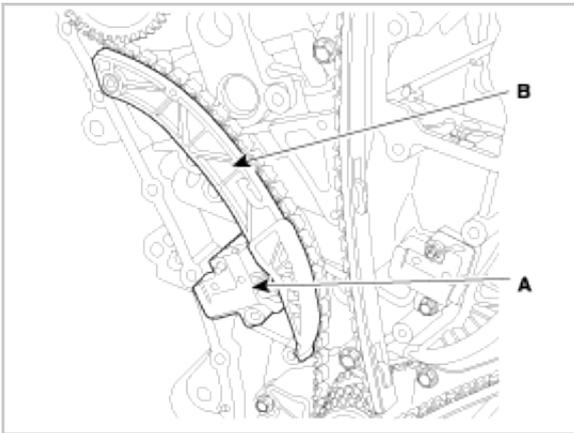
Tightening torque :

18.62 ~ 21.56N.m(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

15. Install the RH timing chain auto tensioner (A).

Tightening torque :

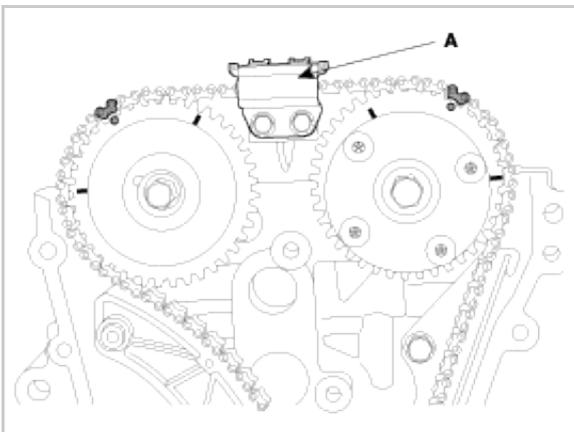
9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



16. Install the RH cam-to-cam guide (A).

Tightening torque :

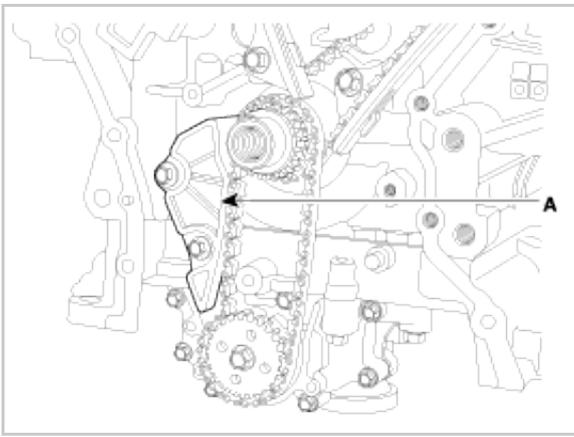
9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



17. Install the oil pump chain guide (A).

Tightening torque :

9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



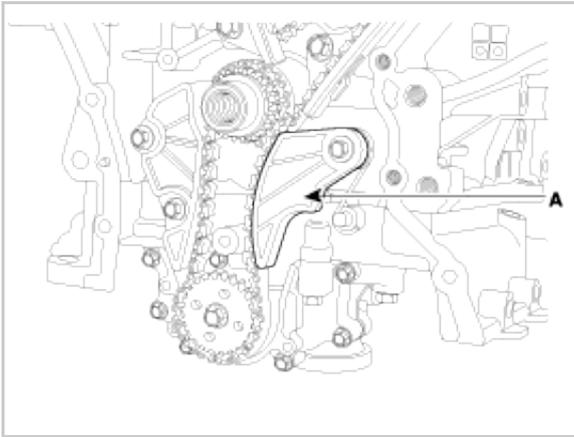
18. Install the oil pump chain tensioner assembly (A).

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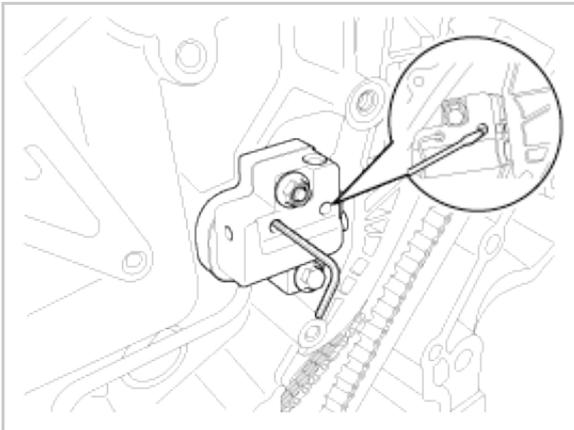
Tightening torque :

9.80 ~ 11.76N.m(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

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19. Pull out the pins of hydraulic tensioners (LH & RH).

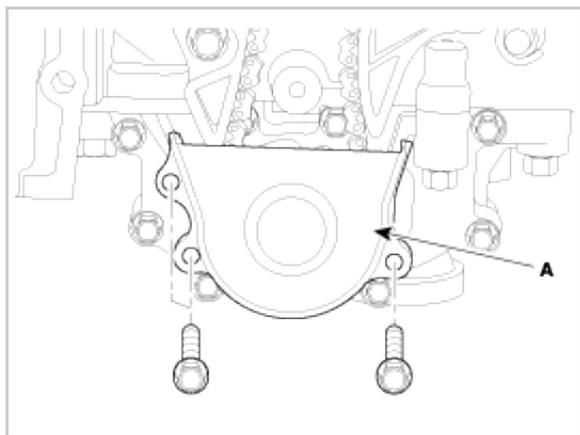


20. Install the oil pump chain cover (A).

---

Tightening torque :

9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



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

**NOTICE**

Always turn the crankshaft clockwise.

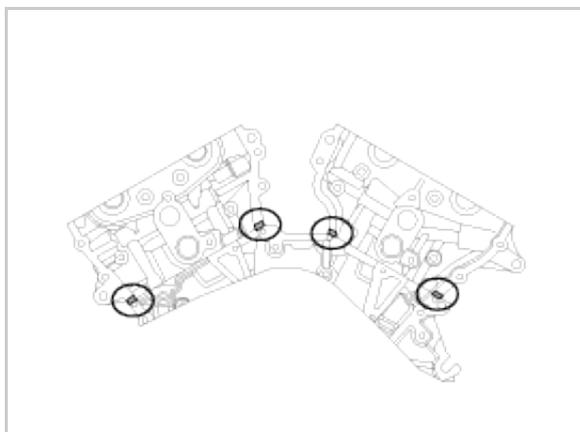
22. Install the timing chain cover.

(1) The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and ETC.

(2) Before assembling the timing chain cover, the liquid sealant TB1217H should be applied on the gap between cylinder head and cylinder block.

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

Bead width : 2.5mm(0.1in.)

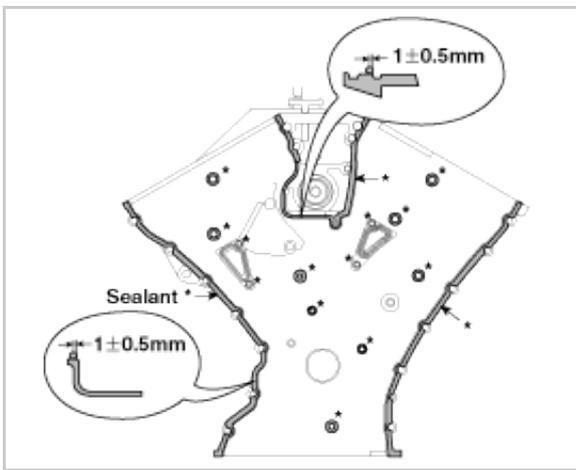


(3) After applying liquid sealant TB1217H on the timing chain cover.

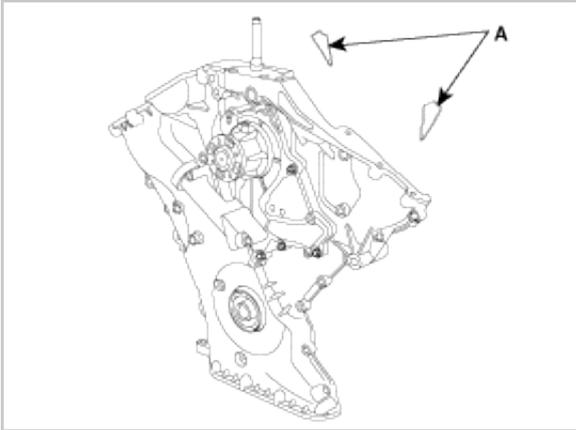
The part must be assembled within 5 minutes after sealant was applied.

Sealant should be applied without discontinuity.

Bead width : 2.5mm(0.1in.)



(4) Install the new gasket (A) to the timing chain cover.



#### NOTICE

During timing cover installation, care not to take off applied sealant on the timing cover by contact with other parts.

(5) The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover to be in exact position.

Tightening torque :

B(17) :18.62 ~ 21.56N.m (1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

C(4) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

D(1) :58.80 ~ 68.80N.m (6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)

E(1) :58.80 ~ 68.80N.m (6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)

F(2) :24.50 ~ 26.46N.m (2.5 ~ 2.7kgf.m, 18.08 ~ 19.53lb-ft)

G(4) :21.56 ~ 23.52N.m (2.2 ~ 2.4kgf.m, 15.91 ~ 17.36lb-ft)

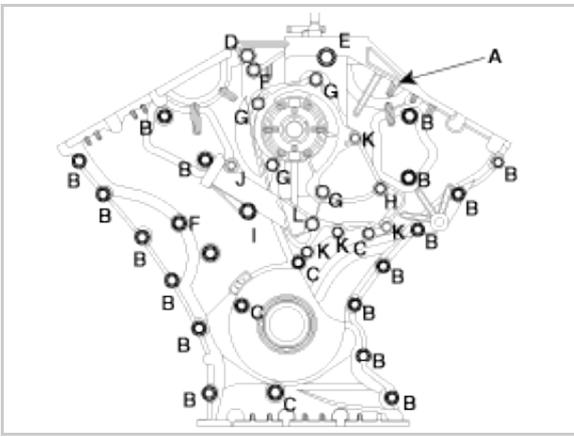
H(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

I(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

J(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

K(4) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

L(1):21.56 ~ 26.46N.m (2.2 ~ 2.7kgf.m, 15.91 ~ 19.53lb-ft) - New bolt

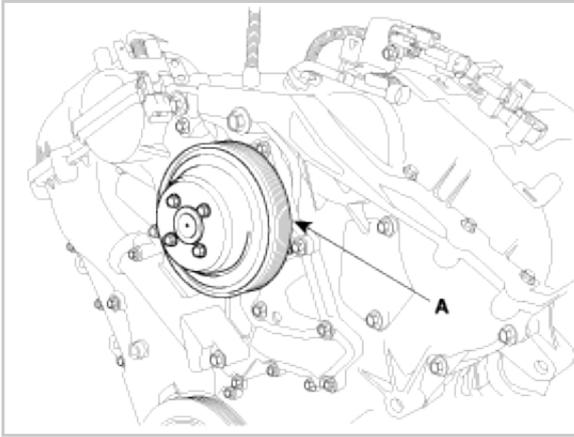


(6) The firing and/or blow out test should not be performed within 30 minutes after the timing chain cover was assembled.

23. Install the water pump pulley (A).

Tightening torque :

7.84 ~ 9.80N.m(0.8 ~ 1.0kgf.m, 5.78 ~ 7.23lb-ft)

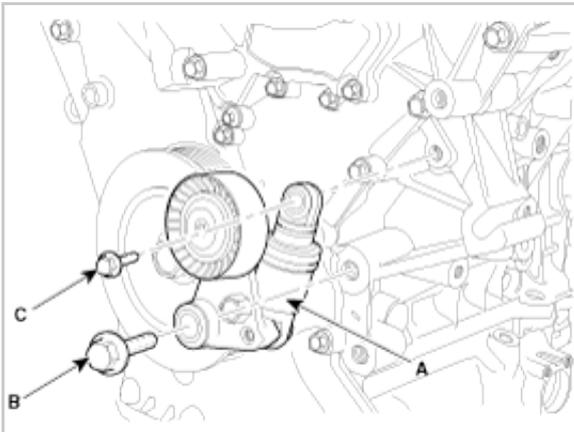


24. Install the drive belt auto tensioner (A).

Tightening torque :

Bolt(B):81.39 ~ 85.32N.m (8.3 ~ 8.7kgf.m, 60.03 ~ 62.93lb-ft)

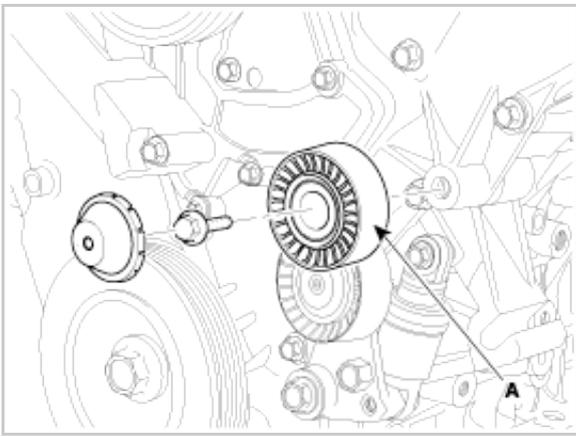
Bolt(C):17.64 ~ 21.56N.m (1.8 ~ 2.2kgf.m, 13.02 ~ 15.91lb-ft)



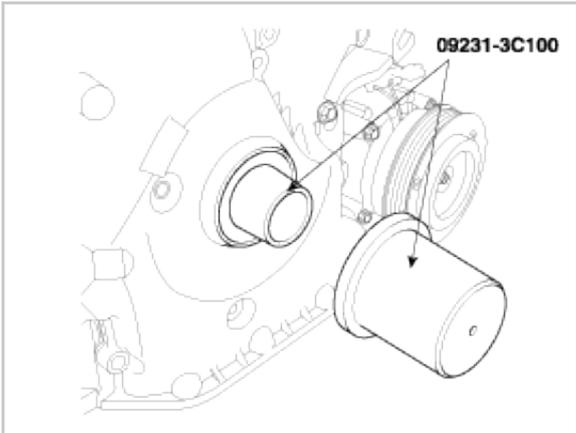
25. Install the drive belt idler (A).

Tightening torque :

52.92 ~ 57.82N.m(5.4 ~ 5.9kgf.m, 39.06 ~ 42.67lb-ft)



- 26. Lower the engine assembly by using the jack.
- 27. Using SST (09231-3C100), install timing chain cover oil seal.

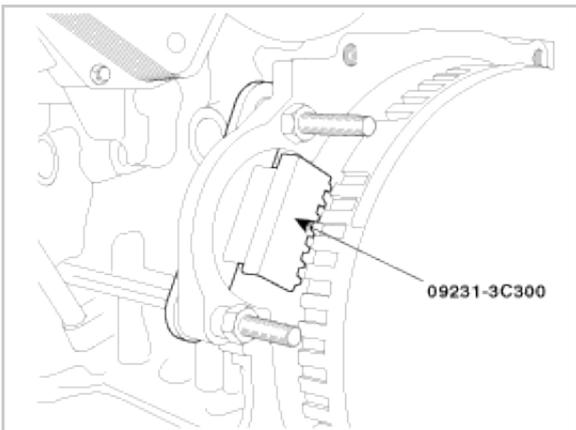
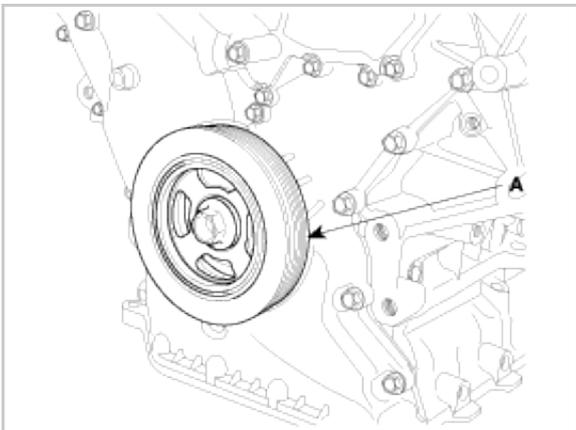


- 28. Using SST (09231-3C300) install the crankshaft damper pulley (A).

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Tightening torque :  
284.2~303.8N.m (29.0~31.0kgf.m, 209.76~224.22lb-ft)

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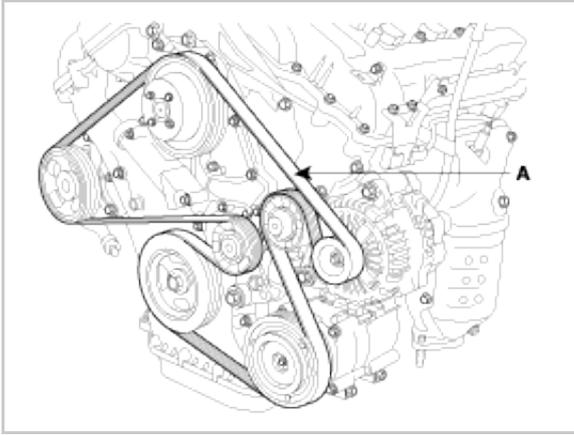


29. Install the drive belt (A).

Crankshaft pulley → A/C pulley → idler pulley → alternator pulley → water pump pulley → P/S pump pulley → tensioner pulley.

Rotate auto tensioner arm in the counterclockwise moving auto tensioner pulley bolt with wrench.

After putting belt on auto tensioner pulley, release the auto tensioner pulley slowly.



30. Install the cylinder head cover.

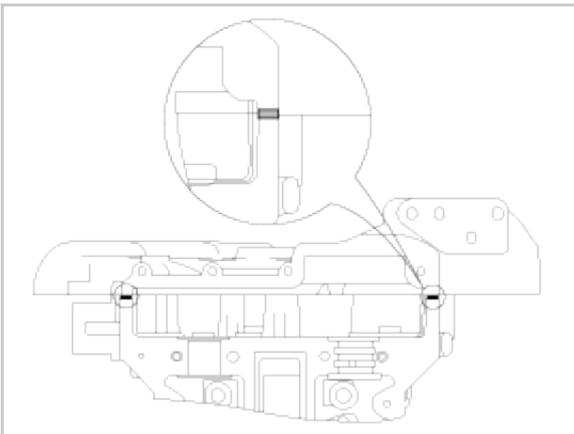
(1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

(2) After applying sealant (TB1217H), it should be assembled within 5 minutes.

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Bead width: 2.5mm(0.1in.)

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(3) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

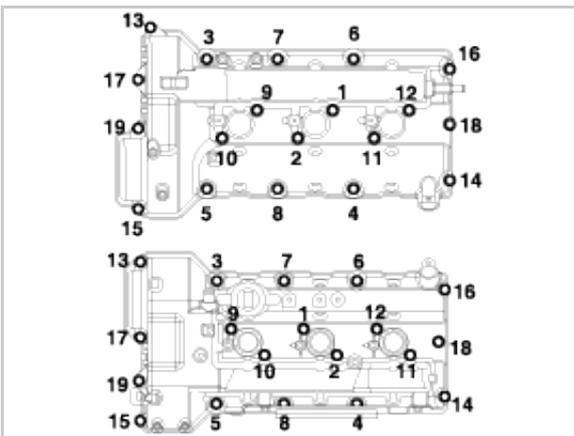
(4) Install the cylinder head cover bolts as following method.

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Tightening torque :

9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

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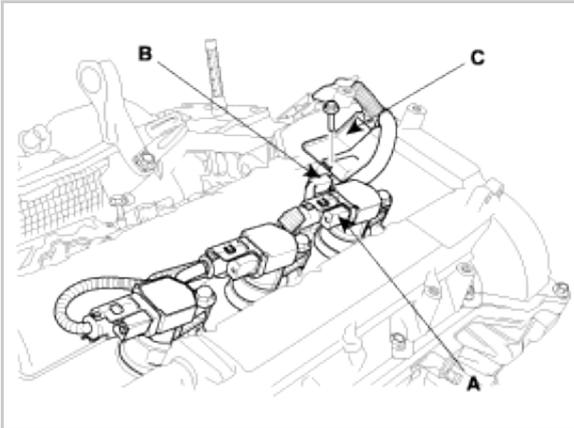


**CAUTION**

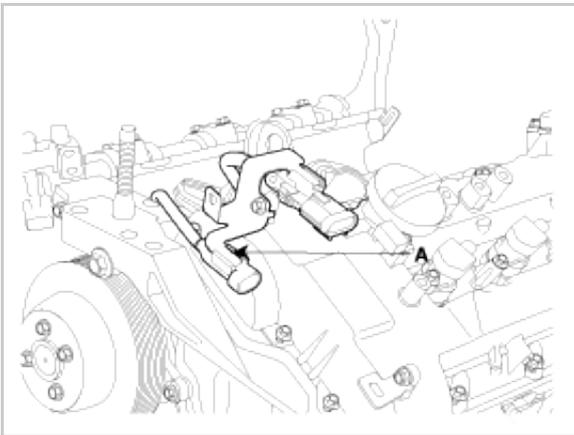
Do not reuse cylinder head cover gasket.

(5) Install the ignition coil.

(6) Connect the RH ignition coil connector (A), the condenser connector (B) and install the wiring bracket (C).



(7) Install the connector bracket (A) to the LH cylinder head cover.

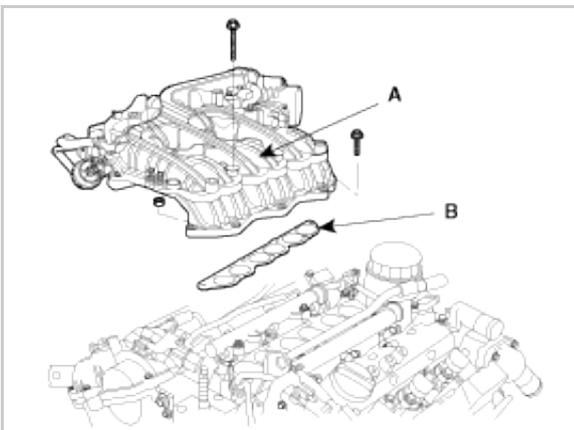


31. Install the surge tank and wiring connectors.

(1) Install the surge tank (A).

Tightening torque :

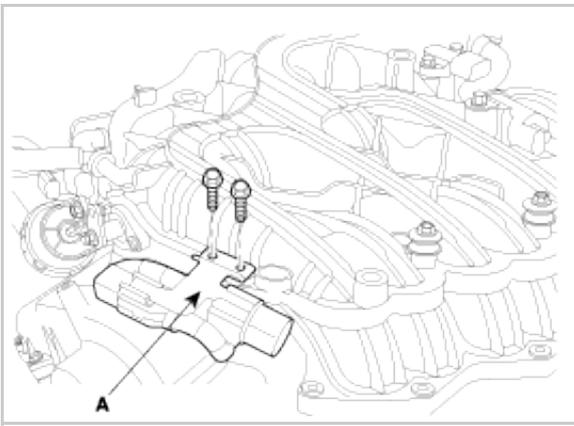
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



(2) Install the connector bracket (A) to the surge tank.

Tightening torque :

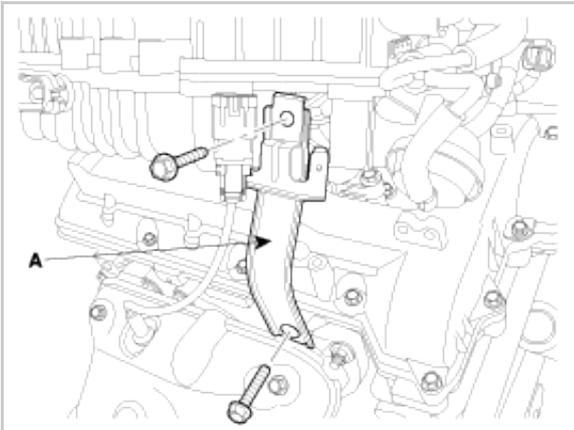
6.86 ~ 10.78N.m (0.7 ~ 1.1kgf.m, 5.06 ~ 7.96lb-ft)



(3) Install the surge tank stay.

Tightening torque :

27.44 ~ 31.36N.m (2.8 ~ 3.2kgf.m, 20.25 ~ 23.14lb-ft)

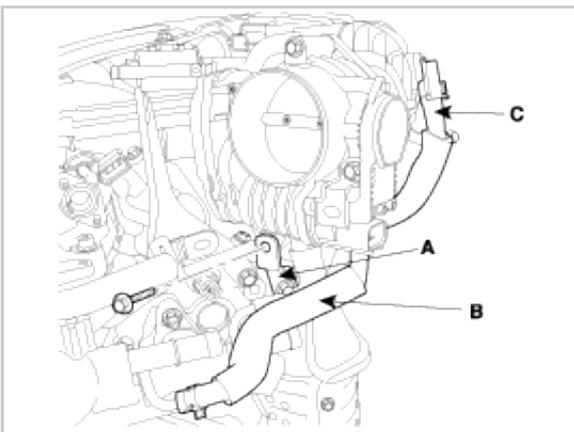


(4) Connect the brake vacuum hose.

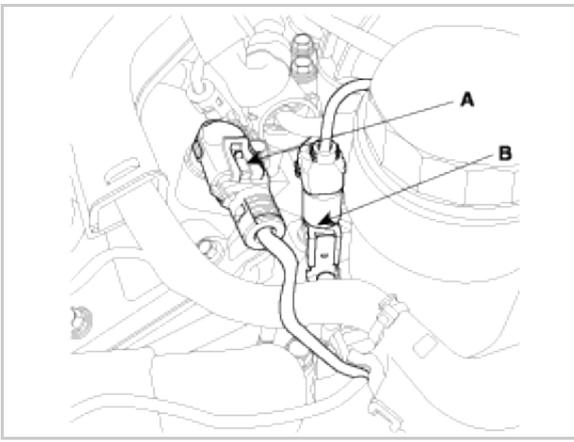
(5) Connect the PCV hose (C).

(6) Connect the water hoses (B) to the ETC.

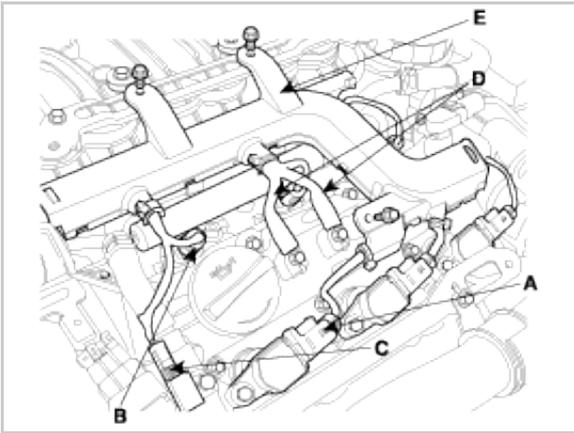
(7) Install the ETC bracket (A).



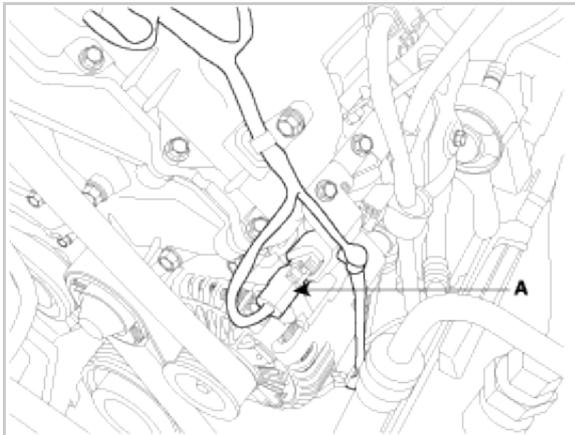
(8) Connect the LH CMPS connector (A) and oil pressure switch connector(B).



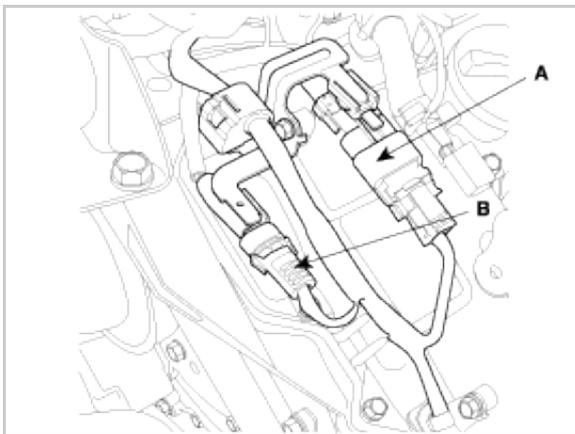
(9) Install the wiring harness protector (E) and connect the LH ignition coil connector (A), injector connector (B), condenser connector (C) and ground (D).



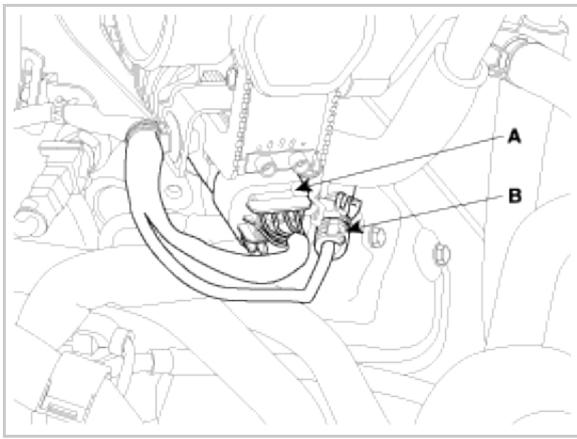
(10) Connect the LH front oxygen sensor connector (A).



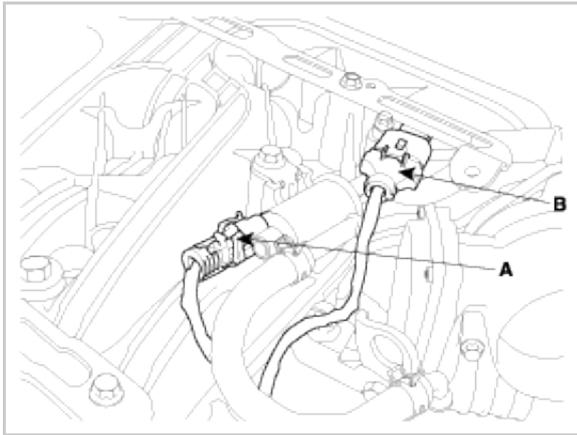
(11) Connect the OCV connector (A) and knock sensor connector (B).



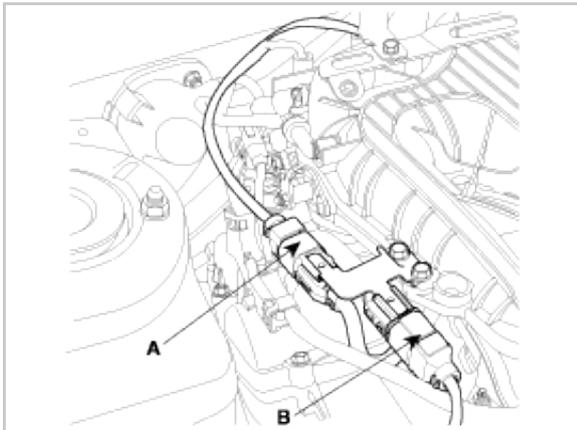
(12) Connect the ETC connector (A) and knock sensor connector (B).



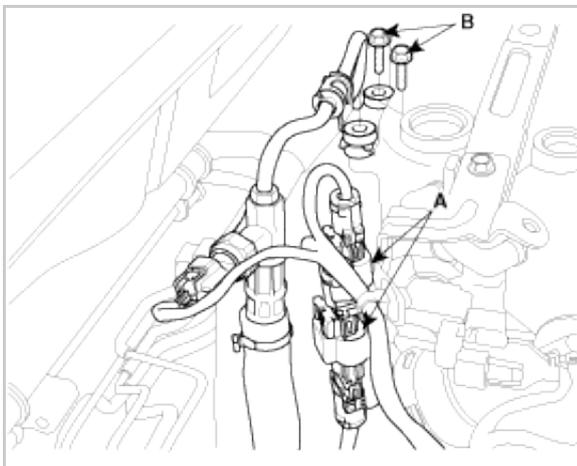
(13) Connect the PCSV connector (A), MAP sensor connector (B) and PCSV hose.



(14) Connect the RH injector connector (A) and ignition coil connector (B).

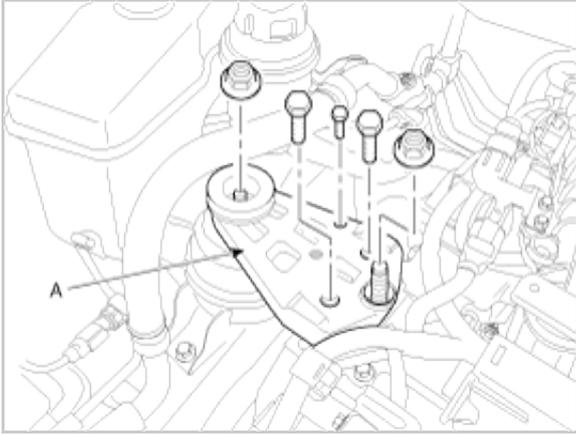


(15) Connect the RH oxygen sensor connector (A) and tighten the power steering hose mounting bolts (B).



32. Install the engine mounting bracket (A).

Tightening torque :



33. Install the coolant reservoir tank.

34. Remove the jack from the upper oil pan.

35. Install lower oil pan.

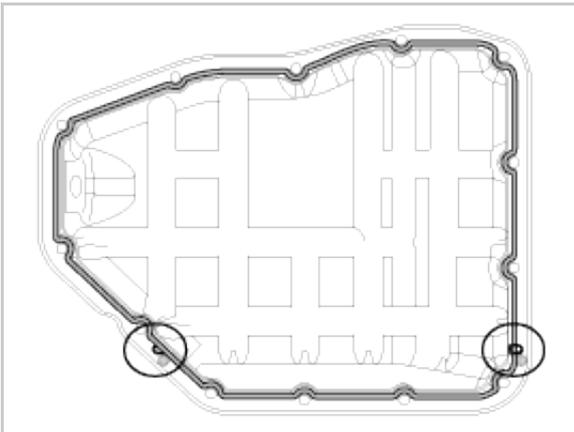
- (1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
- (2) Before assembling the oil pan, the liquid sealant TB1217H should be applied on oil pan.

---

Bead width : 2.5mm(0.1in.).

But marked area(\*) to be 5.0mm(0.2in.)

---



**CAUTION**

- a. Make clean the sealing face before assembling two parts.
- b. Remove harmful foreign matters on the sealing face before applying sealant.
- c. When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- d. To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

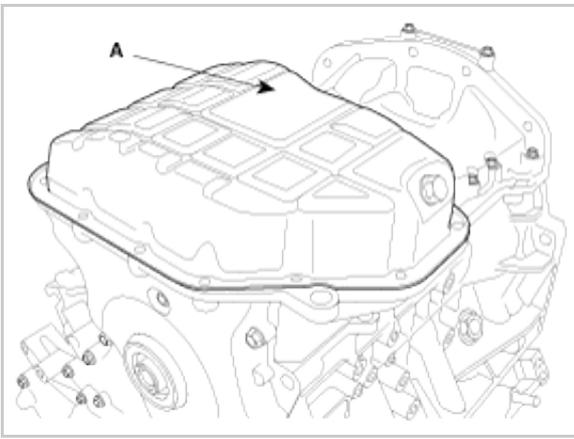
(3) Install the lower oil pan (A).

---

Tightening torque :

9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

---



36. Install the side cover.

---

Tightening torque :  
8.8 ~ 10.8N.m (0.9 ~ 1.1kgf.m, 6.5 ~7.9lb-ft)

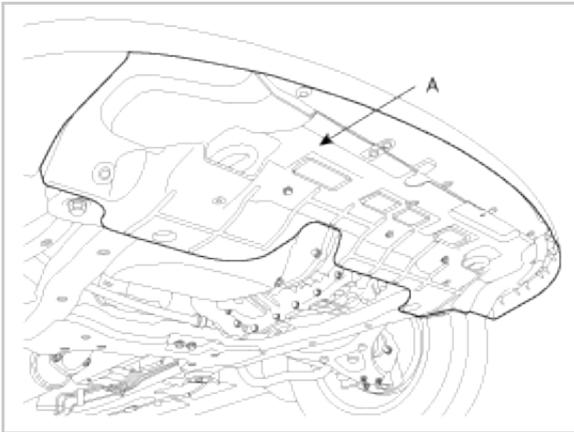
---

37. Install the under cover (A).

---

Tightening torque :  
8.8 ~ 10.8N.m (0.9 ~ 1.1kgf.m, 6.5 ~7.9lb-ft)

---



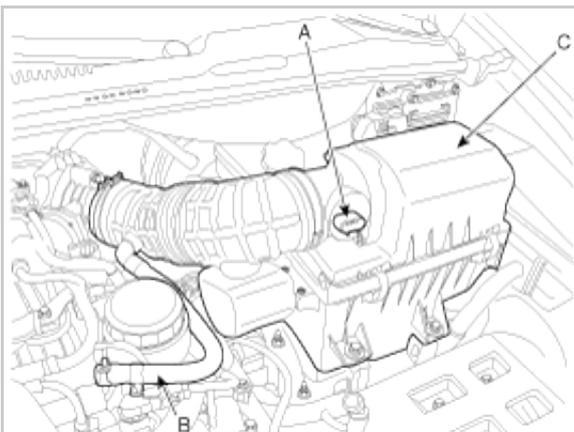
38. Install the RH front wheel.

---

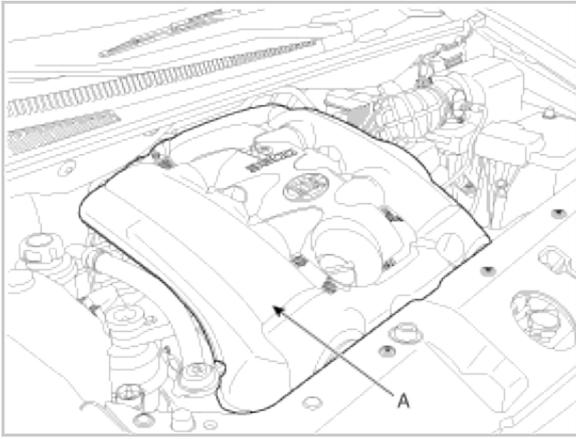
Tightening torque :  
88.3 ~ 107.9N.m (9.0 ~ 11.0kgf.m, 65.1 ~ 79.6lb-ft)

---

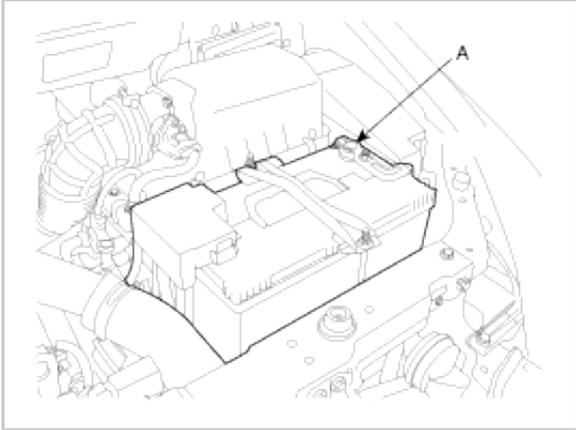
39. Install the intake air hose and air cleaner assembly.
- (1) Install the intake air hose and air cleaner assembly(C).
  - (2) Connect the breather hose (B) to the air intake hose.
  - (3) Connect the MAF sensor connector (A).



40. Install the engine cover (A).



41. Connect the battery negative cable (A).



#### NOTICE

- a. Refill engine with engine oil.
- b. Refill radiator and reservoir tank with engine coolant.
- c. Bleed air from the cooling system.
  - a. Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
  - b. Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
  - c. Put radiator cap on tightly, then run the engine again and check for leaks.

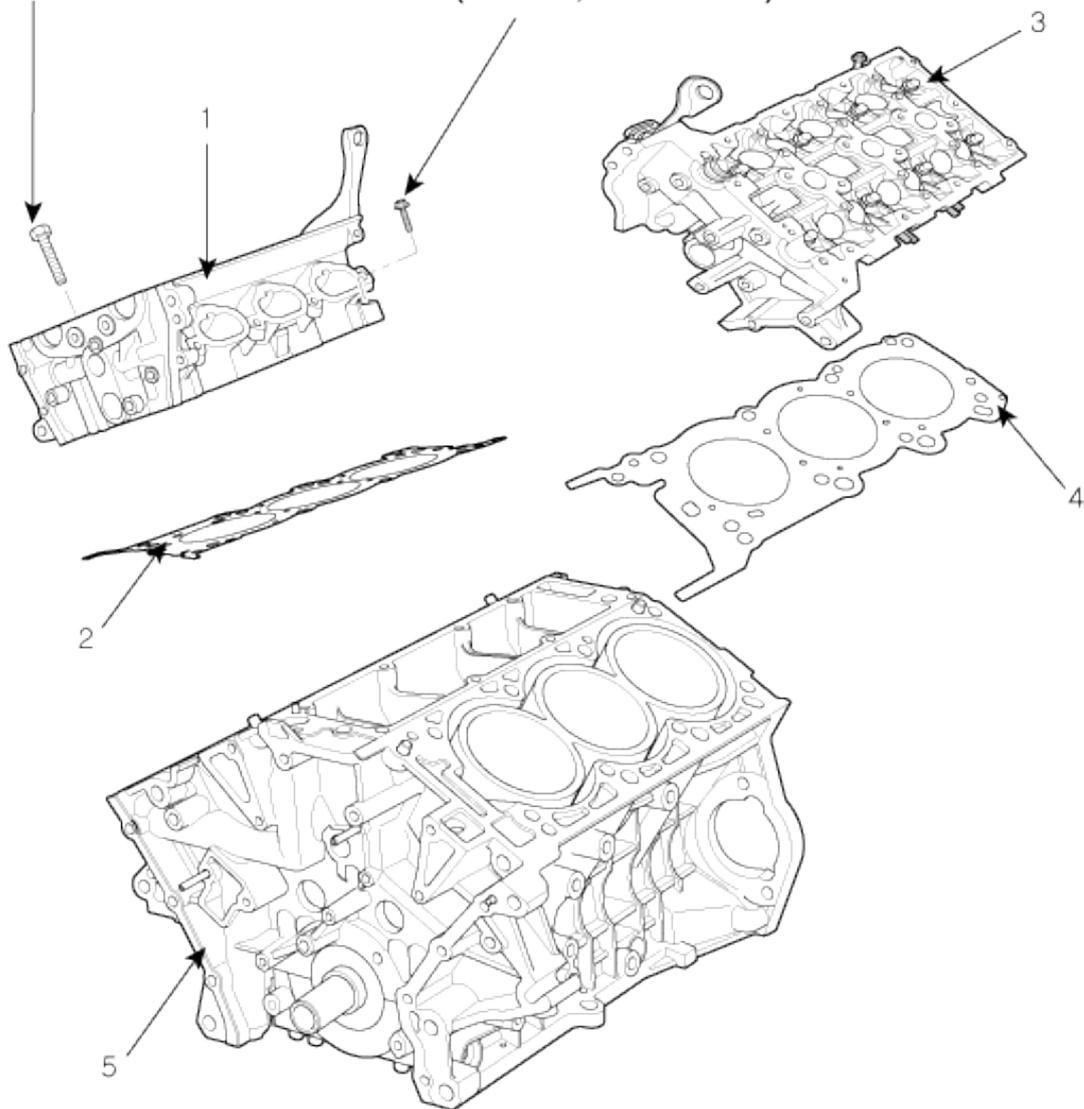
# **Cylinder Head Assembly**



## COMPONENTS

39.2 (4.0, 28.93) + 120° + 90°

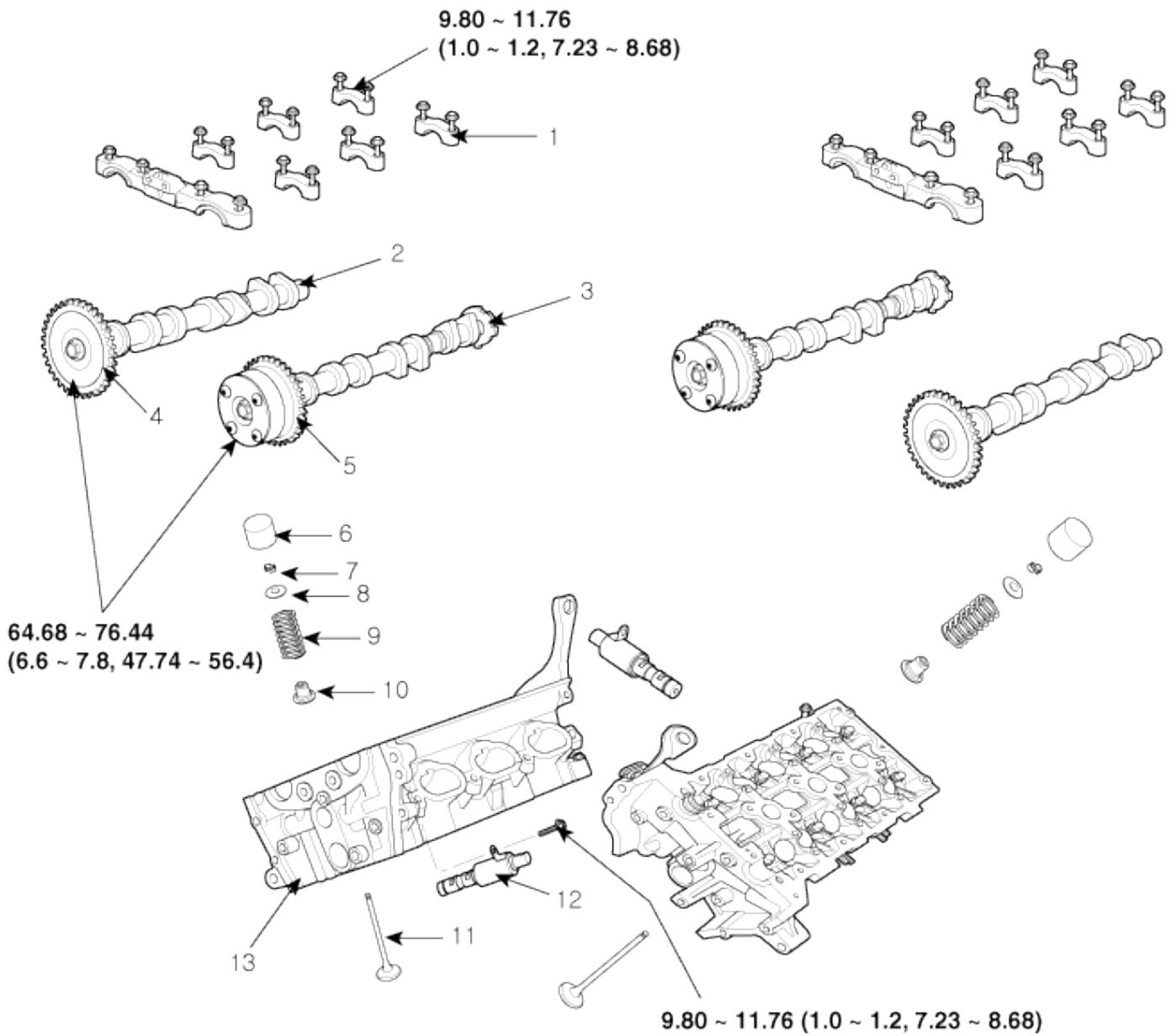
18.62 ~ 23.52  
(1.9 ~ 2.4, 13.74 ~ 17.36)



### TORQUE : N.m (kgf.m, lb-ft)

- 1. RH cylinder head
- 2. RH cylinder head gasket
- 3. LH cylinder head

- 4. LH cylinder head gasket
- 5. Cylinder block



**TORQUE : N.m (kgf.m, lb-ft)**

- |                              |                     |                   |
|------------------------------|---------------------|-------------------|
| 1. Camshaft bearing cap      | 6. MLA              | 11. Valve         |
| 2. Exhaust camshaft          | 7. Retainer lock    | 12. OCV           |
| 3. Intake camshaft           | 8. Retainer         | 13. Cylinder head |
| 4. Exhaust camshaft sprocket | 9. Valve spring     |                   |
| 5. CVVT assembly             | 10. Valve stem seal |                   |



## REMOVAL

### CAUTION

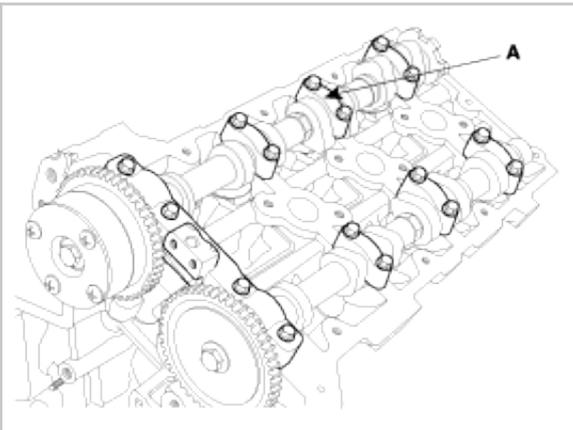
- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal operating temperature before removing it.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.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

### NOTICE

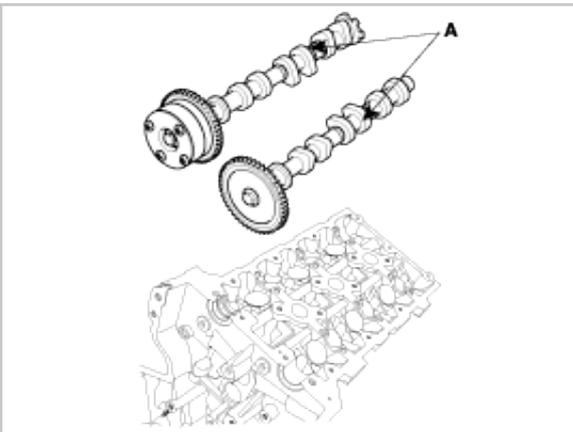
- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

Engine removal is required for this procedure.

- Remove exhaust manifold.
- Remove intake manifold.
- Remove timing chain.
- Remove water temperature control assembly.
- Remove camshaft bearing cap(A).

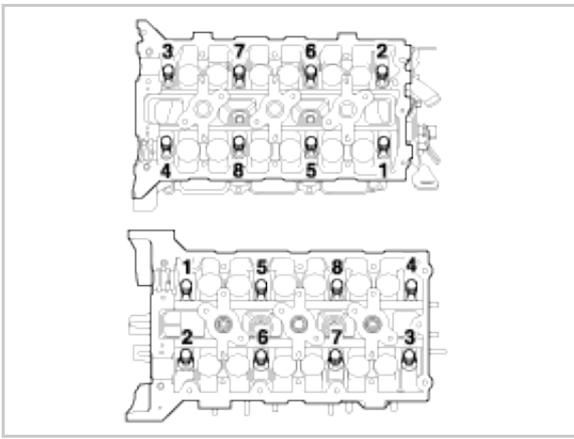


- Remove camshaft assembly(A).



- Remove cylinder head bolts, then remove cylinder head.

(1) Uniformly loosen and remove the 16 cylinder head bolts, in several passes, in the sequence shown. Remove the 16 cylinder head bolts and plate washers.



### CAUTION

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

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

### CAUTION

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

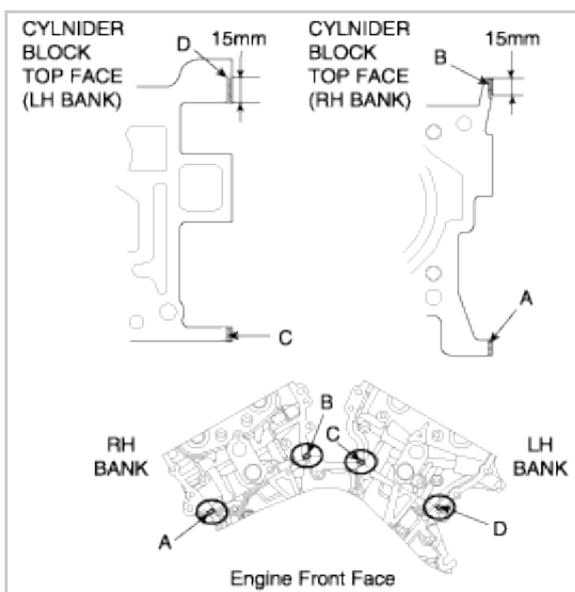
## INSTALLATION

### NOTICE

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

1. Install the cylinder head.

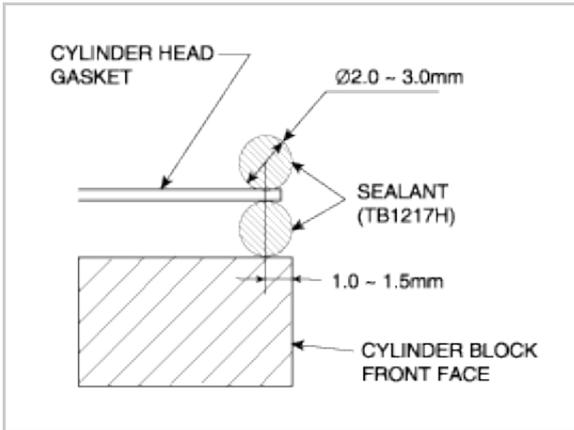
- a. The sealant locations on cylinder head and cylinder block must be free from contamination.
- b. Apply sealant on cylinder block top face before assembling cylinder head gaskets.  
The part must be assembled within 5 minutes after sealant was applied.



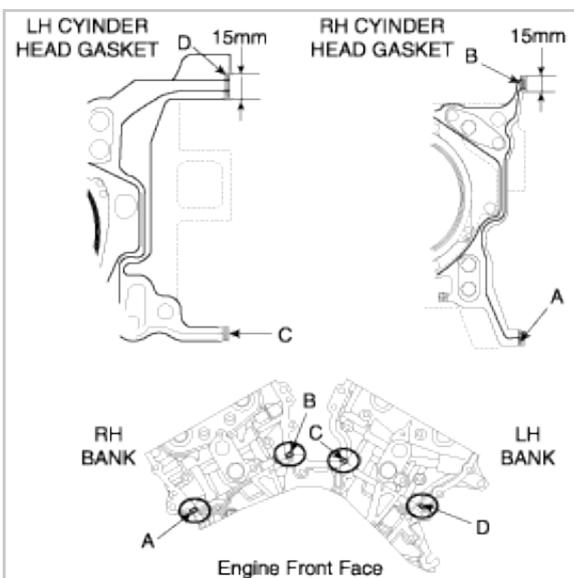
### NOTICE

Refer to below illustration to apply the sealant.

Bead width : 2.0~3.0 mm  
Sealant locations : 1.0~1.5mm from block surface  
Recommended sealant :Liquid sealant TB1217H

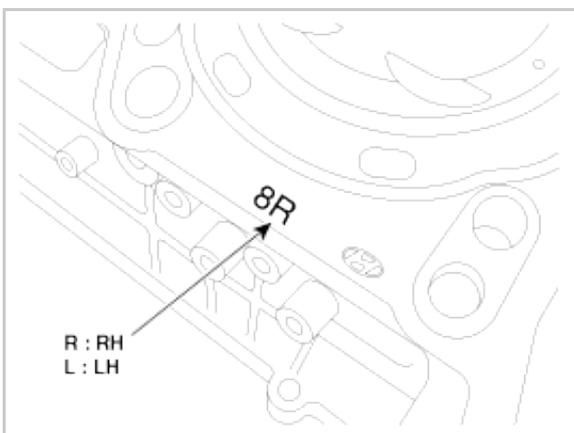


c. Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block. The part must be assembled within 5 minutes after sealant was applied.



**NOTICE**

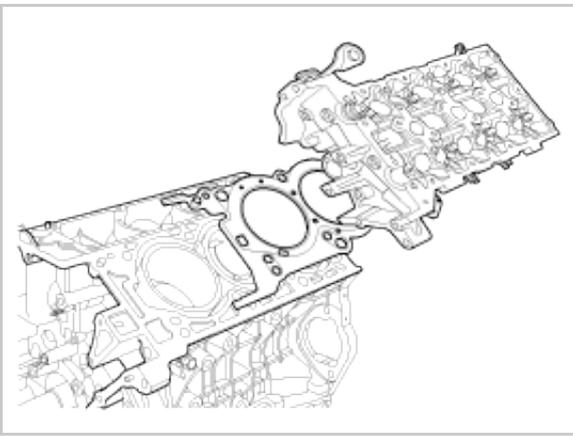
Be careful of the installation direction.



d. Install the cylinder head.

**NOTICE**

Remove the extruded sealant after assembling cylinder heads.



2. Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.
3. Install cylinder head bolts.
  - (1) Do not apply engine oil on the threads and under the heads of 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

1st step: 37.3~41.2Nm(3.8~4.2kgf.m, 27.5~30.4 lbf.ft)

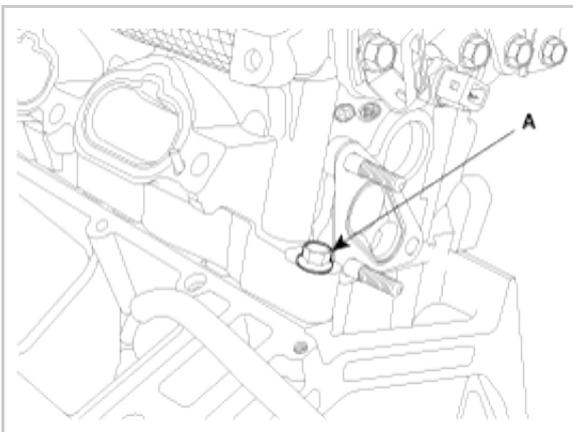
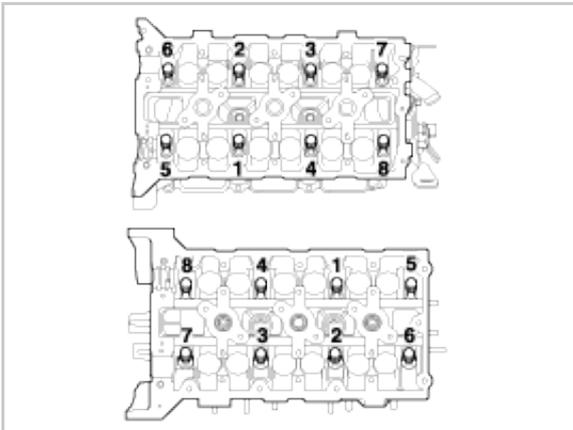
2nd step:  $120^{\circ} \pm 2^{\circ}$

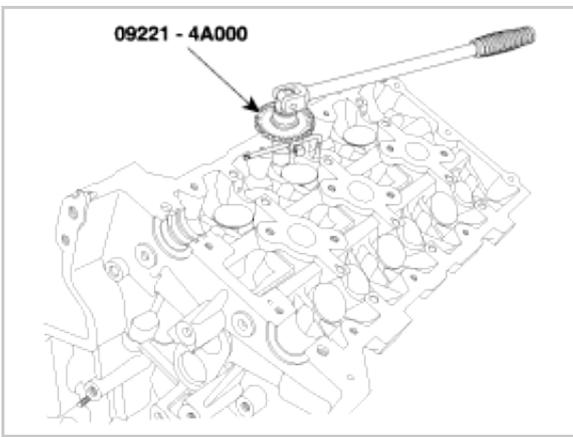
3rd step:  $90^{\circ} \pm 2^{\circ}$

---

**NOTICE**

Always use new cylinder head bolt.

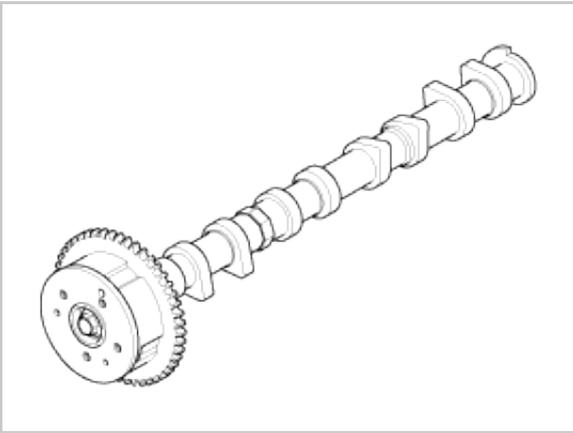




4. Install the CVVT and camshaft sprocket.

Tightening torque

64.68 ~ 76.44Nm(6.6 ~ 7.8 kgf.m, 47.74 ~ 56.4lb-ft)



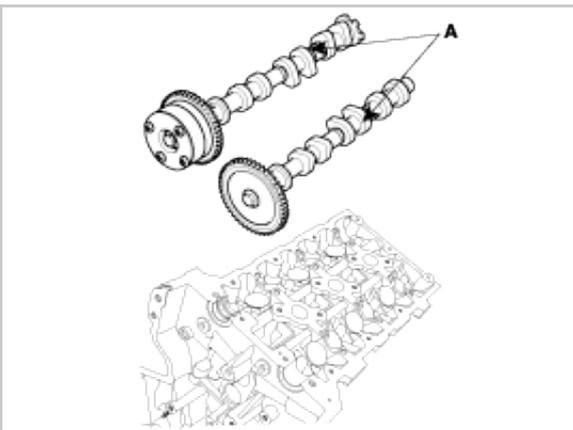
#### NOTICE

- a. Install camshaft-inlet to dowel pin of CVVT assembly .  
Ensure that the camshaft oil inlet is not obstructed.
- b. Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt and CVVT assembly.
- c. Do not rotate CVVT assembly when camshaft is installed to dowel pin of CVVT assembly.

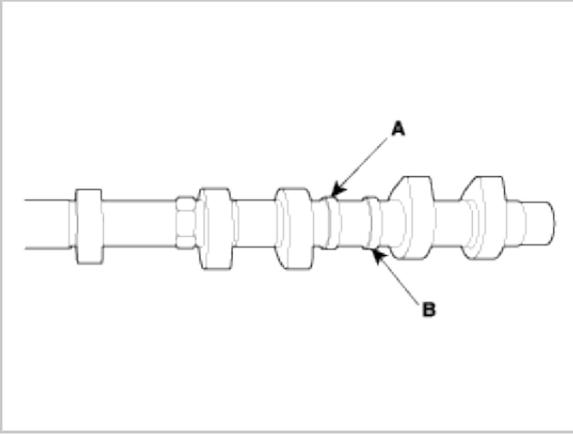
5. Install camshafts(A).

#### NOTICE

- a. Apply a light coat of engine oil on camshaft journals.
- b. Assemble the key groove of camshaft rear side to the same level of head top surface.
- c. Ensure that the camshaft components are installed in the correct locations.

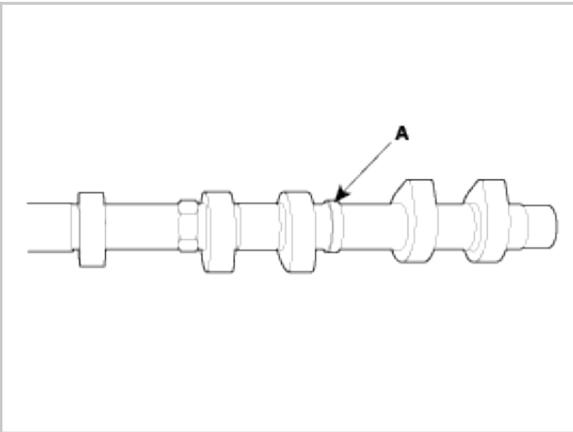


## Intake camshaft



LH	RH
A: 30mm(1.1811in.) B: 27mm(1.0630in.)	A: 27mm(1.0630in.) B: 30mm(1.1811in.)

## Exhaust camshaft



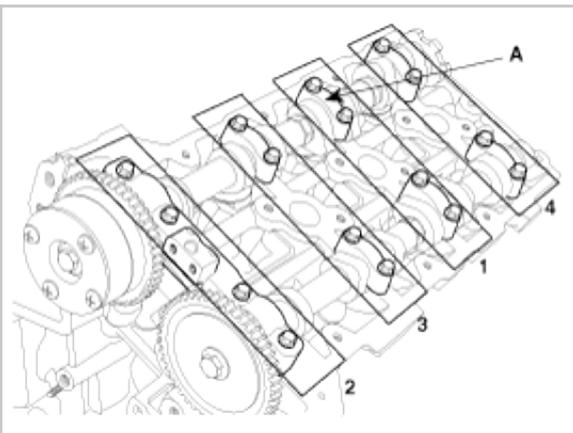
LH	RH
A: 27mm(1.0630in.)	A: 30mm(1.1811in.)

6. Install camshaft bearing caps.  
Assemble camshaft bearing caps as the order below.

Tightening torque

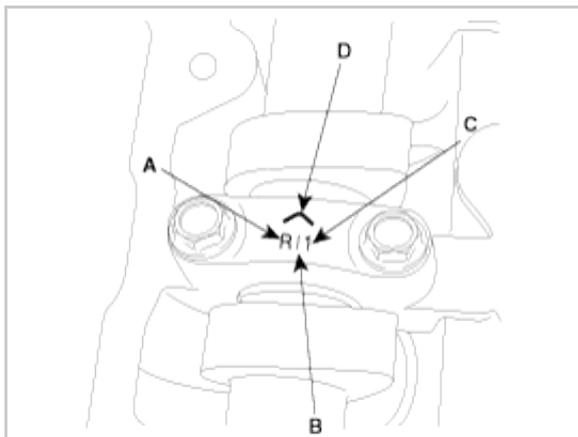
5.9Nm(0.6kgf.m, 4.3lb-ft) - 1st step

9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft) - 2nd step



## NOTICE

Ensure that the cam bearing caps are installed in the correct location and direction. Refer to the table below.



- A : L(LH),R(RH)  
B : I(Intake),None(Exhaust)  
C : Journal number  
D : Front mark

## CAUTION

Rotate the crankshaft not to contact the valves to the pistons by making the pistons below 10mm(0.3937in.) from the top of cylinder block.

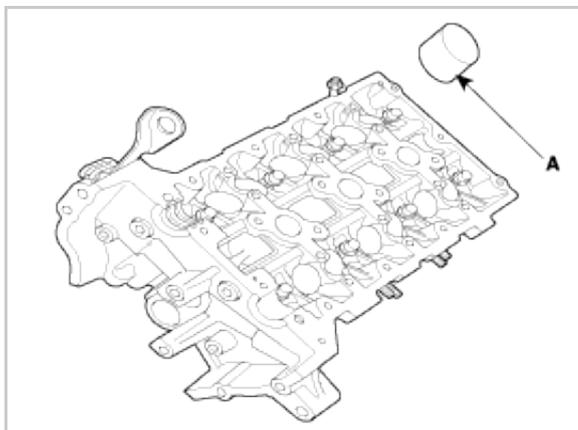
7. Install water temperature control assembly.
8. Install timing chain.
9. Check and adjust valve clearance.
10. Install the exhaust manifold.
11. Install the intake manifold.

## DISASSEMBLY

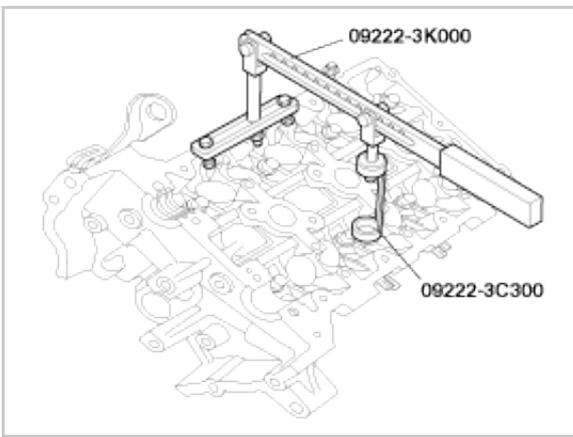
### NOTICE

Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

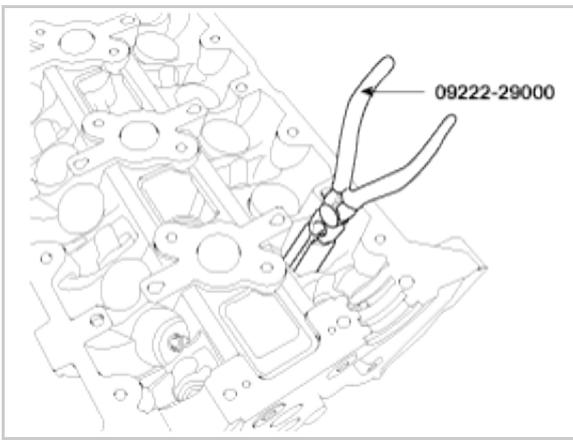
1. Remove MLAs(A).



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



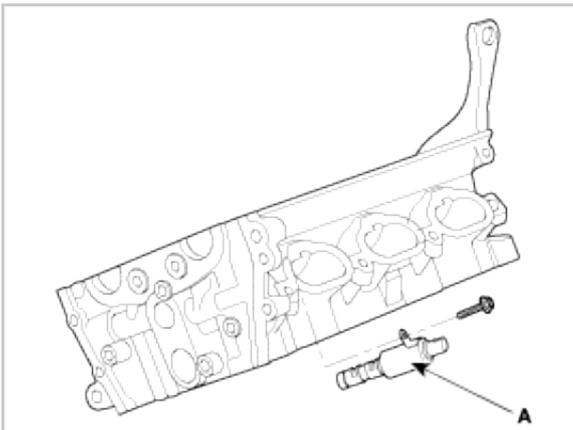
- (2) Remove the spring retainer.
- (3) Remove the valve spring.
- (4) Remove the valve.
- (5) Using SST(09222-29000), remove the valve stem seal.



### NOTICE

Do not reuse old valve stem seals.

3. Remove OCV(A).



## INSPECTION

### CYLINDER HEAD

1. Inspect for flatness.

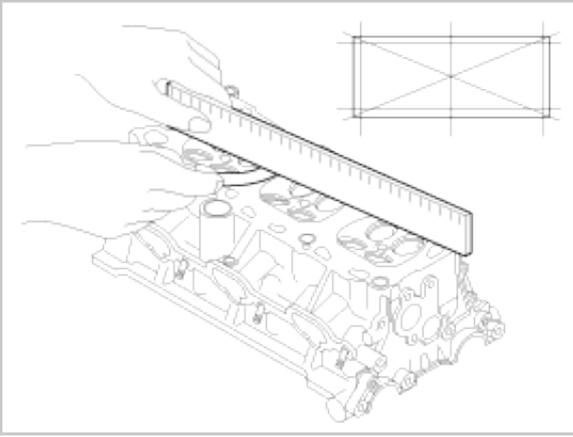
Using a precision straight edge and feeler gauge, measure the surface the contacting the cylinder block and the manifolds for warpage.

Flatness of cylinder head gasket surface

Standard : Less than 0.05mm(0.002in.)[Less than 0.02mm(0.0008in.)/150x150]

Flatness of manifold gasket surface  
Standard : Less than 0.03mm(0.001in)/110x110

---



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.

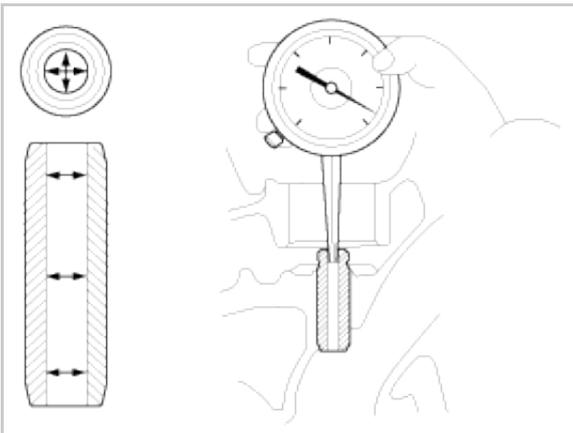
(1) Using a caliper gauge, measure the inside diameter of the valve guide.

---

Valve guide I.D.

Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)

---



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

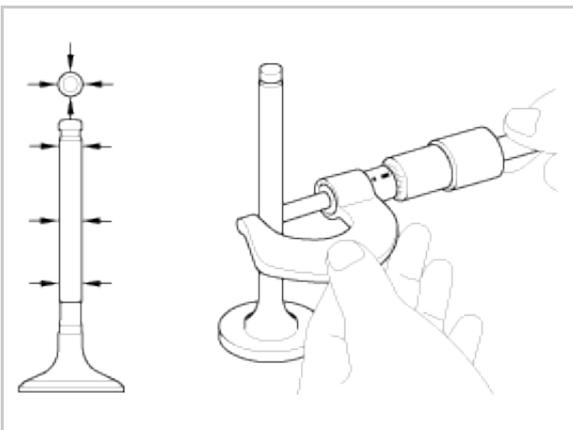
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Valve stem O.D.

Intake : 5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)

Exhaust : 5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)

---



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

---

Valve stem-to-guide clearance

[Standard]

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

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

[Limit]

Intake : 0.07mm (0.0027in.)

Exhaust : 0.09mm (0.0035in.)

---

## 2. Inspect valves.

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

(2) Check that the surface of the valve for wear.

If the valve face is worn, replace the valve.

(3) Check the valve head margin thickness.

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

---

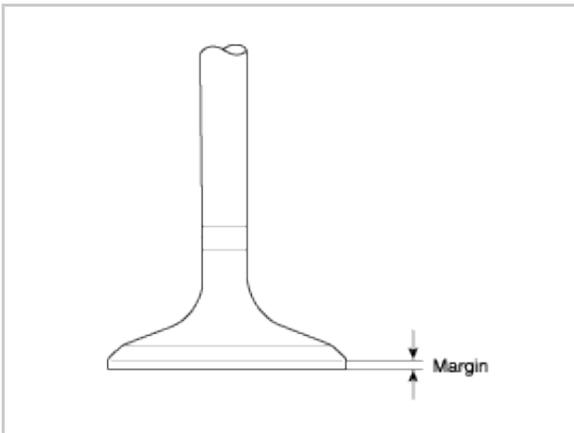
Margin

[Standard]

Intake : 1.56 ~ 1.86mm(0.06142 ~ 0.07323in.)

Exhaust : 1.73 ~ 2.03mm(0.06811 ~ 0.07992in.)

---



(4) Check the valve length.

---

Length

Intake : 105.27mm (4.1445in)

Exhaust : 105.50mm (4.1535in)

---

(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

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

If the valve seat is worn, replace cylinder head.

Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace cylinder head.

Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

## 4. Inspect valve springs.

(1) Using a steel square, measure the out-of-square of the valve spring.

(2) Using a vernier calipers, measure the free length of the valve spring.

---

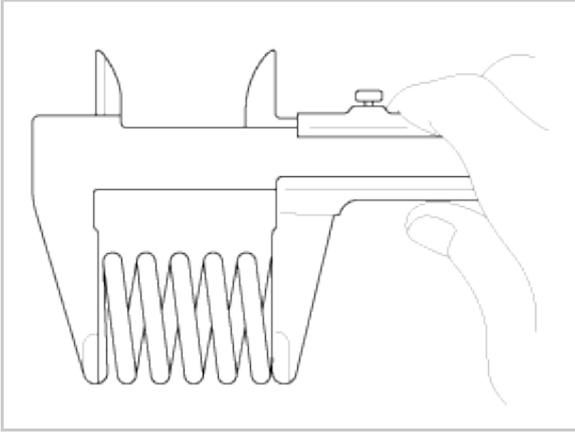
Valve spring

[Standard]

Free height : 43.86mm (1.7267in.)

Out-of-square : 1.5°

---



## MLA

1. Inspect MLA.  
Using a micrometer, measure the MLA outside diameter.
- 

MLA O.D.

Intake/Exhaust : 34.964 ~ 34.980mm(1.3765 ~ 1.3771in.)

---

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

Tappet bore I.D.

Intake/Exhaust : 35.000 ~ 35.025mm(1.3779 ~ 1.3789in.)

---

3. Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.
- 

MLA to tappet bore clearance

[Standard]

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

[Limit]

Intake/Exhaust : 0.07mm(0.0027in.)

---

## CAMSHAFT

1. Inspect cam lobes.  
Using a micrometer, measure the cam lobe height.
- 

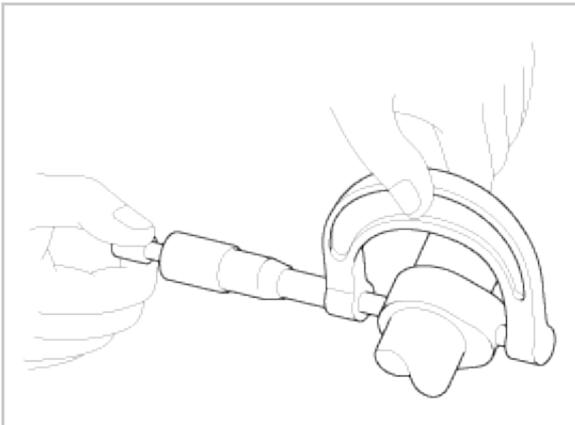
Cam height

[Standard value]

Intake : 46.8mm (1.8425in.)

Exhaust : 45.8mm (1.8031in.)

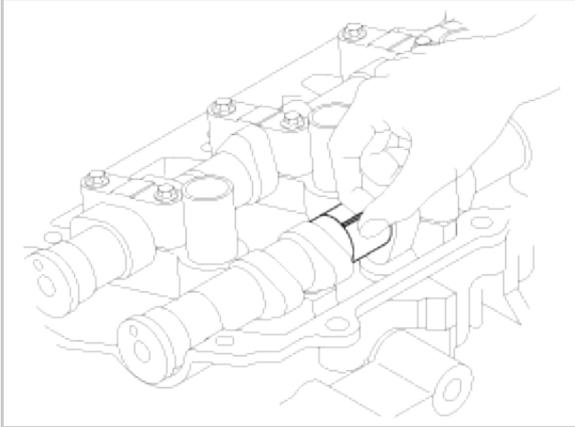
---



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

2. Inspect camshaft journal clearance.

- (1) Clean the bearing caps and camshaft journals.
- (2) Place the camshafts on the cylinder head.
- (3) Lay a strip of plastigage across each of the camshaft journal.



- (4) Install the bearing caps.

**CAUTION**

Do not turn the camshaft.

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

---

Bearing oil clearance

[Standard value]

Intake

No.1 journal : 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)

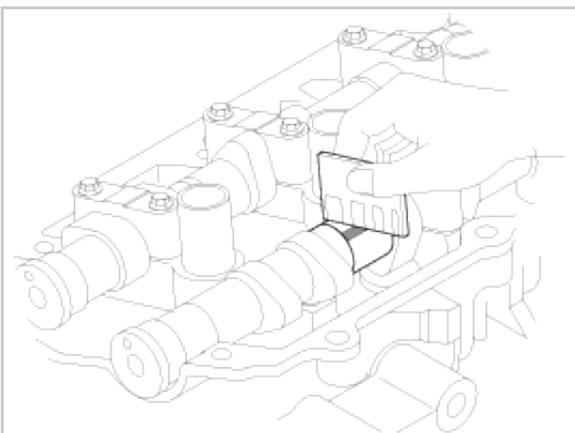
No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)

Exhaust

No.1 journal : 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)

No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)

---



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

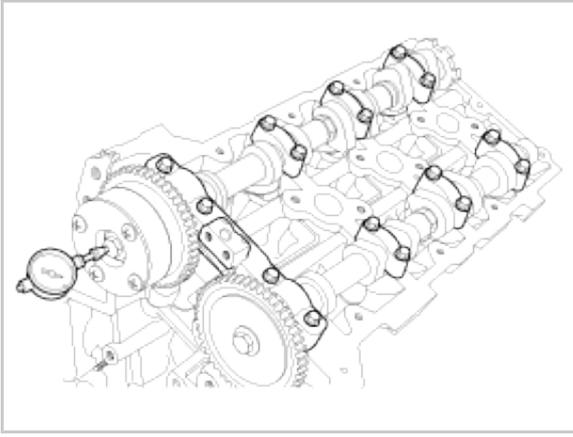
- (7) Completely remove the plastigage.
- (8) Remove the camshafts.

3. Inspect camshaft end play.

- (1) Install the camshafts.
  - (2) Using a dial indicator, measure the end play while moving the camshaft back and forth.
-

## Camshaft end play

[Standard value] : 0.02 ~ 0.18mm(0.0008 ~ 0.0071in.)



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

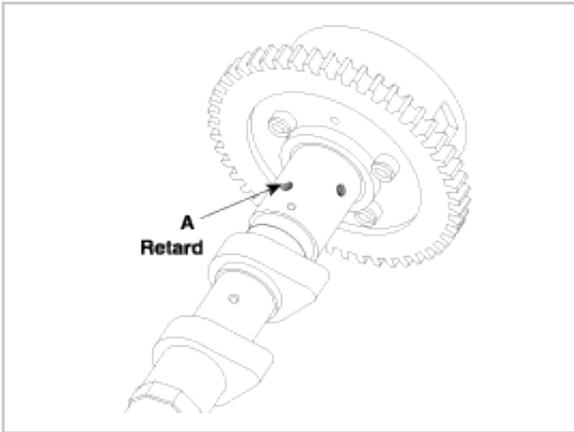
(3) Remove the camshafts.

## CVVT ASSEMBLY

1. Inspect CVVT assembly.

(1) Check that the CVVT assembly will not turn.

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



(3) Wind tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm<sup>2</sup>, 21psi) to the port of the camshaft.

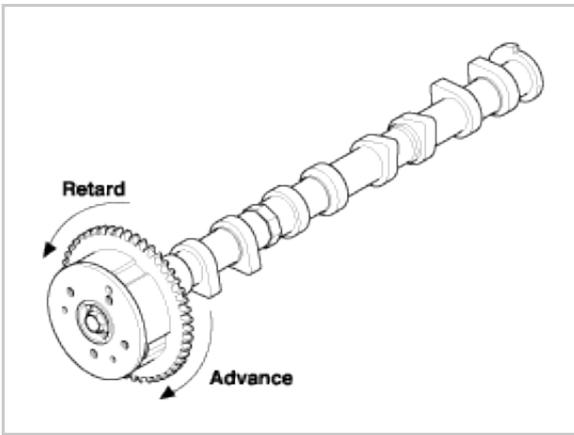
(Perform this order to release the lock pin for the maximum delay angle locking.)

### NOTICE

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

(4) Under the condition of (3), turn the CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.

Depending on the air pressure, the CVVT assembly will turn to the advance side without applying force by hand. Also, If excessive air leaks from the port, the lock pin may not be fully released.



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

Standard: Movable smoothly in the range about 22.5°

(6) Turn the CVVT assembly with your hand and lock it at the maximum delay angle position (counter clockwise).

## REASSEMBLY

### NOTICE

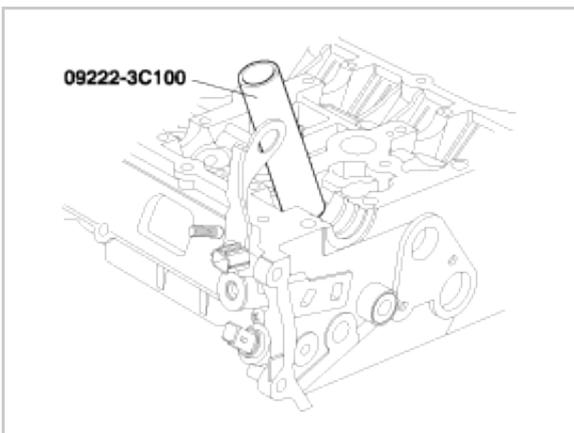
Thoroughly clean all parts to be assembled.  
 Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.  
 Replace oil seals with new ones.

1. Install valves.

(1) Using SST(09222-3C100), push in a new oil seal.

### NOTICE

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

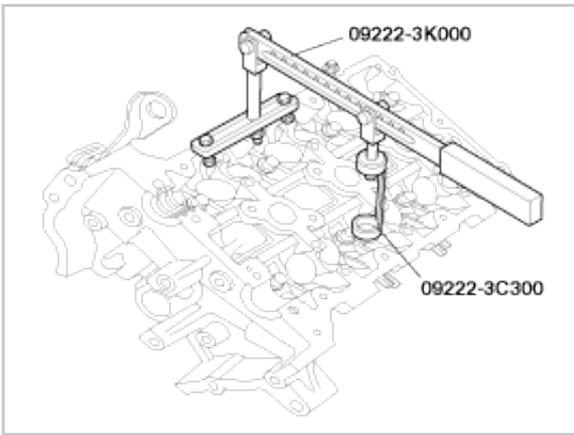


(2) Install the valve, valve spring and spring retainer.

### NOTICE

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

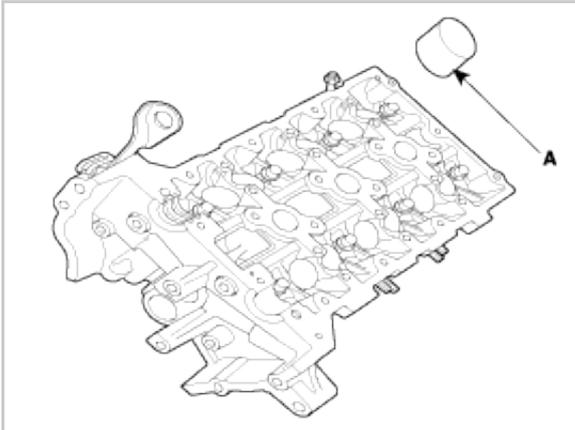
(3) Using the SST(09222 - 3K000, 09222-3C300), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



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

2. Install MLAs.

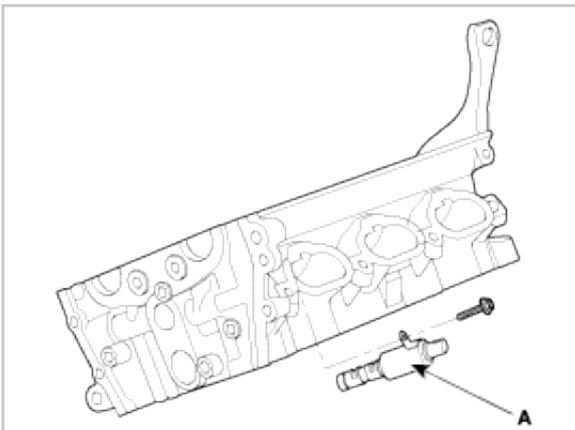
Check that the MLA rotates smoothly by hand.



**NOTICE**  
 MLA can be reinstalled in its original position.

3. Install OCV(A).

Tightening torque  
 9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



**NOTICE**

- a. To install OCV with gray colored connector into RH bank.
- b. To install OCV with black colored connector into LH bank.

**CAUTION**

- a. Do not reuse the OCV when dropped.
- b. Keep the OCV assembly clean.
- c. Do not hold the OCV sleeve during servicing.
- d. When the OCV is installed on the engine, do not move the engine by holding the OCV yoke.

# **Engine And Transaxle Assembly**



## REMOVAL

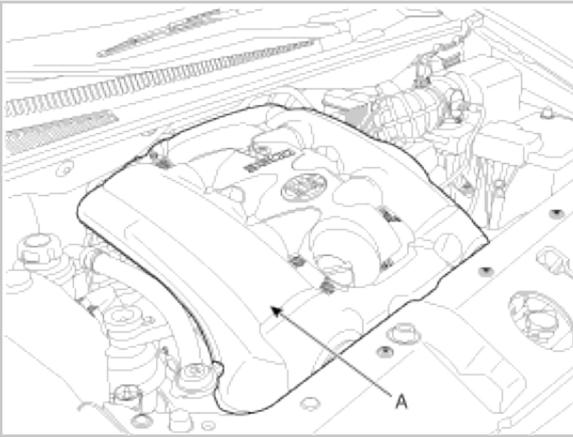
### CAUTION

- a. Use fender covers to avoid damaging painted surfaces.
- b. To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

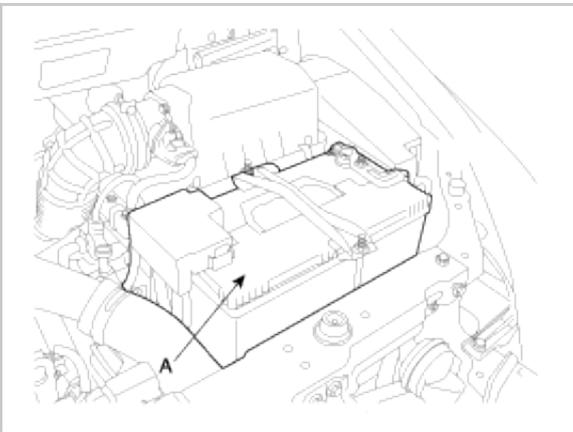
### NOTICE

- a. Mark all wiring and hoses to avoid misconnection.

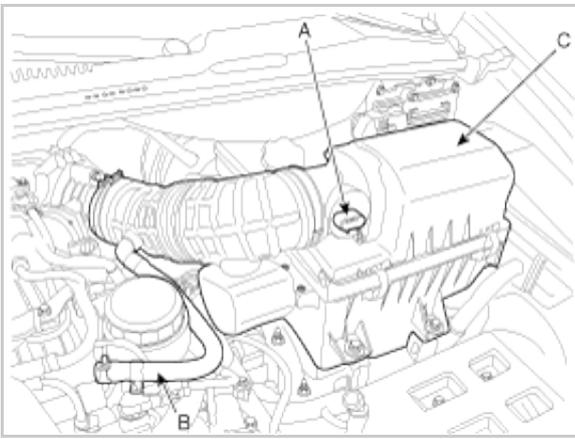
1. Remove the engine cover(A).



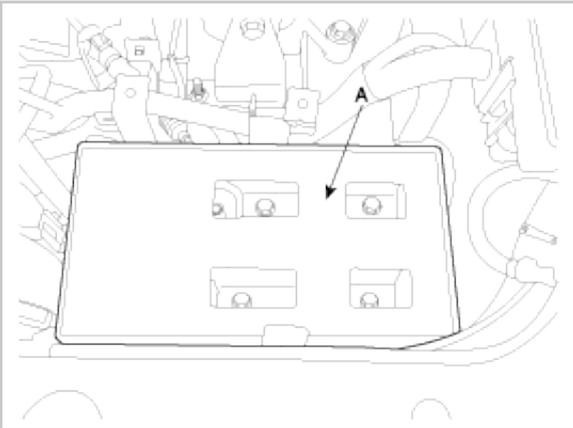
2. Recover refrigerant, opening the high & low pressure pipe caps and connecting the refrigerant station(Refer to HA group).
3. Disconnect the neagative terminal from the battery and remove the battery(A).



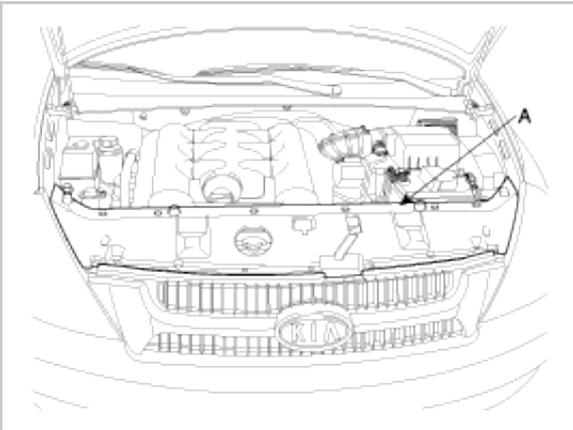
4. Remove the intake air hose and air cleaner assembly.
  - (1) Disconnect the MAF connector(A).
  - (2) Disconnect the breather hose(B) from air cleaner hose.
  - (3) Remove the intake air hose and air cleaner assembly(C).



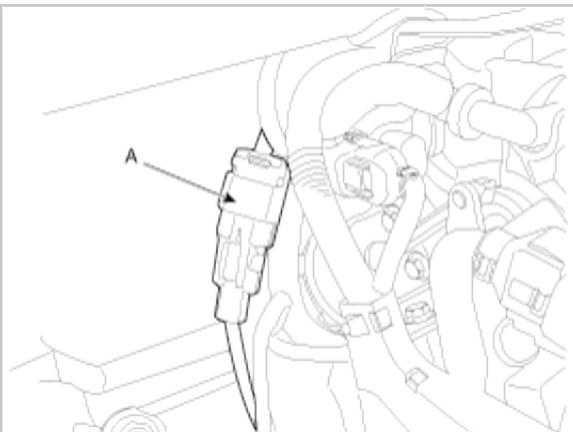
5. Remove the battery tray(A).

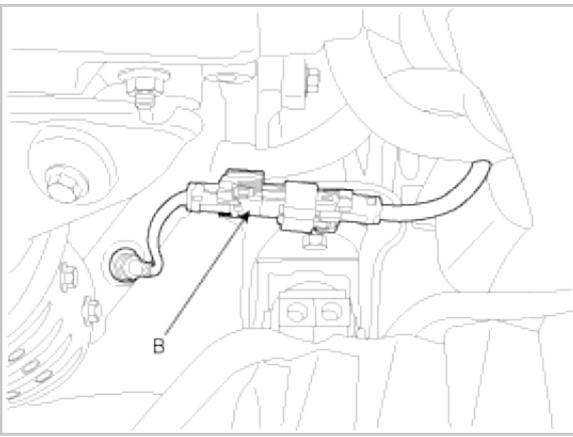


6. Remove the radiator grille upper cover(A).

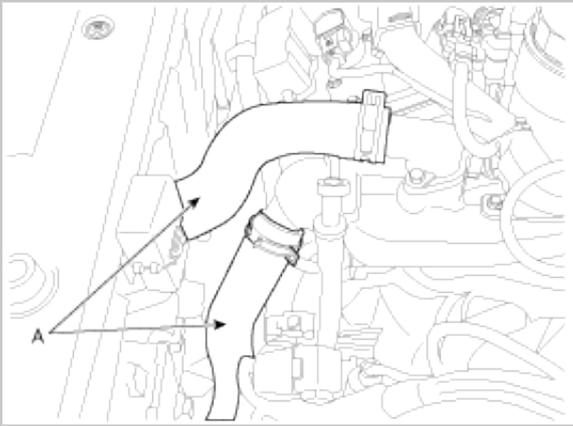


7. Disconnect the RH and LH oxygen sensor connectors(A, B).

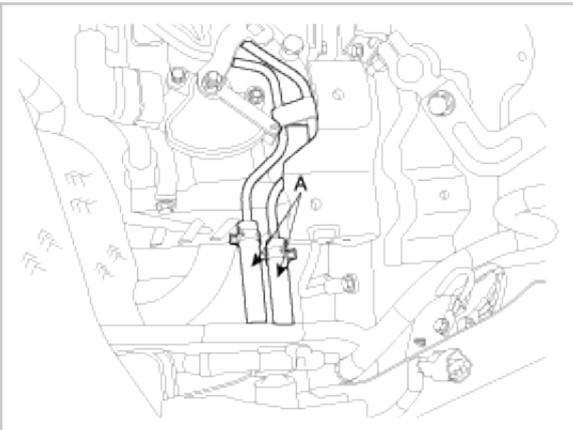




8. Remove the radiator upper and lower hoses(A).



9. Disconnect the automatic transaxle fluid cooler hoses(A).



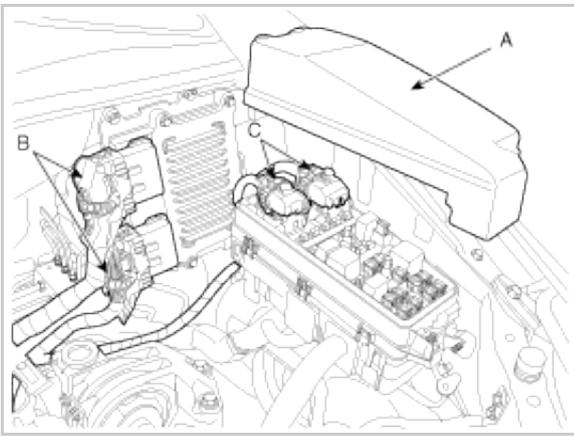
10. Disconnect the high and low pressure pipes from the radiator or the compressor.

11. Disconnect engine wiring.

(1) Remove the engine room fuse and relay box cover(A).

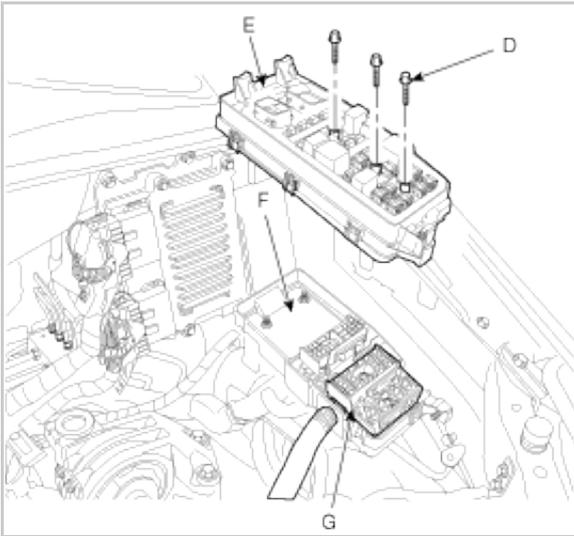
(2) Disconnect the PCM connectors(B).

(3) Disconnect the FAM connectors(C)(Refer to HA group).



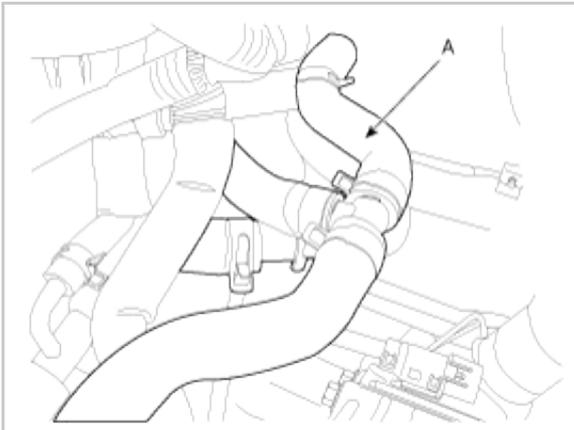
(4) Unscrew the FAM mounting bolts(D-3EA) and take the FAM(E) out of the splash shield(F).

(5) Disconnect the connector(G) from the splash shield(B).

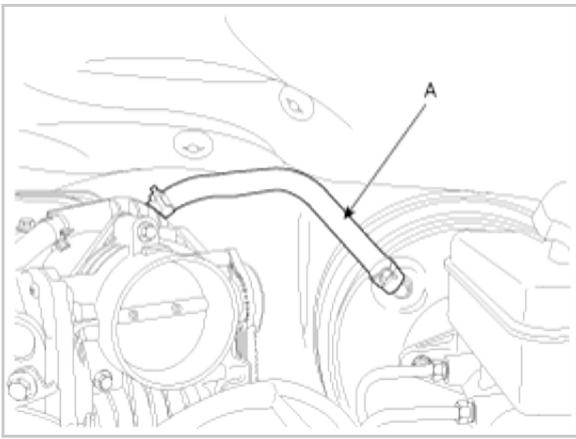


12. Disconnect the transaxle wire harness connector and remove the transaxle control cable(Refer to TR group).

13. Remove heater hose(A).



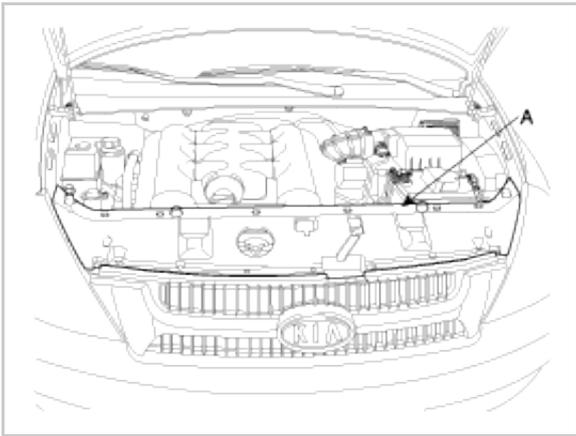
14. Remove the brake vacuum hose(A).



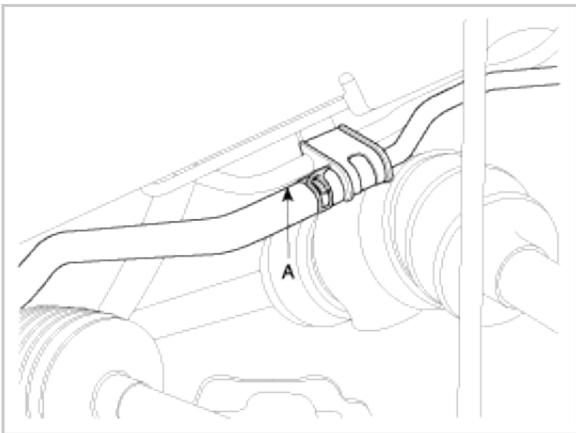
15. Remove power steering pump hose(Refer to ST group).

16. Remove front wheels(Refer to DS group).

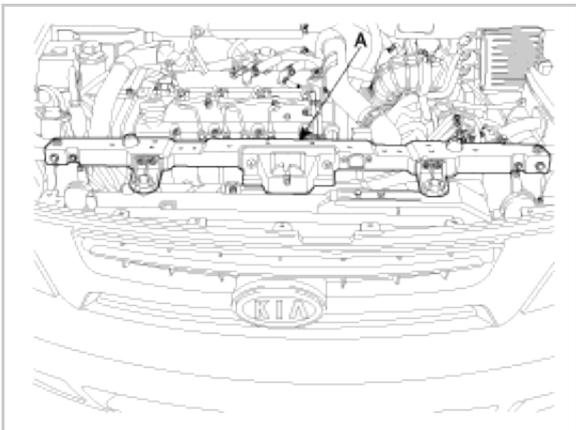
17. Remove the radiator grille upper cover(A) for convenience sake.



18. Disconnect the power steering return hose(A).

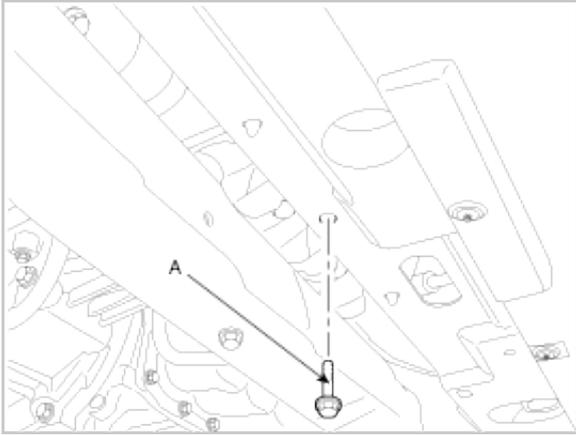


19. Remove the radiator support upper member assembly(A) for convenience sake.

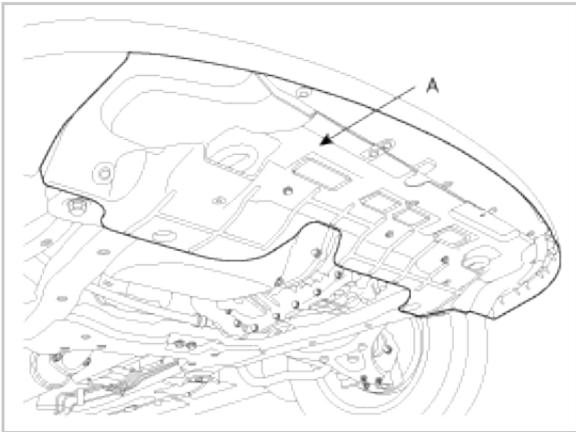


## NOTICE

The bottom side bolt(A) which can be seen after removing the under cover should be loosened for removal of the radiator support upper member assembly.



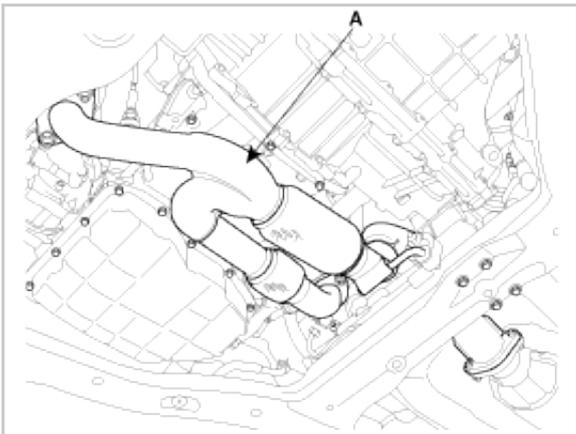
20. Remove the under cover(A).



21. Drain engine oil.

22. Coolant should be drained before heater hose removal.

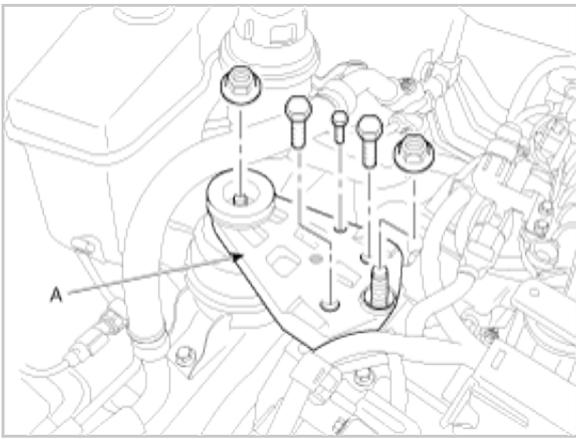
23. Remove front exhaust pipe(A).



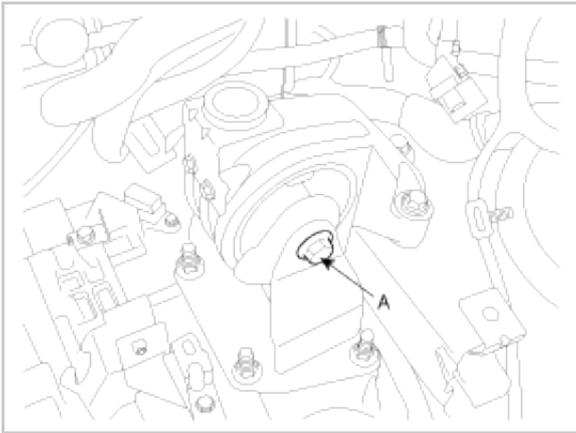
24. Disconnect the wheel speed sensor and the stabilizer bar link(Refer to SS group).

25. Remove the caliper assembly and suspend it with a wire(Refer to DS group).

26. Supporting the engine and transaxle assembly with sub frame, remove the engine mounting bracket(A).



27. Remove the transaxle insulator mounting bolt(A).



28. Supporting the engine and transaxle assembly with a jack, remove the sub frame with the engine and transaxle assembly.

**NOTICE**

When remove the engine and transaxle assembly, be careful not to damage any surrounding parts or body components.

**INSTALLATION**

Installation is in the reverse order of removal.

Perform the following :

- a. Adjust the shift cable.
- b. Refill the engine with engine oil.
- c. Refill the transaxle with fluid.
- d. Refill the radiator with engine coolant.
- e. Bleed air from the cooling system with the heater valve open.
- f. Clean the battery posts and cable terminals with sandpaper assemble them, then apply grease to prevent corrosion.
- g. 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, then check for fuel leakage at any point in the fuel line.

**Cylinder Block**

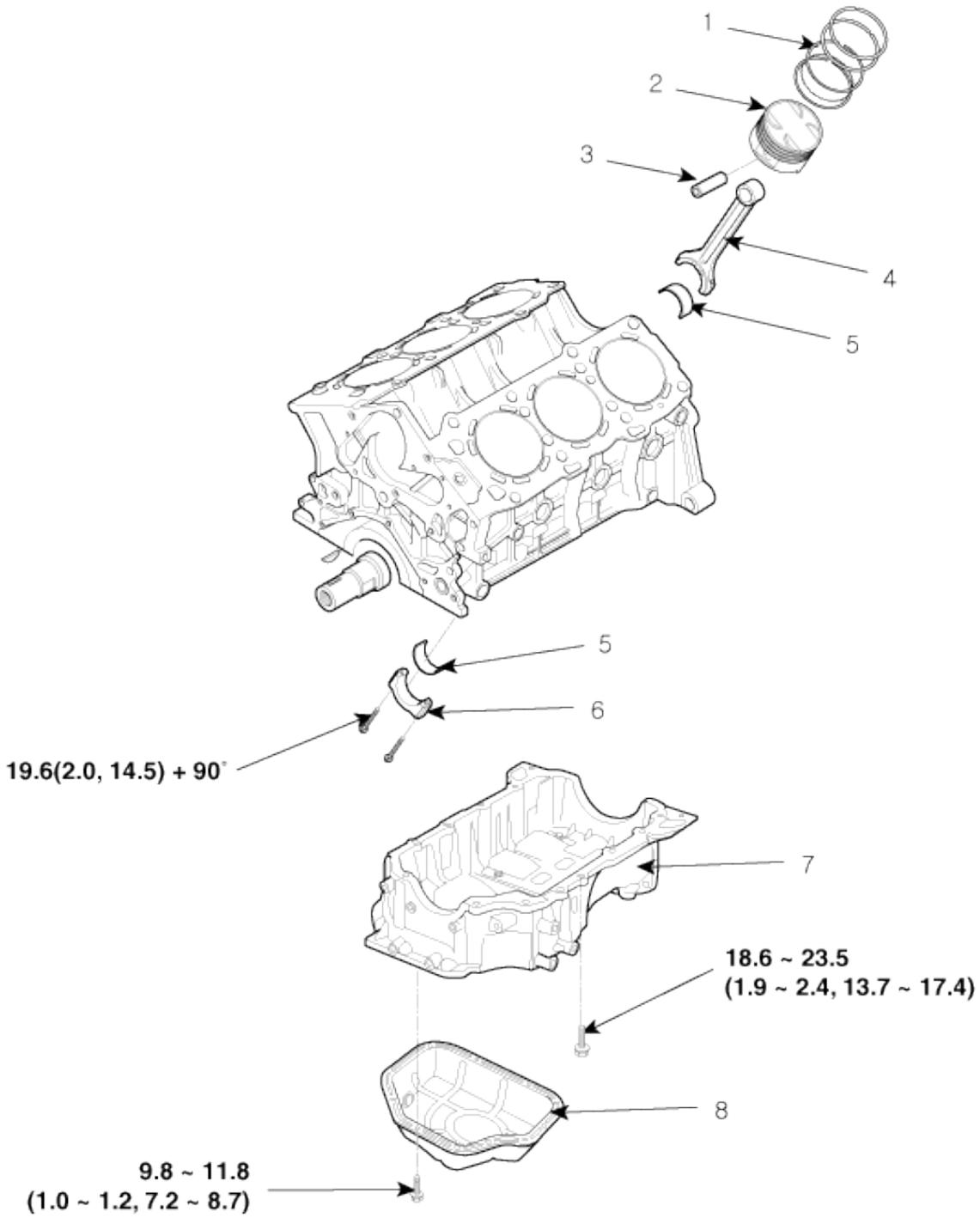
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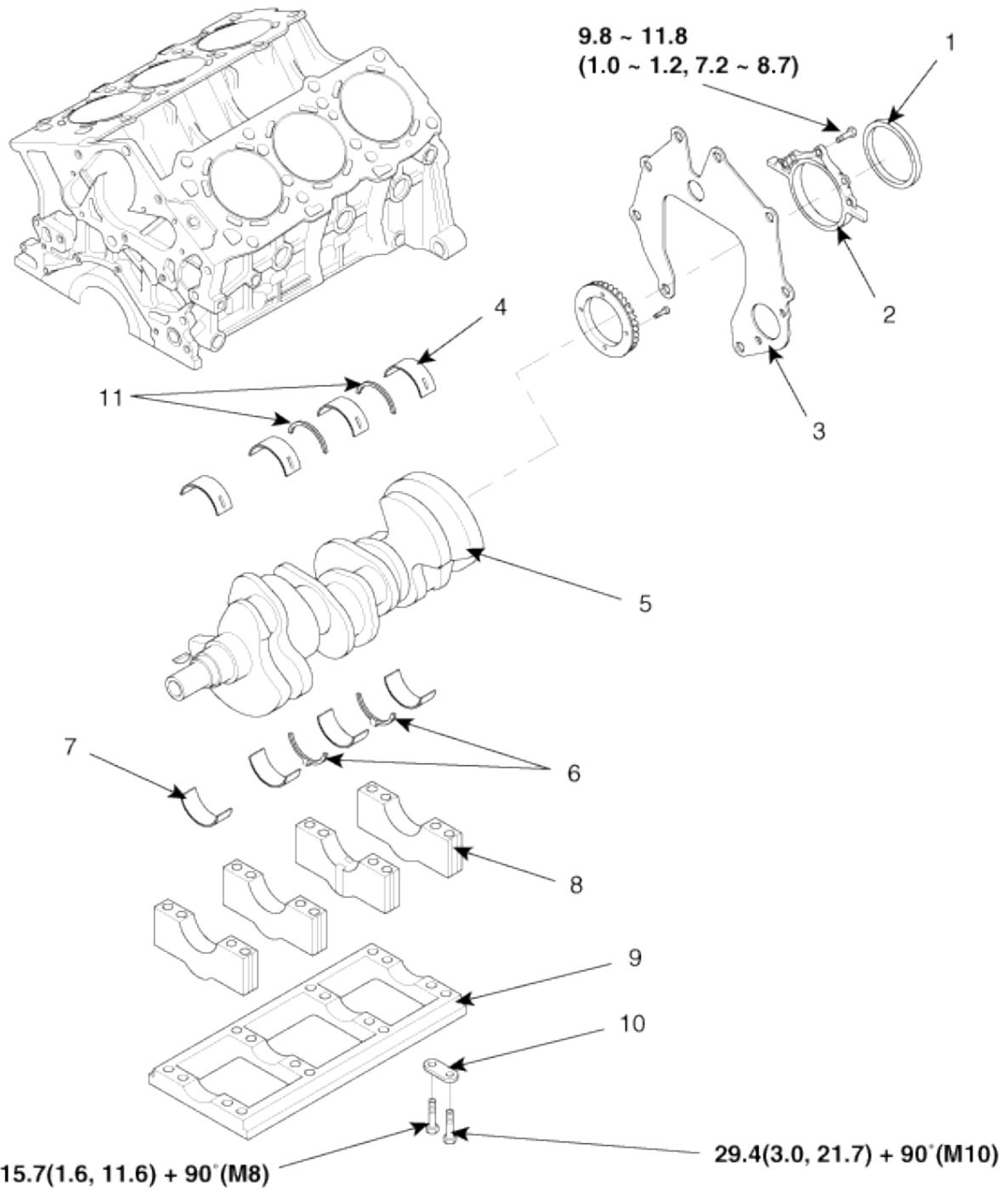
**COMPONENTS**



**TORQUE : N.m (kgf.m, lb-ft)**

- 1. Piston ring
- 2. Piston
- 3. Piston pin
- 4. Connecting rod

- 5. Connecting rod bearing
- 6. Connecting rod cap
- 7. Upper oil pan
- 8. Lower oil pan



**TORQUE : N.m (kgf.m, lb-ft)**

- |                             |                             |
|-----------------------------|-----------------------------|
| 1. Rear oil seal            | 7. Crankshaft lower bearing |
| 2. Rear oil seal case       | 8. Main bearing cap         |
| 3. Rear plate               | 9. Bearing cap bridge       |
| 4. Crankshaft upper bearing | 10. Bearing cap bolt washer |
| 5. Crankshaft               | 11. Upper thrust bearing    |
| 6. Lower thrust bearing     |                             |



## REMOVAL

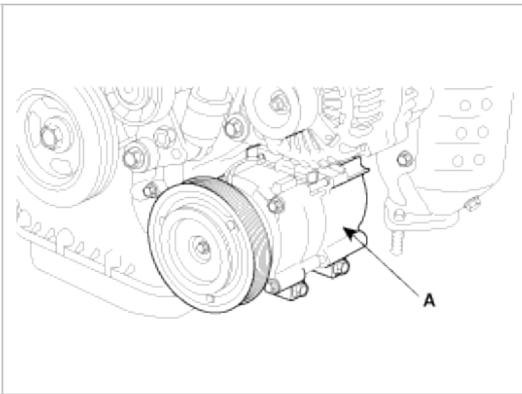
### CAUTION

- a. Use fender covers to avoid damaging painted surfaces.
- b. To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

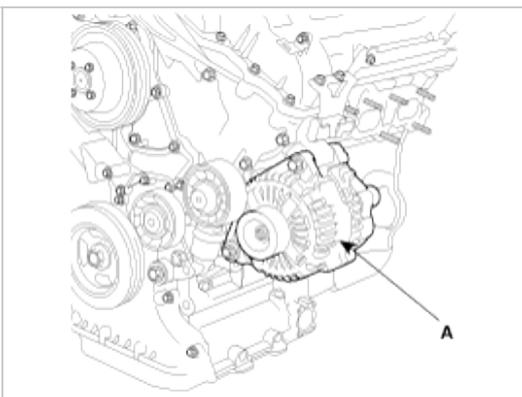
### NOTICE

- a. Mark all wiring and hoses to avoid misconnection.
- b. Inspect the timing belt before removing the cylinder head.
- c. Turn the crankshaft pulley so that the No.1 piston is at top dead center.
- d. Engine removal is required for this procedure.

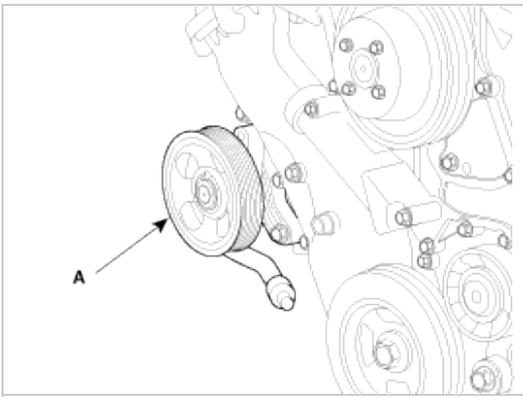
1. Remove exhaust manifold.
2. Remove intake manifold.
3. Remove timing chain.
4. Remove water temperature control assembly.
5. Remove cylinder head.
6. Remove oil pump.
7. Remove oil filter assembly.
8. Remove A/C compressor(A) from engine.



9. Remove generator(A) from engine.



10. Remove power steering pump(A) from engine.

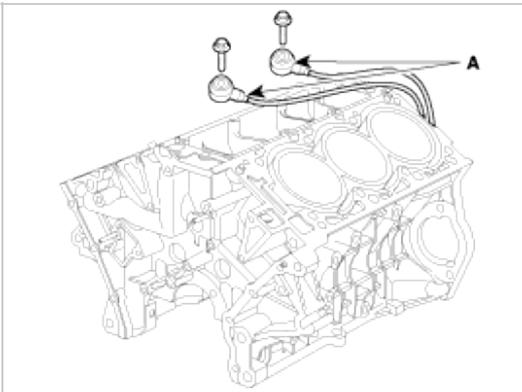


## INSTALLATION

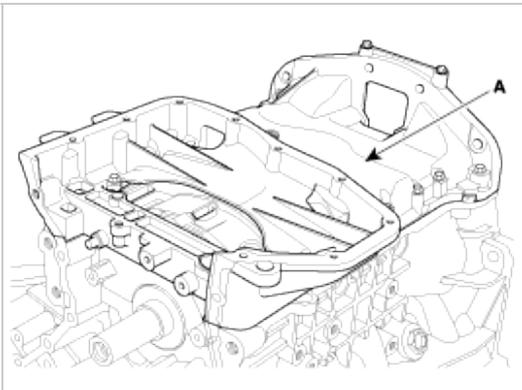
1. Install power steering pump.
2. Install generator.
3. Install air conditioner compressor
4. Install oil filter assembly.
5. Install oil pump.
6. Install cylinder head.
7. Install water temperature control assembly.
8. Install timing chain.
9. Install intake manifold.
10. Install exhaust manifold.

## DISASSEMBLY

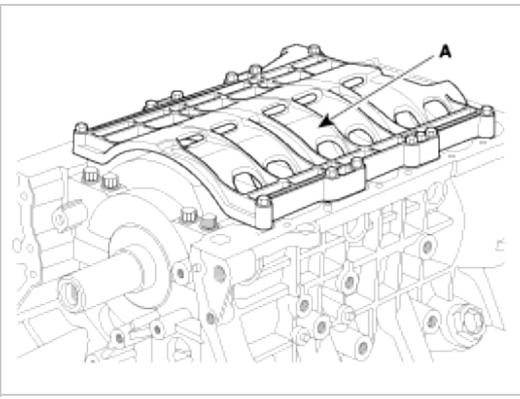
1. Remove drive plate.
2. Remove knock sensor(A).



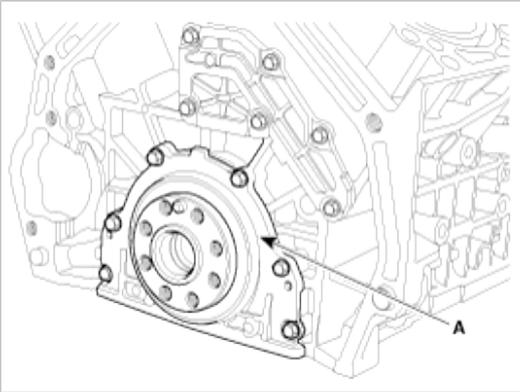
3. Remove upper oil pan(A).



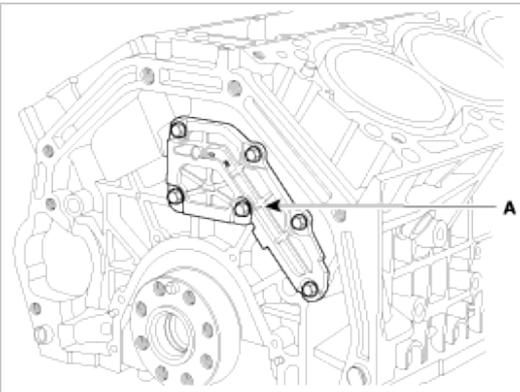
4. Remove baffle plate(A).



5. Remove rear oil seal case(A).



6. Remove oil drain cover(A).



7. Check the connecting rod end play.

8. Check the connecting rod cap oil clearance.

9. Remove piston and connecting rod assemblies.

(1) Using a ridge reamer, remove all the carbon from the top of the cylinder.

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

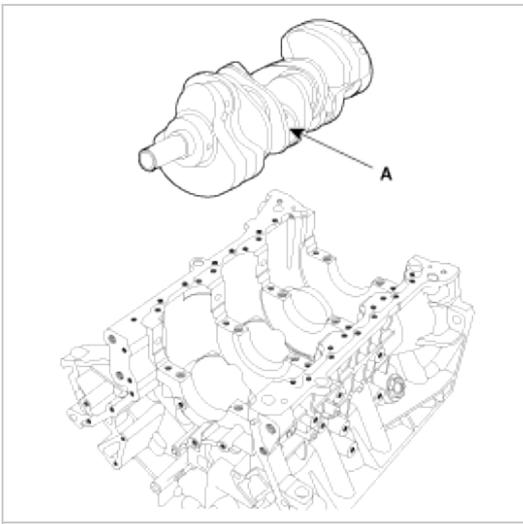
#### NOTICE

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

10. Remove crankshaft main bearing cap and check oil clearance.

11. Check the crankshaft end play.

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



### NOTICE

Arrange the main bearings and thrust bearings in the correct order.

13. 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.
14. Remove piston rings.
  - (1) Using a piston ring expander, remove the 2 compression rings.
  - (2) Remove 2 side rails and the spacer by hand.

### NOTICE

Arrange the piston rings in the correct order only.

15. Disconnect connecting rod from piston.  
Using a press, remove the piston pin from piston.  
(Press-in load : 800 ~ 1400kg (1764 ~ 3086lb))

## INSPECTION

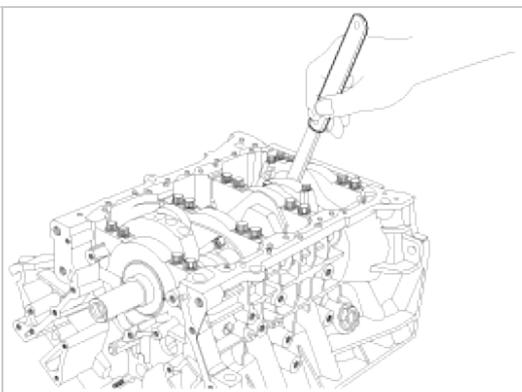
### CONNECTING ROD AND CRANKSHAFT

1. Check the connecting rod end play.  
Using a feeler gauge, measure the end play while moving the connecting rod back and forth.

---

Standard end play : 0.1~ 0.25mm(0.004 ~ 0.010in.)

---



- a. If out-of-tolerance, install a new connecting rod.
  - b. If still out-of-tolerance, replace the crankshaft.
2. Check the connecting rod bearing oil clearance.
    - (1) Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.
    - (2) Remove 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  
19.6Nm (2.0kgf.m, 14.46lb-ft) + 90°

---

**NOTICE**

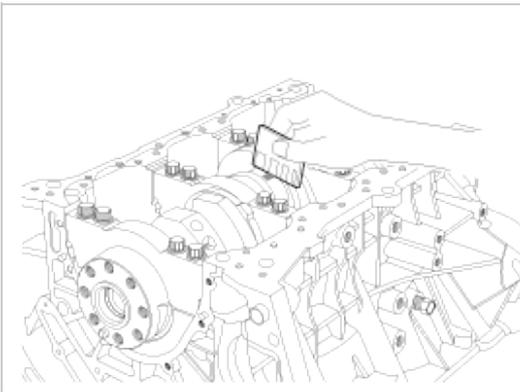
Do not turn the crankshaft.

- (7) Remove 2 bolts, connecting rod cap and bearinghalf.
- (8) Measure the plastigage at its widest point.

---

Standard oil clearance  
0.038 ~ 0.056mm(0.0015 ~ 0.0022in.)

---



- (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.

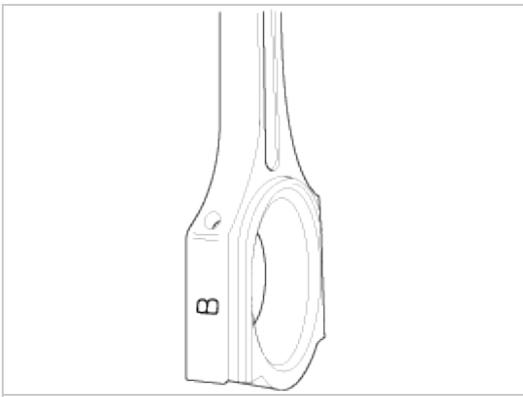
**NOTICE**

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

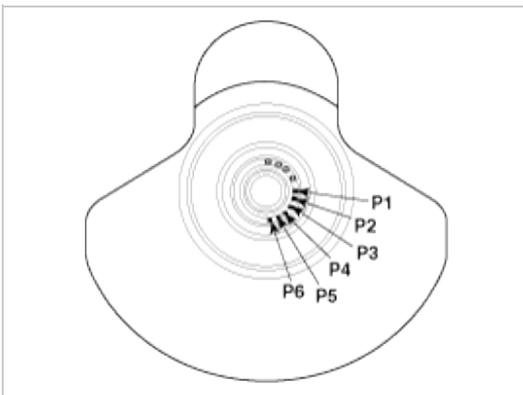


**DISCRIMINATION OF CONNECTING ROD**

CLASS	MARK	INSIDE DIAMETER
0	a	58.000 ~ 58.006mm (2.2834 ~ 2.2837in.)
1	b	58.006 ~ 58.012mm (2.2837 ~ 2.2839in.)
2	c	58.012 ~ 58.018mm (2.2839 ~ 2.2842in.)

**CRANKSHAFT PIN MARK LOCATION**

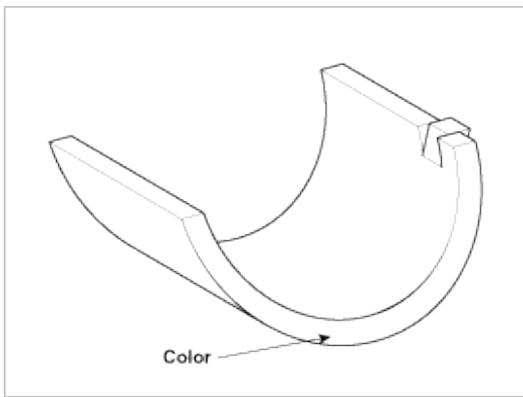
**DISCRIMINATION OF CRANKSHAFT**



**DISCRIMINATION OF CRANKSHAFT**

CLASS	MARK	OUTSIDE DIAMETER OF PIN
I	1 or A	54.966 ~ 54.972mm (2.1640 ~ 2.1642in.)
II	2 or B	54.960 ~ 54.966mm (2.1638 ~ 2.1640in.)
III	3 or C	54.954 ~ 54.960mm (2.1635 ~ 2.1638in.)

**PLACE OF IDENTIFICATION MARK (CONNECTING ROD BEARING)**



**DISCRIMINATION OF CONNECTING ROD BEARING**

CLASS	MARK	THICKNESS OF BEARING
E	BLUE	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
D	BLACK	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	BROWN	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
B	GREEN	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)
A	YELLOW	1.502 ~ 1.505mm (0.0591 ~ 0.0593in.)

(11) Selection

		CONNECTING ROD IDENTIFICATION MARK		
		0(a)	1(b)	2(c)
CRANKSHAFT IDENTIFICATION MARK	1 or A	A (YELLOW)	B (GREEN)	C (BROWN)
	2 or B	B (GREEN)	C (BROWN)	D (BLACK)
	3 or C	C (BROWN)	D (BLACK)	E (BLUE)

3. Check the crankshaft bearing oil clearance.

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

Tightening torque

49.00Nm(5.0 kgf.m, 36.16lb-ft) + 90°

19.60 Nm(2.0 kgf.m, 14.46lb-ft)+ 120°

29.40 ~ 31.36Nm(3.0 ~ 3.2 kgf.m, 21.70 ~ 23.14lb-ft)

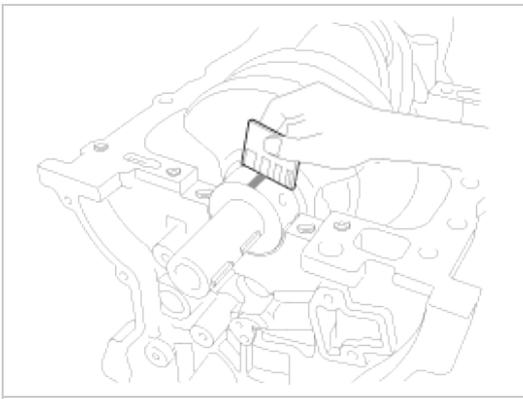
**NOTICE**

Do not turn the crankshaft.

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

Standard oil clearance

0.022 ~ 0.040mm (0.0009 ~ 0.0016in.)



- (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.

**NOTICE**

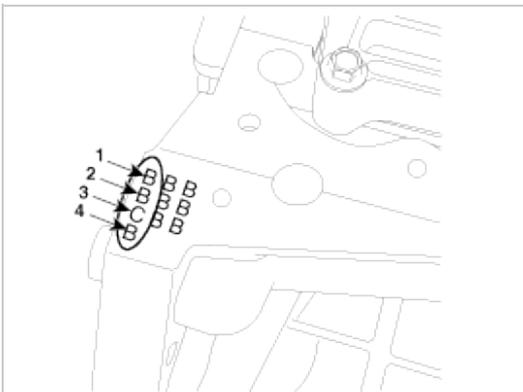
If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

**CAUTION**

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

**Crankshaft bore mark location**

Letters have been stamped on the block as a mark for the 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.

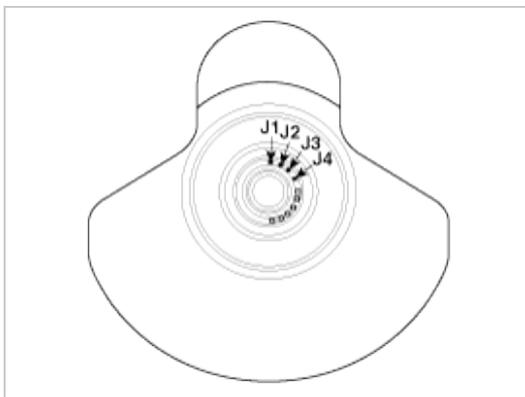


**DISCRIMINATION OF CYLINDER BLOCK**

CLASS	MARK	INSIDE DIAMETER
a	A	73.500 ~ 73.506mm (2.8937 ~ 2.8939in.)
b	B	73.506 ~ 73.512mm (2.8939 ~ 2.8942in.)
c	C	73.512 ~ 73.518mm (2.8942 ~ 2.8944in.)

**CRANKSHAFT JOURNAL MARK LOCATION**

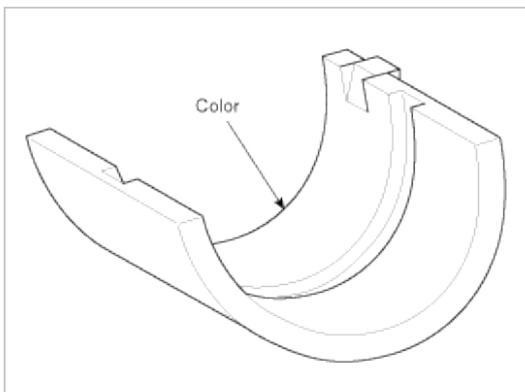
**DISCRIMINATION OF CRANKSHAFT**



### DISCRIMINATION OF CRANKSHAFT

CLASS	MARK	OUTSIDE DIAMETER OF JOURNAL
I	1 or A	68.954 ~ 68.960mm (2.7147 ~ 2.7150in.)
II	2 or B	68.948 ~ 68.954mm (2.7145 ~ 2.7147in.)
III	3 or C	68.942 ~ 68.948mm (2.7142 ~ 2.7145in.)

### PLACE OF IDENTIFICATION MARK (CRANKSHAFT BEARING)



### DISCRIMINATION OF CRANKSHAFT BEARING

CLASS	MARK	THICKNESS OF BEARING
E	BLUE	2.277 ~ 2.280mm (0.0896 ~ 0.0897in.)
D	BLACK	2.274 ~ 2.277mm (0.0895 ~ 0.0896in.)
C	BROWN	2.271 ~ 2.274mm (0.0894 ~ 0.0895in.)
B	GREEN	2.268 ~ 2.271mm (0.0893 ~ 0.0894in.)
A	YELLOW	2.265 ~ 2.268mm (0.0892 ~ 0.0893in.)

### SELECTION

		CRANKSHAFT BORE IDENTIFICATION MARK		
		a(A)	b(B)	c(C)
CRANKSHAFT IDENTIFICATION MARK	1 or A	A (YELLOW)	B (GREEN)	C (BROWN)
	2 or B	B (GREEN)	C (BROWN)	D (BLACK)
	3 or C	C	D	E

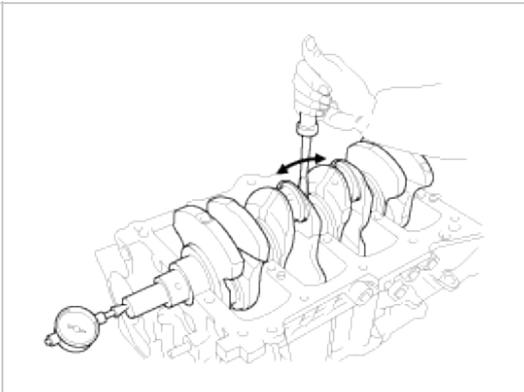
	3 or 4	(BROWN)	(BLACK)	(BLUE)
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4. Check crankshaft end play.

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.)



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

Thrust bearing thickness

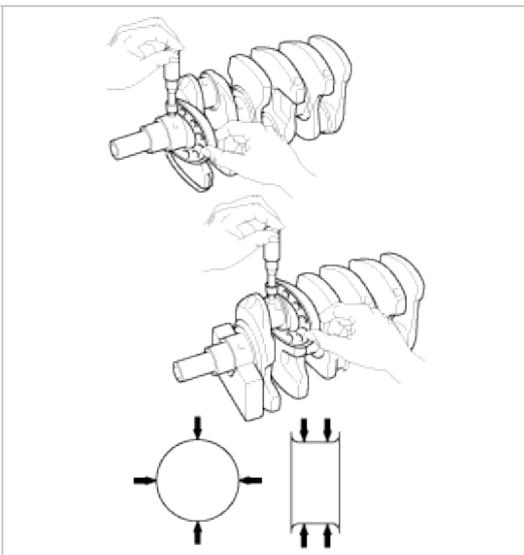
2.41 ~ 2.45mm(0.0949 ~ 0.0964in.)

5. Inspect main journals and crank pins

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

Main journal diameter : 68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)

Crank pin diameter : 54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)



**CONNECTING RODS**

1. 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 notches for holding the bearing in place are on the same side.
2. 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

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## CYLINDER BLOCK

1. Remove gasket material.

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

2. Clean cylinder block

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

3. Inspect top surface of cylinder block for flatness.

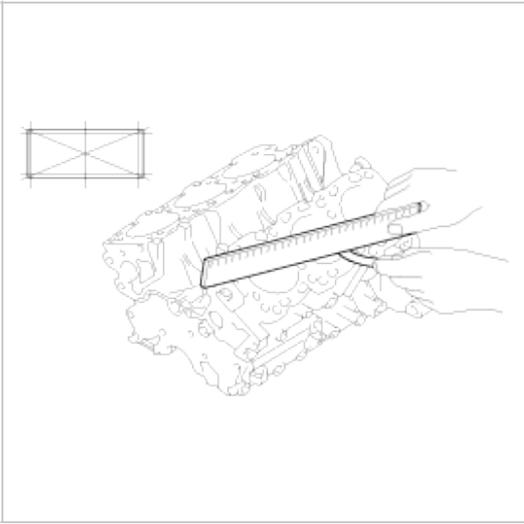
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

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Flatness of cylinder block gasket surface

Standard : Less than 0.05mm(0.0020 in.), Less than 0.02mm(0.0008in.) / 150 x 150

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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

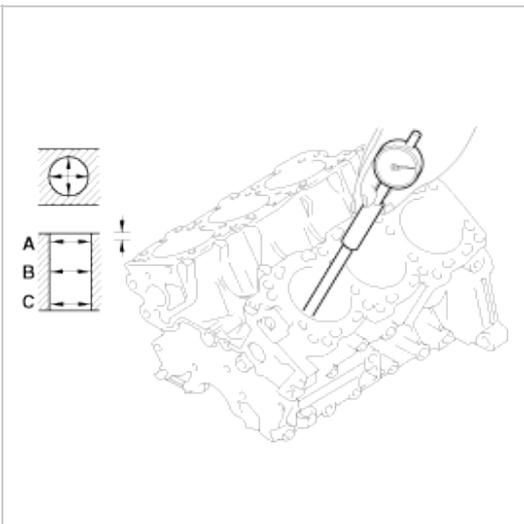
Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

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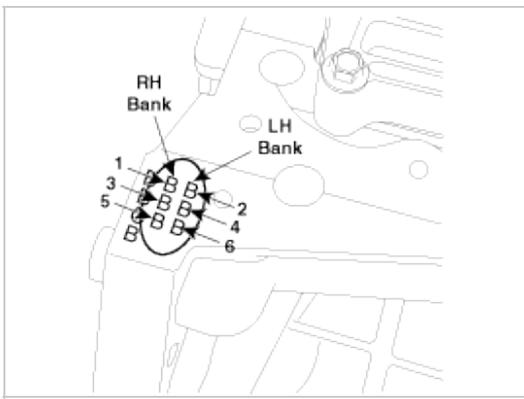
Standard diameter

96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)

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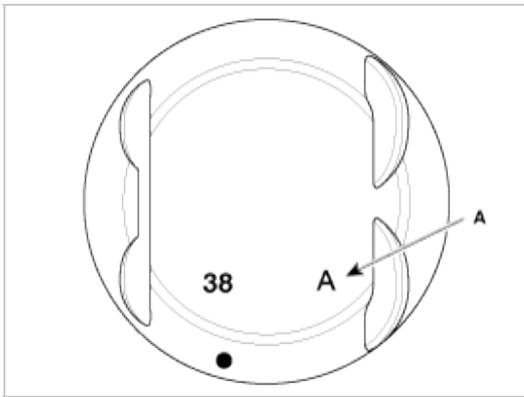


6. Check the cylinder bore size code on the cylinder block.



Class	Size code	Cylinder bore inner diameter
A	A	96.00~96.01mm (3.7795 ~ 3.7799in.)
B	B	96.01~96.02mm (3.7799 ~ 3.7803in.)
C	C	96.02~96.03mm (3.7803 ~ 3.7807in.)

7. Check the piston size code on the piston top face.



Class	Size code	Piston outer diameter
A	A	95.96~95.97mm (3.7779 ~ 3.7783in.)
B	B	95.97~95.98mm (3.7783 ~ 3.7787in.)
C	C	95.98~95.99mm (3.7787 ~ 3.7791in.)

8. Select the piston related to cylinder bore class.

Clearance : 0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)

## PISTON AND RINGS

1. Clean piston

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

### NOTICE

Do not use a wire brush.

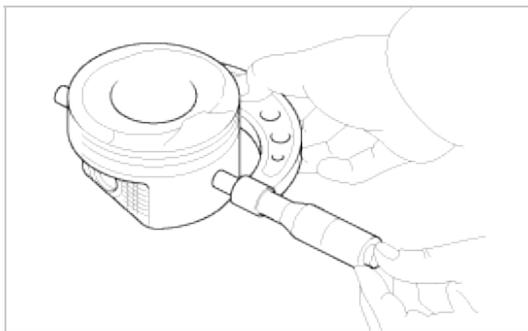
2. The standard measurement of the piston outside diameter is taken 14 mm (0.5512 in.) from the bottom of the piston.

---

Standard diameter

95.96 ~ 95.99mm (3.7779~ 3.7791in.)

---



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

Piston-to-cylinder clearance

0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)

---

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.

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Piston ring side clearance

Standard

No.1 : 0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)

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

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

Limit

No.1 : 0.1mm (0.004in.)

No.2 : 0.1mm (0.004in.)

Oil ring : 0.2mm (0.008in.)

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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. If the bore is over the service limit, the cylinder block must be replaced.

---

Piston ring end gap

Standard

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

No.2 : 0.32 ~ 0.47m (0.0126 ~ 0.0185in.)

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

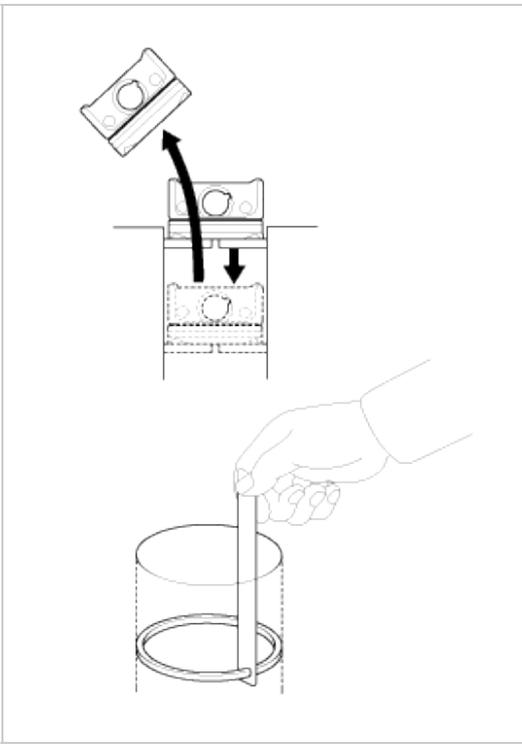
Limit

No.1 : 0.6mm (0.0236in.)

No.2 : 0.7mm (0.0275in.)

Oil ring : 0.8mm (0.0315in.)

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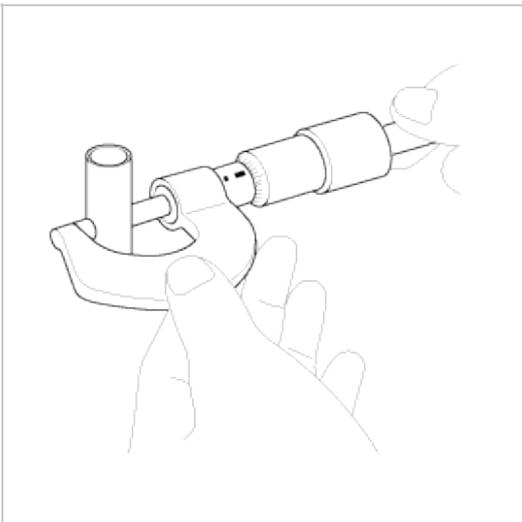


## PISTON PINS

1. Measure the diameter of the piston pin.

Piston pin diameter

23.002 ~ 23.006mm (0.9056 ~ 0.9057in.)



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

Piston pin-to-piston clearance

0.009 ~ 0.017mm (0.0004 ~ 0.0007in.)

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

Piston pin-to-connecting rod interference

-0.032 ~ -0.017mm (-0.0012 ~ -0.0007in.)

## REASSEMBLY

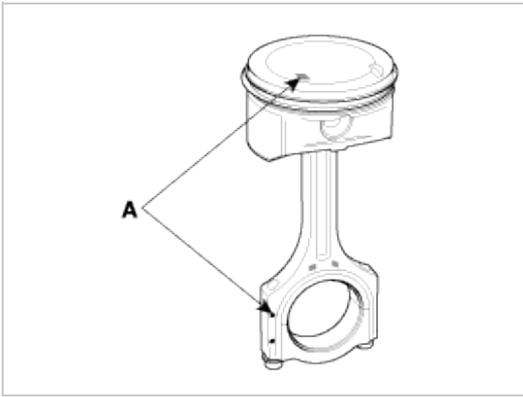
### NOTICE

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

1. Assemble piston and connecting rod.

(1) Use a hydraulic press for installation.

(2) The piston front mark and the connecting rod front mark must face the timing belt side of the engine.

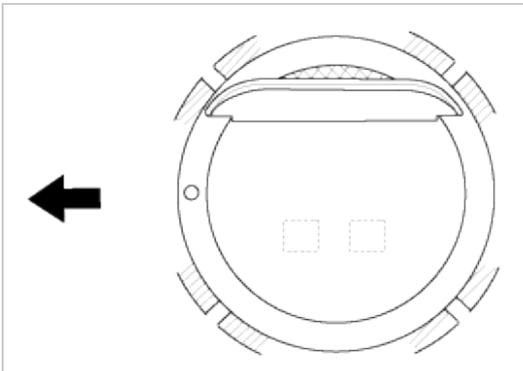


2. Install piston rings.

(1) Install the oil ring spacer and 2 side rails by hand.

(2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.

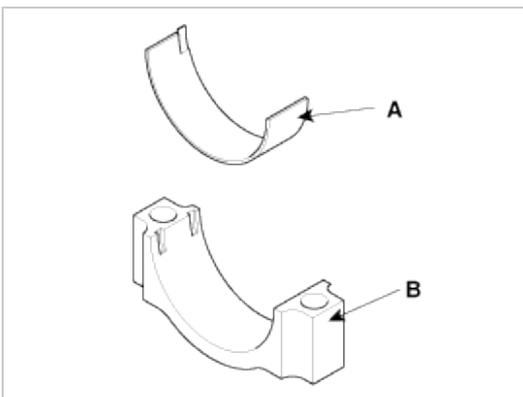
(3) Position the piston rings so that the ring ends are as shown.



3. Install 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).



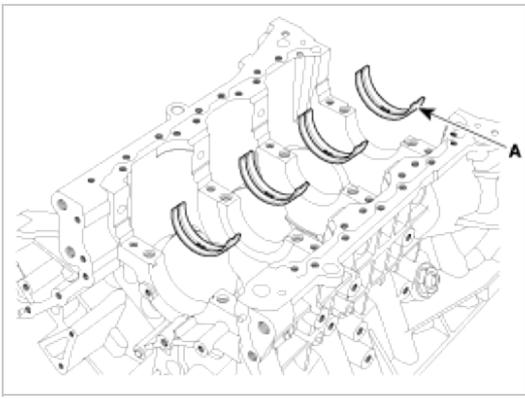
4. Install main bearings.

**NOTICE**

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

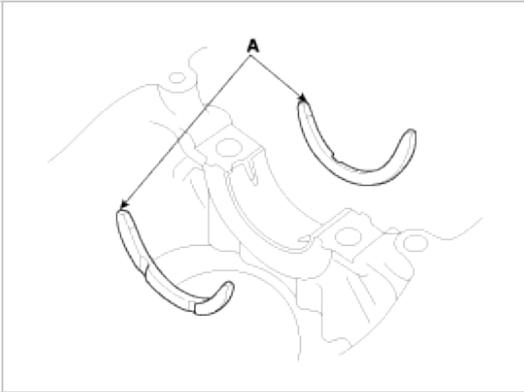
(1) Align the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings.

(2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 4 lower bearings(A).

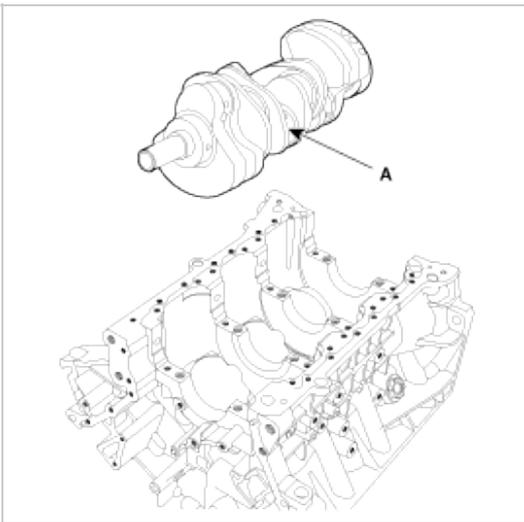


5. Install thrust bearings.

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



6. Place crankshaft on the cylinder block.



7. Place main bearing caps on cylinder block.

8. Install main bearing cap bolts.

(1) Install and uniformly tighten the bearing cap bolts, in several passes, in the sequence shown.

Tightening torque

Main bearing cap bolt

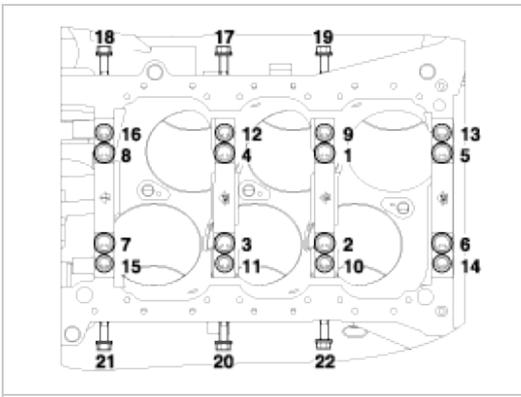
49.00Nm(5.0 kgf.m, 36.16lb-ft) + 90° (1 ~ 8)

19.60 Nm(2.0 kgf.m, 14.46lb-ft)+ 120° (9 ~ 16)

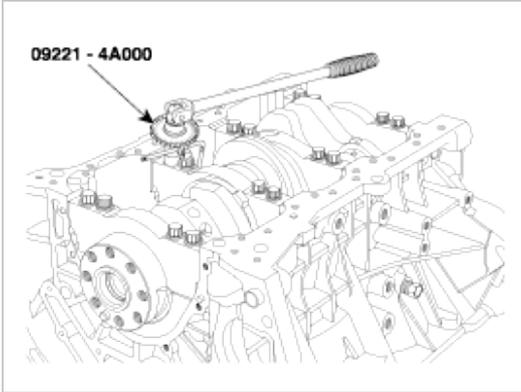
29.40 ~ 31.36Nm(3.0 ~ 3.2 kgf.m, 21.70 ~ 23.14lb-ft) (17 ~ 22)

**NOTICE**

- a. Always use new main bearing cap bolt.
- b. If any of the bearing cap bolts in broken or deformed, replace it.



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



(2) Check that the crankshaft turns smoothly.

9. Check crankshaft end play.

10. Install piston and connecting rod assemblies.

#### NOTICE

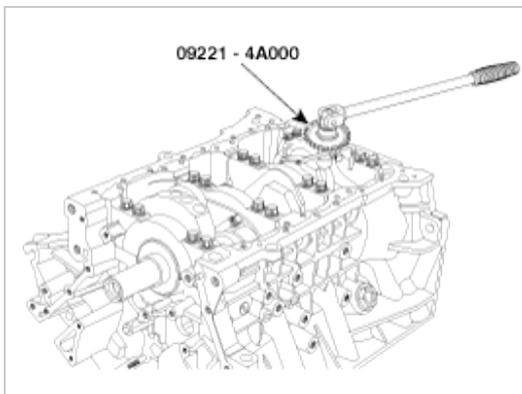
Before installing the pistons, apply a coat of engine oil to the ring grooves and cylinder bores.

- (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

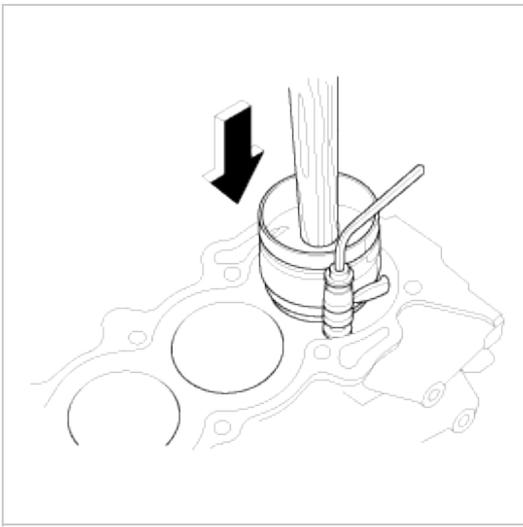
19.6Nm (2.0kgf.m, 14.46lb-ft) + 90°

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



#### NOTICE

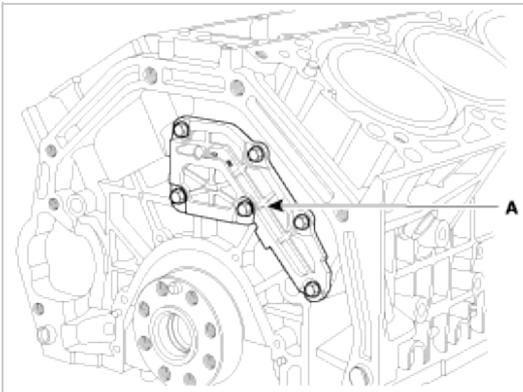
- a. Always use new connecting rod bearing cap bolt.
- b. Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



11. Check the connecting rod end play.
12. Install oil drain cover.

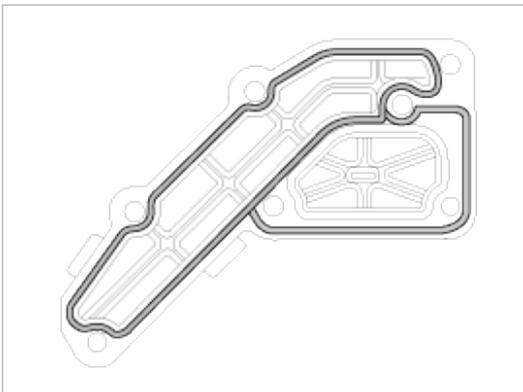
Tightening torque

9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68b-ft)



#### NOTICE

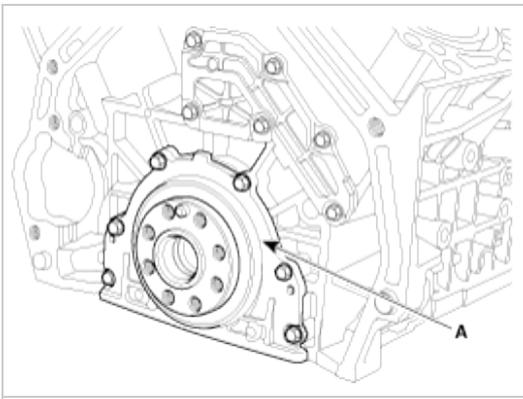
- a. Ensure the sealing face is clean before assembling two parts.
- b. Remove harmful foreign matters on the sealing face before applying sealant
- c. Be assembling oil drain cover, the liquid sealant TB1217H should be applied oil drain cover.
- d. The part must be assembled within 5 minutes after sealant was applied.
- e. Apply sealant to the inner threads of the bolt holes.



13. Install rear oil seal case.

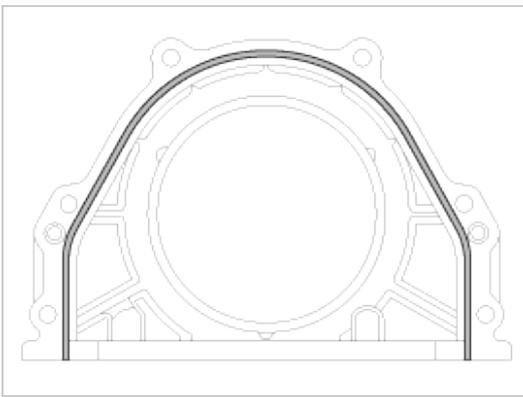
Tightening torque

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

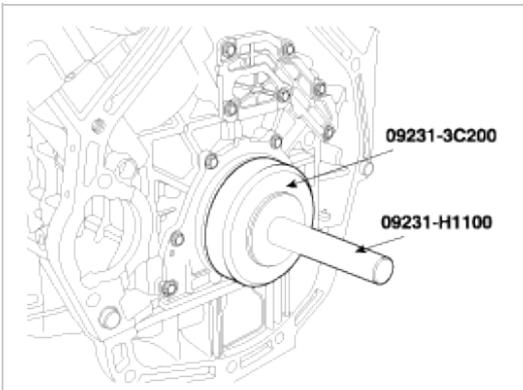


### NOTICE

- a. Make clean the sealing face before assembling two parts.
- b. Remove harmful foreign matters on the sealing face before applying sealant
- c. Be assembling rear oil seal case, the liquid sealant TB1217H should be applied rear oil seal case.
- d. The part must be assembled within 5 minutes after sealant was applied.
- e. Apply sealant to the inner threads of the bolt holes.



14. Using SST(09231-3C200, 09231-H1100), install rear oil seal.

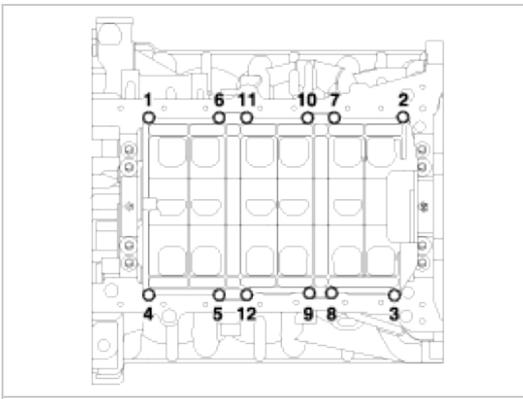


15. Install baffle plate.

Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

Tightening torque

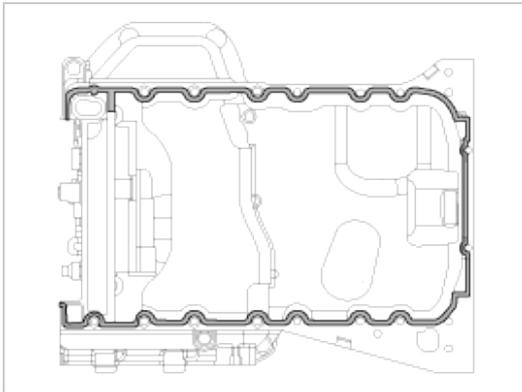
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



16. Install upper oil pan.

- a. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
- b. Before assembling the oil pan, the liquid sealant TB1217H should be applied on upper oil pan. The part must be assembled within 5 minutes after the sealant was applied.

Bead width : 2.5mm(0.1in.)



**NOTICE**

- a. Ensure the sealing face is clean before assembling two parts.
- b. Remove harmful foreign matters on the sealing face before applying sealant
- c. When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- d. To prevent leakage of oil, apply sealant gasket of the inner threads of the bolt holes.

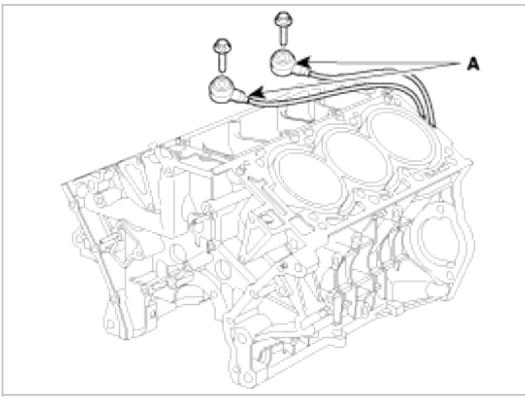
- c. Install upper oil pan.  
Uniformly tighten the bolts in several passes.

Tightening torque  
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



17. Install knock sensor.

Tightening torque  
15.68 ~ 23.52Nm (1.6 ~ 2.4kgf.m, 11.57 ~ 17.36lb-ft)



18. Install drive plate.

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Tightening torque

71.54 ~ 75.46Nm (7.3 ~ 7.7kgf.m, 52.80 ~ 55.69lb-ft)

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# Cooling system



## ENGINE COOLANT REFILLING AND BLEEDING

### 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.

### CAUTION

When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

1. Make sure the engine and radiator are cool to the touch.
2. Remove radiator cap.
3. Loosen the drain plug, and drain the coolant.
4. Tighten the radiator drain plug securely.
5. Remove, drain and reinstall the reservoir. Fill the tank halfway to the "F" mark with water, then up to the "F" mark with antifreeze.
6. Fill fluid mixture with coolant and water(4 : 6) slowly through the radiator cap. Push the upper/lower hoses of the radiator to ensure proper air bleeding.

### NOTICE

- a. Use only genuine antifreeze/coolant.
- b. For best corrosion protection, the coolant concentration must be maintained year-round at 50% minimum. Coolant concentrations less than 50% may not provide sufficient protection against corrosion or freezing.
- c. Coolant concentrations greater than 60% will impair cooling efficiency and are not recommended.

### CAUTION

- a. Do not mix different brands of antifreeze/coolants.
- b. Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.

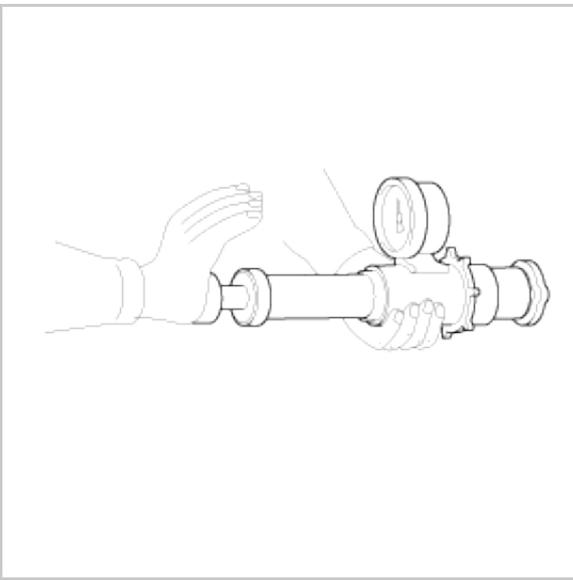
7. Start the engine.  
When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
8. Repeat 7 until the cooling fan cycles 3 ~ 5 times and bleed air sufficiently out of the cooling system.
9. Install the radiator cap and fill the reservoir tank to the "MAX" line with coolant.
10. Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.
11. Stop the engine and wait until the cooling system is cool to the touch.
12. Repeat 6 to 11 until the coolant level doesn't fall any more, bleed air out of the cooling system.

### NOTICE

Proper cooling system operation depends on the absence of trapped air within the system. It is essential that the cooling system be properly filled and bled before returning the vehicle to service.

## CAP TESTING

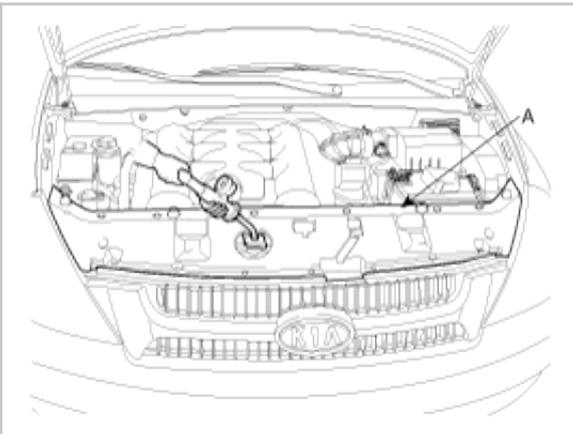
1. Remove the radiator cap, wet its seal with engine coolant, then install it no pressure tester.



2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm<sup>2</sup>, 14 ~ 19psi)
3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

## TESTING

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install it on the pressure tester.



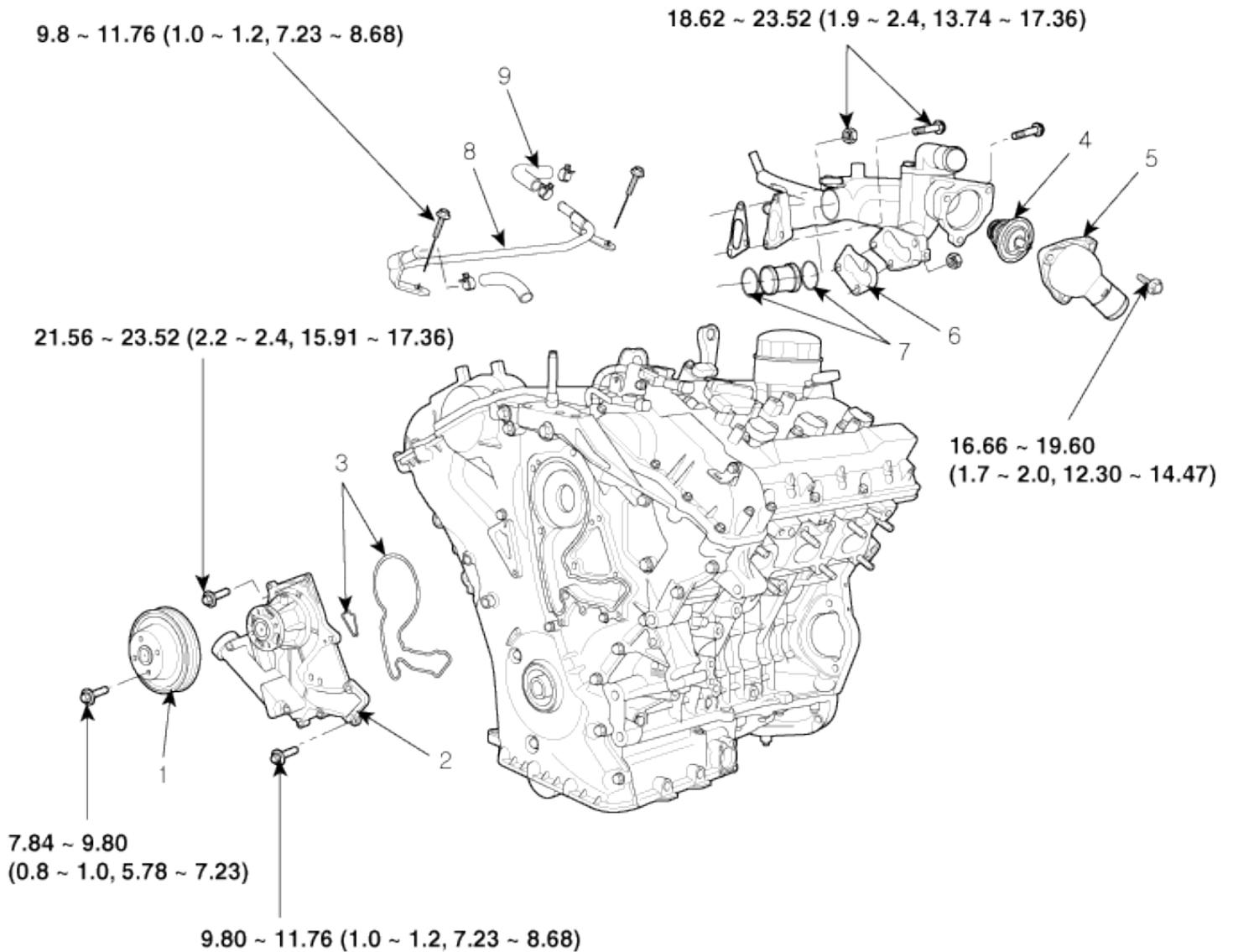
2. Apply a pressure tester to the radiator and apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm<sup>2</sup> 14 ~18psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

### NOTICE

Check for engine oil in the coolant and/or coolant in the engine oil.



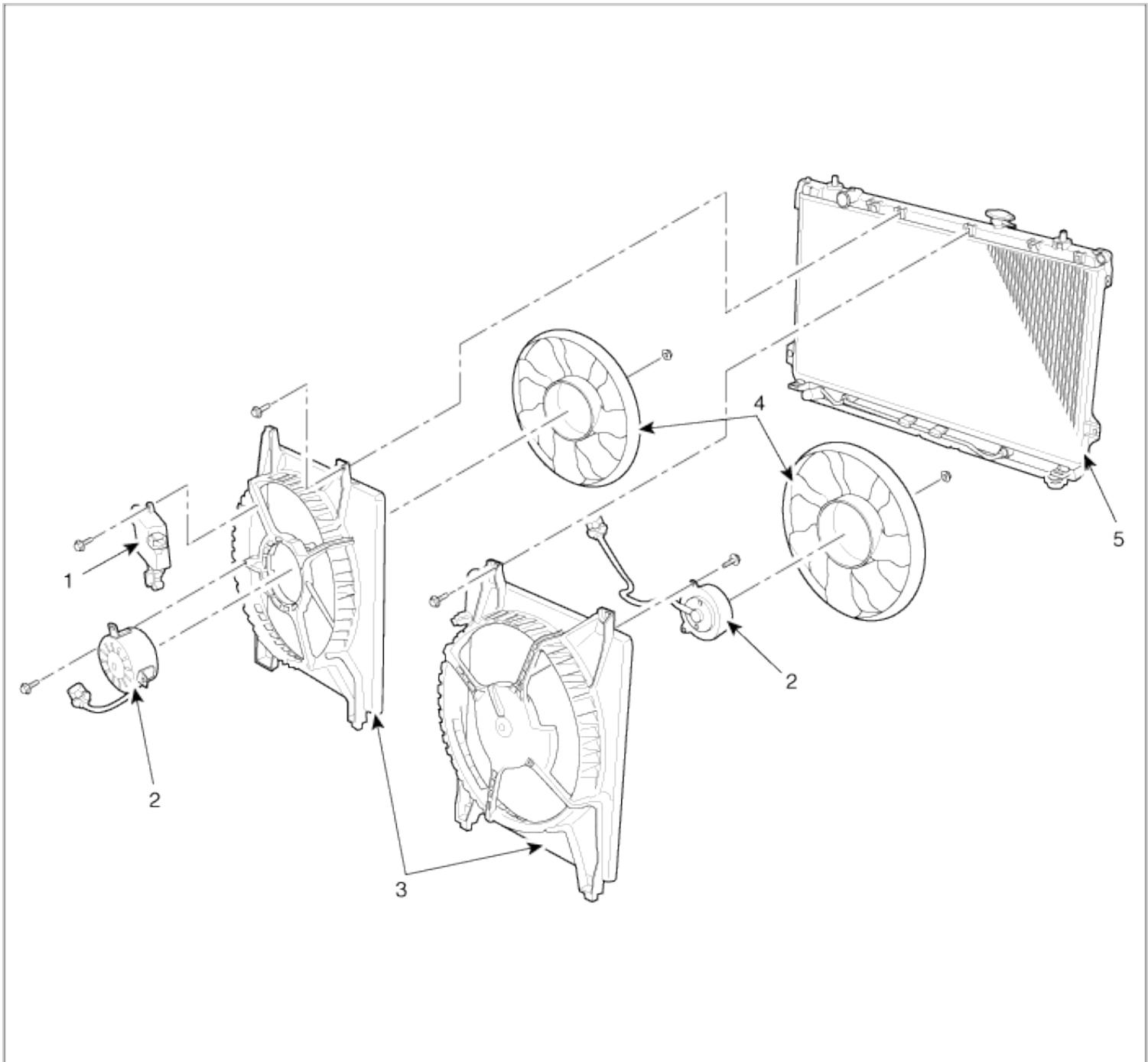
**COMPONENT**



**TORQUE : N.m (kgf.m, lb-ft)**

- 1. Water pump pulley
- 2. Water pump
- 3. Water pump gasket
- 4. Thermostat

- 5. Water inlet pipe
- 6. Gasket
- 7. O - ring
- 8. Air vent pipe
- 9. Hose



- 1. Cooling fan controller
- 2. Cooling fan motor
- 3. Cooling fan cover
- 4. Cooling fan
- 5. Radiator assembly



## REMOVAL

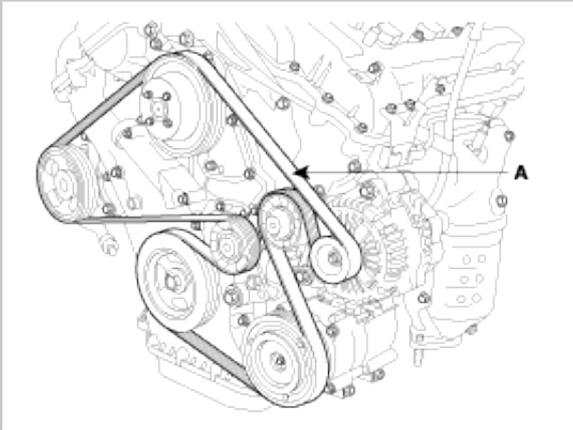
### WATER PUMP

1. Drain the engine coolant.

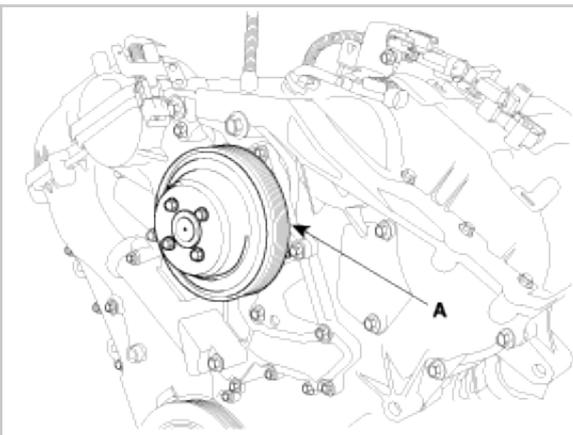
#### WARNING

System is under high pressure when the engine is hot. To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

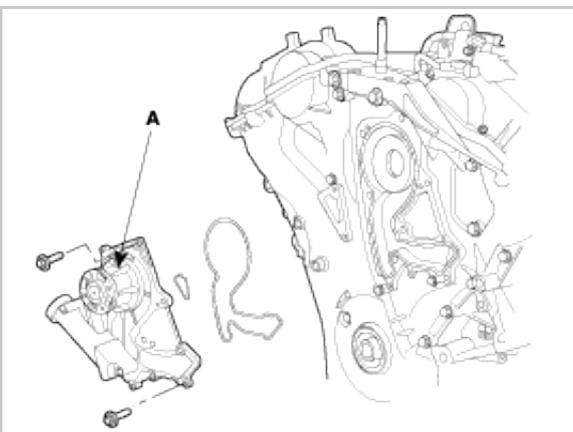
2. Remove drive belt(A).



3. Remove the 4 bolts and pump pulley(A).



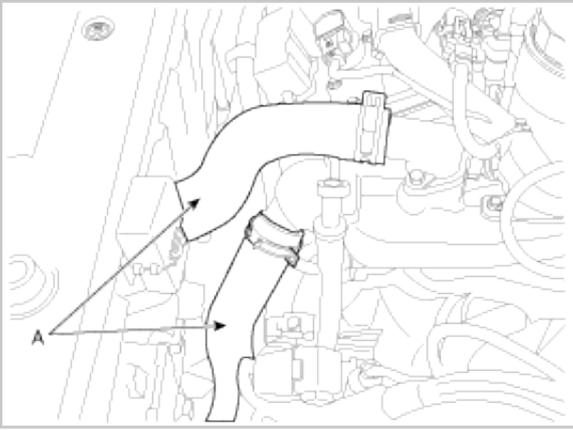
4. Remove the water pump(A) and gasket.



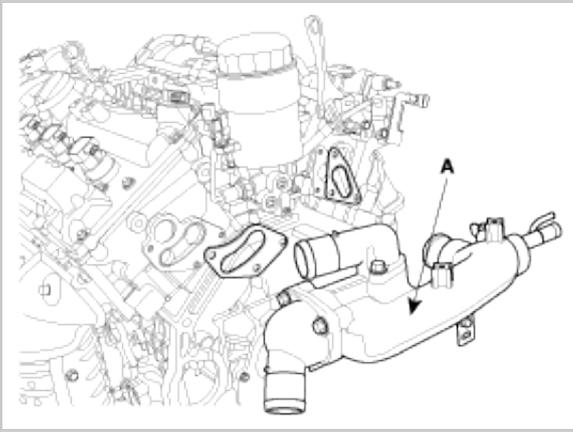
### WATER TEMPERATURE CONTROL ASSEMBLY

1. Drain the engine coolant.
2. Remove air cleaner assembly.

3. Disconnect radiator upper and lower hose(A).



4. Disconnect ECT connector.
5. Disconnect heater hose, water vent hose and water hose from water temperature control assembly.
6. Remove wiring protector.
7. Remove water temperature control assembly(A).

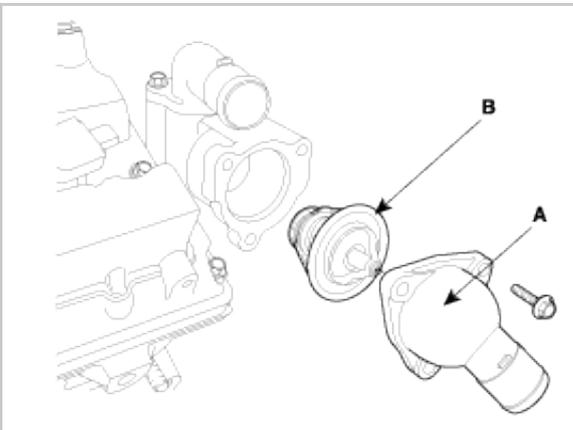


## THERMOSTAT

### NOTICE

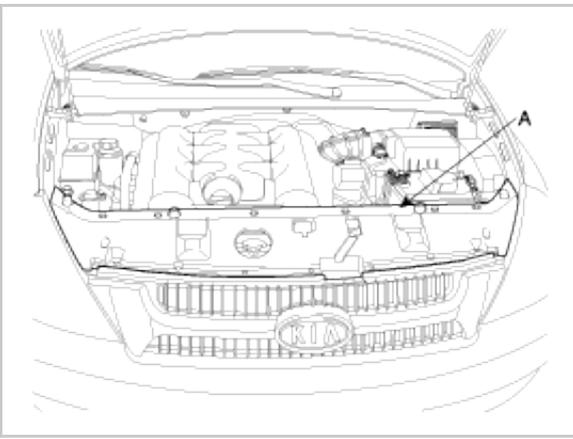
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. Drain engine coolant so its level is below thermostat.
2. Remove water inlet(A) and thermostat(B).

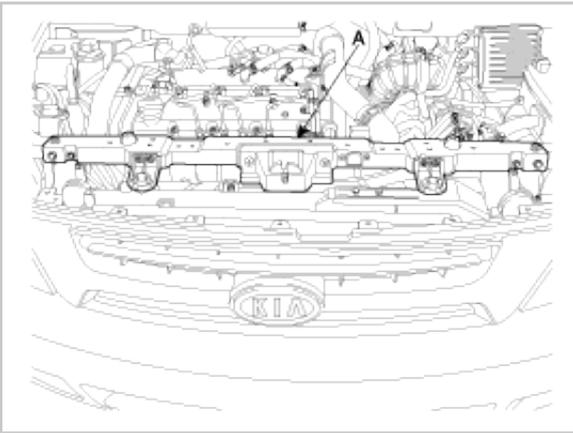


## RADIATOR

1. Drain the engine coolant.
2. Remove the radiator grille upper cover(A).

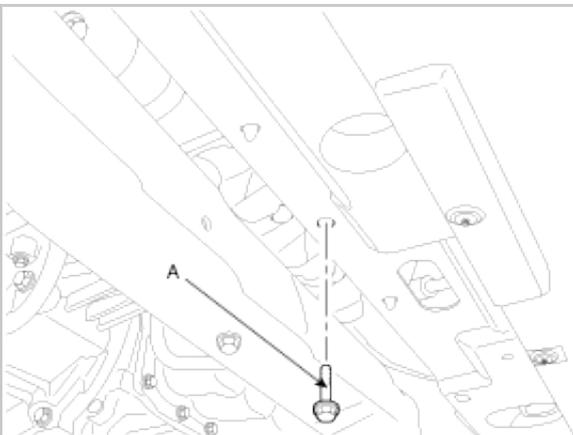


3. Remove the radiator support upper member assembly(A) for convenience sake.

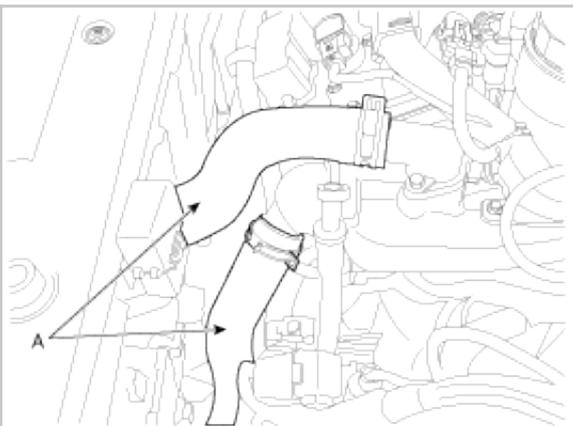


**NOTICE**

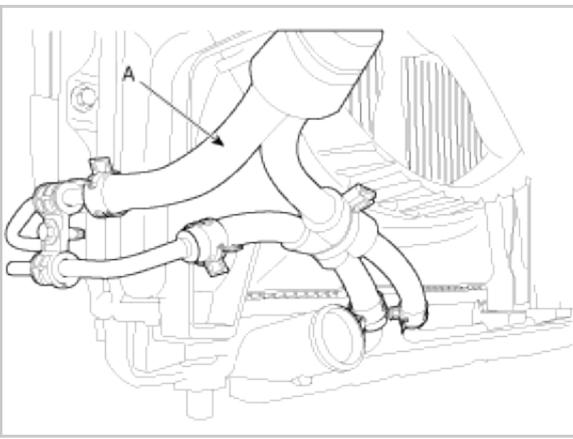
The bottom side bolt(A) which can be seen after removing the under cover should be loosened for removal of the radiator support upper member assembly.



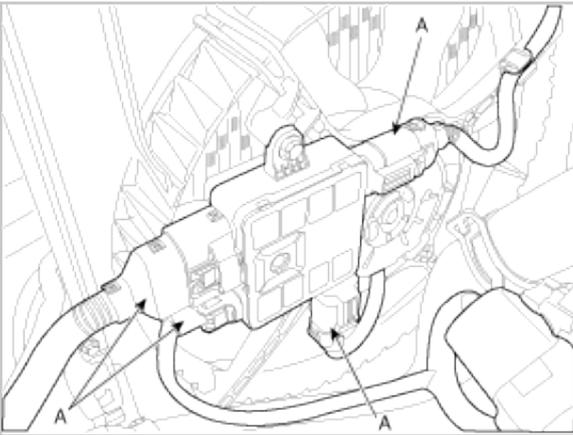
4. Disconnect radiator upper and lower hoses(A).



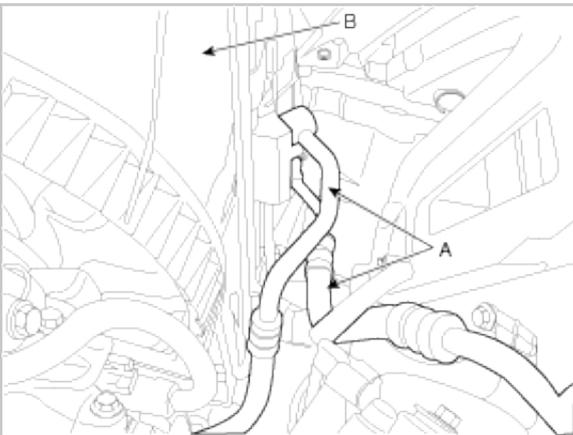
5. Disconnect transaxle oil cooler hoses(A).(Refer to TR group)



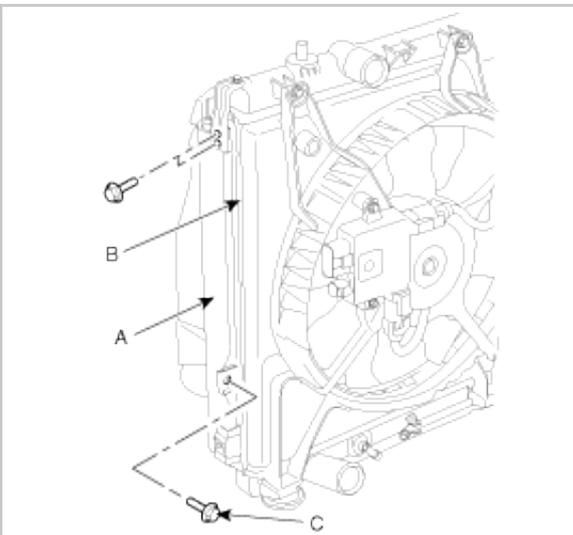
6. Disconnect the radiator fan connectors(A).

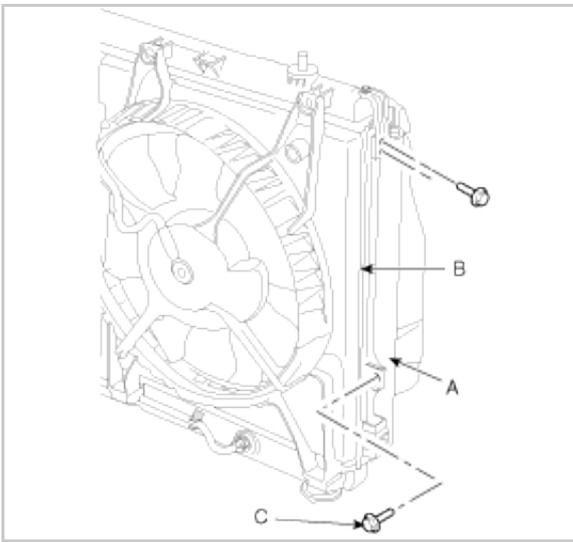


7. Disconnect the pressure lines(A) from the radiator assembly(B).

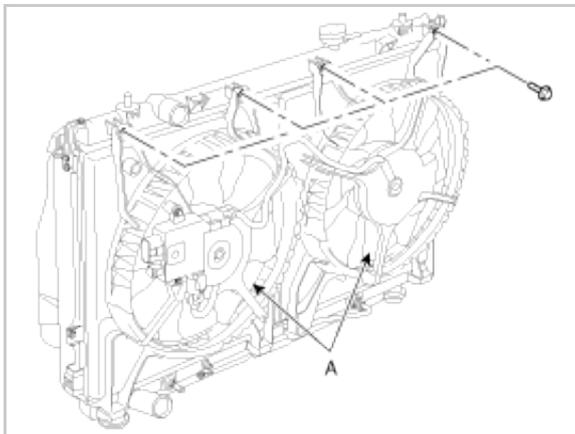


8. Separate the condenser(A) from the radiator assembly(B) by removing the bolts(C).





9. Remove the radiator bracket.
10. Remove the radiator assembly.
11. Remove the radiator cooling fan(A).



## INSTALLATION

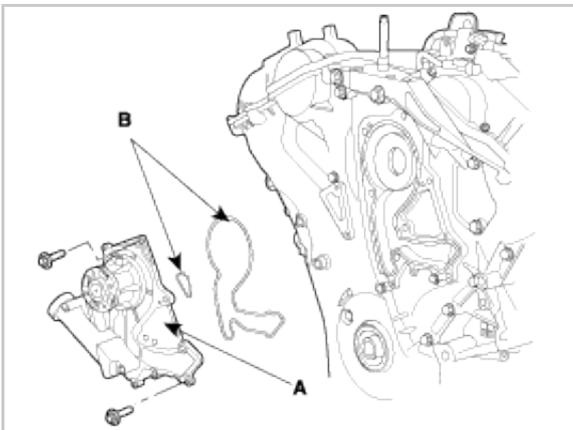
### WATER PUMP

1. Install the water pump(A) and a new gasket(B) with 12 bolts.

Tightening torque

21.56 ~ 23.52Nm (2.2 ~ 2.4kgf.m, 15.91 ~ 17.36lb-ft)

9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



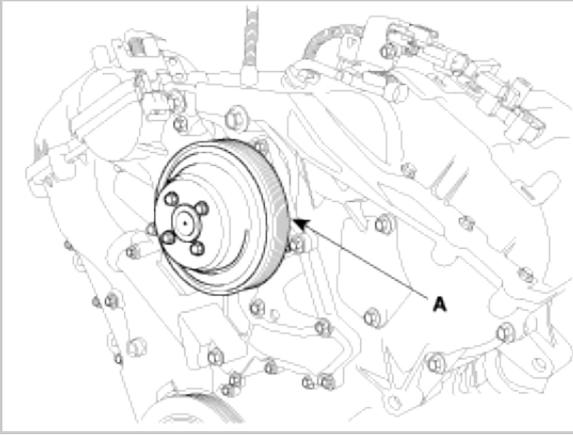
### NOTICE

Make clean the contact face before assembly.

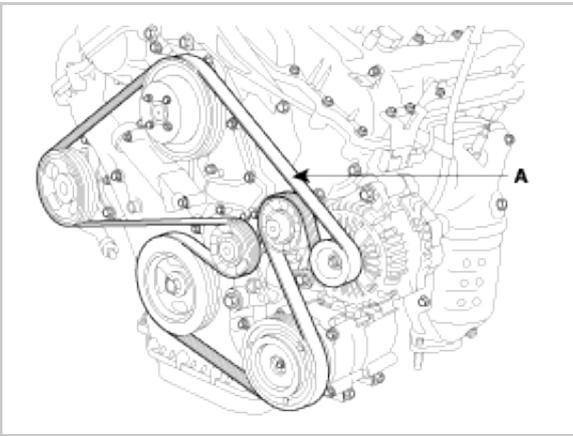
2. Install the 4 bolts and pump pulley(A).

Tightening torque

7.84 ~ 9.80Nm (0.8 ~ 1.0kgf.m, 5.78 ~ 7.23lb-ft)



3. Install drive belt(A).



4. Fill with engine coolant.
5. Start engine and check for leaks.
6. Recheck engine coolant level.

## WATER TEMPERATURE CONTROL ASSEMBLY

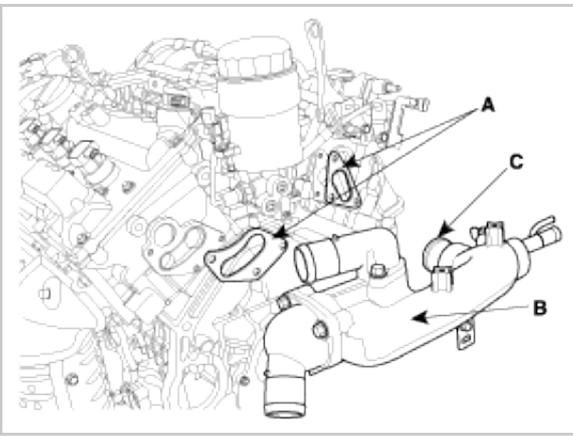
### NOTICE

Make clean the contact face before assembly.

1. Install water temperature control assembly(B) and new gasket(A).

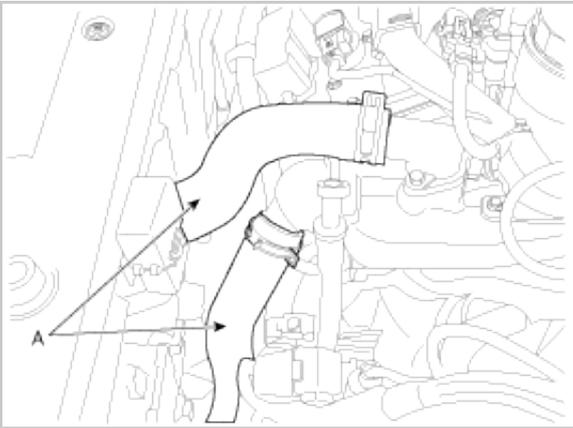
Tightening torque

18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)



**NOTICE**  
 Use new O-rings(C) when reassembling.

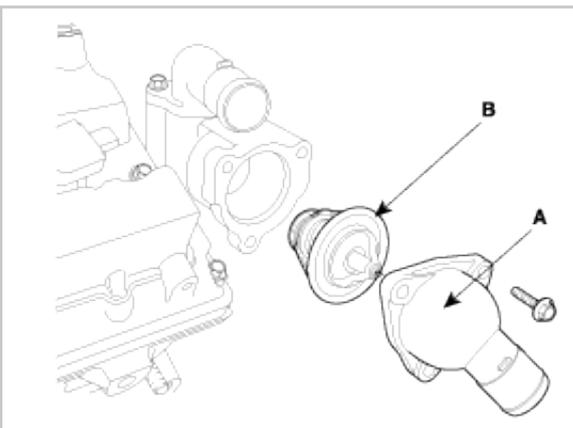
2. Connect water hoses to the water temperature control assembly.
3. Install wiring protector.
4. Connect ECT connector.
5. Connect radiator upper and lower hose(A).



6. Install air cleaner assembly.
7. Fill with engine coolant.
8. Start engine and check for leaks.
9. Recheck engine coolant level.

## THERMOSTAT

1. Place thermostat in thermostat housing.
  - (1) Install the thermostat with the jiggle valve upward.
  - (2) Install a new thermostat(B).



2. Install water inlet(A).

---

Tightening torque

16.66 ~ 19.60Nm (1.7 ~ 2.0kgf.m, 12.30 ~ 14.47lb-ft)

---

3. Fill with engine coolant.
4. Start engine and check for leaks.

## RADIATOR

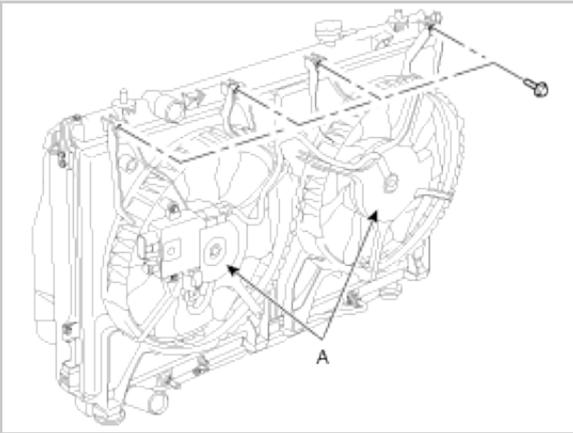
1. Install the radiator fan(A) to the radiator.

---

Tightening torque

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

---



2. Install the radiator assembly to the vehicle.
3. Install the radiator bracket.
4. Fix the condenser with the radiator assembly.

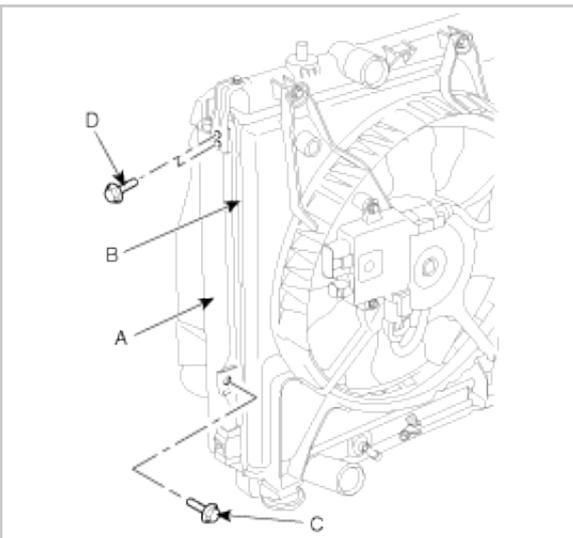
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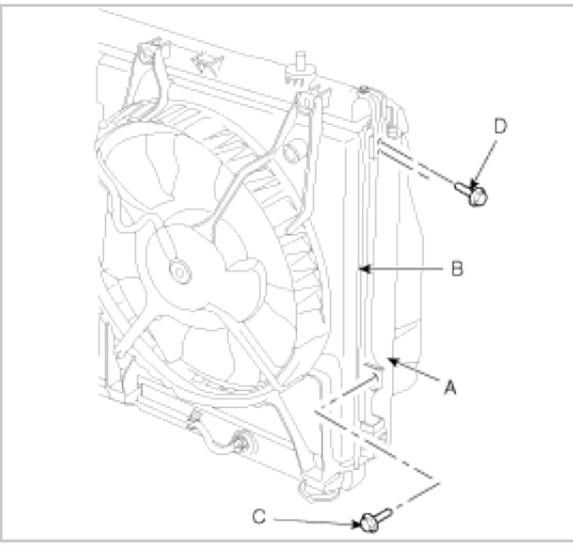
Tightening torque

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

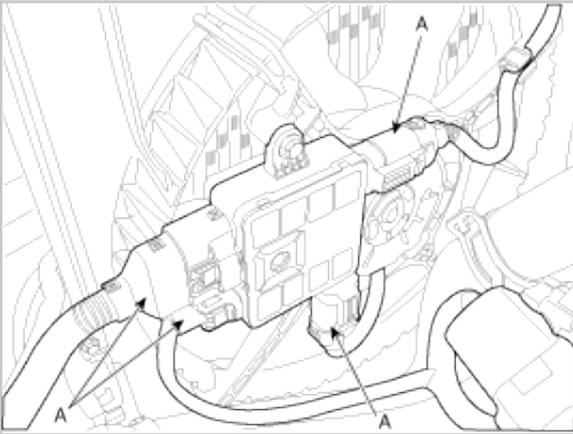
6.9 ~ 9.8Nm (0.7 ~ 1.0kgf.m, 5.1 ~ 7.2lb-ft) - C

---

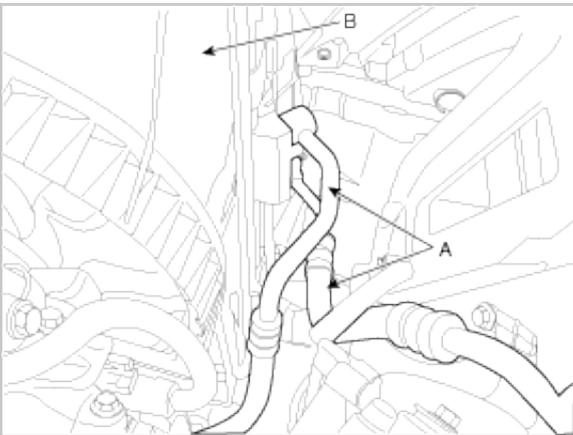




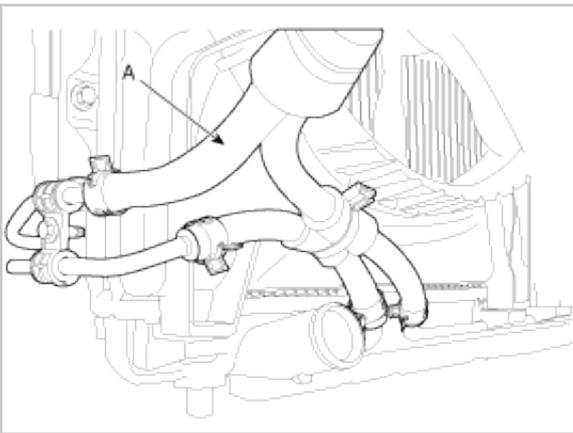
5. Connect the radiator fan connectors(A).



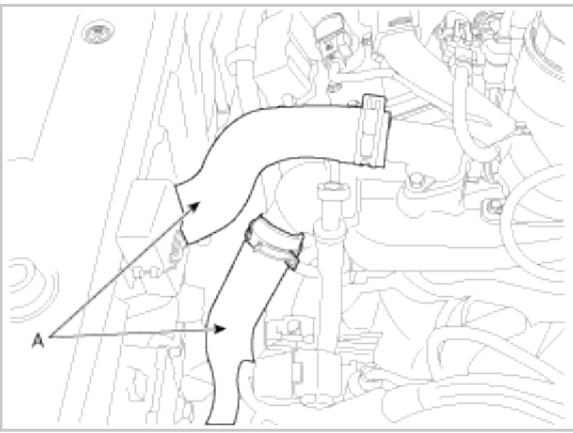
6. Connect the pressure lines(A) to the radiator assembly(B).



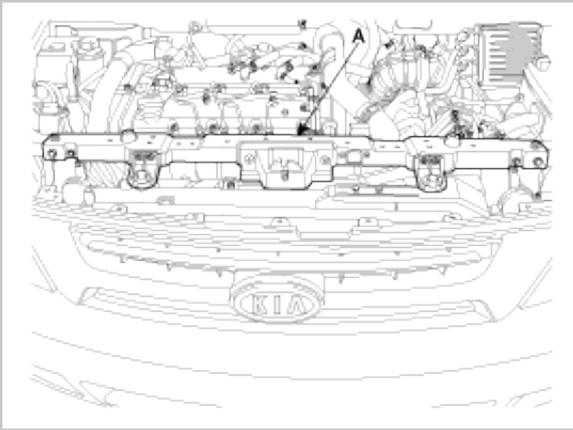
7. Connect transaxle oil cooler hoses(A).(Refer to TR group)



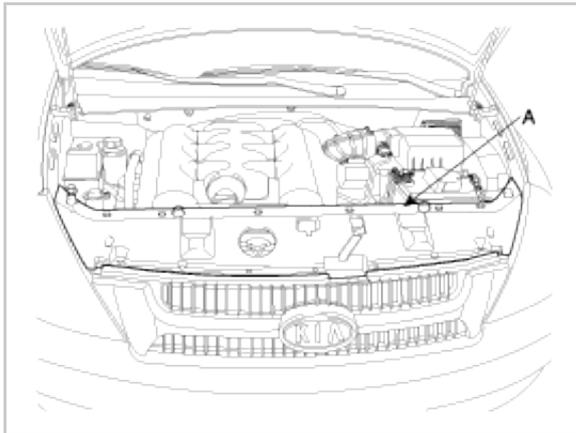
8. Connect radiator upper and lower hoses(A).



9. Install the radiator support upper member assembly(A).



10. Install the radiator grille upper cover(A).



11. Fill with engine coolant.

12. Start engine and check for leaks.

13. Recheck engine coolant level.

## INSPECTION

### WATER PUMP

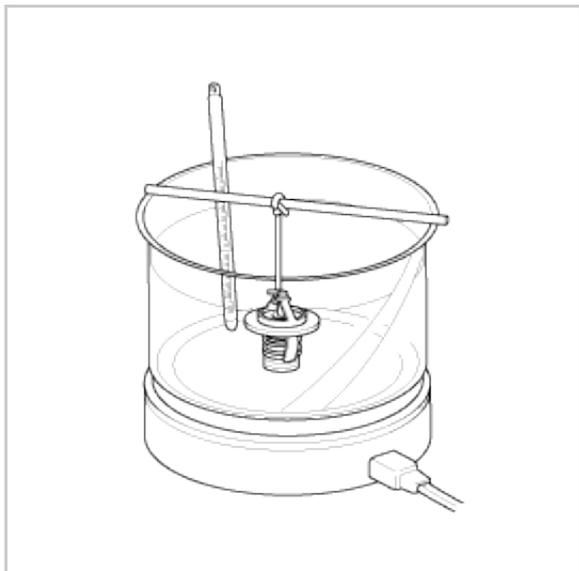
1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is malfunctioning. Replace the coolant pump assembly.

### NOTICE

A small amount of "weeping" from the bleed hole is normal.

## THERMOSTAT

1. Immerse the thermostat in water and gradually heat the water.



2. Check the valve opening temperature.

Valve opening temperature : 82°C (177°F)

Full opening temperature : 95°C (205°F)

If the valve opening temperature is not as specified, replace the thermostat.

3. Check the valve lift.

Valve lift : Min. 10mm (0.4in.) at 95°C (205°F)

If the valve lift is not as specified, replace the thermostat.

# **Lubrication system**

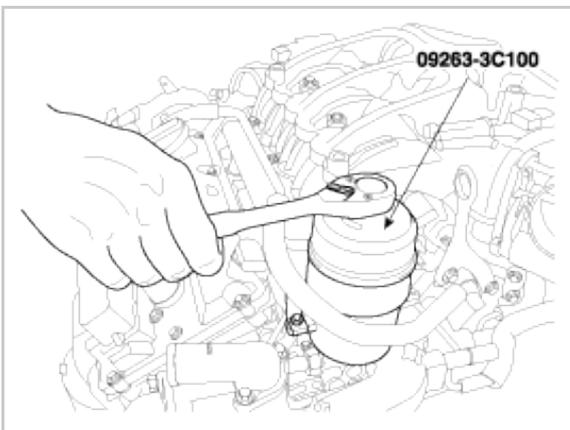


## OIL AND FILTER

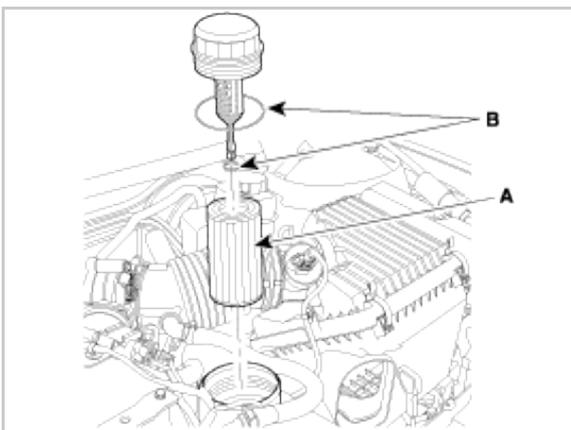
### CAUTION

- a. Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.
- b. Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.
- c. In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.

1. Park the car on level ground.  
Start the engine and let it warm up.
2. Turn the engine off and open the hood.  
Remove the engine cover.
3. Loosen the oil filter cap by turning it clockwise with SST (09263-3C100). Allow 5 minutes for the oil in the filter assembly to drain.



4. Drain the engine oil.
  - a. Remove the oil filler cap.
  - b. After lifting the car, remove the oil drain plug and drain the oil into a container.
5. Replace oil filter.
  - a. Disconnect the oil filter cap from oil filter body.
  - b. Remove the oil filter element.
  - c. Check and clean the oil filter installation surface.
  - d. Check the part number of the new oil filter is as same as old one.
  - e. Install new oil filter element(A) and two new O-rings(B).



- f. Apply clean engine oil to the new O-rings.

Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.  
g. Finally tighten it again by specified tightening torque.

---

Tightening torque  
24.50Nm (2.5kgf.m, 18.08lb-ft)

---

6. Refill with engine oil.  
a. Install the oil drain plug with a new gasket.

---

Tightening torque  
34.3 ~ 44.1Nm (3.5 ~ 4.5kgf.m, 25.3 ~ 32.5lb-ft)

---

- b. Fill with fresh engine oil, after removing the engine oil level gauge.

---

Capacity  
Total : 6.0 L (6.34 US qt, 5.27 Imp qt)  
Oil pan : 5.5 L (5.81 US qt, 4.83 Imp qt)  
Drain and refill including oil filter : 5.2 L (5.49 US qt, 4.57 Imp qt)  
Oil quality : ABOVE API SJ / SL or SAE 5W-20

---

- c. Install the oil filler cap and oil level gauge.

7. Start the engine and check to be sure no oil is leaking from the drain plug or oil filter.  
8. Recheck engine oil level.

## INSPECTION

1. Check engine oil quality.  
Check the oil for deterioration, entry of water, discoloring or thinning.  
If the quality is visibly poor, replace the oil.
2. Check engine oil level.  
After warming up the engine and then 5 minutes after the engine stop, oil level should be between the "L" and "F" marks on the dipstick.  
If low, check for leakage and add oil up to the "F" mark.

### NOTICE

Do not fill with engine oil above the "F" mark.

## SELECTION OF ENGINE OIL

Recommended API classification : Above SJ or SL

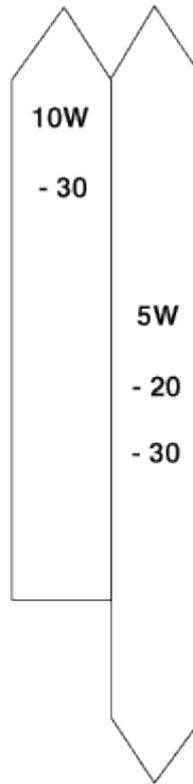
Recommended SAE viscosity grades : 5W-20

If 5W-20 engine oil is not available, 5W-30 or secondary recommended engine oil for corresponding temperature range can be used.

Temperature range  
anticipated before  
next oil change

Recommended SAE viscosity number

- 18°C - 0.4°F



#### NOTICE

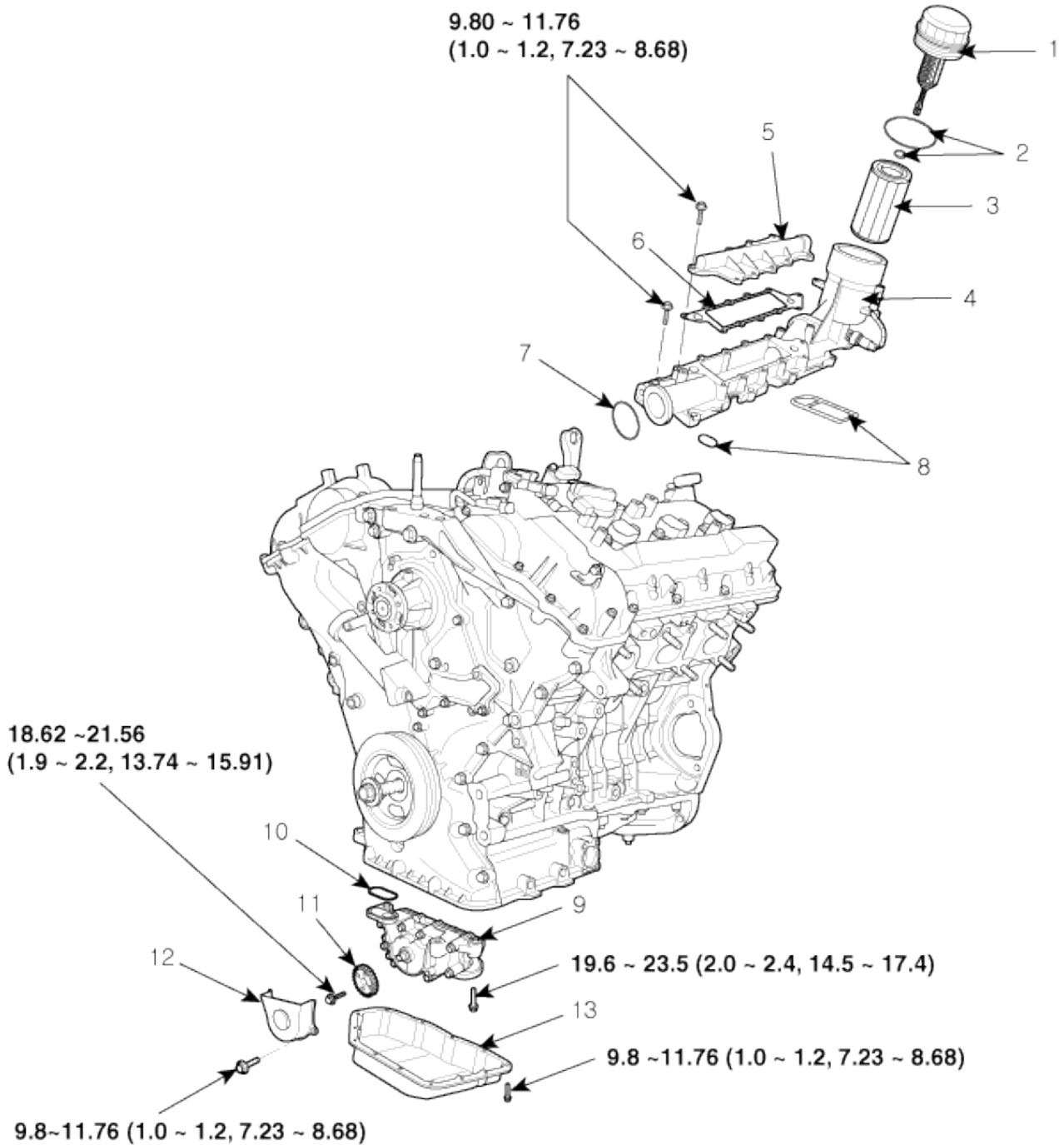
For best performance and maximum protection of all types of operation, select only those lubricants which :

- Satisfy the requirement of the API classification.
- Have proper SAE grade number for expected ambient temperature range.

Lubricants that do not have both an SAE grade number and API service classification on the container should not be used.



**COMPONENT**



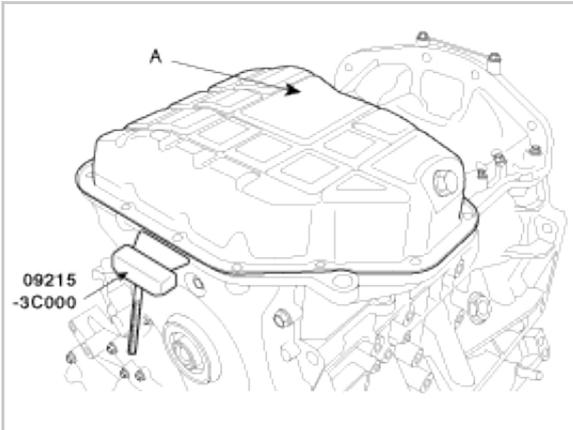
**TORQUE : N.m (kgf.m, lb-ft)**

- |                          |             |                          |
|--------------------------|-------------|--------------------------|
| 1. Oil filter cap        | 6. Gasket   | 11. Oil pump sprocket    |
| 2. O - ring              | 7. O - ring | 12. Oil pump chain cover |
| 3. Oil filter element    | 8. Gasket   | 13. Lower oil pan        |
| 4. Oil filter body       | 9. Oil pump |                          |
| 5. Oil filter body cover | 10. Gasket  |                          |

## REMOVAL

### Oil pump

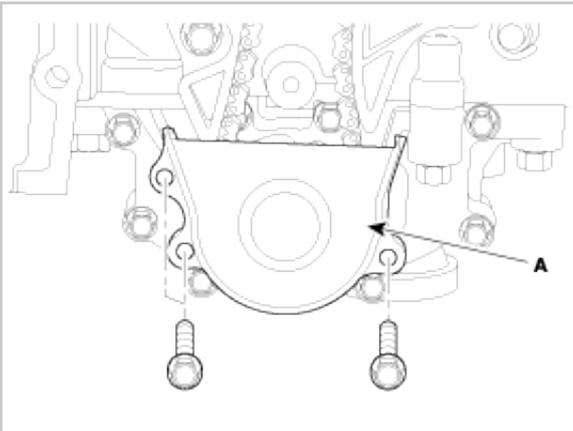
1. Drain engine oil.
2. Using SST(09215-3C000) remove lower oil pan(A).



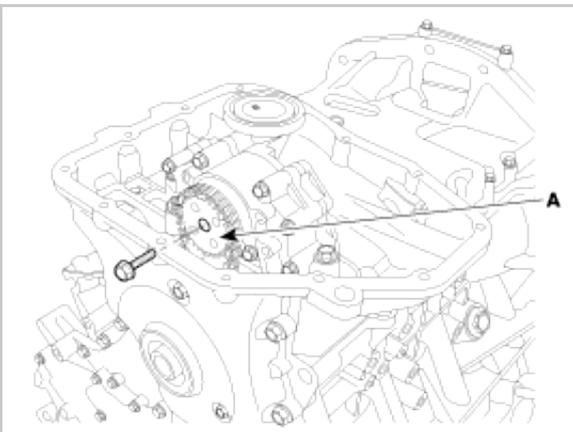
### CAUTION

Be careful not to damage the contact surfaces of upper oil pan and lower oil pan.

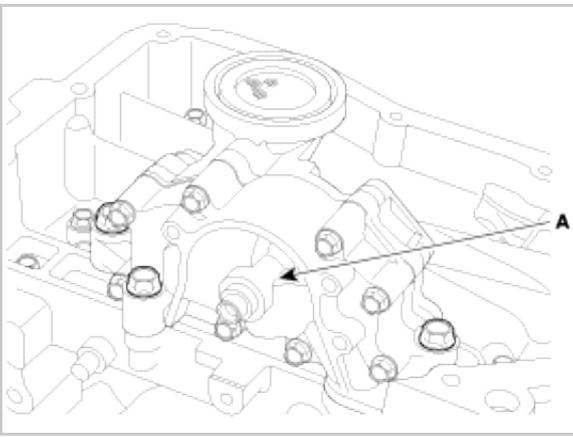
3. Remove oil pump chain cover(A).



4. Remove oil pump chain sprocket(A).

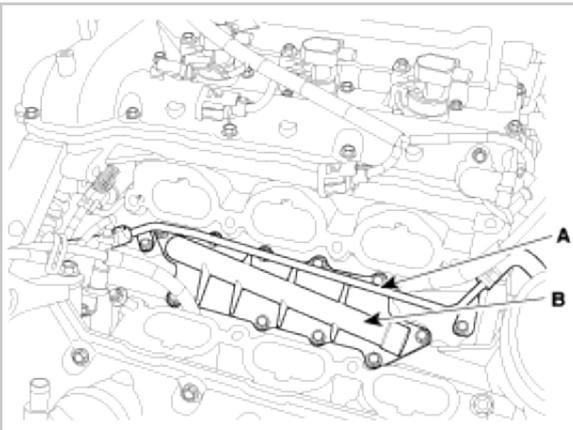


5. Remove oil pump(A).

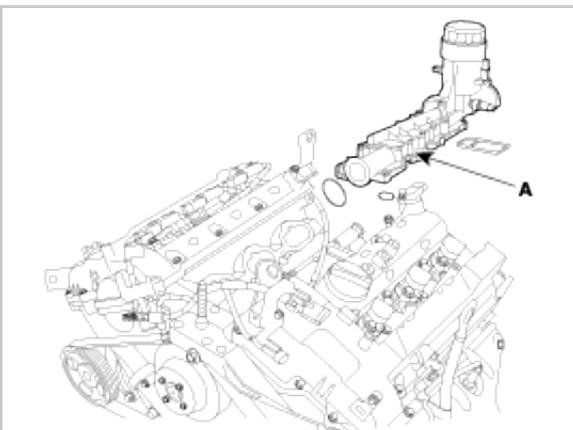


### Oil filter assembly

1. Loosen the oil filter cap by turning it clockwise with SST (09263-3C100). Allow 5 minutes for the oil in the filter assembly to drain.
2. Remove surge tank and intake manifold.
3. Disconnect oil pressure switch connector.
4. Drain the engine coolant.
5. Disconnect water hoses from ETC.
6. Remove water temperature control assembly.
7. Disconnect water vent hose(A).
8. Remove oil filter body cover(B).



9. Remove oil filter body.(A).



#### NOTICE

Be careful of the knock sensor connector.

## INSTALLATION

## Oil pump

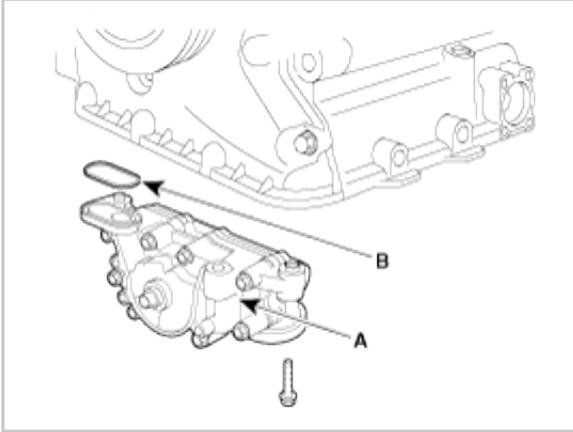
1. Install oil pump(A).

Tightening torque

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

### NOTICE

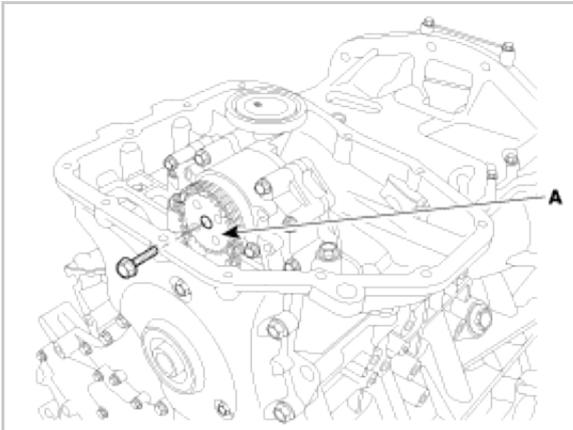
Always use a new O-ring(B).



2. Install oil pump sprocket(A) and oil pump chain on the oil pump.

Tightening torque

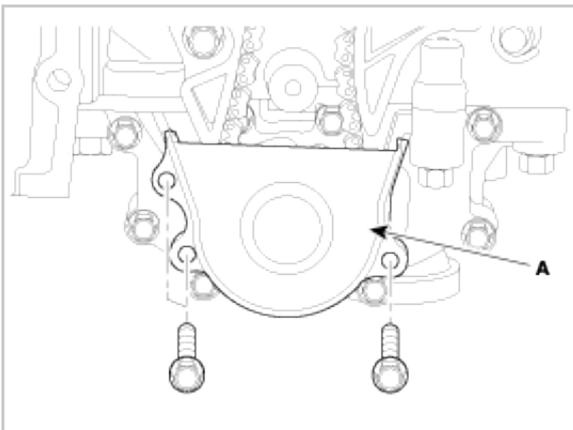
18.62 ~ 21.56Nm (1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)



3. Install oil pump chain cover(A).

Tightening torque

9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



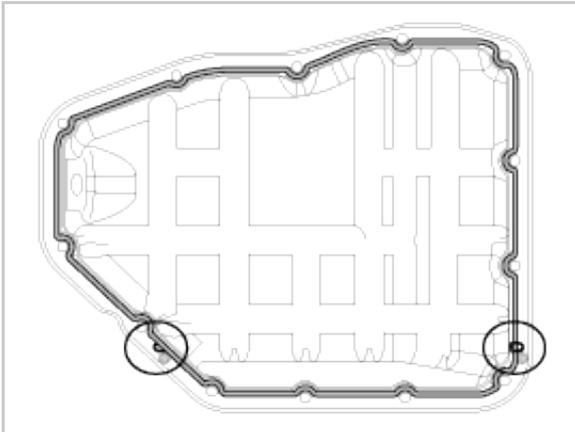
4. Install lower oil pan.

- a. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
- b. Before assembling the oil pan, the liquid sealant TB1217H should be applied on upper oil pan. The part must be assembled within 5 minutes after the sealant was applied.

---

Bead width : 2.5mm(0.1in.)  
But marked area(\*) to be 5.0mm(0.2in.)

---



**CAUTION**

- a. Ensure the sealing face is clean before assembling two parts.
- b. Remove harmful foreign matters on the sealing face before applying sealant
- c. When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- d. To prevent leakage of oil, apply sealant gasket of the inner threads of the bolt holes.

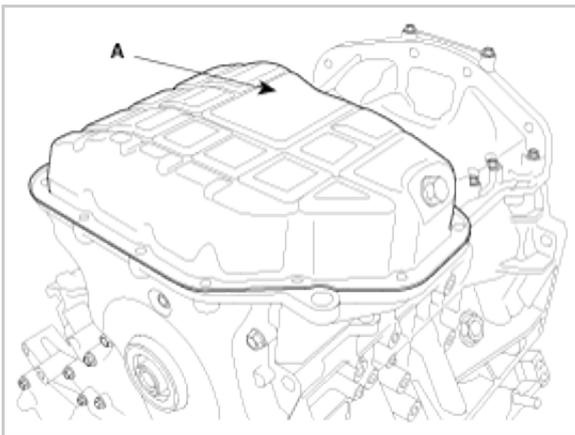
c. Install lower oil pan.

Uniformly tighten the bolts in several passes.

---

Tightening torque  
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

---



- d. After assembly, wait at least 30 minutes before filling the engine with oil.

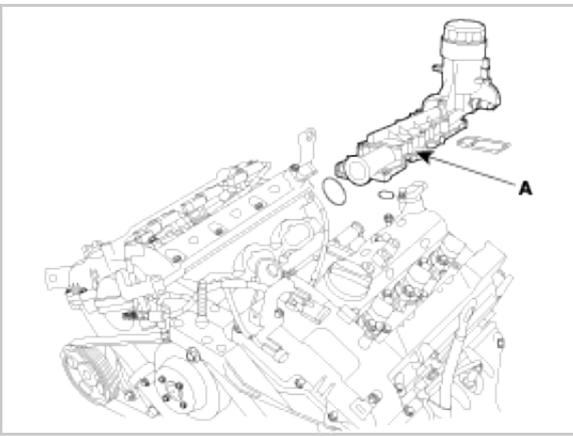
## OIL FILTER ASSEMBLY

1. Install oil filter body(A) and new O-rings.

---

Tightening torque  
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

---



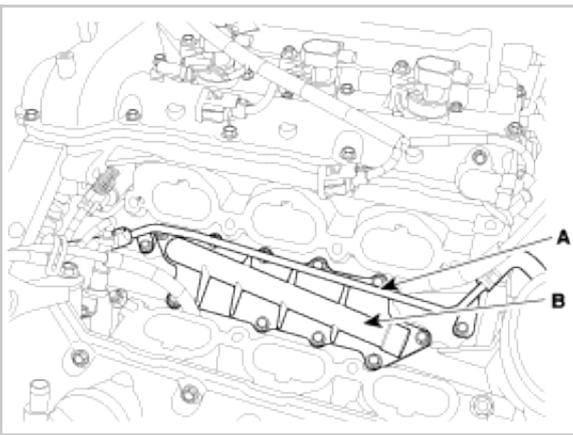
### NOTICE

- a. All rubber gasket must be no damaged by assembling parts.
- b. Be careful of the knock sensor connector.
- c. Always use a new O-ring

2. Install oil filter body cover(B) and new gasket on the oil filter body.

Tightening torque

9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



3. Connect water vent hose(A)

Tightening torque

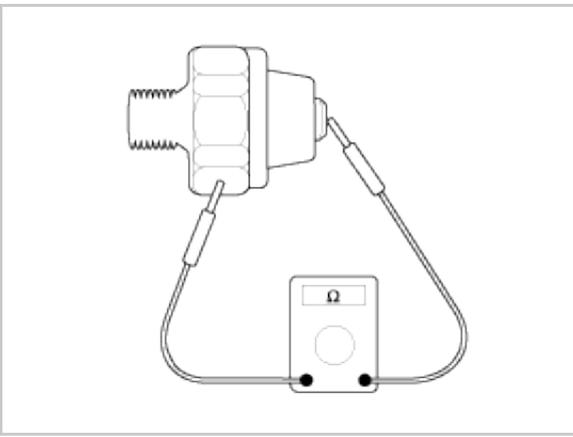
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

4. Install water temperature control assembly.
5. Connect water hoses on the ETC.
6. Connect oil pressure switch connector.
7. Install intake manifold and surge tank.
8. Fill with engine coolant.
9. Start engine and check for leaks.
10. Recheck engine coolant level.

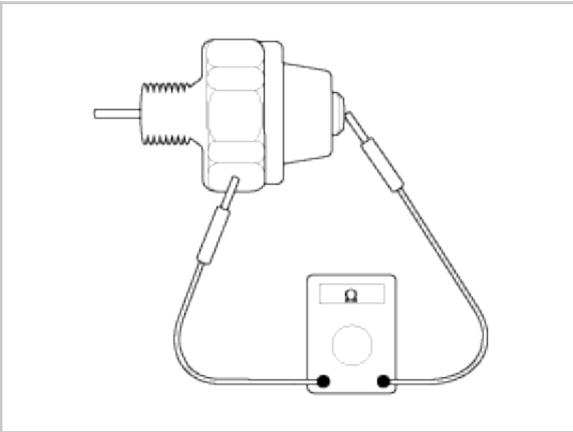
## INSPECTION

### OIL PRESSURE SWITCH

1. Check the continuity between the terminal and the body with an ohmmeter.  
If there is no continuity, replace the oil pressure switch.



2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.
3. If there is no continuity when a 50kpa (7psi) vacuum is applied through the oil hole, the switch is operating properly. Check for air leakage. If air leaks, the diaphragm is broken. Replace it.



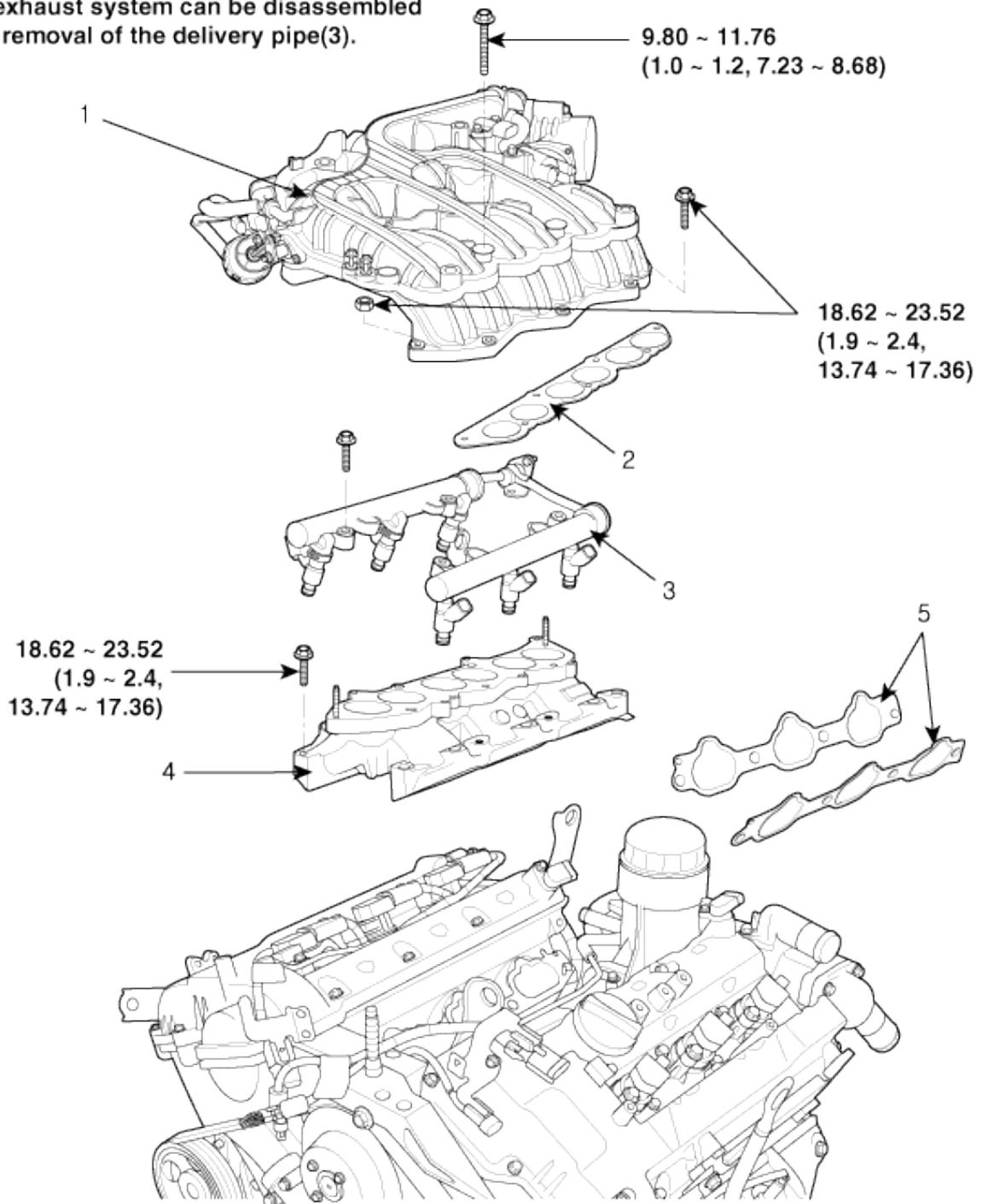
# **Intake and Exhaust system**



**COMPONENT**

**<NOTE>**

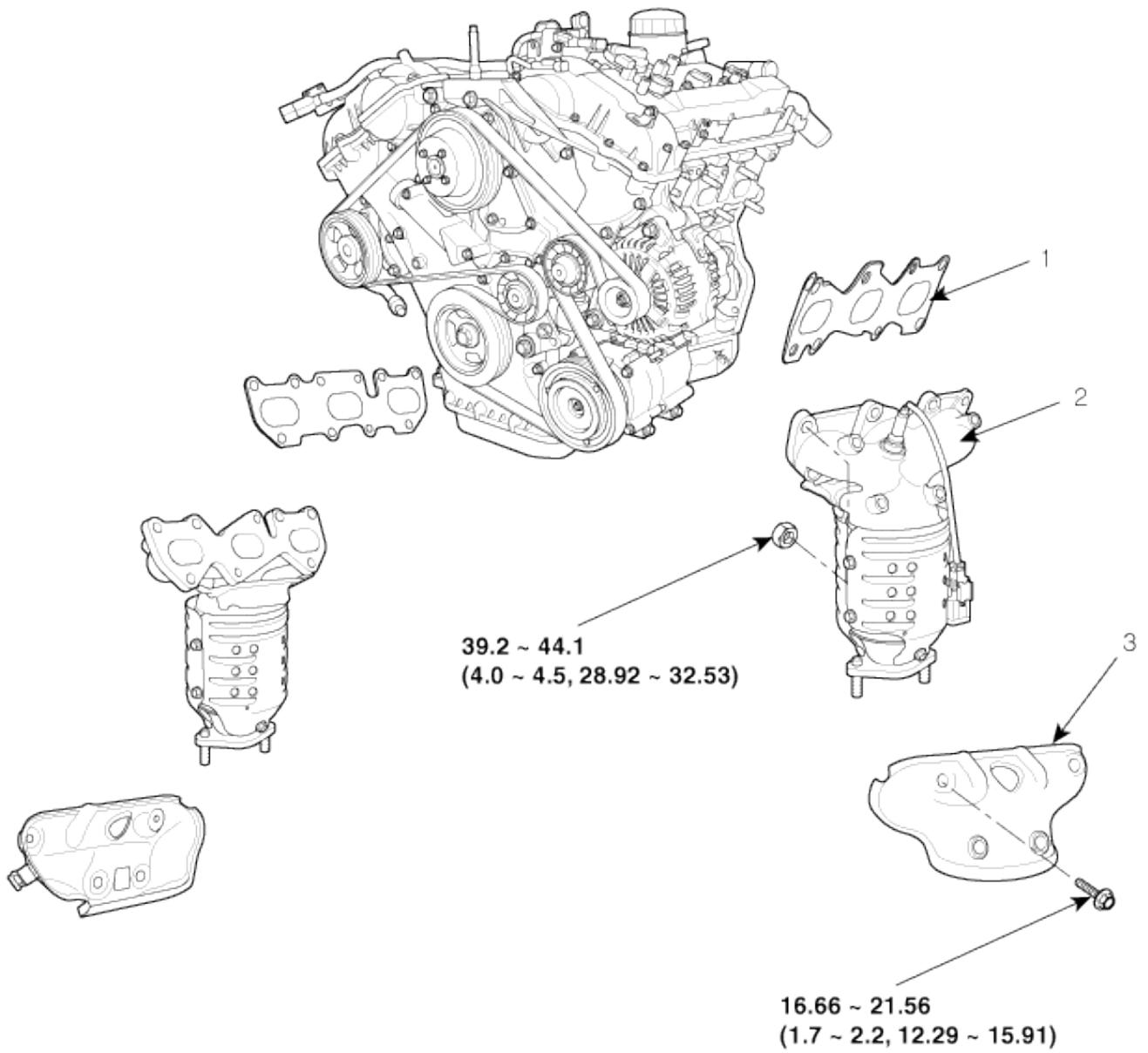
Intake and exhaust system can be disassembled without the removal of the delivery pipe(3).



**TORQUE : N.m (kgf.m, lb-ft)**

- 1. Surge tank
- 2. Surge tank gasket
- 3. Delivery pipe

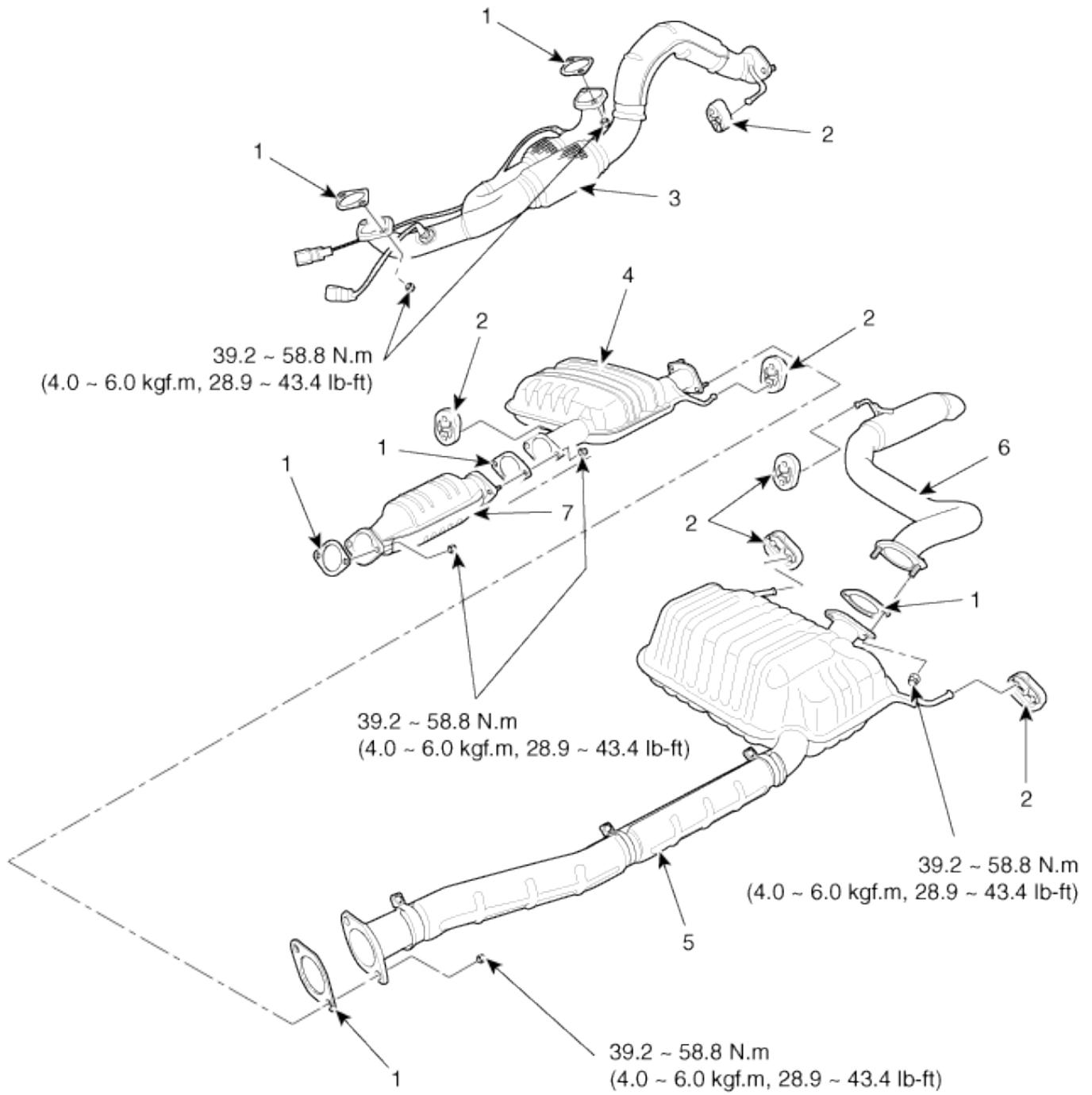
- 4. Intake manifold
- 5. Intake manifold gasket



**TORQUE : N.m (kgf.m, lb-ft)**

- 1. Gasket
- 2. Exhaust manifold

- 3. Heat protector



- 1. Gasket
- 2. Hanger
- 3. Front muffler assembly
- 4. Center muffler assembly

- 5. Main muffler assembly
- 6. Tail pipe muffler assembly
- 7. Catalytic converter assembly



## REMOVAL

### INTAKE MANIFOLD

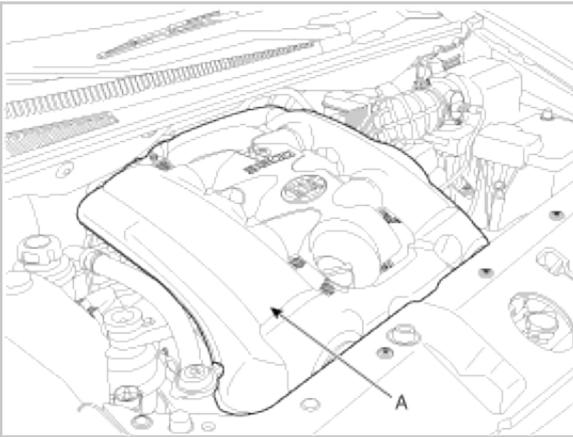
#### CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

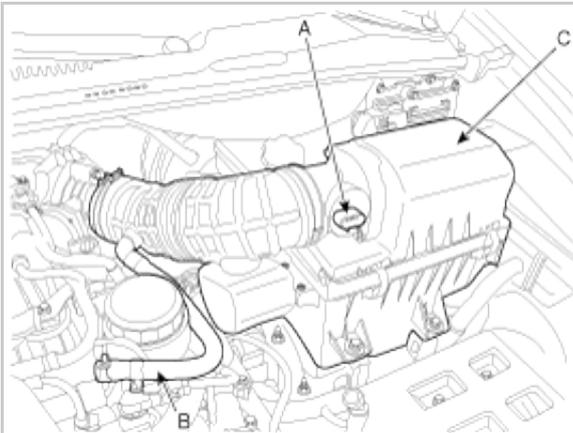
#### NOTICE

- Mark all wiring and hoses to avoid misconnection.

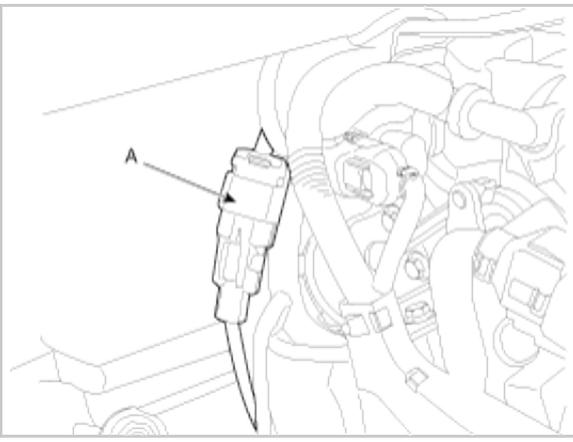
1. Remove the engine cover(A).



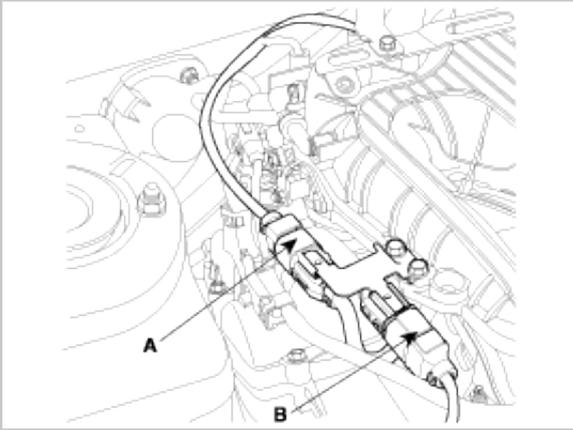
2. Remove the intake air hose and air cleaner assembly.
  - (1) Disconnect the MAF connector(A).
  - (2) Disconnect the breather hose(B) from air cleaner hose.
  - (3) Remove the intake air hose and air cleaner assembly(C).



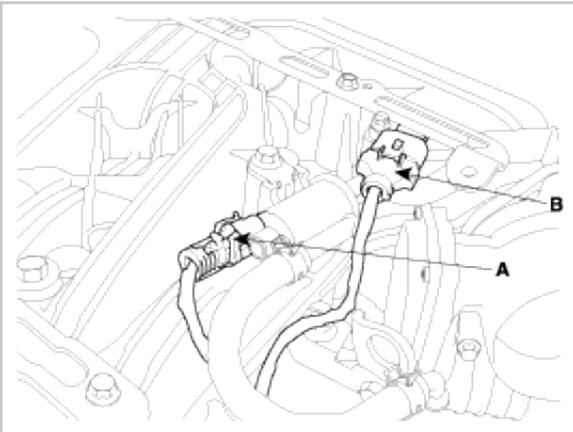
3. Disconnect RH oxygen sensor connector(A).



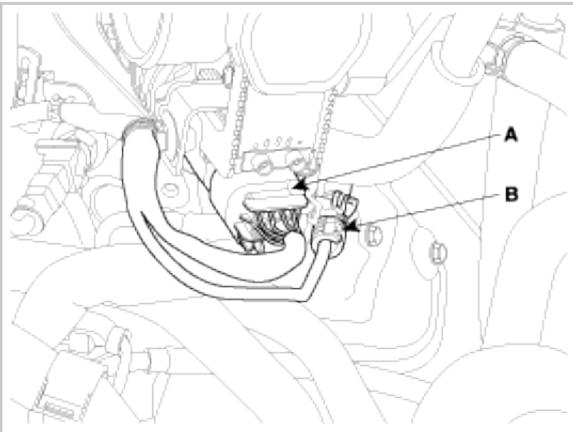
4. Disconnect RH injector connector(A) and ignition coil connector(B).



5. Disconnect PCSV connector(A), MAP sensor connector(B) and PCSV hose.



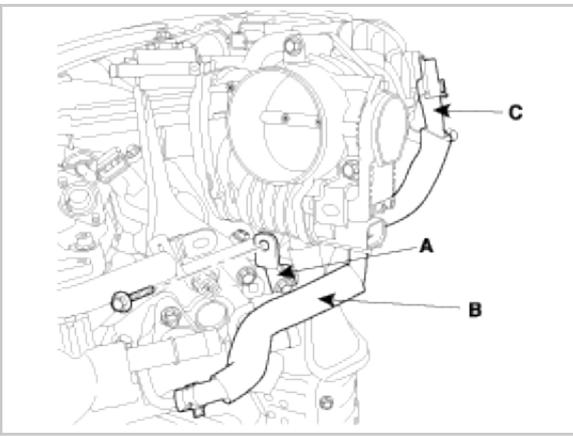
6. Disconnect ETC connector(A) and knock sensor connector(B).



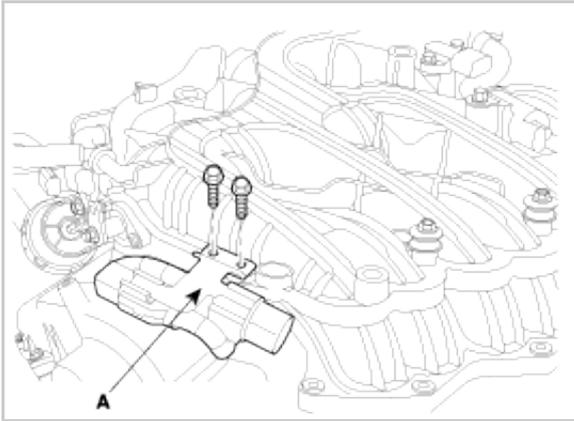
7. Remove ETC bracket(A).

8. Disconnect water hoses(B) from ETC.

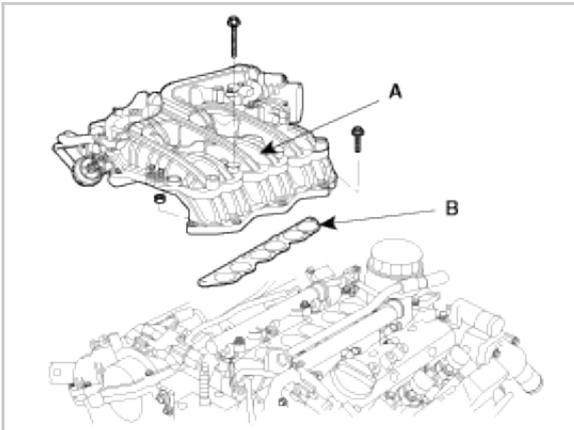
9. Disconnect PCV(C) hose.



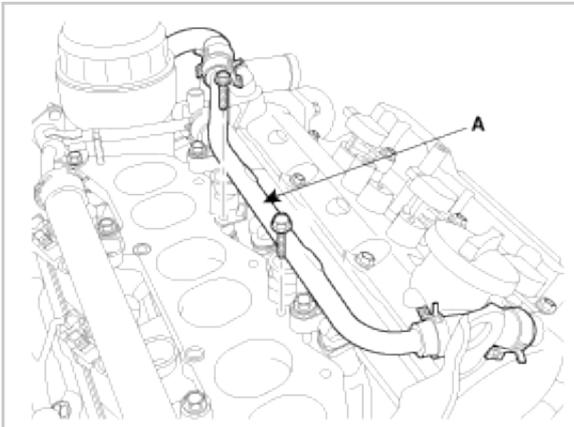
- 10. Disconnect brake vacuum hose.
- 11. Remove surge tank stay.
- 12. Remove connector bracket(A) from surge tank.



- 13. Remove surge tank(A).



- 14. Disconnect breather Pipe assembly(A).

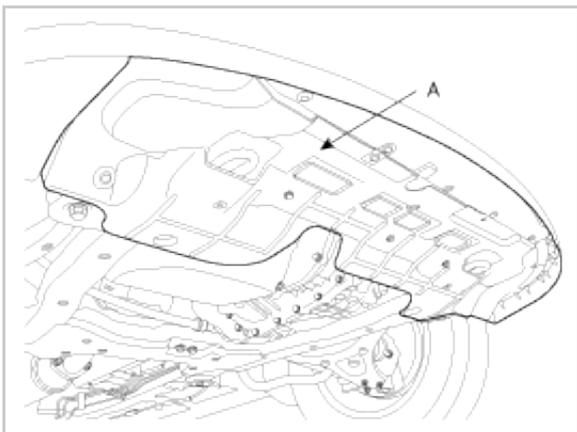


- 15. Disconnect LH injector connector.

16. Remove the delivery pipe and intake manifold together.

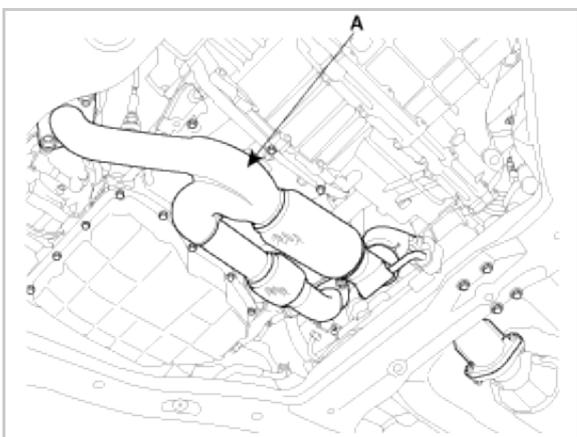
## EXHAUST MANIFOLD

1. Remove under cover(A).



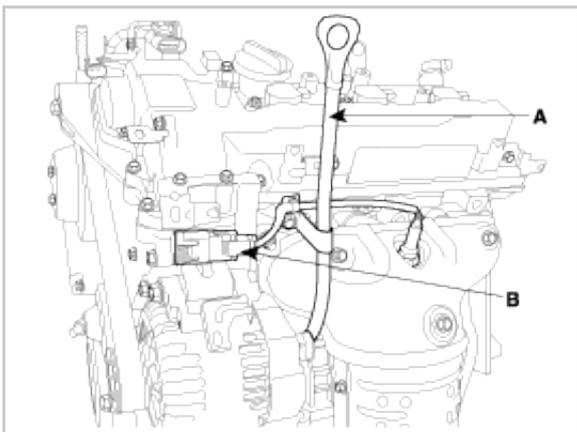
2. Disconnect LH,RH rear oxygen sensor connector from bracket.

3. Remove front muffler(A).

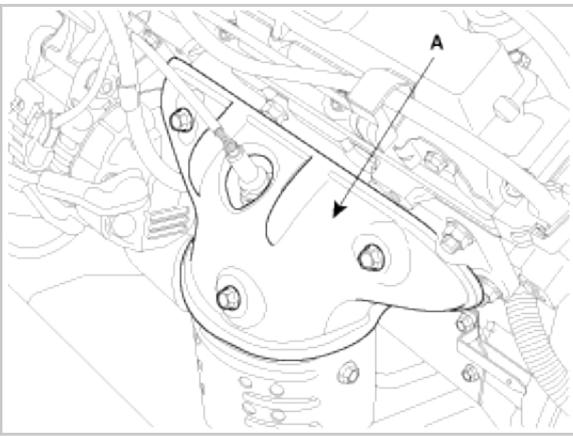


4. Remove oil level gauge(A).

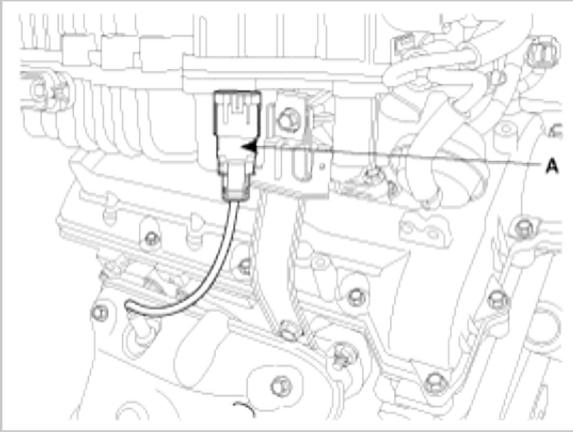
5. Disconnect LH front oxygen sensor connector(B) from bracket.



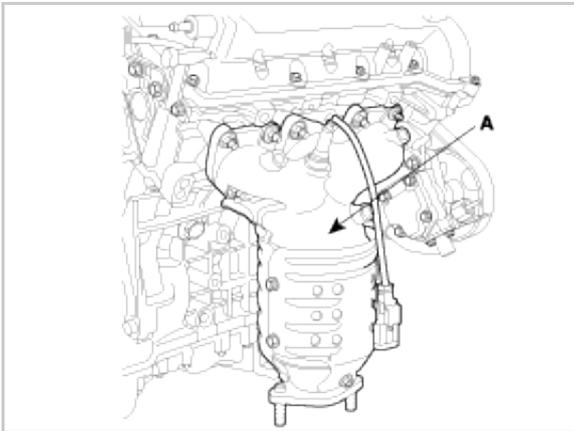
6. Remove LH heat protector(A).



7. Remove LH exhaust manifold.
8. Disconnect RH front oxygen sensor connector from bracket.



9. Remove RH heat protector.
10. Remove RH exhaust manifold.



## INSTALLATION

### INTAKE MANIFOLD

1. Install intake manifold and new gasket on the cylinder head.

Tightening torque

1st : 3.9 ~ 5.9Nm (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

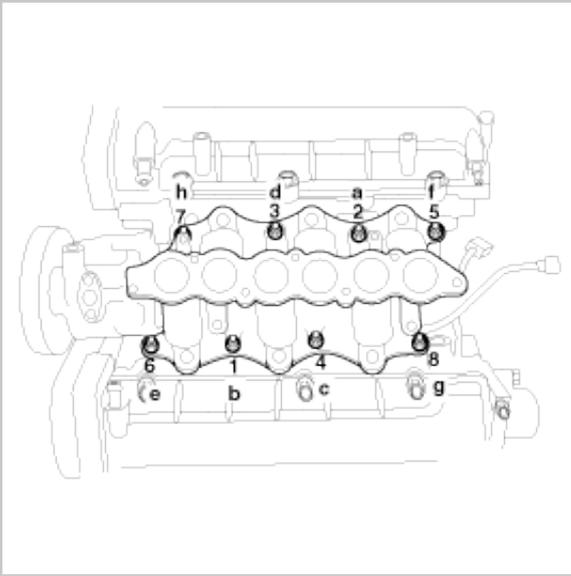
2st : 18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)

3st : Repeat 2nd step twice or more.

### NOTICE

Be careful of the installation direction.

a - h : 1st step order



2. Install delivery pipe.(Refer to FL group)
3. Connect LH injector connector.
4. Connect breather Pipe assembly.

---

Tightening torque  
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

---

5. Install surge tank.

---

Tightening torque  
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

---

6. Install connector bracket on the surge tank.

---

Tightening torque  
6.86 ~ 10.78Nm (0.7 ~ 1.1kgf.m, 5.06 ~ 7.96lb-ft)

---

7. Install surge tank stay.

---

Tightening torque  
27.44 ~ 31.36Nm (2.8 ~ 3.2kgf.m, 20.25 ~ 23.14lb-ft)

---

8. Connect brake vacuum hose.
9. Connect PCV hose.
10. Connect water hoses to ETC.
11. Install ETC bracket.

---

Tightening torque  
15.68 ~ 25.48Nm (1.6 ~ 2.6kgf.m, 11.57 ~ 18.80lb-ft)

---

12. Connect ETC connector and knock sensor connector.
13. Connect PCSV connector, MAP sensor connector and PCSV hose.
14. Connect RH injector connector and ignition coil connector.
15. Connect RH oxygen sensor connector.
16. Install air cleaner upper cover and intake hose.
17. Connect MAF(A) and breather hose.

## EXHAUST MANIFOLD

1. Install new gasket and exhaust manifold.

---

Tightening torque

39.2 ~ 44.1Nm(4.0 ~ 4.5kgf.m, 28.92 ~ 32.53lb-ft)

---

2. Install heat protector.

---

Tightening torque

3.9 ~ 5.9Nm(0.4 ~ 0.6kgf.m, 2.89 ~ 4.34lb-ft)

---

3. Install front muffler.

---

Tightening torque

39.2 ~ 58.8N.m(4.0 ~ 6.0kgf.m, 28.92 ~ 43.37lb-ft)

---

4. Connect oxygen sensor connector.

5. Install under cover.

## **CHAPTER 3:**

# **Engine Electrical System**

# **General information**

**TROUBLE SHOOTING****IGNITION SYSTEM**

Symptom	Suspect area	Remedy
Engine will not start or is hard to start (Crank OK)	Ignition lock switch Ignition coil Spark plugs Ignition wiring disconnected or broken	Inspect ignition lock switch, or replace as required Inspect ignition coil, or replace as required Inspect spark plugs, or replace as required Repair wiring, or replace as required
Rough idle or stalls	Ignition wiring Ignition coil	Repair wiring, or replace as required Inspect ignition coil, or replace as required
Engine hesitates/poor acceleration	Spark plugs and spark plug cables Ignition wiring	Inspect spark plugs / cable, or replace as required Repair wiring, or replace as required
Poor mileage	Spark plugs and spark plug cables	Inspect spark plugs / cable, or replace as required

**CHARGING SYSTEM**

Symptom	Suspect area	Remedy
Charging warning indicator does not light with ignition switch "ON" and engine off.	Fuse blown Light burned out Wiring connection loose Electronic voltage regulator	Check fuses Replace light Tighten loose connection Replace voltage regulator
Charging warning indicator does not go out with engine running. (Battery requires frequent recharging)	Drive belt loose or worn Battery cable loose, corroded or worn Electronic voltage regulator or alternator Wiring	Adjust belt tension or replace belt Inspect cable connection, repair or replace cable Replace voltage regulator or alternator Repair or replace wiring
Overcharge	Electronic voltage regulator Voltage sensing wire	Replace voltage regulator Repair or replace wiring
Discharge	Drive belt loose or worn Wiring connection loose or short circuit Electronic voltage regulator or alternator Poor grounding Worn battery	Adjust belt tension or replace belt Inspect wiring connection, repair or replace wiring Replace voltage regulator or alternator Inspect ground or repair Replace battery

**STARTING SYSTEM**

Symptom	Suspect area	Remedy
Engine will not crank	Battery charge low Battery cables loose, corroded or worn out Transaxle range switch (Vehicle with automatic transaxle only) Fuse blown Starter motor faulty Ignition switch faulty	Charge or replace battery Repair or replace cables Refer to TR group-automatic transaxle Replace fuse Replace Replace
Engine cranks slowly	Battery charge low Battery cables loose, corroded or worn out Starter motor faulty	Charge or replace battery Repair or replace cables Replace
Starter keeps running	Starter motor	Replace

	Ignition switch	Replace
Starter spins but engine will not crank	Short in wiring Pinion gear teeth broken or starter motor Ring gear teeth broken	Repair wiring Replace Replace fly wheel or torque converter

**SPECIFICATION****IGNITION SYSTEM**

Items			Specification( 3.8L)
Ignition coil	Primary resistance		0.62 ± 10 % (Ω)
	Secondary resistance		7.0 ± 15 % (kΩ)
Spark plugs	Unleaded	NGK	IFR5G-11
		Gap	1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)

**STARTING SYSTEM**

Items			Specification
			3.8L
Starter	Rated voltage		12 V, 1.4 kW
	No. of pinion teeth		8
	No-load characteristics	Voltage	11.5 V
		Ampere	85A, MAX
Speed		2,600 rpm, MIN	

**CHARGING SYSTEM**

Items			Specification
			/ 3.8L
Alternator	Type		Battery voltage sensing
	Rate voltagea		13.5V, 130A
	Speed in use		1,000 ~ 18,000 rpm
	Voltage regulator		IC regulator built-in type
	Regulator setting voltage		14.2 ~ 14.8V
	Temperature compensation		-4 ± 4 mV / °C
Battery	Type		MF 68AH(3.3L) / MF 80AH(3.8L)
	Cold cranking amperage [at -18°C(-0.4°F)]		600 A(3.3L) / 630 A(3.8L)
	Reserve capacity		110 min(3.3L) / 130 min(3.8L)
	Specific gravity [at 20°C(68°F)]		1.280 ± 0.01

**NOTICE**

- COLD CRANKING AMPERAGE is the amperage a battery can deliver for 30 seconds and maintain a terminal voltage of 7.2V or greater at a specified temperature.
- RESERVE CAPACITY RATING is amount of time a battery can deliver 25A and maintain a minimum terminal voltage of 10.5V at 26.7°C(80.1°F).

**AUTO CRUISE CONTROL SYSTEM**

Items	Specification
Setting error	Within ± 1.5Km/h on level road
Vehicle speed memory variation	No variation

Setting time	0.1sec max
Resuming time	0.1sec max.
Minimum operating speed	40 ± 2Km/h
Cancel speed range	15 ± 2Km/h
Maximum memorized speed	160 ± 2Km/h
Pulling force	127N(13Kgf)
Main switch serial resistance value	3.9kΩ ± 1%
Command switch serial resistance value	SET switch : 220Ω ± 1%
	RESUME switch : 910Ω ± 1%

# Ignition System



## DESCRIPTION

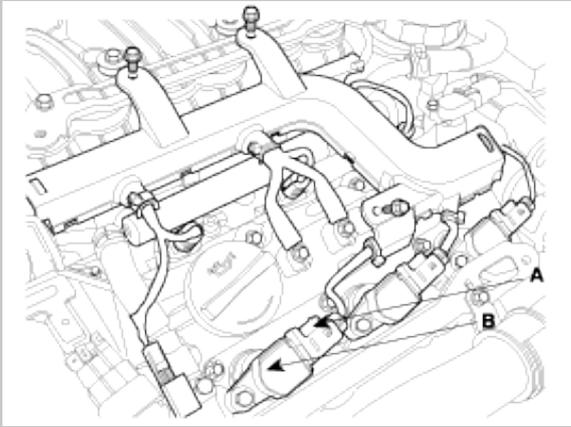
Ignition timing is controlled by the electronic control ignition timing system. The standard reference ignition timing data for the engine operating conditions are preprogrammed in the memory of the ECM (Engine Control Module). The engine operating conditions (speed, load, warm-up condition, etc.) are detected by the various sensors. Based on these sensor signals and the ignition timing data, signals to interrupt the primary current are sent to the ECM. The ignition coil is activated, and timing is controlled.



## REMOVAL

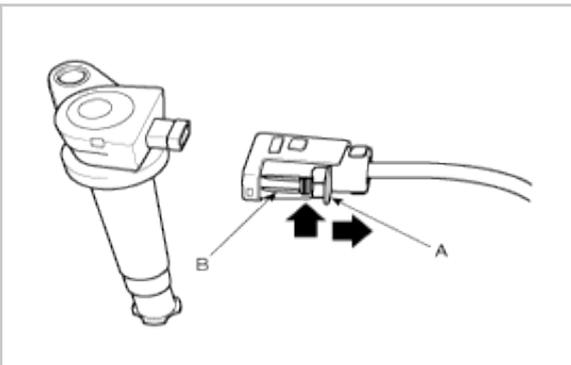
### IGNITION COIL

1. Remove the engine cover.
2. Disconnect the ignition coil connector(A).



#### NOTICE

When removing the ignition coil connector, pull the lock pin(A) and push the clip(B).

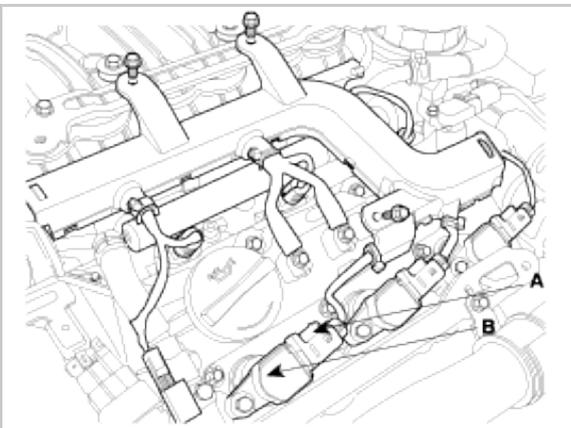


3. Remove the ignition coil (B).
4. Installation is the reverse of removal.

## ON-VEHICLE INSPECTION

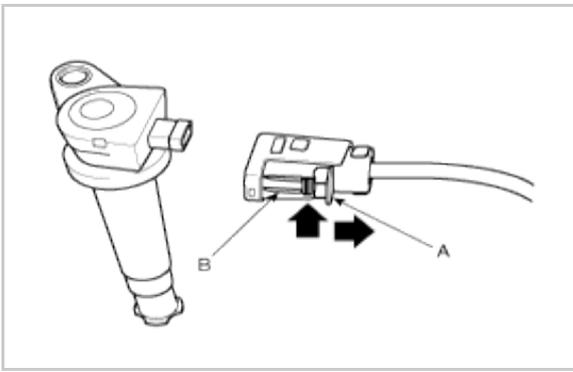
### SPARK TEST

1. Remove the ignition coil connector(A).

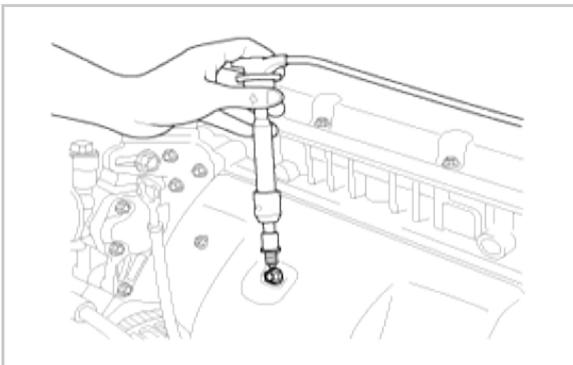


#### NOTICE

When removing the ignition coil connector, pull the lock pin (A) and push the clip(B).



2. Remove bolt holding down the ignition coil.
3. Remove ignition coil from engine.
4. Using a spark plug socket, remove the spark plug.
5. Attach the spark plug to the ignition coil.
6. Reconnect ignition coil harness connector to ignition coil.
7. Ground the spark plug to the engine.

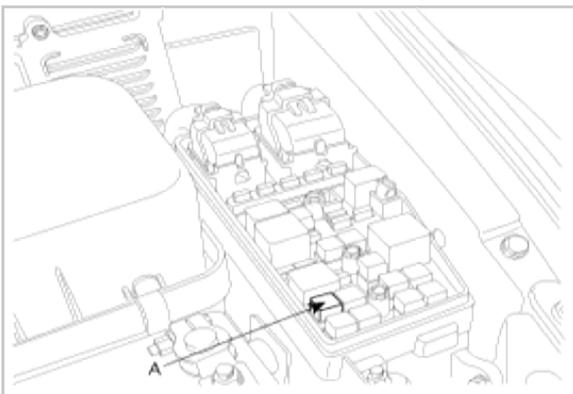


8. Check if spark occurs while engine is being cranked.

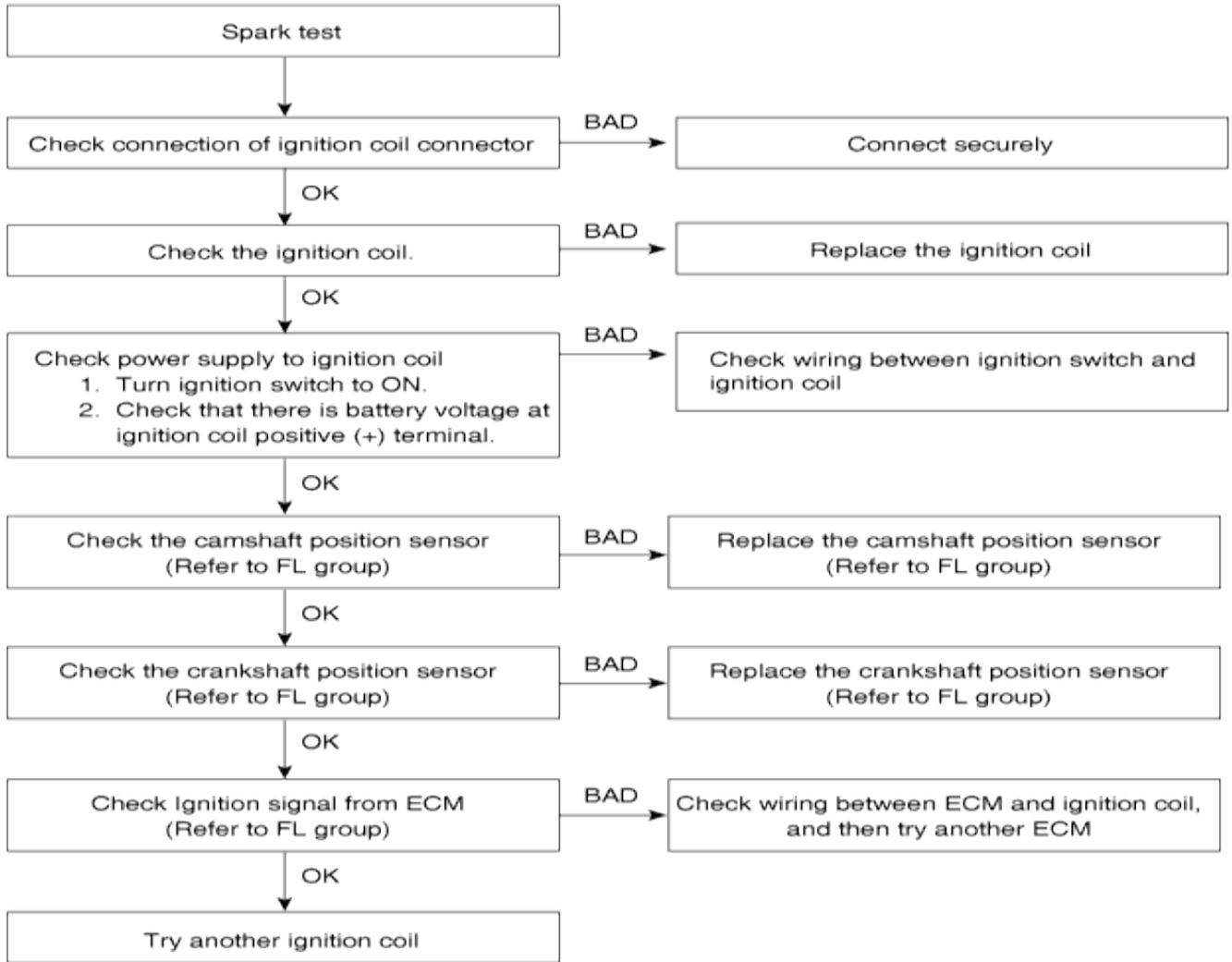
#### NOTICE

To prevent fuel being injected from injectors while the engine is being cranked, remove the fuel pump relay(A) from the fuse box.

Crank the engine for no more than 5 ~ 10 seconds.

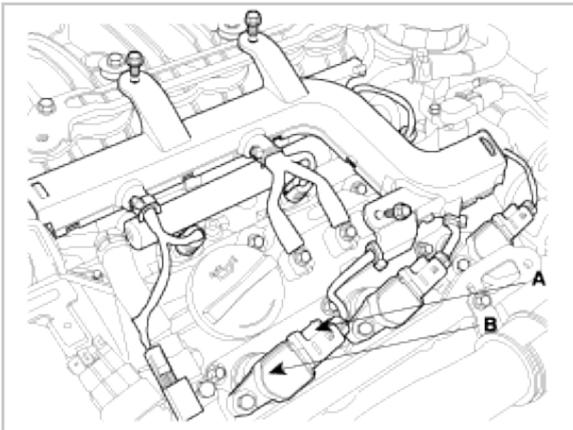


9. Continue to inspect other cylinders of suspected 'no spark' concerns.
10. Install in the reverse order of testing and removal.

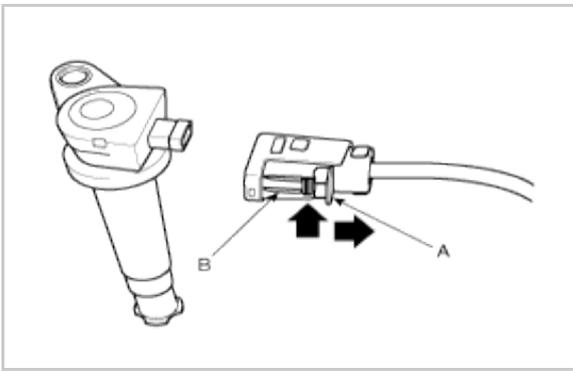


## INSPECT SPARK PLUG

1. Remove the ignition coil connector(A).



**NOTICE**  
 When removing the ignition coil connector, pull the lock pin(A) and push the clip(B).

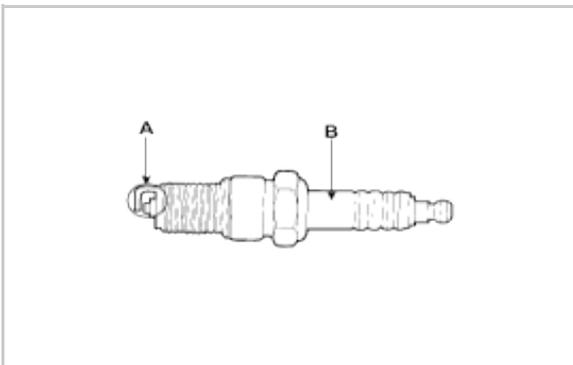


2. Remove the ignition coil(B).
3. Using a spark plug socket, remove the spark plug.

**CAUTION**

Be careful that no contaminants enter through the spark plug holes.

4. Inspect the electrodes (A) and ceramic insulator (B).

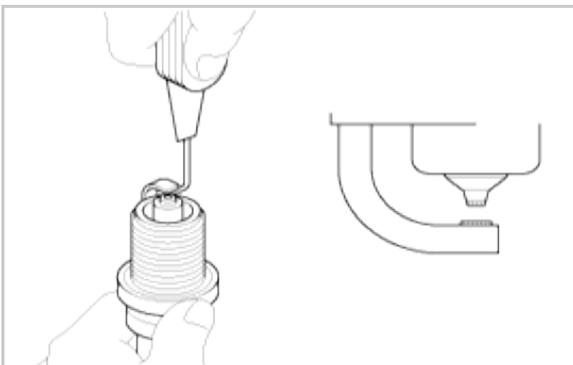


**INSPECTION OF ELECTRODES**

Condition	Dark deposits	White deposits
Description	a. Fuel mixture too rich b. Low air intake	a. Fuel mixture too lean b. Advanced ignition timing c. Insufficient plug tightening torque

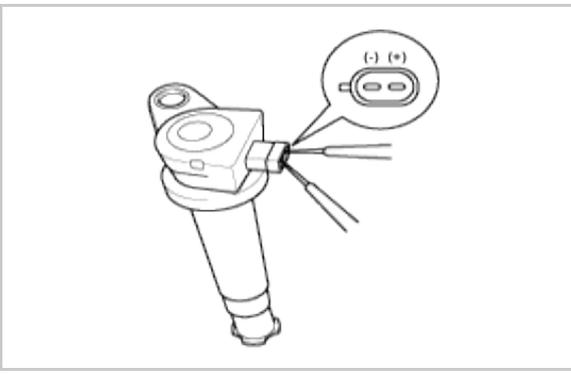
5. Check the electrode gap (A).

Standard :  
 Unleaded : 1.0 ~ 1.1 mm (0.0394 ~ 0.0433 in.)



**INSPECT IGNITION COIL**

1. Measure the primary coil resistance between terminals (+) and (-).



---

Standard value:  $0.62\Omega \pm 10\%$

---

# Charging System



## DESCRIPTION

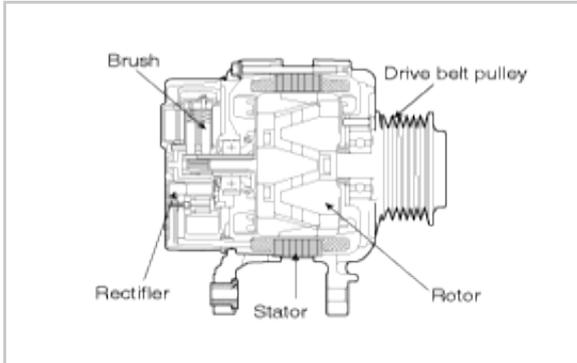
The charging system included a battery, an alternator with a built-in regulator, and the charging indicator light and wire.

The Alternator has built-in diodes, each rectifying AC current to DC current.

Therefore, DC current appears at alternator "B" terminal.

In addition, the charging voltage of this alternator is regulated by the battery voltage detection system.

The alternator is regulated by the battery voltage detection system. The main components of the alternator are the rotor, stator, rectifier, capacitor brushes, bearings and V-ribbed belt pulley. The brush holder contains a built-in electronic voltage regulator.





## ON-VEHICLE INSPECTION

### CAUTION

- a. Check that the battery cables are connected to the correct terminals.
- b. Disconnect the battery cables when the battery is given a quick charge.
- c. Never disconnect the battery while the engine is running.

### CHECK BATTERY VOLTAGE

1. If 20 minutes have not passed since the engine was stopped, turn the ignition switch ON and turn on the electrical system (headlamp, blower motor, rear defogger etc.) for 60 seconds to remove the surface charge.
2. Turn the ignition switch OFF and turn off the electrical systems.
3. Measure the battery voltage between the negative (-) and positive (+) terminals of the battery.

---

Standard voltage : 12.5 ~ 12.9V at 20°C(68°F)

---

If the voltage is less than specification, charge the battery.

### CHECK THE BATTERY TERMINALS AND FUSES

1. Check that the battery terminals are not loose or corroded.
2. Check the fuses for continuity.

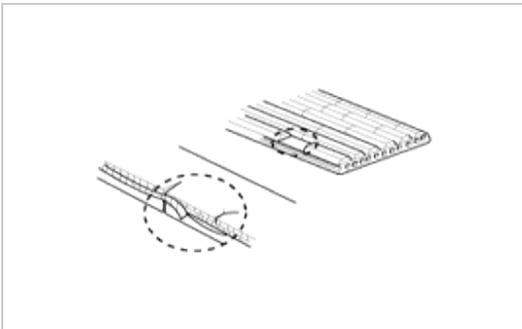
### INSPECT DRIVE BELT

Visually check the belt for excessive wear, frayed cords etc.

If any defect has been found, replace the drive belt.

### NOTICE

Cracks on the rib side of a belt are considered acceptable. If the belt has chunks missing from the ribs, it should be replaced.



### VISUALLY CHECK ALTERNATOR WIRING AND LISTEN FOR ABNORMAL NOISES

1. Check that the wiring is in good condition.
2. Check that there is no abnormal noise from the alternator while the engine is running.

### CHECK DISCHARGE WARNING LIGHT CIRCUIT

1. Warm up the engine and then turn it off.
2. Turn off all accessories.
3. Turn the ignition switch "ON". Check that the discharge warning light is lit.
4. Start the engine. Check that the light is lit.  
If the light does not go off as specified, troubleshoot the discharge light circuit.

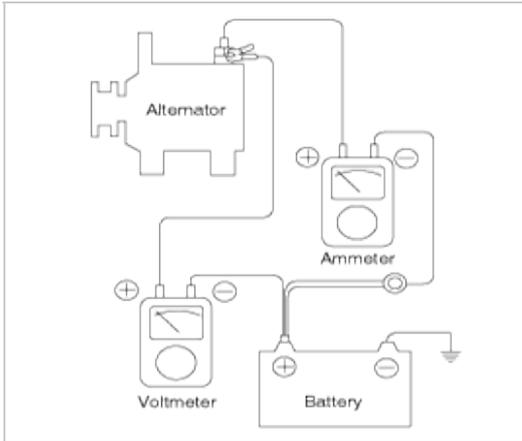
### INSPECT CHARGING SYSTEM

#### VOLTAGE DROP TEST OF ALTERNATOR OUTPUT WIRE

This test determines whether or not the wiring between the alternator "B" terminal and the battery (+) terminal is good by the voltage drop method.

#### PREPARATION

1. Turn the ignition switch to "OFF".
2. Disconnect the output wire from the alternator "B" terminal. Connect the (+) lead wire of ammeter to the "B" terminal of alternator and the (-) lead wire of ammeter to the output wire. Connect the (+) lead wire of voltmeter to the "B" terminal of alternator and the (-) lead wire of voltmeter to the (+) terminal of battery.



## TEST

1. Start the engine.
2. Turn on the headlamps and blower motor, and set the engine speed until the ammeter indicates 20A. And then, read the voltmeter at this time.

## RESULT

1. The voltmeter may indicate the standard value.

---

Standard value: 0.2V max

---

2. If the value of the voltmeter is higher than expected (above 0.2V max.), poor wiring is suspected. In this case check the wiring from the alternator "B" terminal to the battery (+) terminal. Check for loose connections, color change due to an over-heated harness, etc. Correct them before testing again.
3. Upon completion of the test, set the engine speed at idle. Turn off the headlamps, blower motor and the ignition switch.

## OUTPUT CURRENT TEST

This test determines whether or not the alternator gives an output current that is equivalent to the normal output.

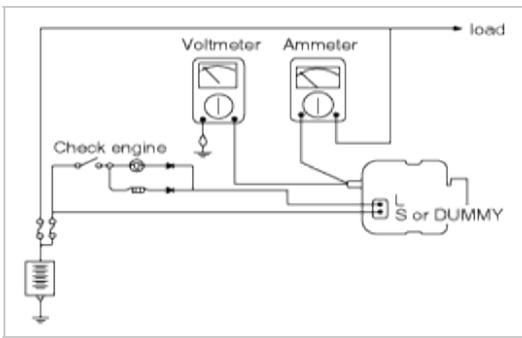
### PREPARATION

1. Prior to the test, check the following items and correct as necessary.  
Check the battery installed in the vehicle to ensure that it is good condition. The battery checking method is described in the section "Battery".  
The battery that is used to test the output current should be one that has been partially discharged. With a fully charged battery, the test may not be conducted correctly due to an insufficient load.  
Check the tension of the alternator drive belt. The belt tension check method is described in the section "Inspect drive belt".
2. Turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Disconnect the alternator output wire from the alternator "B" terminal.
5. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Be sure to connect the (-) lead wire of the ammeter to the disconnected output wire.

### NOTICE

Tighten each connection securely, as a heavy current will flow. Do not rely on clips.

6. Connect a voltmeter (0 to 20V) between the "B" terminal and ground. Connect the (+) lead wire to the alternator "B" terminal and (-) lead wire to a good ground.
7. Attach an engine tachometer and connect the battery ground cable.
8. Leave the engine hood open.



## TEST

1. Check to see that the voltmeter reads as the same value as the battery voltage. If the voltmeter reads 0V, and the open circuit in the wire between alternator "B" terminal and battery (-) terminal or poor grounding is suspected.
2. Start the engine and turn on the headlamps.
3. Set the headlamps to high beam and the heater blower switch to HIGH, quickly increase the engine speed to 2,500 rpm and read the maximum output current value indicated by the ammeter.

### NOTICE

After the engine start up, the charging current quickly drops. Therefore, the above operation must be done quickly to read the maximum current value correctly.

## RESULT

1. The ammeter reading must be higher than the limit value. If it is lower but the alternator output wire is in good condition, remove the alternator from the vehicle and test it.

---

Limit value : 70% of the rated current

---

### NOTICE

- a. The nominal output current value is shown on the nameplate affixed to the alternator body.
- b. The output current value changes with the electrical load and the temperature of the alternator itself. Therefore, the nominal output current may not be obtained. If such is the case, keep the headlamps on the cause discharge of the battery, or use the lights of another vehicle to increase the electrical load. The nominal output current may not be obtained if the temperature of the alternator itself or ambient temperature is too high. In such a case, reduce the temperature before testing again.

2. Upon completion of the output current test, lower the engine speed to idle and turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Remove the ammeter and voltmeter and the engine tachometer.
5. Connect the alternator output wire to the alternator "B" terminal.
6. Connect the battery ground cable.

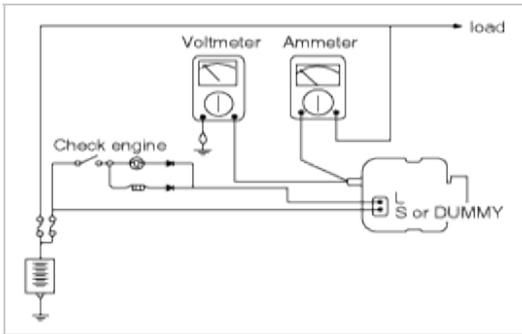
## REGULATED VOLTAGE TEST

The purpose of this test is to check that the electronic voltage regulator controls voltage correctly.

## PREPARATION

1. Prior to the test, check the following items and correct if necessary.
  - Check that the battery installed on the vehicle is fully charged. The battery checking method is described in the section "Battery".
  - Check the alternator drive belt tension. The belt tension check method is described in the section "Inspect drive belt".
2. Turn ignition switch to "OFF".
3. Disconnect the battery ground cable.
4. Connect a digital voltmeter between the "B" terminal of the alternator and ground. Connect the (+) lead of the voltmeter to the "B" terminal of the alternator. Connect the (-) lead to good ground or the battery (-) terminal.
5. Disconnect the alternator output wire from the alternator "B" terminal.

6. Connect a DC ammeter (0 to 150A) in series between the "B" terminal and the disconnected output wire. Connect the (-) lead wire of the ammeter to the disconnected output wire.
7. Attach the engine tachometer and connect the battery ground cable.



## TEST

1. Turn on the ignition switch and check to see that the voltmeter indicates the following value.

Voltage: Battery voltage

If it reads 0V, there is an open circuit in the wire between the alternator "B" terminal and the battery and the battery (-) terminal.

2. Start the engine. Keep all lights and accessories off.
3. Run the engine at a speed of about 2,500 rpm and read the voltmeter when the alternator output current drops to 10A or less

## RESULT

1. If the voltmeter reading agrees with the value listed in the regulating voltage table below, the voltage regulator is functioning correctly. If the reading is other than the standard value, the voltage regulator or the alternator is faulty.

### REGULATING VOLTAGE TABLE

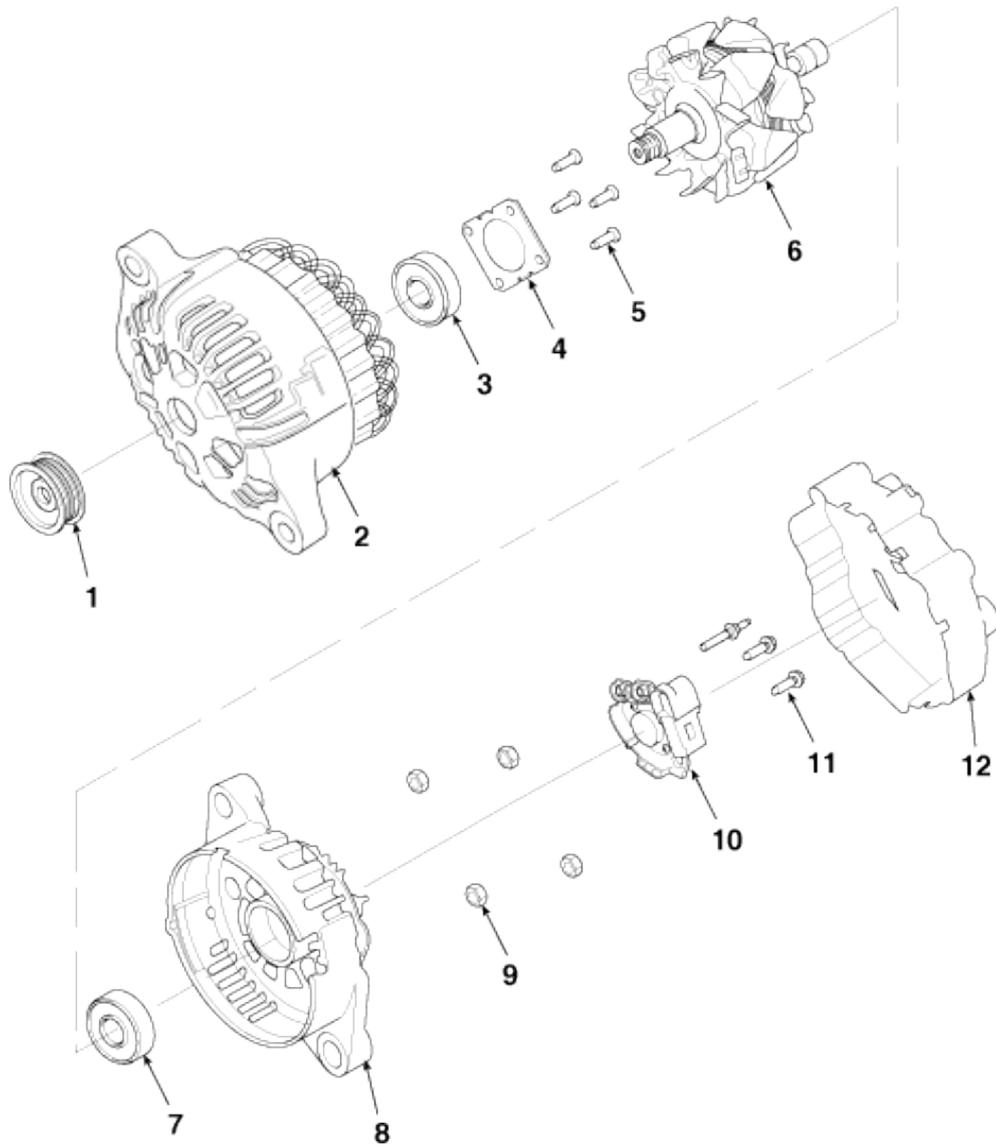
Voltage regulator ambient temperature °C (°F)	Regulating voltage (V)
-20 (-4)	14.2 ~ 15.4
20 (68)	14.0 ~ 15.0
60 (140)	13.7 ~ 14.9
80 (176)	13.5 ~ 14.7

2. Upon completion of the test, reduce the engine speed to idle, and turn off the ignition switch.
3. Disconnect the battery ground cable.
4. Remove the voltmeter and ammeter and the engine tachometer.
5. Connect the alternator output wire to the alternator "B" terminal.
6. Connect the battery ground cable.

# Alternator



## COMPONENT



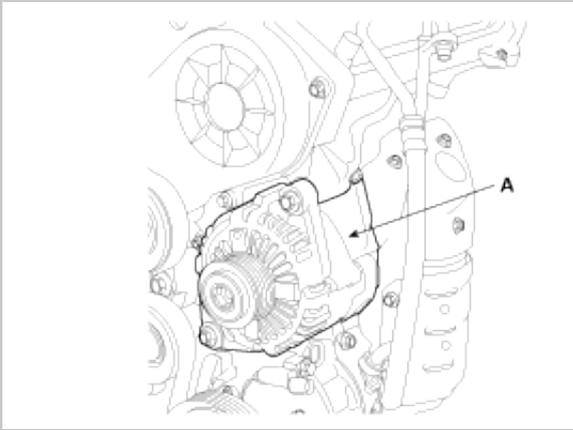
1. Pulley
2. Front bracket
3. Front bearing
4. Bearing cover
5. Bearing cover bolt
6. Rotor coil

7. Rear bearing
8. Rear bracket
9. Nut
10. Brush holder assembly
11. Brush holder bolt
12. Rear cover



## REMOVAL

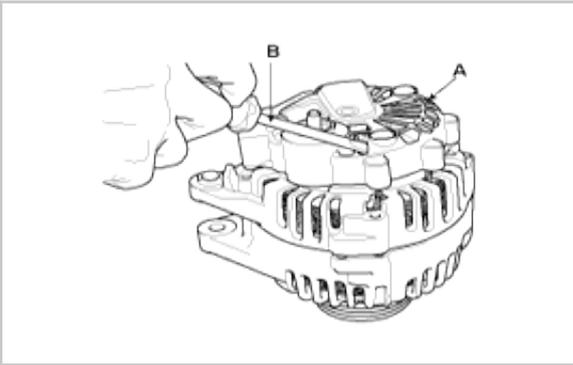
1. Disconnect the battery negative terminal first, then the positive terminal.
2. Disconnect the alternator connector, and remove the cable from alternator "B" terminal.
3. Remove the drive belt.
4. Pull out the through bolt and then remove the alternator(A).



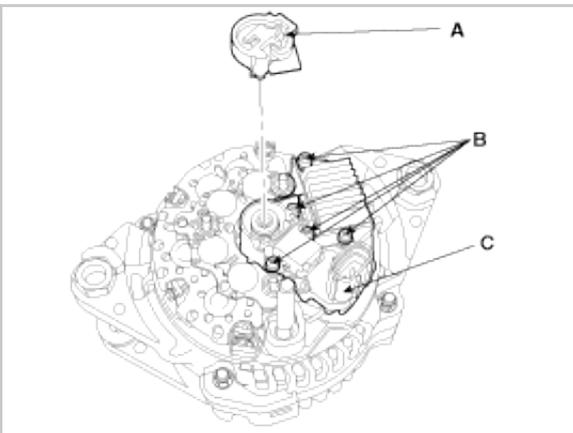
5. Installation is the reverse of removal.

## DISASSEMBLY

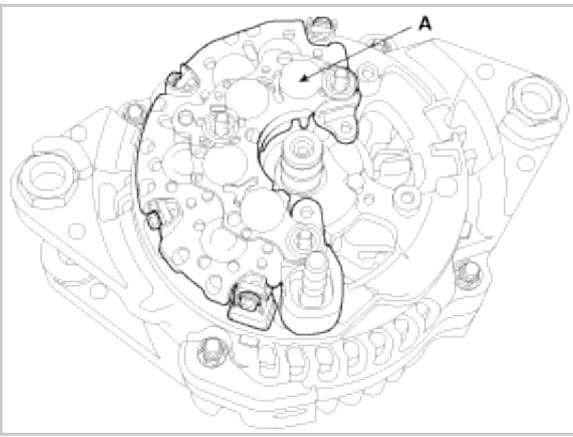
1. Remove the alternator cover(A) using a screw driver(B).



2. Remove the slip ring guide(A).
3. Loosen the mounting bolts(B) and disconnect the brush holder assembly(C).



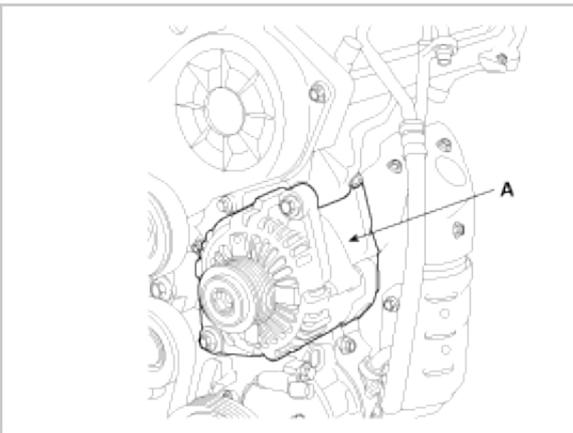
4. Remove the rectifier(A) with 4 screws.



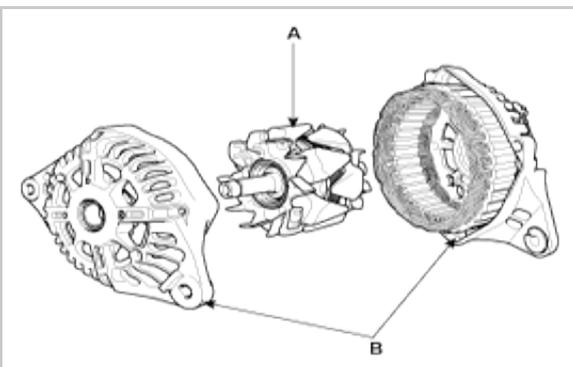
5. Remove the nut, pulley(A) and spacer.



6. Loosen the 4 through bolts(A).



7. Disconnect the rotor(A) and cover(B).

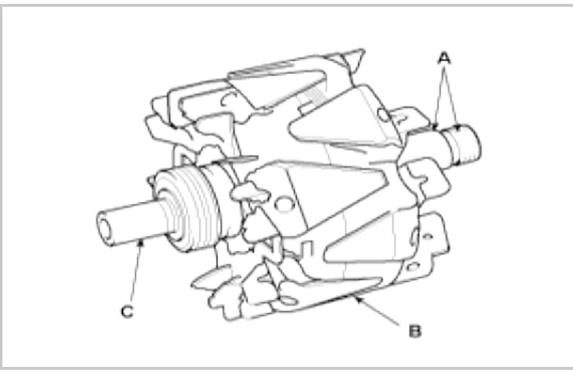


8. Reassembly is the reverse order of disassembly.

## INSPECTION

### INSPECT ROTOR

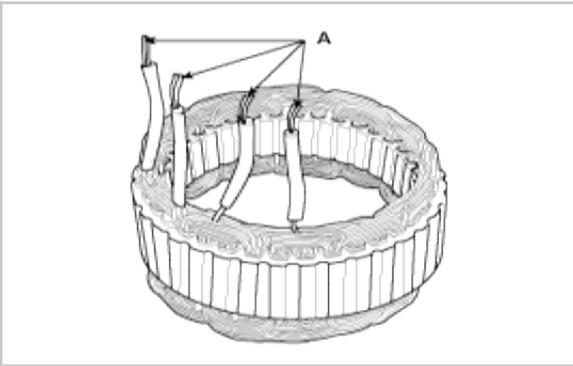
1. Check that there is continuity between the slip rings (A).



2. Check that there is no continuity between the slip rings and the rotor (B) or rotor shaft (C).
3. If the rotor fails either continuity check, replace the alternator.

## INSPECT STATOR

1. Check that there is continuity between each pair of leads (A).



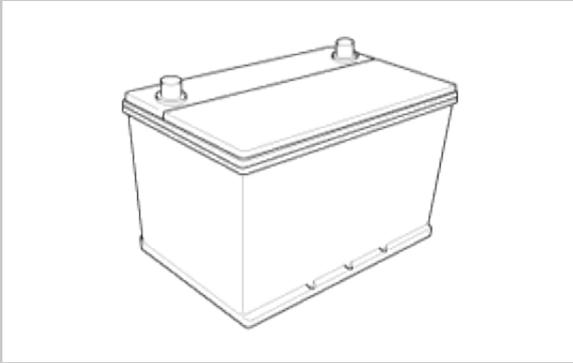
2. Check that there is no continuity between each lead and the coil core.
3. If the coil fails either continuity check, replace the alternator.

# Battery



## DESCRIPTION

1. The maintenance-free battery is, as the name implies, totally maintenance free and has no removable battery cell caps.
2. Water never needs to be added to the maintenance-free battery.
3. The battery is completely sealed, except for small vent holes in the cover.

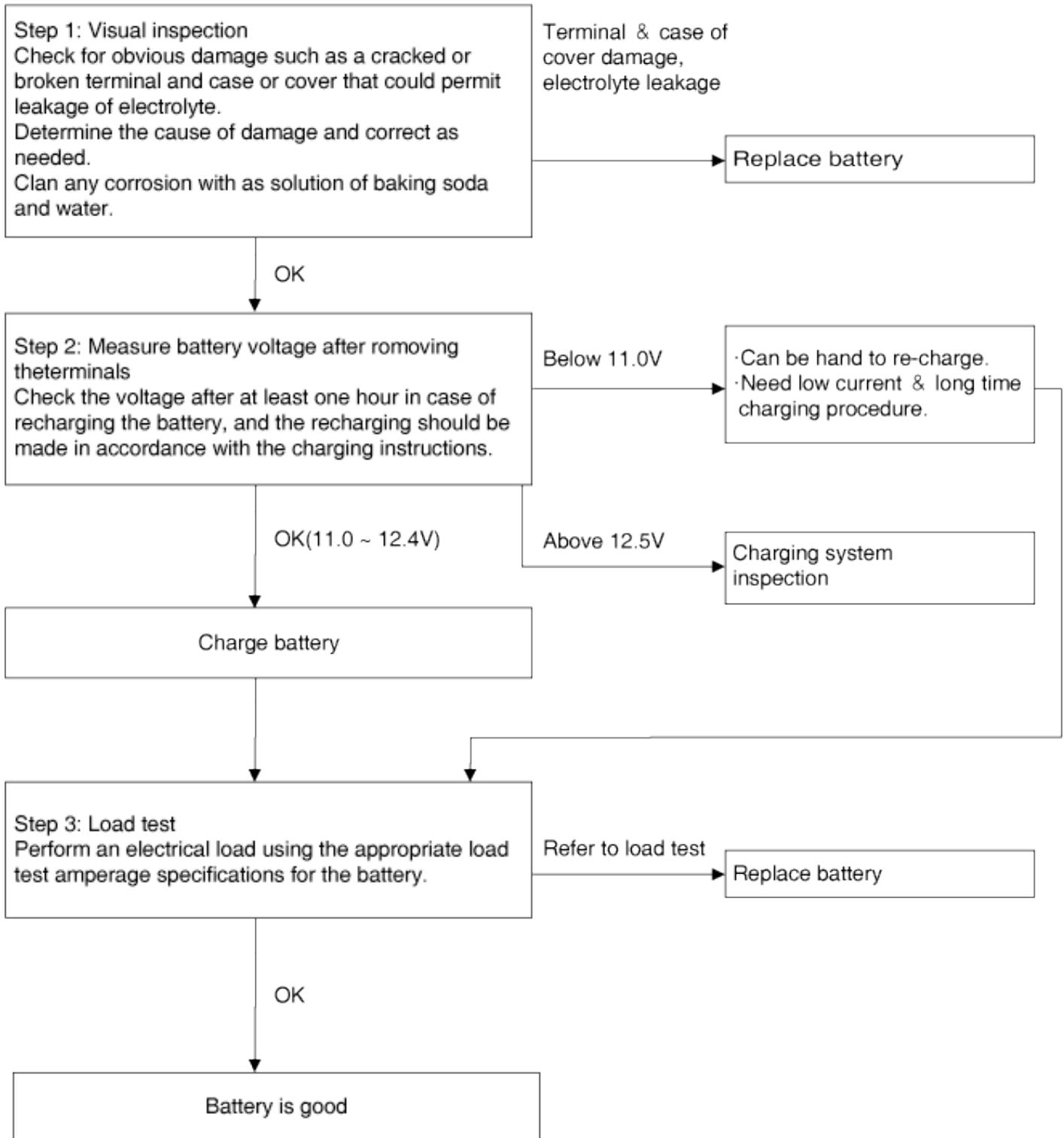




## INSPECTION

### BATTERY DIAGNOSTIC TEST (1)

#### CHECKING FLOW



### LOAD TEST

1. Perform the following steps to complete the load test procedure for maintenance free batteries.
2. Connect the load tester clamps to the terminals and proceed with the test as follow:

- (1) If the battery has been on charge, remove the surface charge by connect a 300ampere load for 15 seconds.
- (2) Connect the voltmeter and apply the specified load.
- (3) Read the voltage after the load has been applied for 15 seconds.
- (4) Disconnect the load.
- (5) Compare the voltage reading with the minimum and replace the battery if battery test voltage is below that shown in the voltage table.

Voltage	Temperature
9.6V	20°C (68.0°F) and above
9.5V	16°C (60.8°F)
9.4V	10°C (50.0°F)
9.3V	4°C (39.2°F)
9.1V	-1°C (30.2°F)
8.9V	-7°C (19.4°F)
8.7V	-12°C (10.4°F)
8.5V	-18°C (-0.4°F)

#### NOTICE

- a. If the voltage is greater shown in the table, the battery is good.
- b. If the voltage is less than shown in the table, replace the battery.

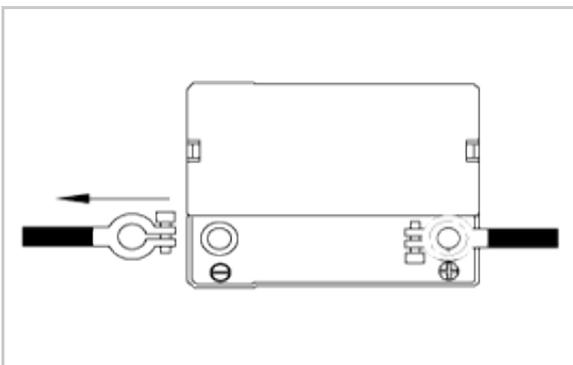
## BATTERY DIAGNOSTIC TEST (2)

1. Make sure the ignition switch and all accessories are in the OFF position.
2. Disconnect the battery cables (negative first).
3. Remove the battery from the vehicle.

#### CAUTION

Care should be taken in the event the battery case is cracked or leaking, to protect your skin from the electrolyte.

Heavy rubber gloves (not the household type) should be wore when removing the battery.



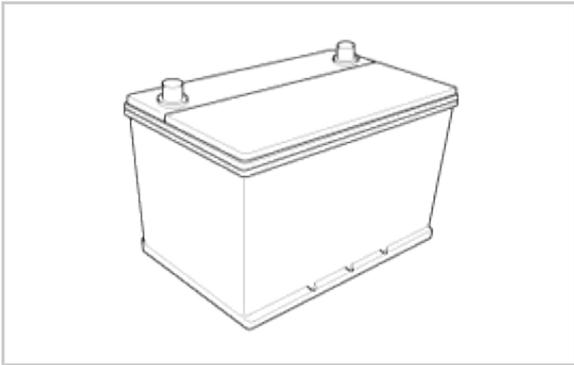
4. Inspect the battery tray for damage caused by the loss of electrolyte. If acid damage is present, it will be necessary to clean the area with a solution of clean warm water and baking soda. Scrub the area with a stiff brush and wipe off with a cloth moistened with baking soda and water.
5. Clean the top of the battery with the same solution as described above.
6. Inspect the battery case and cover for cracks. If cracks are present, the battery must be replaced.
7. Clean the battery posts with a suitable battery post tool.

8. Clean the inside surface of the terminal clamps with a suitable battery cleaning tool. Replace damaged or frayed cables and broken terminal clamps.
9. Install the battery in the vehicle.
10. Connect the cable terminals to the battery post, making sure tops of the terminals are flush with the tops of the posts.
11. Tighten the terminal nuts securely.
12. Coat all connections with light mineral grease after tightening.

**CAUTION**

When batteries are being charged, an explosive gas forms beneath the cover of each cell. Do not smoke near batteries being charged or which have recently been charged. Do not break live circuit at the terminals of batteries being charged.

A spark will occur when the circuit is broken. Keep open flames away from battery.



# Starting System

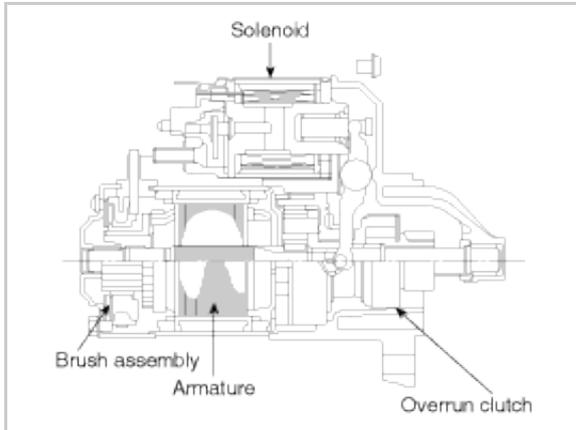


## DESCRIPTION

The starting system includes the battery, starter, solenoid switch, ignition switch, inhibitor switch (A/T), ignition lock switch, connection wires and the battery cable.

When the ignition key is turned to the start position, current flows and energizes the starter motor's solenoid coil. The solenoid plunger and clutch shift lever are activated, and the clutch pinion engages the ring gear.

The contacts close and the starter motor cranks. In order to prevent damage caused by excessive rotation of the starter armature when the engine starts, the clutch pinion gear overruns.



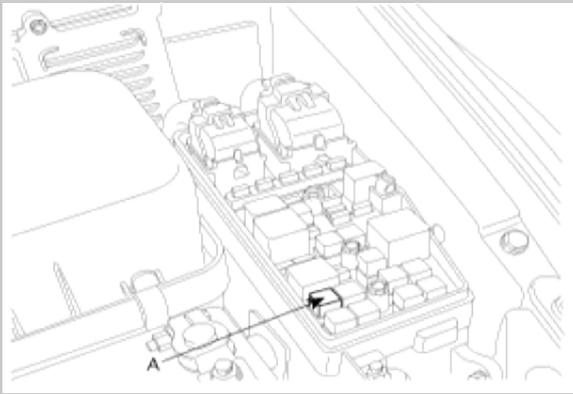


## STARTER CIRCUIT TROUBLESHOOTING

### NOTICE

The battery must be in good condition and fully charged.

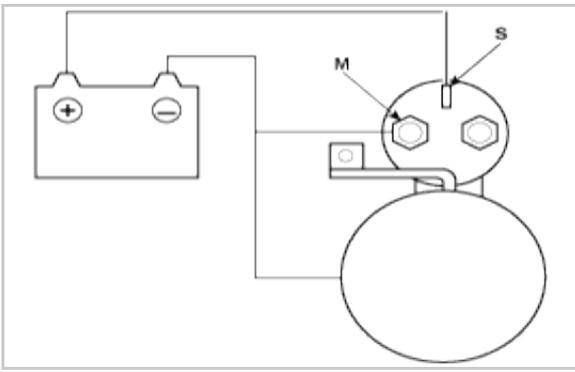
1. Remove the fuel pump relay(A) from the fuse box.



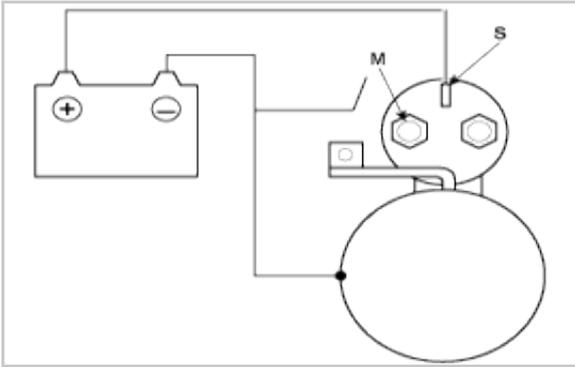
2. With the shift lever in N or P (A/T) or clutch pedal pressed (M/T), turn the ignition switch to "START"  
If the starter normally cranks the engine, starting system is OK. If the starter will not crank the engine at all, go to next step.  
If it won't disengage from the ring gear when you release key, check for the following until you find the cause.
  - a. Solenoid plunger and switch malfunction.
  - b. Dirty pinion gear or damaged overrunning clutch.
3. Check the battery condition. Check electrical connections at the battery, battery negative cable connected to the body, engine ground cables, and the starter for looseness and corrosion. Then try starting the engine again.  
If the starter cranks normally the engine, repairing the loose connection repaired the problem. The starting system is now OK.  
If the starter still does not crank the engine, go to next step.
4. Disconnect the connector from the S-terminal of solenoid. Connect a jumper wire from the B-terminal of solenoid to the S-terminal of solenoid.  
If the starter cranks the engine, go to next step.  
If the starter still does not crank the engine, remove the starter, and repair or replace as necessary.
5. Check the following items in the order listed until you find the open circuit.
  - a. Check the wire and connectors between the driver's under-dash fuse/relay box and the ignition switch, and between the driver's under-dash fuse/relay box and the starter.
  - b. Check the ignition switch (Refer to BE group - ignition system)
  - c. Check the transaxle range switch connector or ignition lock switch connector.
  - d. Inspect the starter relay.

### STARTER SOLENOID TEST

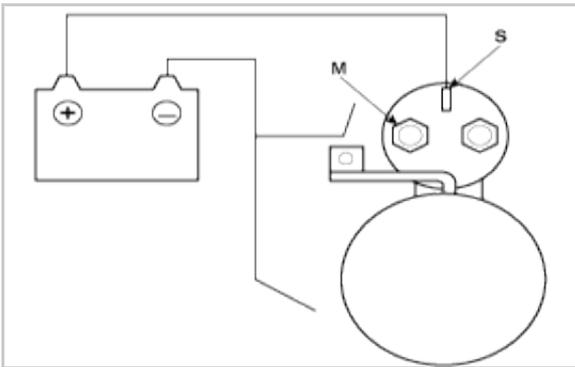
1. Disconnect the field coil wire from the M-terminal of solenoid switch.
2. Connect the battery as shown. If the starter pinion pops out, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



3. Disconnect the battery from the M terminal.  
If the pinion does not retract, the hold-in coil is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.

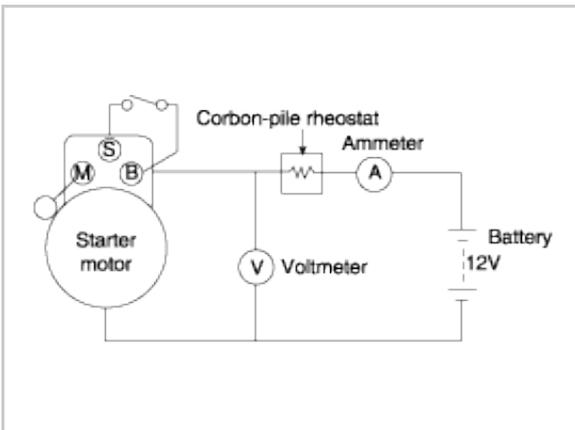


4. Disconnect the battery also from the body. If the pinion retracts immediately, it is working properly. To avoid damaging the starter, do not leave the battery connected for more than 10 seconds.



## FREE RUNNING TEST

1. Place the starter motor in a vise equipped with soft jaws and connect a fully-charged 12-volt battery to starter motor as follows.
2. Connect a test ammeter (100-ampere scale) and carbon pile rheostats as shown in the illustration.
3. Connect a voltmeter (15-volt scale) across starter motor.



4. Rotate carbon pile to the off position.

5. Connect the battery cable from battery's negative post to the starter motor body.
6. Adjust until battery voltage shown on the voltmeter reads 11volts.
7. Confirm that the maximum amperage is within the specifications and that the starter motor turns smoothly and freely.

---

Current : 85A MAX

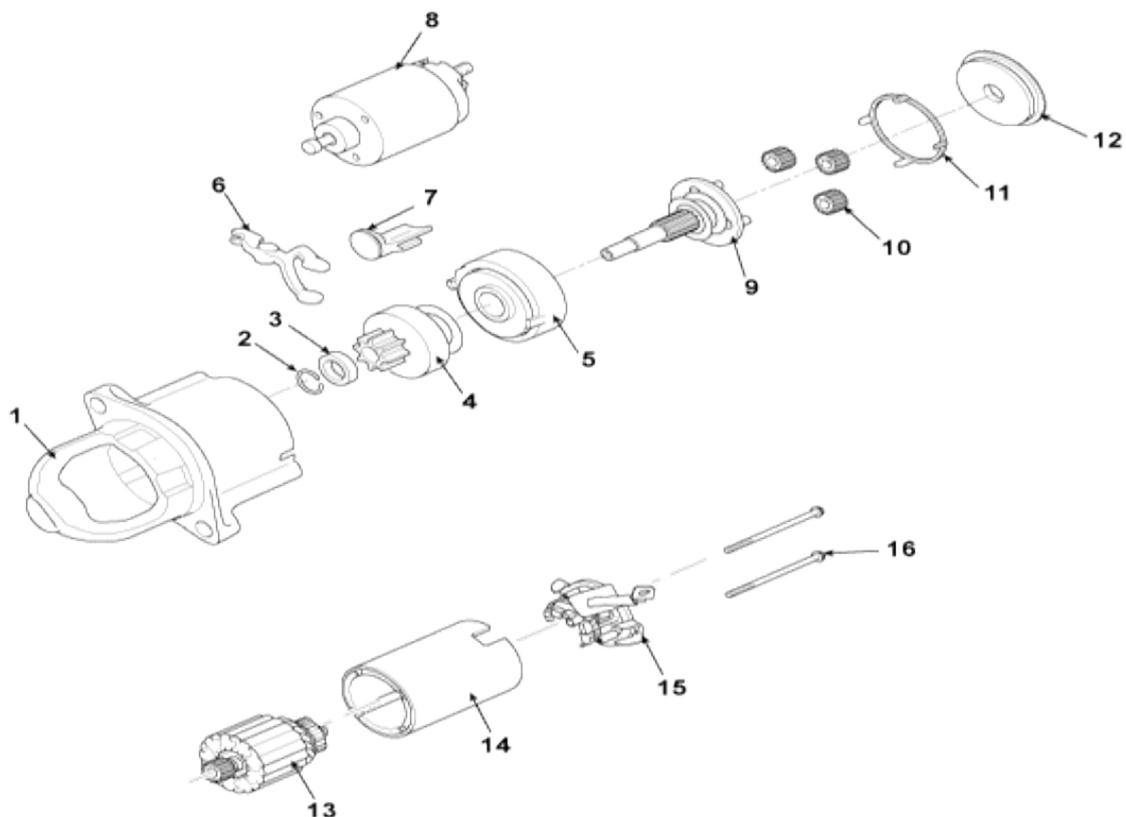
Speed : 2,600 rpm

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# Starter



## COMPONENT



1. Front bracket
2. Stop ring
3. Stopper
4. Overrun clutch assembly
5. Internal gear assembly
6. Lever
7. Lever packing
8. Magnet switch assembly

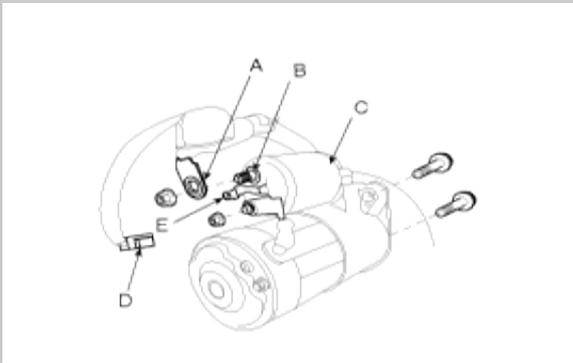
9. Planet shaft assembly
10. Planetary gear assembly
11. Packing
12. Shield
13. Armature assembly
14. Yoke assembly
15. Brush holder assembly
16. Through bolt



## REMOVAL

### STATATER

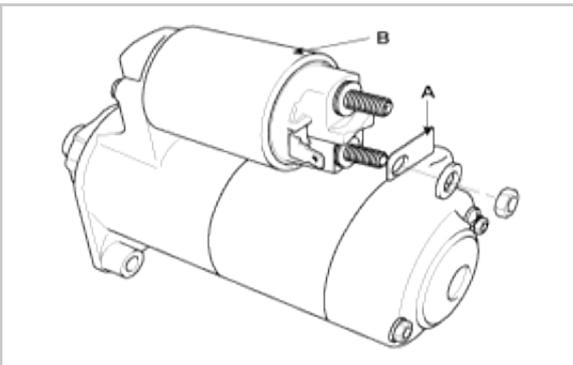
1. Disconnect the battery negative cable.
2. Disconnect the starter cable (A) from the B terminal (B) on the solenoid (C), then disconnect the connector (D) from the S terminal (E).



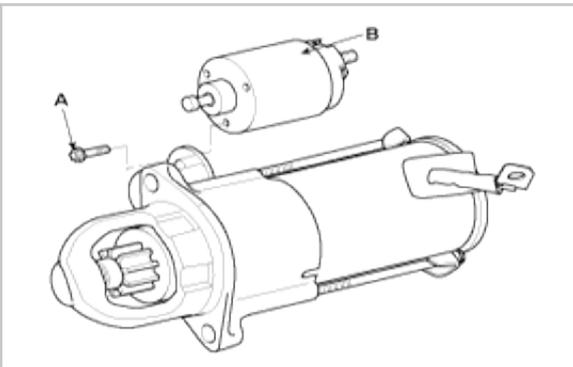
3. Remove the 2 bolts holding the starter, then remove the starter.
4. Installation is the reverse of removal.
5. Connect the battery negative cable to the battery.

## DISASSEMBLY

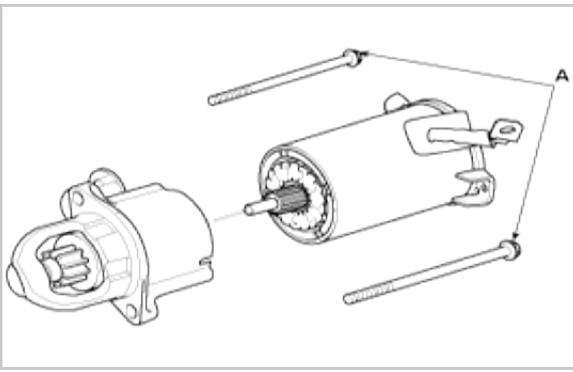
1. Disconnect the M-terminal (A) on the magnet switch assembly (B).



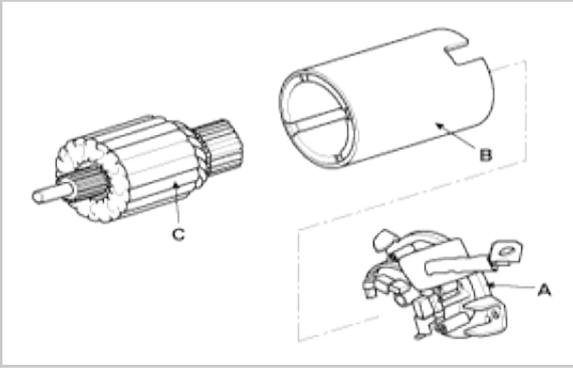
2. After loosening the 3 screws (A), detach the magnet switch assembly (B).



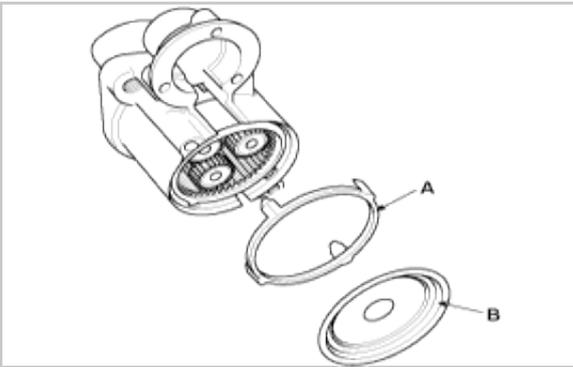
3. Loosen the through bolts (A).



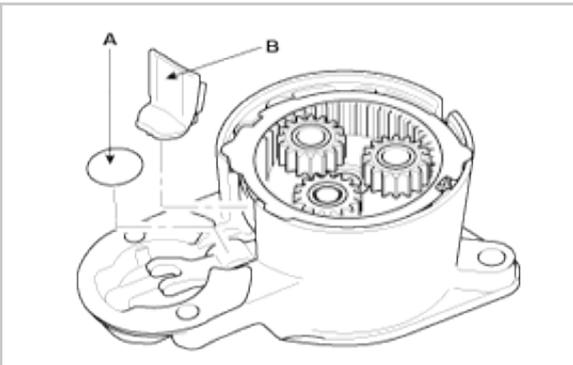
4. Remove the brush holder assembly (A), yoke (b) and armature (C).



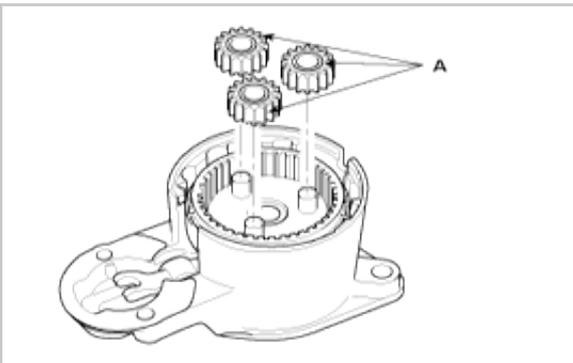
5. Remove the shield (A) and packing (B).



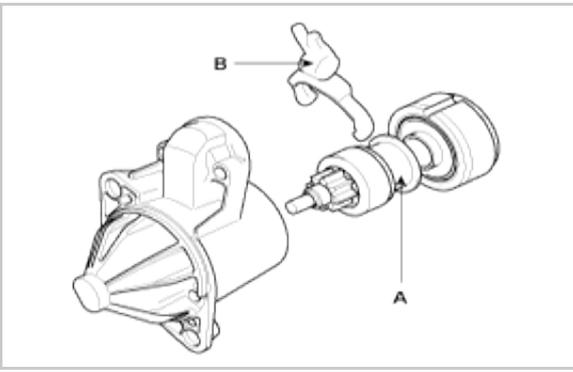
6. Remove the lever plate (A) and lever packing (B).



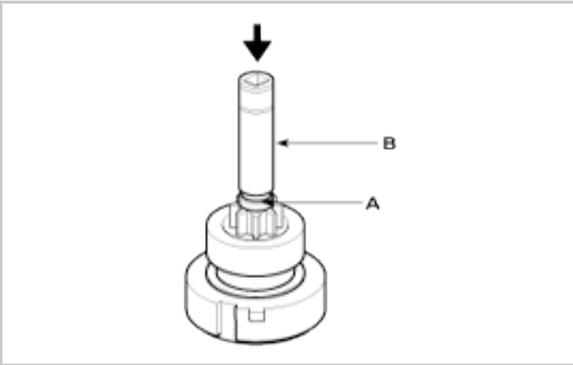
7. Disconnect the planet gear (A).



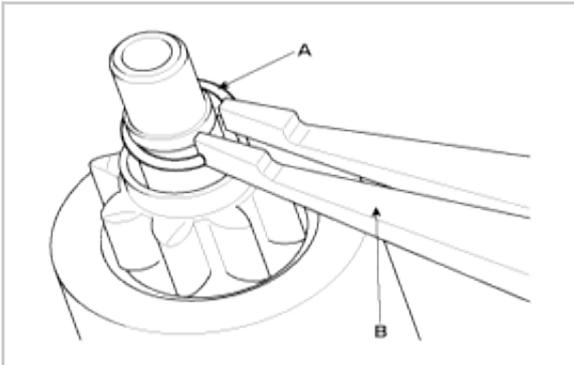
8. Disconnect the planet shaft assembly (A) and lever (B).



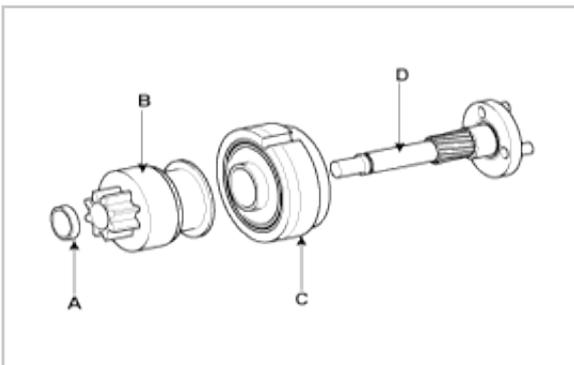
9. Press the stop ring (A) using a socket (B).



10. After removing the stopper (A) using stopper pliers (B).



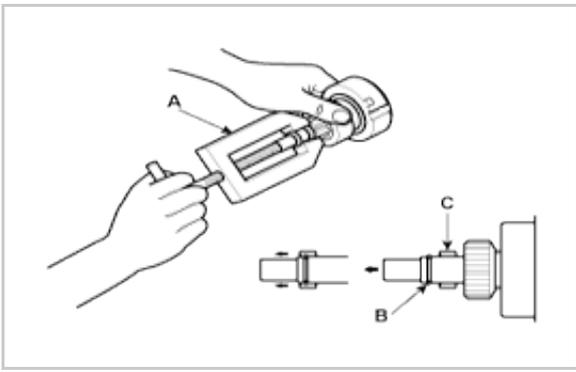
11. Disconnect the stop ring (A), overrunning clutch (B), internal gear (C) and planet shaft (D).



12. Reassembly is the reverse of disassembly.

### NOTICE

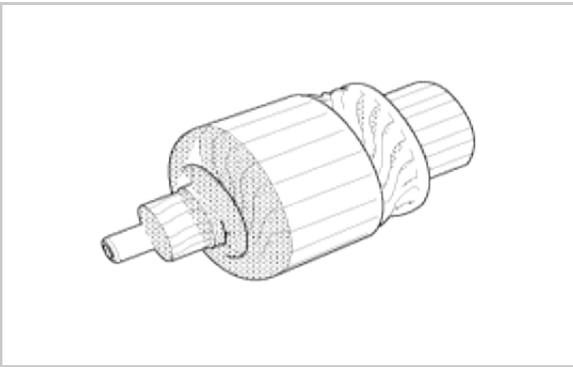
Using a suitable pulling tool (A), pull the overrunning clutch stop ring (B) over the stopper (C).



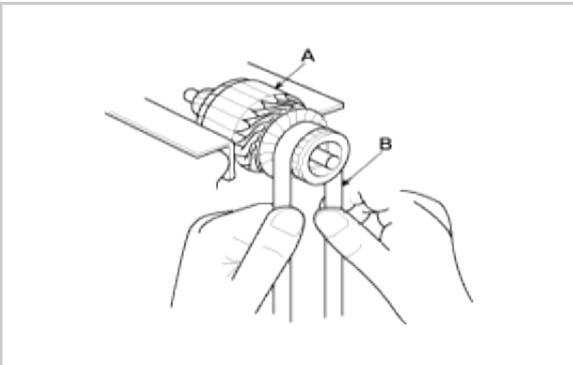
## INSPECTION

### ARMATURE INSPECTION AND TEST

1. Remove the starter.
2. Disassemble the starter as shown at the beginning of this procedure.
3. Inspect the armature for wear or damage from contact with the permanent magnet. If there is wear or damage, replace the armature.



4. Check the commutator (A) surface. If the surface is dirty or burnt, resurface with emery cloth or a lathe within the following specifications, or recondition with #500 or #600 sandpaper (B).



5. Measure the commutator (A) runout.
  - a. If the commutator runout is within the service limit, check the commutator for carbon dust or brass chips between the segments.
  - b. If the commutator run out is not within the service limit, replace the armature.

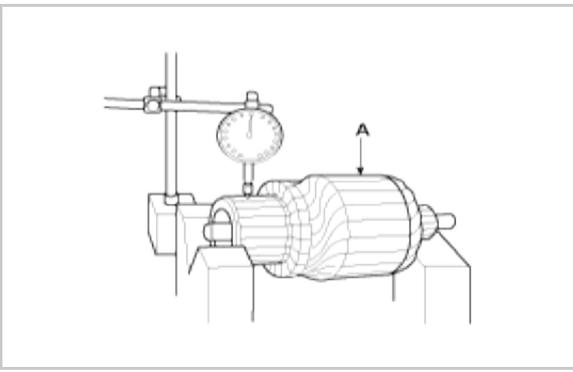
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Commutator runout

Standard (New): 0.02mm (0.0008in.) max

Service limit: 0.05mm (0.0020in.)

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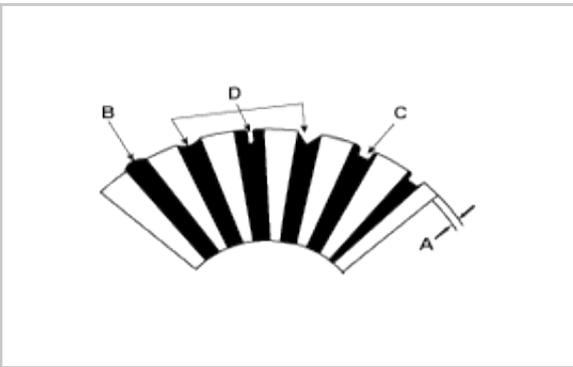


6. Check the mica depth (A). If the mica is too high (B), undercut the mica with a hacksaw blade to the proper depth. Cut away all the mica (C) between the commutator segments. The undercut should not be too shallow, too narrow, or v-shaped (D).

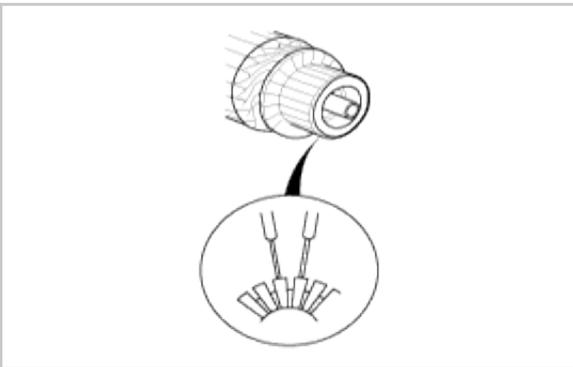
Commutator mica depth

Standard (New) : 0.5 mm (0.0197 in.)

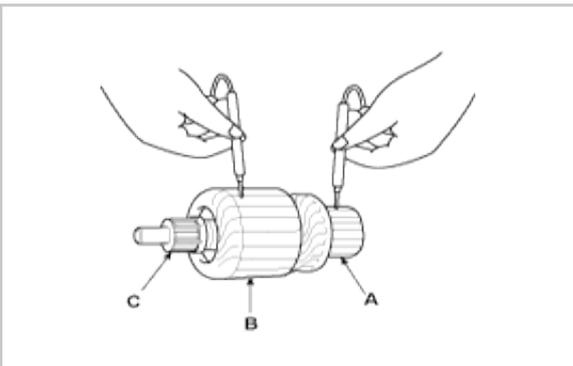
Limit : 0.2mm (0.0079 in.)



7. Check for continuity between the segments of the commutator. If an open circuit exists between any segments, replace the armature.

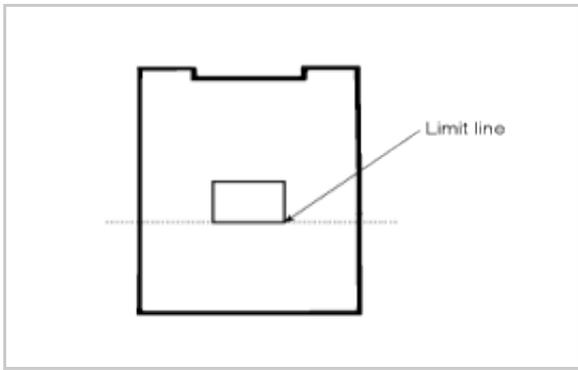


8. Check with an ohmmeter that no continuity exists between the commutator (A) and armature coil core (B), and between the commutator and armature shaft (C). If continuity exists, replace the armature.



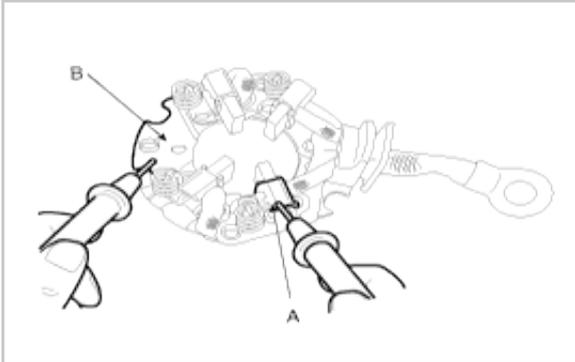
## INSPECT STARTER BRUSH

Brushes that are worm out, or oil-soaked, should be replaced.

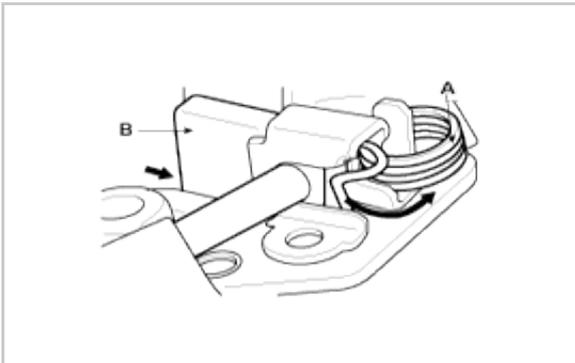


## STARTER BRUSH HOLDER TEST

1. Check that there is no continuity between the (+) brush holder (A) and (-) brush holder (B). If there is no continuity, replace the brush holder assembly.



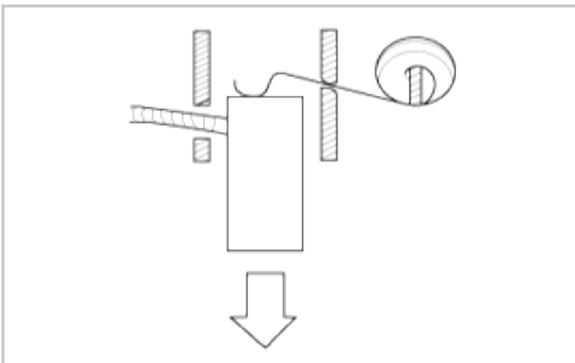
2. Pry back each brush spring (A) with a screwdriver, then position the brush (B) about halfway out of its holder, and release the spring to hold it there.



3. Install the armature in the housing, and install the brush holder. Next, pry back each brush spring again, and push the brush down until it seats against the commutator, then release the spring against the end of the brush.

### NOTICE

To seat new brushes, slip a strip of #500 or #600 sandpaper, with the grit side up, between the commutator and each brush, and smoothly rotate the armature. The contact surface of the brushes will be sanded to the same contour as the commutator.

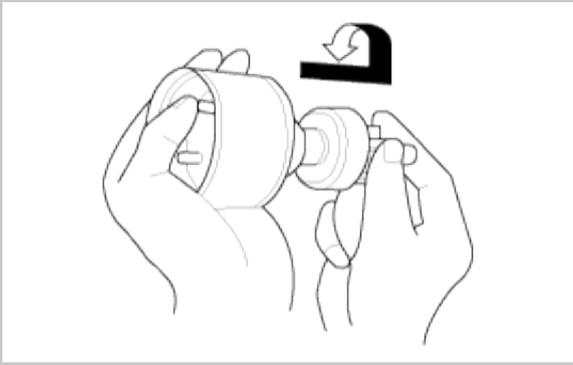


## INSPECT OVERRUNNING CLUTCH

1. Slide the overrunning clutch along the shaft.  
Replace it if it does not slide smoothly.

2. Rotate the overrunning clutch both ways.

Does it lock in one direction and rotate smoothly in reverse? If it does not lock in either direction or it locks in both directions, replace it.



3. If the starter drive gear is worn or damaged, replace the overrunning clutch assembly. (the gear is not available separately).

Check the condition of the flywheel or torque converter ring gear if the starter drive gear teeth are damaged.

## CLEANING

1. Do not immerse parts in cleaning solvent. Immersing the yoke assembly and/or armature will damage the insulation. Wipe these parts with a cloth only.

2. Do not immerse the drive unit in cleaning solvent. The overrun clutch is pre-lubricated at the factory and solvent will wash lubrication from the clutch.

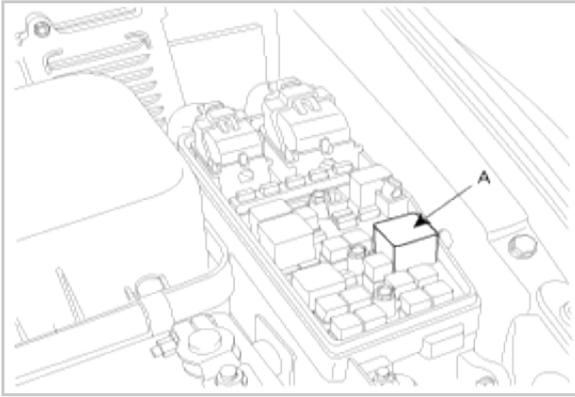
3. The drive unit may be cleaned with a brush moistened with cleaning solvent and wiped dry with a cloth.

# **Starter Relay**



## INSPECTION

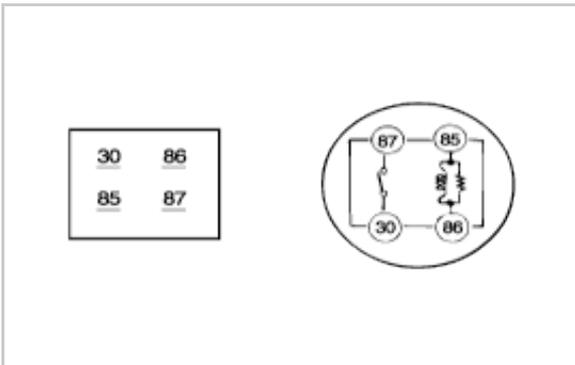
1. Remove the fuse box cover.
2. Remove the starter relay (A).



3. Using an ohmmeter, check that there is continuity between each terminal.

Terminal	Continuity
30 - 87	NO
85 - 86	YES

4. Apply 12V to terminal 85 and ground to terminal 86.  
Check for continuity between terminals 30 and 87.

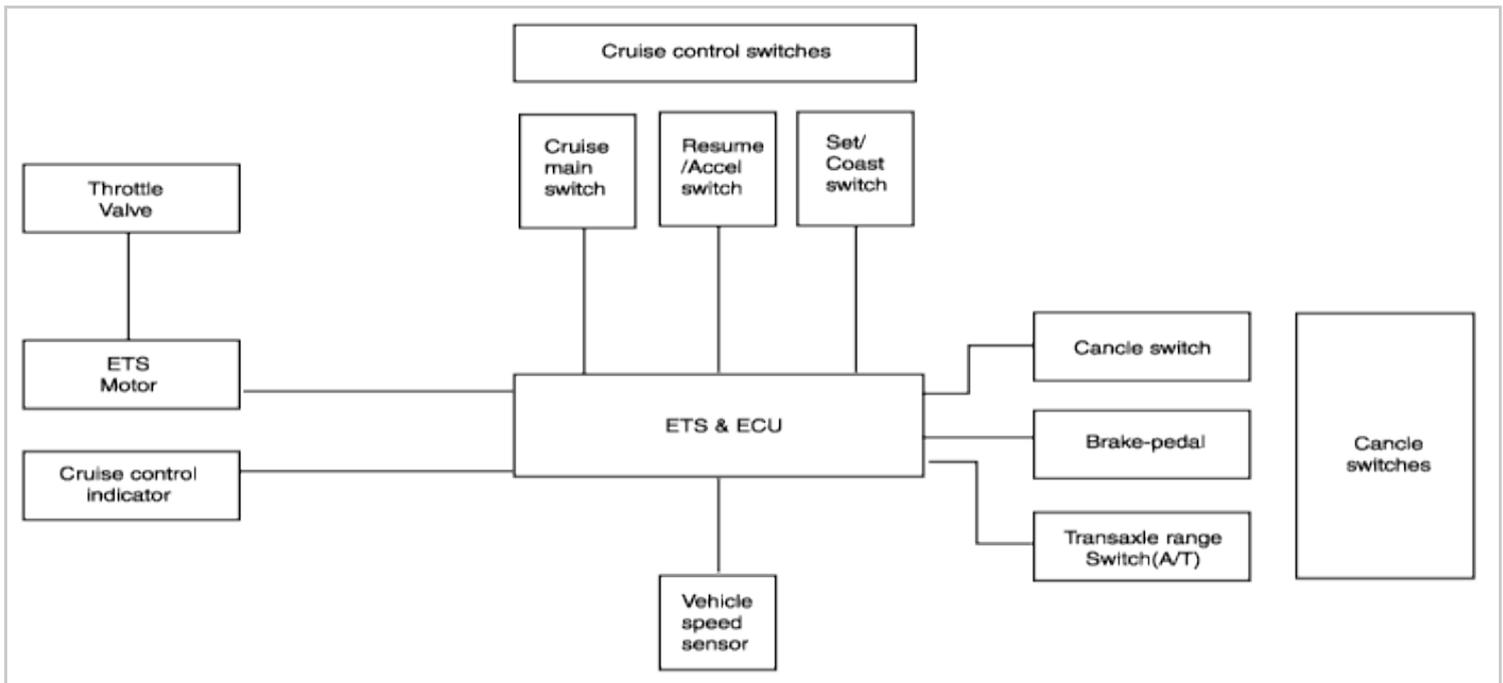


5. If there is no continuity, replace the starter relay.
6. Install the starter relay.
7. Install the fuse box cover.

# **Cruise Control System**



## SYSTEM BLOCK DIAGRAM



### COMPONENT PARTS AND FUNCTION OUTLINE

Component part		Function
Vehicle-speed sensor		Converts vehicle speed to pulse.
Engine control module (ECM)		Receives signals from sensor and control switches;
Cruise control indicator		Illuminate when CRUISE main switch is ON (Built into cluster)
Cruise Control switches	CRUISE main switch	Switch for automatic speed control power supply.
	Resume/Accel switch	Controls automatic speed control functions by Resume/Accel switch (Set/Coast switch)
	Set/Coast switch	
Cancel switch	Cancel switch	Sends cancel signals to ECM
	Brake-pedal switch	
	Transaxle range switch (A/T)	
	Clutch switch (M/T)	
ETS motor		Regulates the throttle valve to the set opening by ECM.

\* ETS : Electronic Throttle System

### CRUISE CONTROL

Cruise control system is engaged by "ON. OFF" main switch located on right of steering wheel column. System has the capability to cruise, coast, resume speed, and accelerate, and raise "tap-up" or lower "tap-down" set speed. It also has a safety interrupt, engaged upon depressing brake or shifting select lever.

ECM is a speed control system that maintains a required vehicle speed at normal driving conditions.

The main components of cruise control system are mode control switches, transaxle range switch, brake switch, vehicle speed sensor, ECM and ETS motor that connect throttle body.

ECM contains a low speed limit which will prevent system engagement below a minimum speed of 40km/h (25mph).

The operation of the controller is controlled by mode control switches located on steering wheel.

Transaxle range switch and brake switch are provided to disengage the cruise control system. The switches are on brake pedal bracket and transaxle. When the brake pedal is depressed or select lever shifted, the cruise control system is electrically disengaged and the throttle is returned to the idle position.

#### Cruise main switch

Cruise control system is engaged by pressing "ON. OFF" push button. Releasing "ON.OFF" push button release throttle, clears cruise memory speed, and puts vehicle in a non-cruise mode.

#### Coast/Set switch

COAST.SET switch located on right of steering wheel column has two positions - "Normal" and "Depressed". The set position - With COAST.SET switch depressed and then released the cruise speed will be set at the speed the vehicle was going when COAST.SET switch was released. The coast position - With COAST.SET switch fully depressed, driver can lower cruise speed. To decrease cruise speed, COAST.SET switch is held in, disengaging cruise control system. When vehicle has slowed to required cruise speed, releasing COAST.SET switch will re-engage speed at new selected speed.

The tap down - To lower vehicle speed, cruise must be engaged and operating. Tap down is done by quickly pressing and releasing COAST.SET switch. Do not hold COAST.SET switch in depressed position.

Tap down is a function in which cruise speed can be decreased by 1mph (1.6km/h)

#### Resume/Accel switch

RES.ACCEL switch located on right of steering wheel column has two positions - "Normal" and "Depressed".

The resume position - With RES.ACCEL switch depressed and then release, this switch also returns cruise control operation to last speed (Which is temporarily disengaged by Cancel switch or Brake pedal), setting when momentarily operating RES.ACCEL switch by constant acceleration.

The accel position - With RES.ACCEL switch depressed and held in, disengaging cruise control system, when vehicle has accelerated to required cruise speed, releasing RES.ACCEL switch will re-engage speed at new selected speed.

The tap up - To increase vehicle speed, the cruise must be engaged and operating.

Tap up is done by quickly pressing and releasing RES.ACCEL switch less than 0.5 second. Do not hold RES.ACCEL switch in depressed position. Tap up is a function in which cruise speed can be increased by 1mph (1.6km/h).

#### Cancel switch

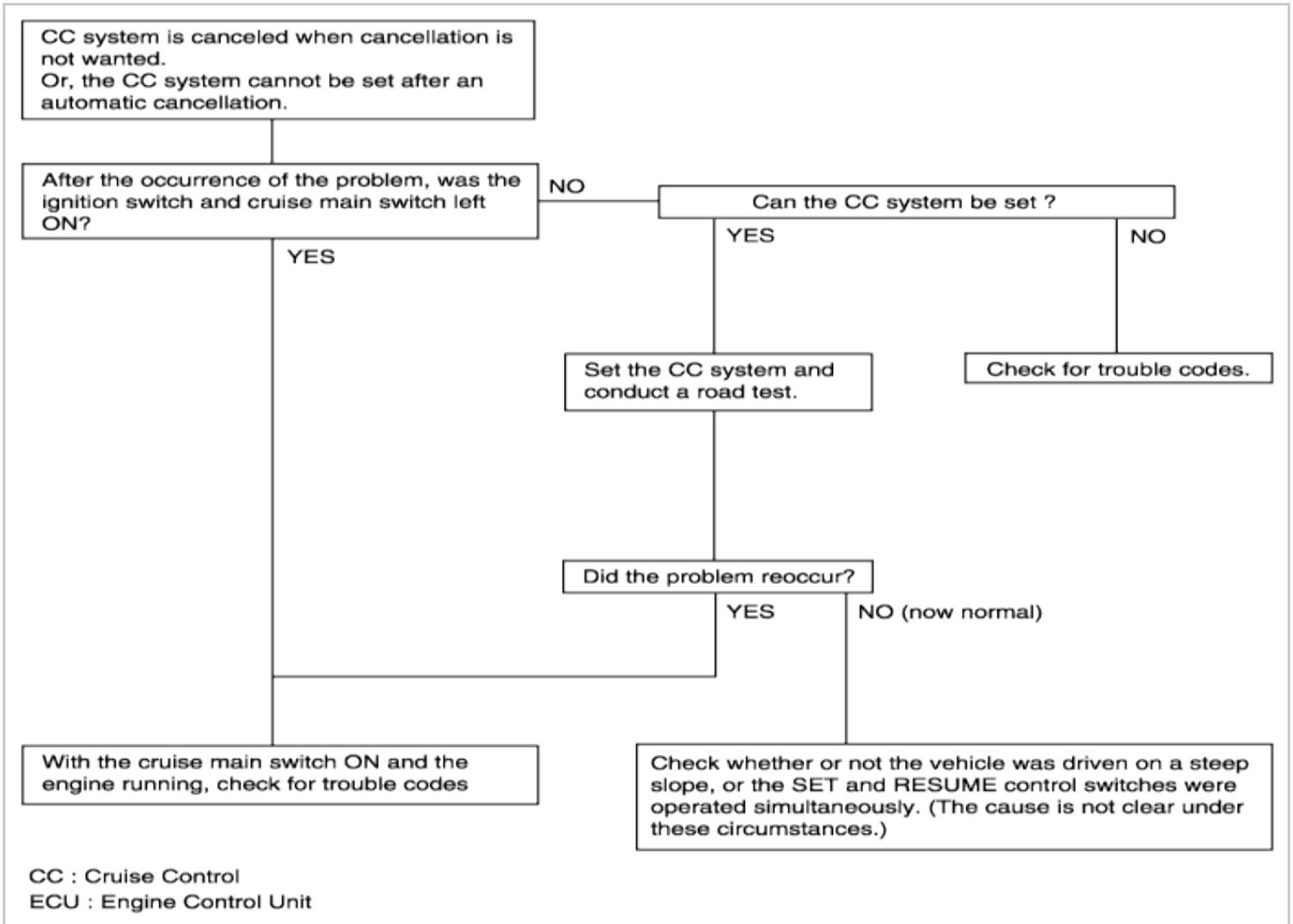
Cruise control system is temporarily disengaged by pressing "CANCEL" switch.

Cruise speed canceled by this switch will be recovered by RES.ACCEL switch



## TROUBLE SYMPTOM CHARTS

### TROUBLE SYMPTOM 1



### TROUBLE SYMPTOM 2

Trouble symptom	Probable cause	Remedy
The set vehicle speed varies greatly upward or downward "Surging" (repeated alternating acceleration and deceleration) occurs after setting	Malfunction of the vehicle speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	Malfunction of ECM	Replace the ECM

### TROUBLE SYMPTOM 3

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when the brake pedal is depressed	Damaged or disconnected wiring of the brake pedal switch	Repair the harness or replace the brake pedal switch
	Malfunction of the ECM	Replace the ECM

### TROUBLE SYMPTOM 4

Trouble symptom	Probable cause	Remedy
The CC system is not canceled when	Damaged or disconnected wiring of inhibitor switch input circuit	Repair the harness or repair or

the shift lever is moved to the "N" position (It is canceled, however, when the brake pedal is depressed)	Improper adjustment of inhibitor switch	replace the inhibitor switch
	Malfunction of the ECM	Replace the ECM

#### TROUBLE SYMPTOM 5

Trouble symptom	Probable cause	Remedy
Cannot decelerate (coast) by using the SET switch	Temporary damaged or disconnected wiring of SET switch input circuit	Repair the harness or replace the SET switch
	Malfunction of the ECM	Replace the ECM

#### TROUBLE SYMPTOM 6

Trouble symptom	Probable cause	Remedy
Cannot accelerate or resume speed by using the RESUME switch	Damaged or disconnected wiring, or short circuit, or RESUME switch input circuit	Repair the harness or replace the RESUME switch
	Malfunction of the ECM	Replace the ECM

#### TROUBLE SYMPTOM 7

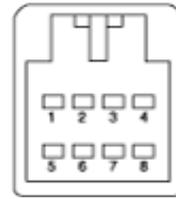
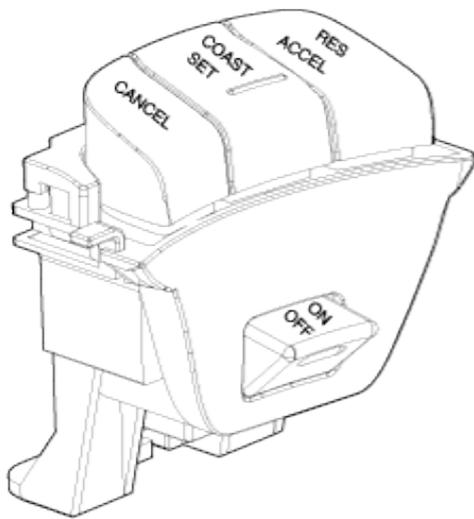
Trouble symptom	Probable cause	Remedy
CC system can be set while driving at a vehicle speed of less than 40km/h (25mph), or there is no automatic cancellation at that speed	Malfunction of the vehicle-speed sensor circuit	Repair the vehicle speed sensor system, or replace the part
	Malfunction of the ECM	Replace the ECM

#### TROUBLE SYMPTOM 8

Trouble symptom	Probable cause	Remedy
The cruise main switch indicator lamp does not illuminate (But CC system is normal)	Damaged or disconnected bulb of cruise main switch indicator lamp	Repair the harness or replace the part.
	Harness damaged or disconnected	

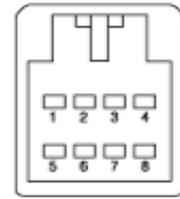


CIRCUIT DIAGRAM



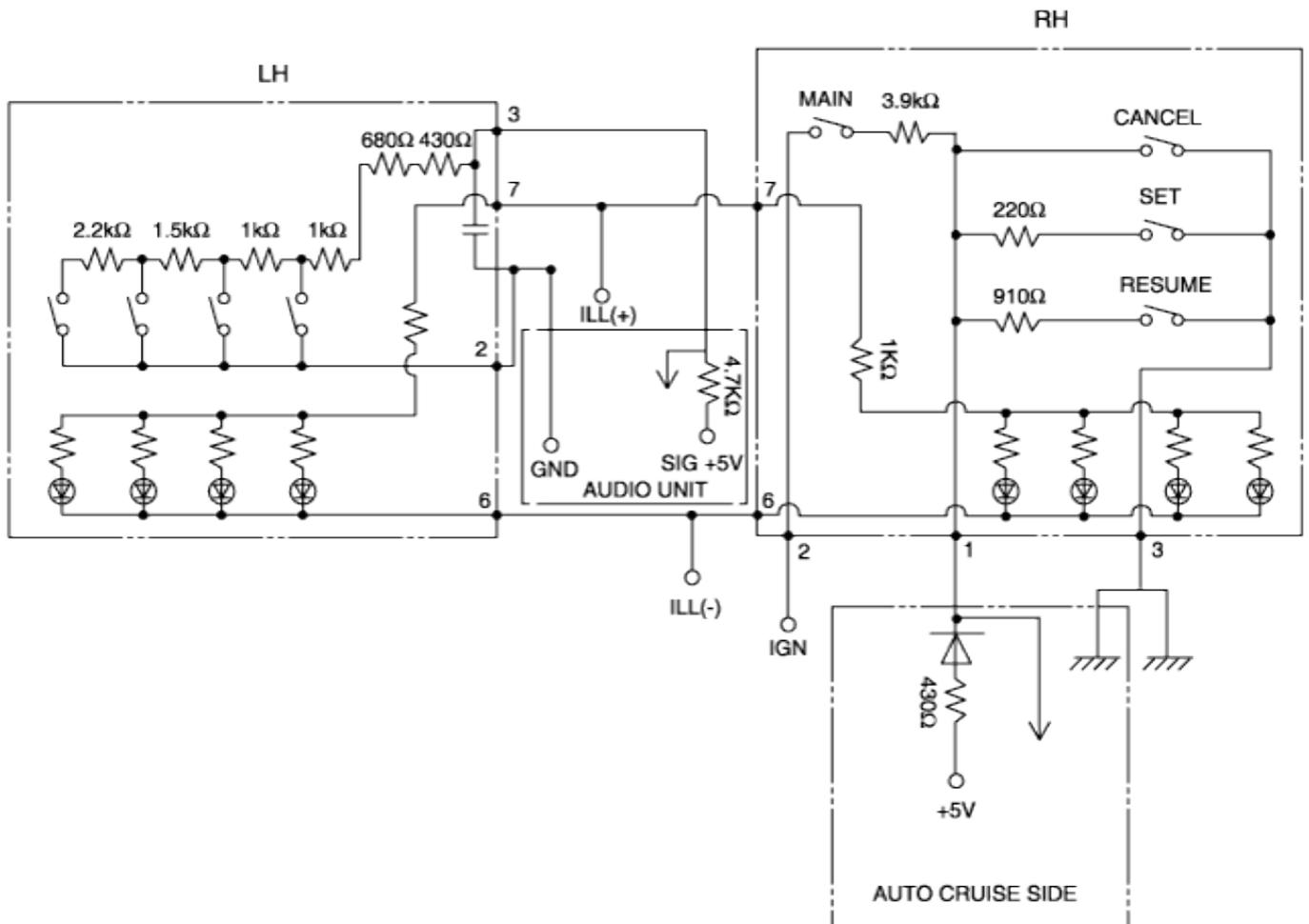
LH CONNECTOR

NO	CONNECTOR
1	-
2	AUDIO UNIT (GND)
3	AUDIO UNIT (SIG IN)
4	-
5	-
6	ILL(-)
7	ILL(+)



RH CONNECTOR

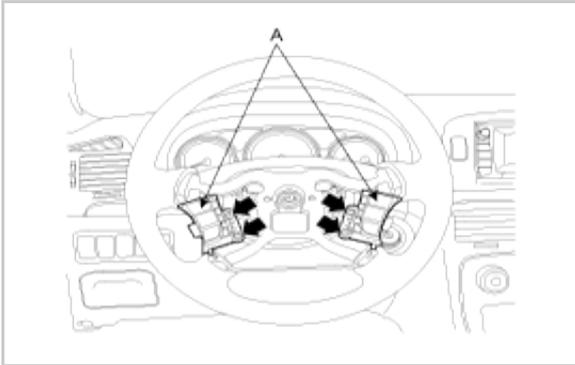
NO	CONNECTOR
1	CRUSIE SW(SIG IN)
2	CRUSIE MAIN SW(IGN)
3	CRUSIE SW(SIG OUT)
4	-
5	-
6	ILL(-)
7	ILL(+)





## REMOVAL

1. Disconnect the battery (-) terminal.
2. Remove the driver side air bag module. (Refer to RT GR.)
3. Disconnect the cruise control switch connector and then remove the cruise control switch(A) with two screws.

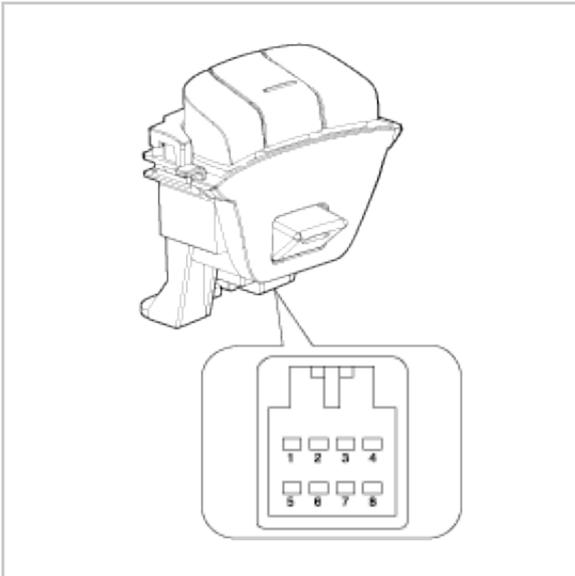


4. Installation is the reverse of removal.

## INSPECTION

### MEASURING RESISTANCE

1. Disconnect the cruise control switch connector from the control switch.



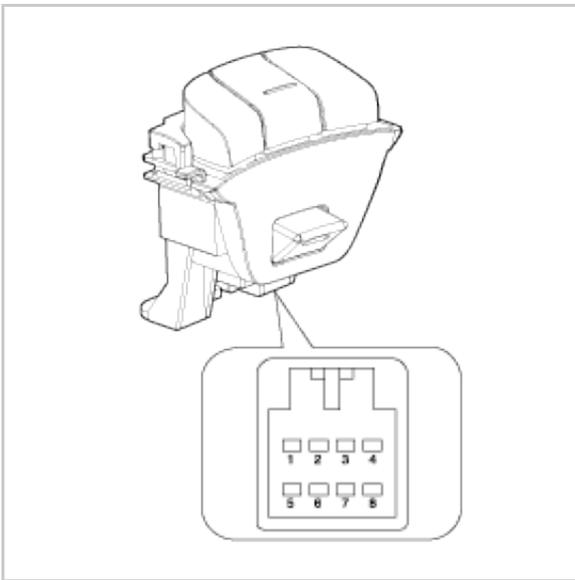
2. Measure resistance between terminals on the control switch when each function switch is ON (switch is depressed).

Function switch	Terminal	Resistance
Cruise Main	RH 1-2	3.9k $\Omega$ $\pm$ 1%
Cancel	RH 1-3	0 $\Omega$ $\pm$ 1%
Set/Coast	RH 1-3	220 $\Omega$ $\pm$ 1%
Resume/Accel	RH 1-3	910 $\Omega$ $\pm$ 1%

3. If not within specification, replace switch.

### MEASURING VOLTAGE

1. Connect the cruise control switch connector to the control switch.



2. Measure voltage between terminals on the harness side connector when each function switch is ON (switch is depressed).

Function switch	Terminal	Voltage
Cruise Main	RH 1-2	-
Cancel	RH 1-3	0.0V $\pm$ 0.22V
Set/Coast	RH 1-3	1.5V $\pm$ 0.22V
Resume/Accel	RH 1-3	3.0V $\pm$ 0.22V

3. If not within specification, replace switch.

## **CHAPTER 4:**

# **Emission Control System**

# **General Information**



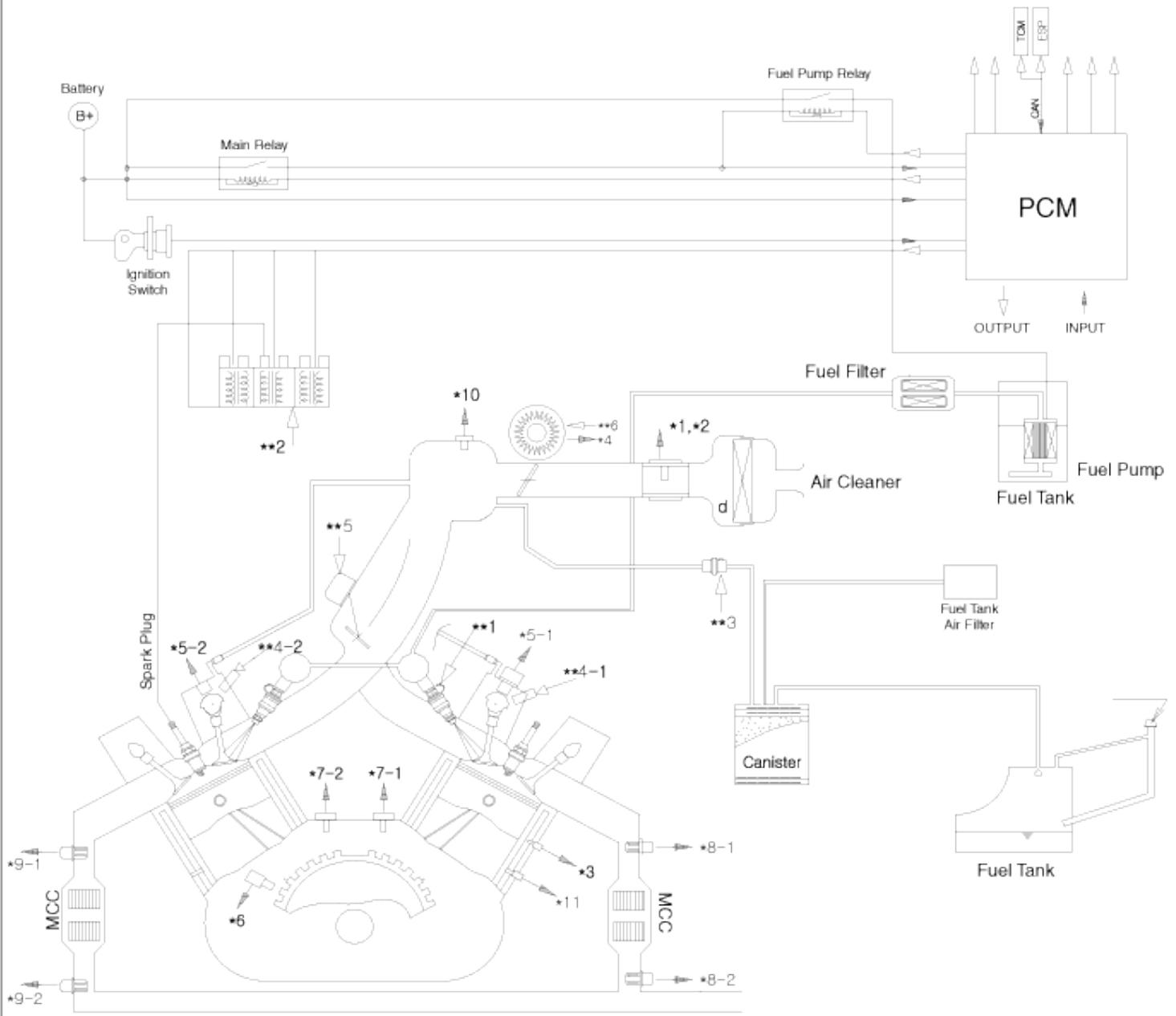
## SCHEMATIC DIAGRAM

- \*1. Mass Air Flow Sensor (MAFS)
- \*2. Intake Air Temperature Sensor (IATS)
- \*3. Engine Coolant Temperature Sensor (ECTS)
- \*4. Throttle Position Sensor (TPS)
- \*5-1. Camshaft Position Sensor (CMPS) [BANK1]
- \*5-2. Camshaft Position Sensor (CMPS) [BANK2]
- \*6. Crankshaft Position Sensor (CKPS)
- \*7-1. Knock Sensor (KS) #1
- \*7-2. Knock Sensor (KS) #2
- \*8-1. Heated Oxygen Sensor (HO2S) [B1/S1]
- \*8-2. Heated Oxygen Sensor (HO2S) [B1/S2]
- \*9-1. Heated Oxygen Sensor (HO2S) [B2/S1]
- \*9-2. Heated Oxygen Sensor (HO2S) [B2/S2]
- \*10. Manifold Absolute Pressure Sensor (MAPS)
- \*11. CVVT Oil Temperature Sensor (OTS)

- Ignition Switch
- Battery Voltage
- Vehicle Speed Signal
- Coolant Load Signal
- "PNP" Switch (A/T only)
- Fuel Pump Relay Signal



- \*\*1. Fuel Injector
- \*\*2. Ignition Coil
- \*\*3. Purge Control Solenoid Valve (PCSV)
- \*\*4-1. CVVT Oil control valve (OCV) [BANK1]
- \*\*4-2. CVVT Oil control valve (OCV) [BANK2]
- \*\*5. Variable Intake Manifold solenoid (VIS) Valve
- \*\*6. ETC Motor
- Fuel Pump Control
- Main Relay
- Cooler Relay
- Ignition Timing Control
- Diagnosis

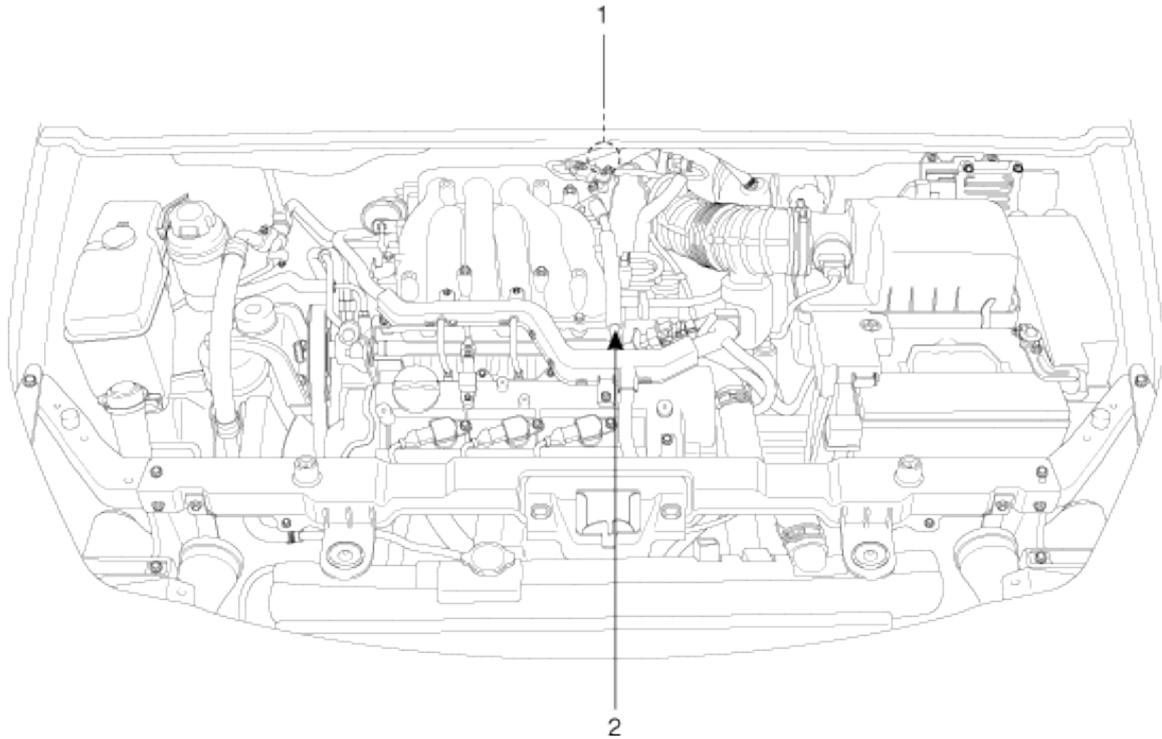


**DESCRIPTION**

<b>Components</b>	<b>Function</b>	<b>Remarks</b>
Crankcase Emission System a. Positive Crankcase Ventilation (PCV) valve	HC reduction	Variable flow rate type
Evaporative Emission System a. Evaporative emission canister b. Purge Control Solenoid Valve (PCSV)	HC reduction HC reduction	Duty control solenoid valve
Exhaust Emission System a. MFI system (air-fuel mixture control device) b. Three-way catalytic converter	CO, HC, NOx reduction CO, HC, NOx reduction	Heated oxygen sensor feedback type Monolithic type

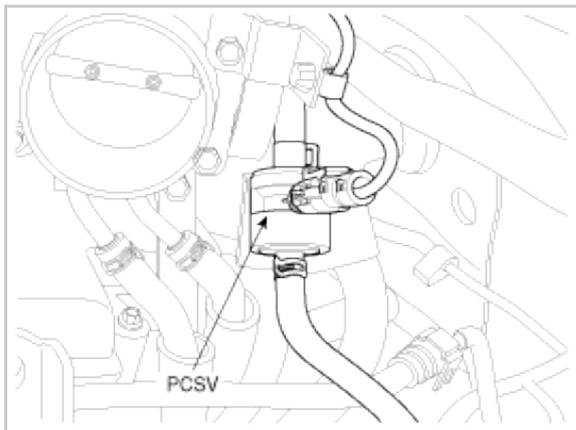


**COMPONENT LOCATION**

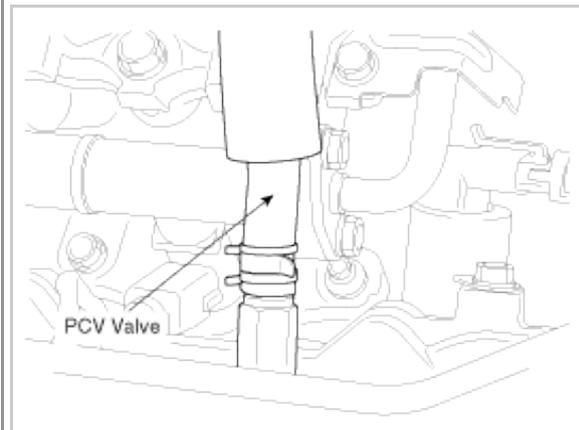


- 1. Purge Control Solenoid Valve (PCSV)
- 2. PCV Valve
- 3. Canister
- 4. Catalytic Converter (Bank1)
- 5. Catalytic Converter (Bank2)

1 | Purge Control Solenoid Valve (PCSV)

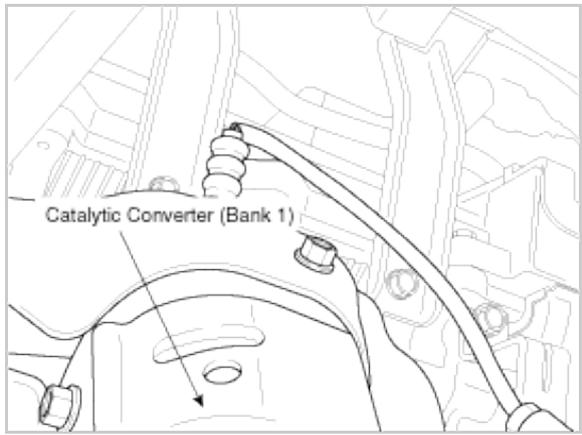
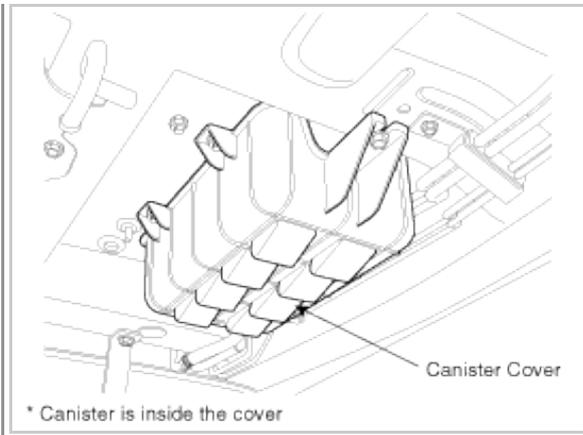


2 | Positive Crankcase Ventilation (PCV) Valve

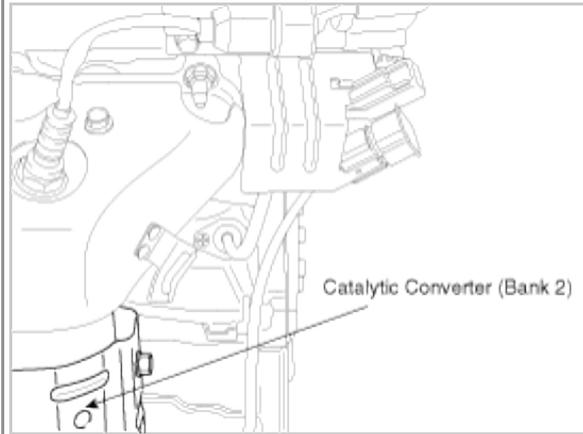


3 | Canister

4 | Catalytic Converter (Bank 1)



5 Catalytic Converter (Bank 2)



**TROUBLESHOOTING**

<b>Symptom</b>	<b>Suspect area</b>	<b>Remedy</b>
Engine will not start or hard to start	Vacuum hose disconnected or damaged	Repair or replace
	Malfunction of the Purge Control Solenoid Valve	Repair or replace
Rough idle or engine stalls	Vacuum hose disconnected or damaged	Repair or replace
	Malfunction of the PCV valve	Replace
	Malfunction of the evaporative emission canister purge system	Check the system; if there is a problem, check related components parts
Excessive oil consumption	Positive crankcase ventilation line clogged	Check positive crankcase ventilation system



## TIGHTENING TORQUES

Item	N·m	kgf·m	lbf·m
Positive Crankcase Ventilation Valve	8.0 ~ 12.0	0.8 ~ 1.2	6.0 ~ 8.0

## SPECIFICATIONS

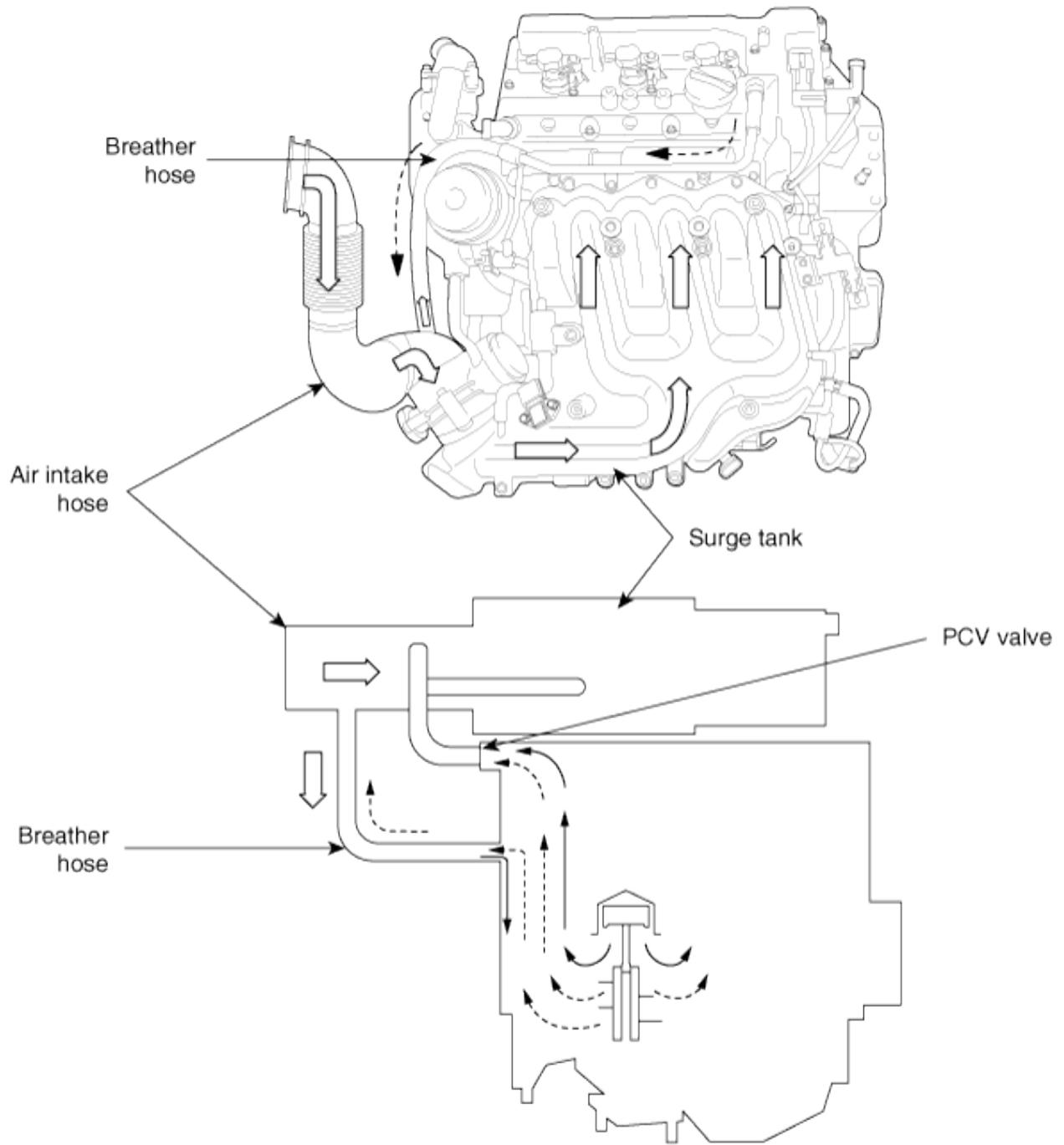
▷ Specification

Item	Specification
Coil Resistance ( $\Omega$ )	19.0 ~ 22.0 $\Omega$ [20°C (68°F)]

# **Crankcase Emission Control System**



# COMPONENTS



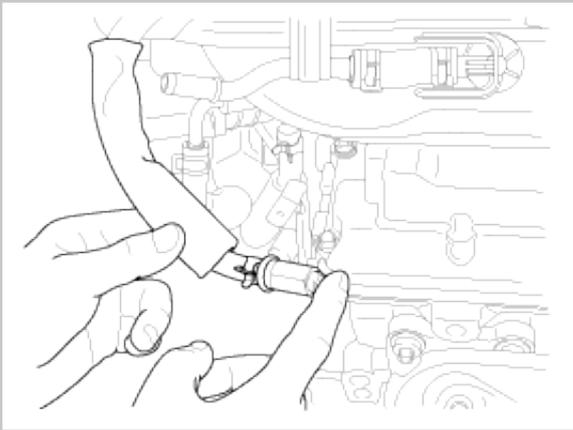


## INSPECTION

1. Disconnect the ventilation hose from the positive crankcase ventilation (PCV) valve. Remove the PCV valve from the rocker cover and reconnect it to the ventilation hose.
2. Run the engine at idle and put a finger on the open end of the PCV valve and make sure that intake manifold vacuum can be felt.

### NOTICE

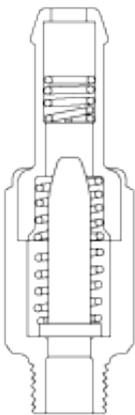
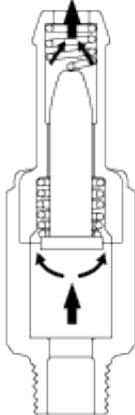
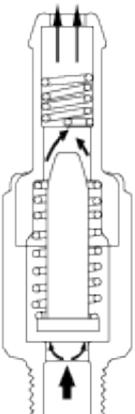
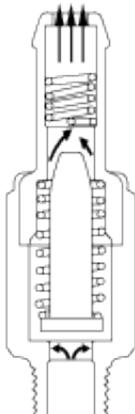
The plunger inside the PCV valve will move back and forth.



# **Positive Crankcase Ventilation (PVC) Valve**



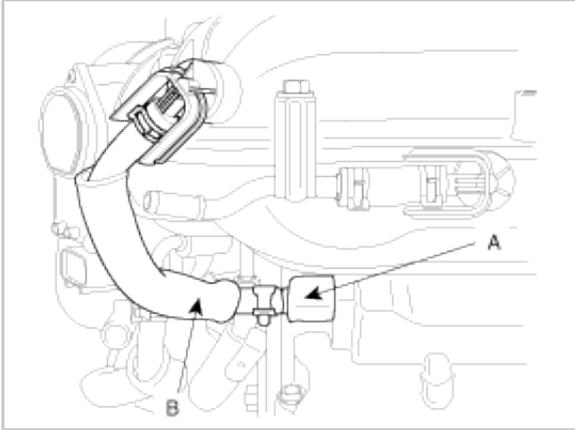
**OPERATION**

<p>Intake manifold side (No vacuum)</p>  <p>Rocker cover side</p>		<p>Intake manifold side (High vacuum)</p>  <p>Rocker cover side</p>	
Engine condition	Not running	Engine condition	Idling or decelerating
PCV valve	Not operating	PCV valve	Fully operating
Vacuum passage	Restricted	Vacuum passage	Small
<p>Intake manifold side (Moderate vacuum)</p>  <p>Rocker cover side</p>		<p>Intake manifold side (Low vacuum)</p>  <p>Rocker cover side</p>	
Engine condition	Normal operation	Engine condition	Accelerating and high load
PCV valve	Properly operating	PCV valve	Slightly operating
Vacuum passage	Large	Vacuum passage	Very large



## REMOVAL

1. Remove the valve pad (A) and disconnect the vacuum hose (B).



2. Remove the PCV Valve.

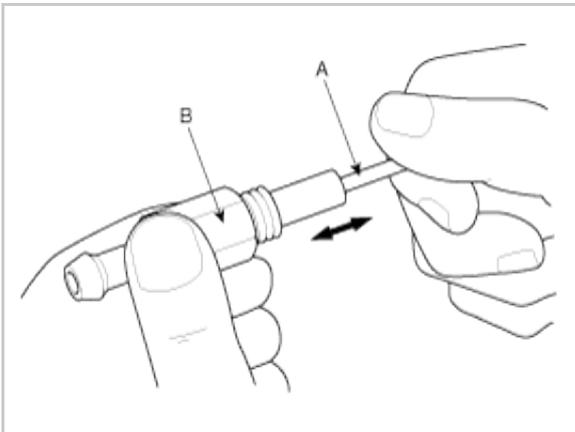
## INSTALLATION

Install the PCV valve and tighten to the specified torque.

PCV Valve installation : 7.8 ~ 11.8 N·m (0.8 ~ 1.2 kgf·m, 5.8 ~ 8.7lb·ft)

## INSPECTION

1. Remove the PCV valve.
2. Insert a thin stick(A) into the PCV valve(B) from the threaded side to check that the plunger moves.
3. If the plunger does not move, the PCV valve is clogged. Clean it or replace.



# **Evaporative Emission Control System**



**INSPECTION**

1. Disconnect the vacuum hose from the throttle body, and connect a vacuum pump to the vacuum hose.
2. Check the following points when the engine is cold [engine coolant temperature 60°C(140°F) or below] and when it is warm [engine coolant temperature 80°C(176°F) or higher].

**WHEN ENGINE IS COLD**

Engine operating condition	Applied vacuum	Result
Idling	50 kPa (7.3 psi)	Vacuum is held
3,000 rpm		

**WHEN ENGINE IS WARM**

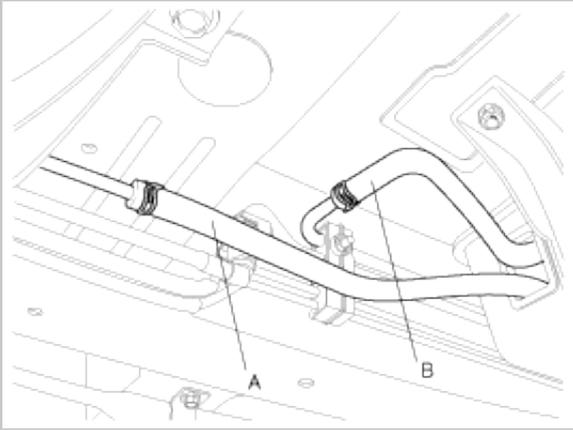
Engine operating condition	Applied vacuum	Result
Idling	50 kPa (7.3 psi)	Vacuum is held
Within 3 minutes after engine start at 3,000 rpm	Try to apply vacuum	Vacuum is released
After 3 minutes have passed after engine start at 3,000 rpm	50 kPa (7.3 psi)	Vacuum will be held momentarily, after which, it will be released

# Canister

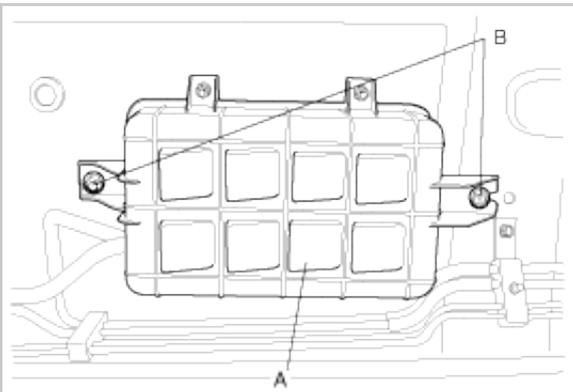


## REMOVAL

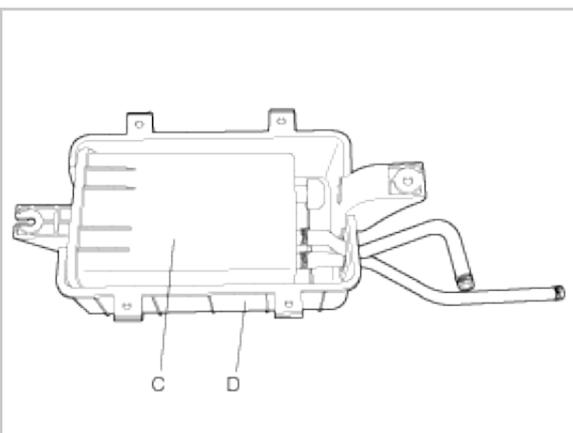
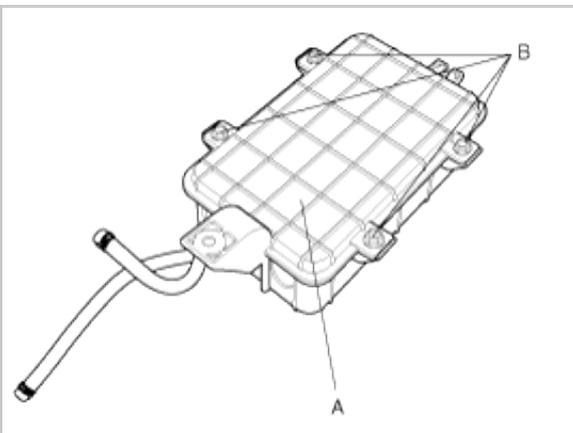
1. Disconnect the vacuum hoses (A,B).



2. Remove the canister assembly (A) with unscrewing the two mounting bolts (B).



3. Open the canister upper cover (A) with unfastening the four bolts (B) and remove the canister (C) from the canister lower cover (D).

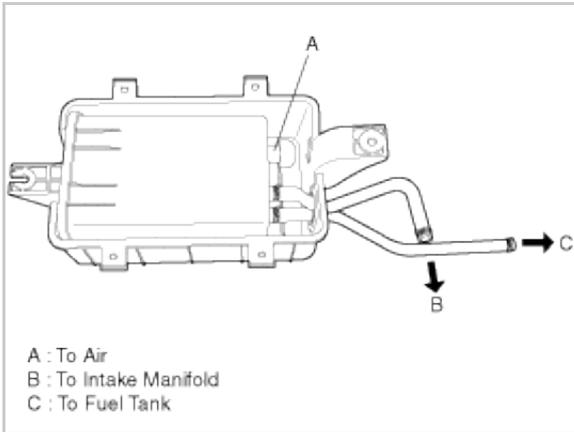


## INSTALLATION

Install the canister according to the reverse order of "REMOVAL" procedure.

## INSPECTION

1. Look for loose connections, sharp bends or damage to the fuel vapor lines.
2. Look for distortion, cracks or fuel damage.
3. After removing the canister, inspect for cracks, damage or saturated canister.



# **Purge Control Solenoid Valve (PCSV)**



## INSPECTION

### NOTICE

When disconnecting the vacuum hose, make an identification mark on it so that it can be reconnected to its original position.

1. Disconnect the vacuum hose from the solenoid valve.
2. Detach the harness connector.
3. Connect a vacuum pump to the nipple which is connected to intake manifold.
4. Apply vacuum and check when voltage is applied to the PCSV and when the voltage is discontinued.

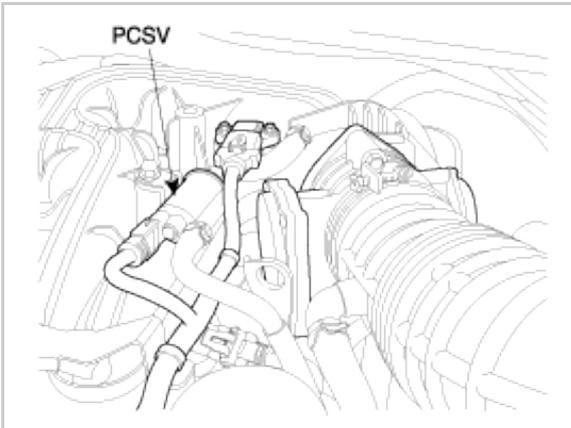
Battery voltage	Normal condition
When applied	Vacuum is released
When discontinued	Vacuum is maintained

5. Measure the resistance between the terminals of the solenoid valve.

PCSV coil resistance( $\Omega$ ) :  
19.0 ~ 22.0 $\Omega$  at 20°C (68°F)

## DESCRIPTION

Purge Control Solenoid Valve (PCSV) is installed on the surge tank and controls the passage between the canister and the intake manifold. It is a solenoid valve and is open when the PCM grounds the valve control line. When the passage is open (PCSV ON), fuel vapors stored in the canister is transferred to the intake manifold.

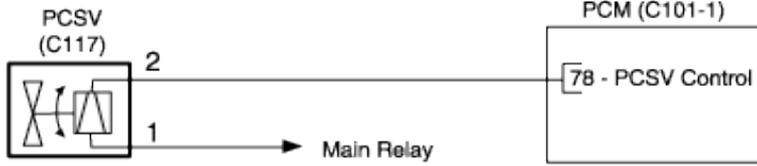


## SPECIFICATION

Item	Specification
Coil Resistance ( $\Omega$ )	19.0 ~ 22.0 $\Omega$ at 20°C (68°F)

## SCHEMATIC DIAGRAM

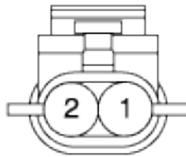
[CIRCUIT DIAGRAM]



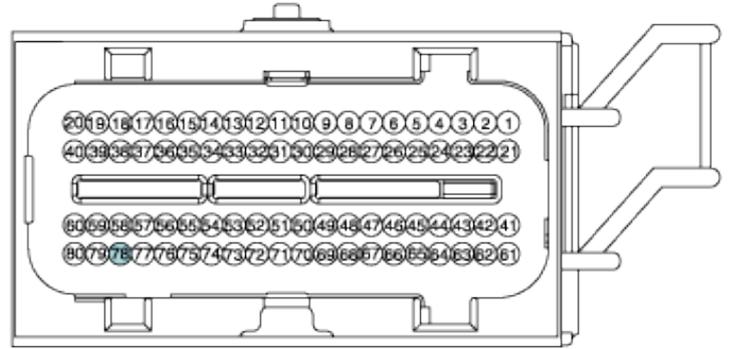
[CONNECTION INFORMATION]

Terminal	Connected to	Function
1	Main Relay	Battery Voltage (B+)
2	PCM C101-1 (78)	PCSV Control

[HARNES CONNECTORS]



**C117**  
PCSV

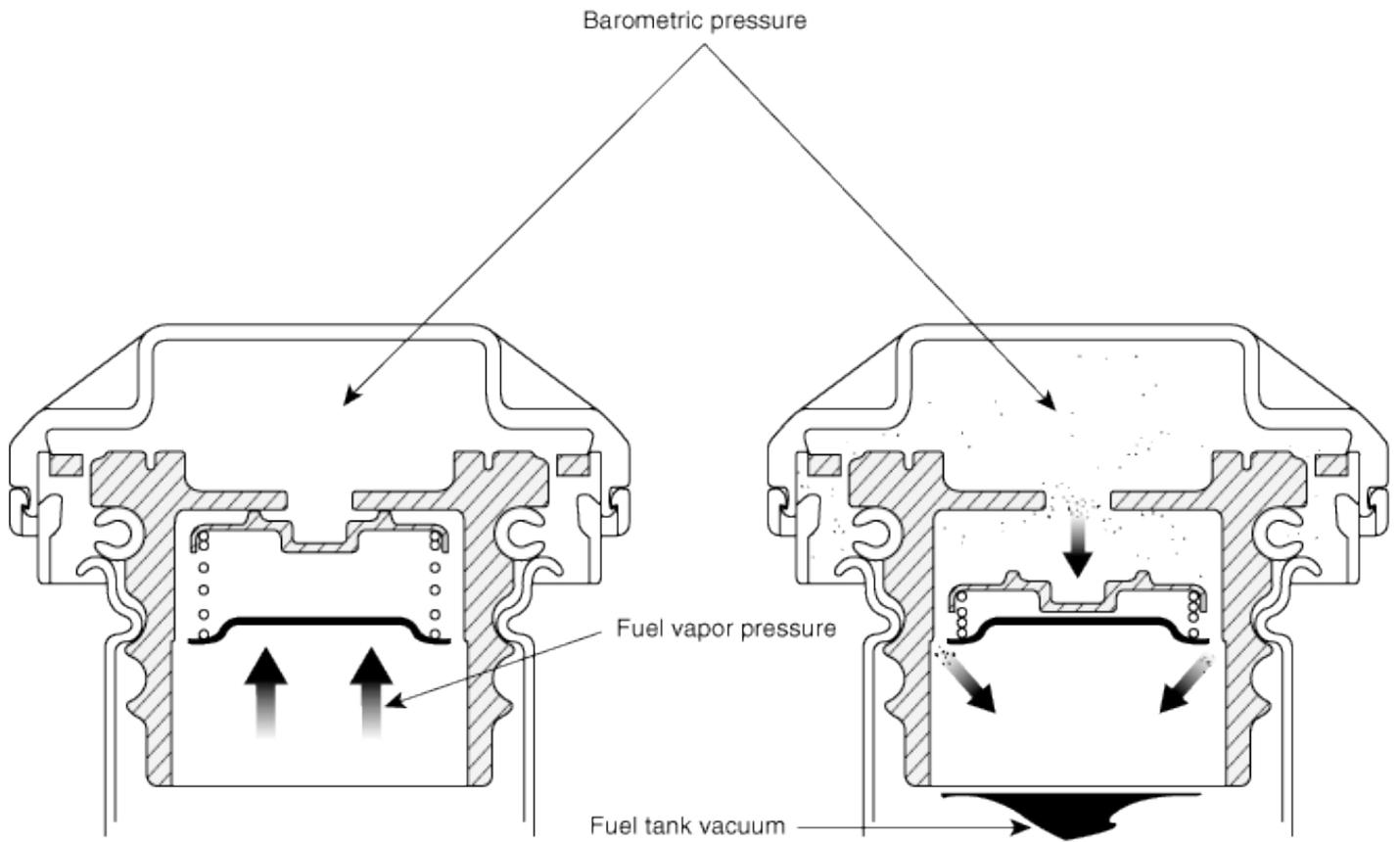


**C101-1**  
PCM

# Fuel Filler cap



## DESCRIPTION



When fuel tank is under pressure.

When fuel tank is under vacuum.

# **Exhaust Emission Control System**



## DESCRIPTION

Modifications to the combustion chamber, intake manifold, camshaft and ignition system form the basic control system. These items have been integrated into a highly effective system which controls exhaust emissions while maintaining good driveability and fuel economy.

### **AIR/FUEL MIXTURE CONTROL SYSTEM [MULTIPOINT FUEL INJECTION (MFI) SYSTEM]**

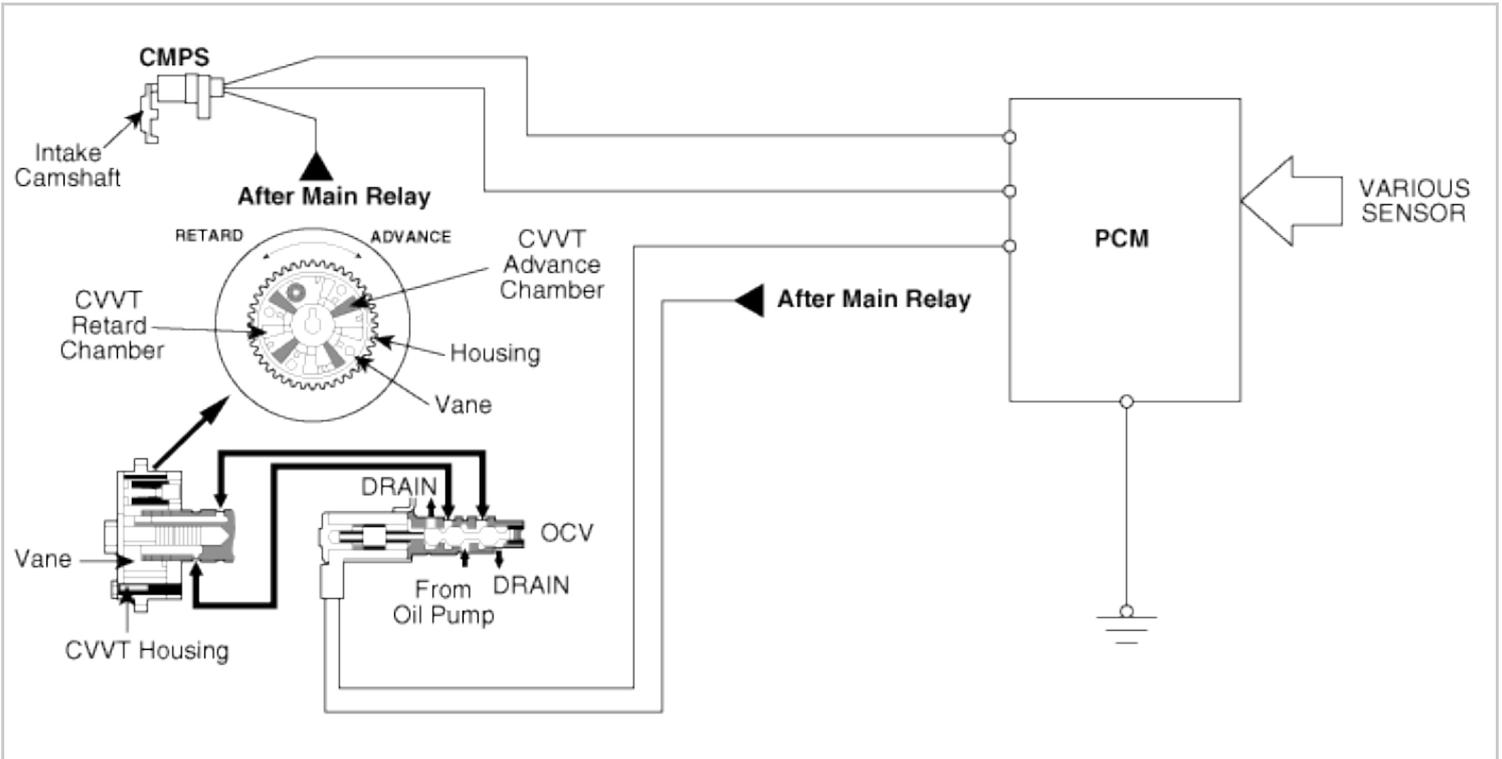
This in turn allows the engine to produce exhaust gases of the proper composition to permit the use of a three way catalyst. The three way catalyst is designed to convert the three pollutants (1) hydrocarbons (HC), (2) carbon monoxide (CO), and (3) oxides of nitrogen (NOx) into harmless substances. There are two operating modes in the MFI system.

1. Open Loop air/fuel ratio is controlled by information programmed into the ECM.
2. Closed Loop air/fuel ratio is adjusted by the ECM based on information supplied by the oxygen sensor.

**CVVT**  
**(Continuously Variable**  
**Valve Timing)**  
**System**



**DESCRIPTION**



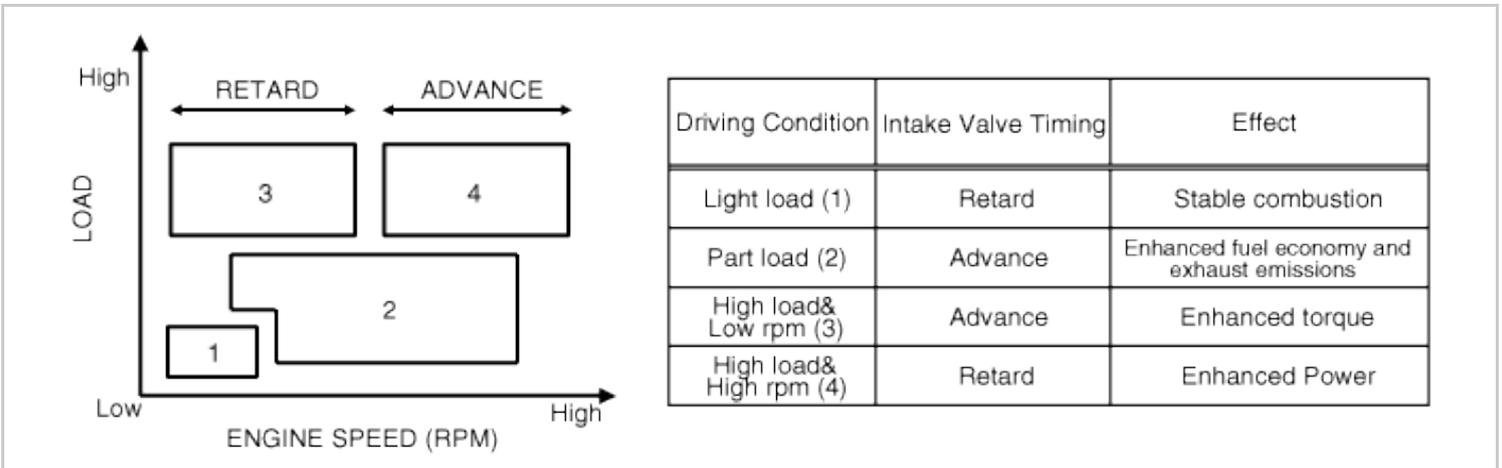
The CVVT (Continuously Variable Valve Timing) which is installed on the exhaust camshaft controls intake valve open and close timing in order to improve engine performance.

The intake valve timing is optimized by CVVT system depending on engine rpm.

This CVVT system improves fuel efficiency and reduces NOx emissions at all levels of engine speed, vehicle speed, and engine load by EGR effect because of valve over-lap optimization.

The CVVT changes the phase of the intake camshaft via oil pressure.

It changes the intake valve timing continuously.



**OPERATION**

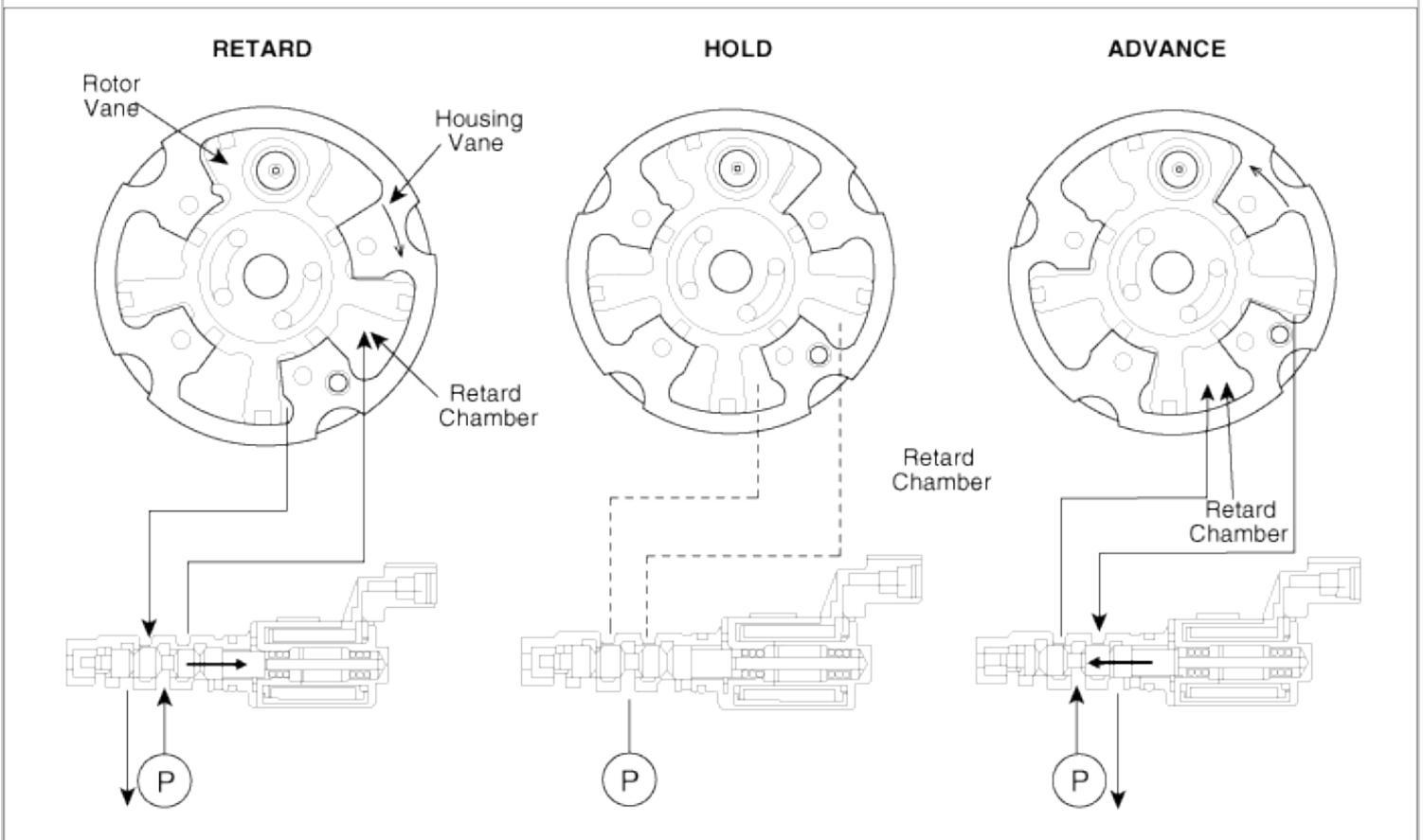
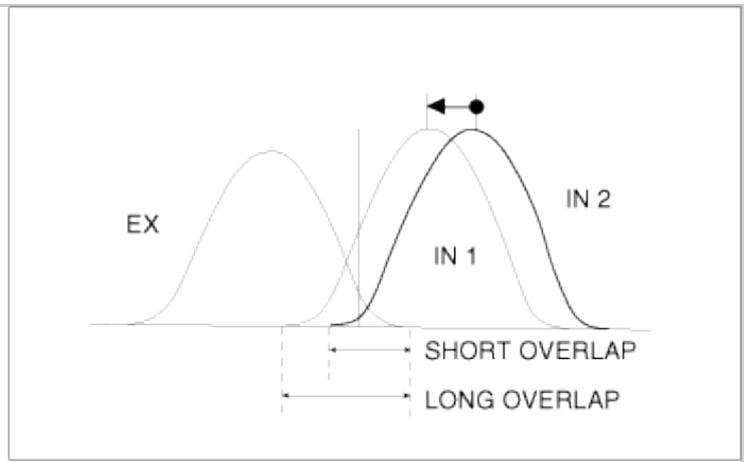
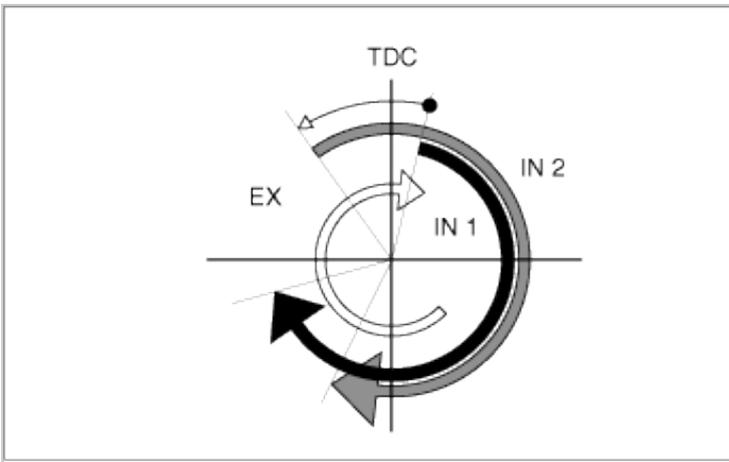
The CVVT system makes continuous intake valve timing changes based on operating conditions.

Intake valve timing is optimized to allow the engine to produce maximum power.

Cam angle is advanced to obtain the EGR effect and reduce pumping loss. The intake valve is closed quickly to reduce the entry of the air/fuel mixture into the intake port and improve the changing effect.

Reduces the cam advance at idle, stabilizes combustion, and reduces engine speed.

If a malfunction occurs, the CVVT system control is disabled and the valve timing is fixed at the fully retarded position.



1. The above figure shows the relative operation structures of the housing vane to the rotor vane.

2. If the CVVT is held a certain control angle, to hold this state, oil is replenished as much as oil leaks from the oil pump.

The OCV (Oil-flow Control Valve) spool location at this time is as follows.

Oil pump → Advance oil chamber (Little by little open the inflow side to the advance oil chamber) → Almost close the drain side

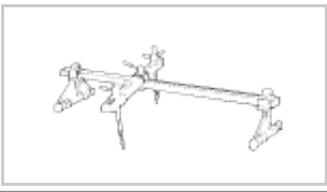
Be sure there might be a difference in the position according to the engine running state (rpm, oil temperature, and oil pressure).

## **CHAPTER 6:**

# **Automatic Transaxle System**

# **General Information**

**SPECIAL TOOLS**

<b>TOOL (Number and name)</b>	<b>Illustration</b>	<b>Use</b>
09200 - 38001 Engine support fixture		Removal and installation of transaxle.



## SPECIFICATIONS

Engine type		DIESEL(J2.9)	GASOLINE(λ-3.8)
Transaxle type		A5HF1	A5HF1
Gear ratio	1ST	4.497	←
	2ND	2.442	←
	3RD	1.686	←
	4TH	1.233	←
	5TH	0.868	←
	REV.	4.586	←
Final gear ratio		3.333	←
T/M oil capacity(ℓ)※		10.7	10.9

※ The quantity in the chart above is for the reference. The actual filling quantity of the automatic transaxle fluid must be set according to 'INSPECTION' or 'REPLACEMENT' procedure of the automatic transaxle fluid.

Recommended transaxle oil			Diamond ATF SP III or SK ATF SP III
Check & Replenishment			Every one year or every 20,000km Every one year or every 15,000km only for European countries
Replacement	Private use	Normal use	No service required Every 100,000km only for Australia Every 90,000km only for European countries
		Severe use(※)	Every 40,000km Every 45,000km only for European countries
	Business use		

※ Severe use(marked '※') is defined as:

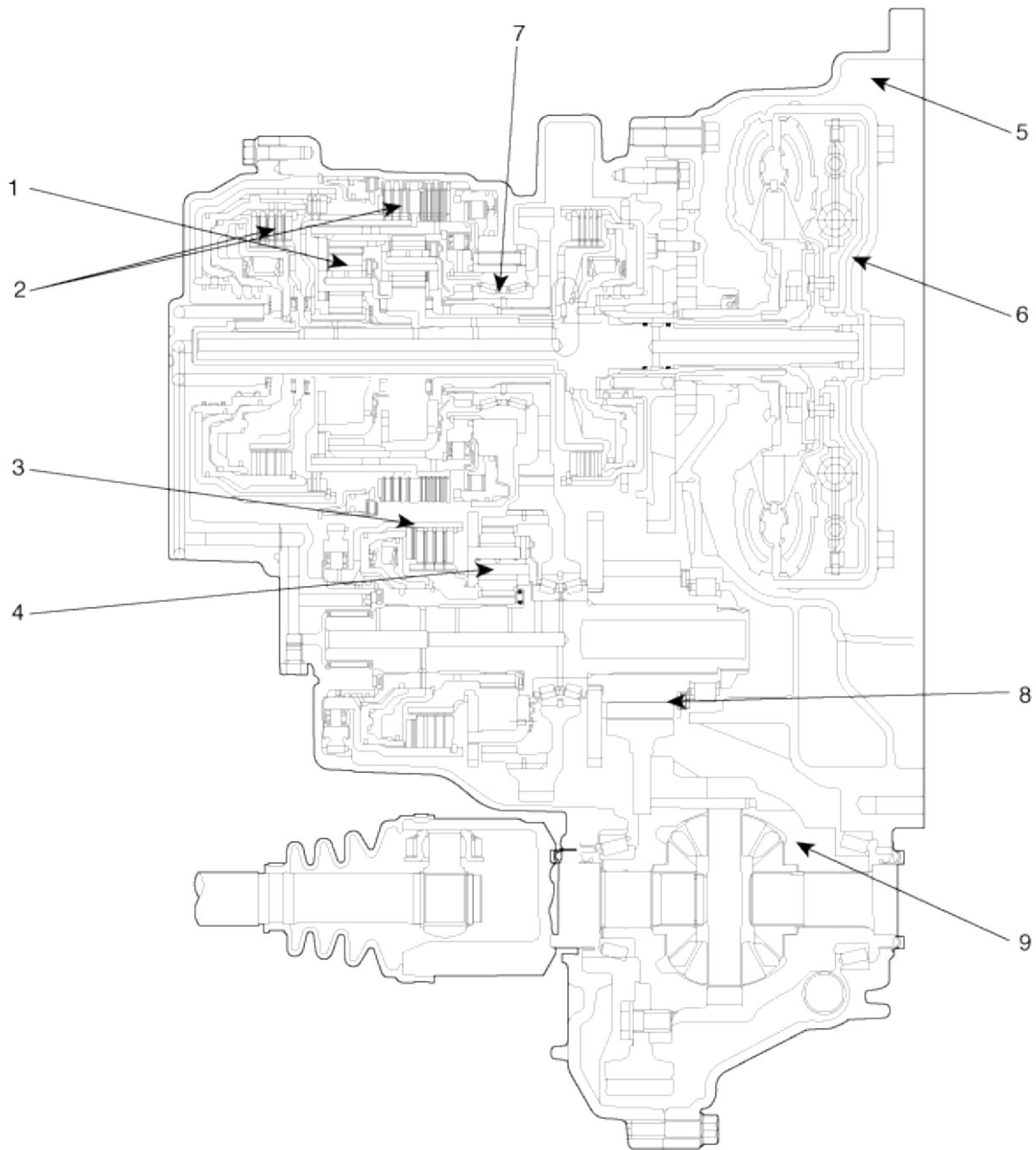
1. Driving on rough road(bumpy road, gravel road, snowy road, unpaved road etc.).
2. Driving on mountain road, ascent/descent.
3. Repetition of short distance driving.
4. More than 50% operation in heavy city traffic during hot weather above 32°C(89.6°F).
5. Police car, Taxi, Commercial type operation or trailer towing, etc.

# **Automatic Transaxle System**



## DESCRIPTION

### 1. Structure & Technical highlights



- |   |  |
|---|--|
| 1. Overdrive planetary gear (3→4 pinions)                     | 5. Case/ Housing intensity reinforced & redesigned |
| 2. SSP(Single sided plate)<br>-Overdrive clutch<br>-2ND brake | 6. High capacity torque converter                  |
| 3. Reduction band (Piston increased)                          | 7. Bearing outer diameter increased ( $\Phi 5$ mm) |
| 4. Direct planetary gear (3→4 pinions)                        | 8. Differential gear (Increased width by 2mm)      |
|   | 9. Differential capacity increased (6.1→7)         |

### 2. Variable Line Pressure Control

#### a. Description

a. Form the most suitable line pressure according to the vehicle driving condition

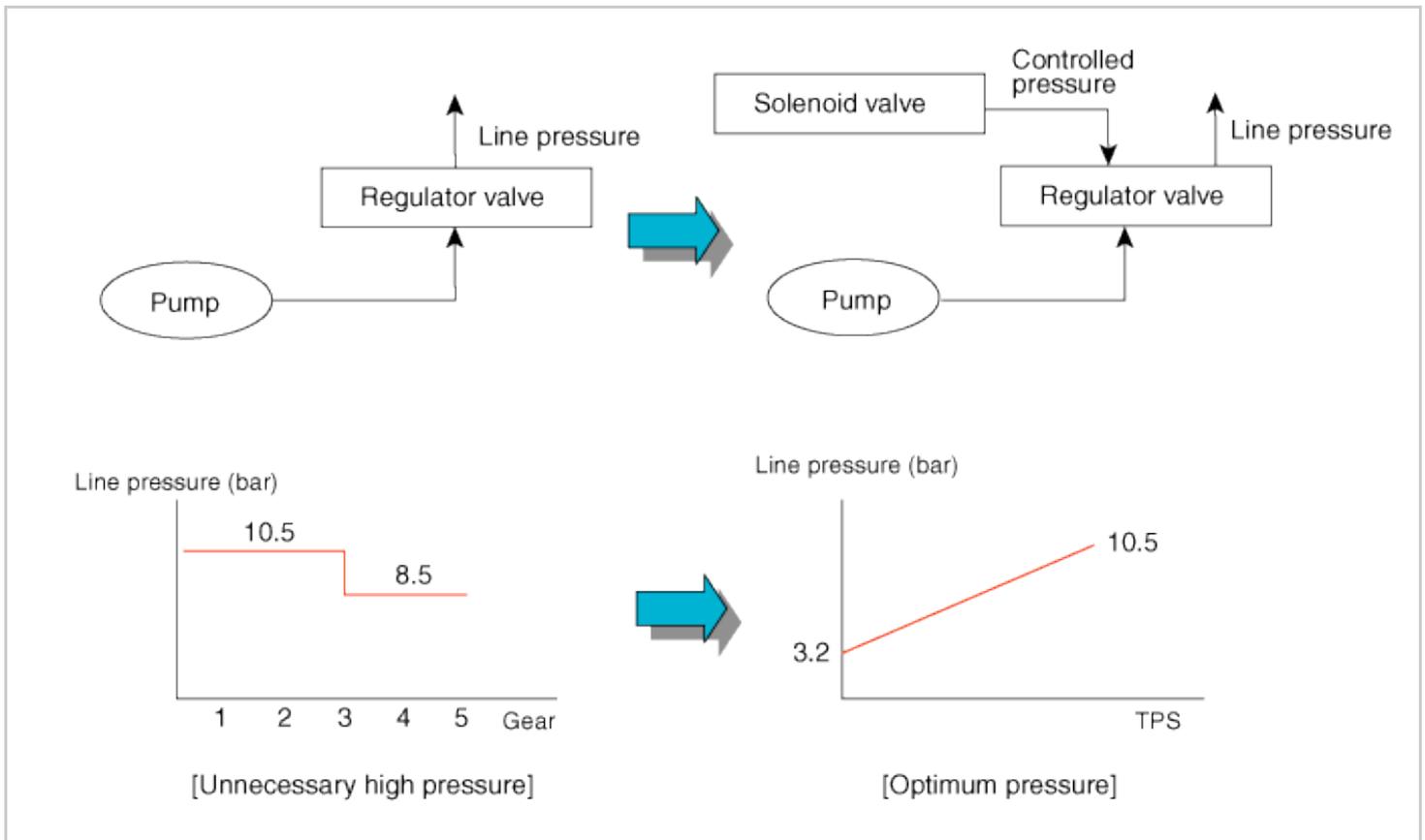
#### b. Special Features

a. VFS (Variable Force Solenoid) valve (For varying line pressure)

b. Reducing valve added(Stabilize control pressure in shiftings)

#### c. Effects

a. Improved power transmission efficiency and fuel consumption



3. Gear durability improvement and less-noisy gear development

a. Description

a. Optimal gear transmission ratio design from analyzing gears

b. Special Features

- a. Apply High-strength gear material
- b. Gear teeth width increased
- c. Planetary gear (3 pinions → 4 pinions)
- d. Less-noisy gear development

c. Effects

- a. Durability improvement
- b. Reduction of noise level

4. Case/Housing intensity reinforced

a. Description

a. Case/Housing intensity reinforced

b. Special Features

- a. Converter housing intensity reinforced(Ribs added and thickness increased)
- b. Most suitable stiff reinforcement through analyzing

c. Effects

- a. Intensity increased and banding vibration decreased
- b. NVH Performance improvement

5. New frictional material

a. Description

a. Apply new frictional material for capacity and durability improvement

b. Special Features

- a. SSP (Single Sided Plate) applied only on overdrive clutch and 2nd brake
- b. Apply the next generation frictional material(BWA 6100/D 0880-88)

c. Effects

- a. Thermal absorption capacity improvement
- b. Energy capacity and durability improvement

## MECHANICAL SYSTEM

### CLUTCHES AND BRAKES FOR EACH RANGE

	UD Clutch	OD Clutch	2ND Brake	LR Brake	REV Clutch	RED Brake	DIR Clutch	OWC 1	OWC 2
P	-	-	-	O	-	O	-	-	-
R	-	-	-	O	O	O	-	-	-
N	-	-	-	O	-	O	-	-	-
D	1st	O	-	O	-	O	-	●	●
	2nd	O	-	O	-	O	-	-	●
	3rd	O	O	-	-	O	-	-	●
	4th	-	O	O	-	O	-	-	●
	5th	-	O	O	-	-	O	-	-

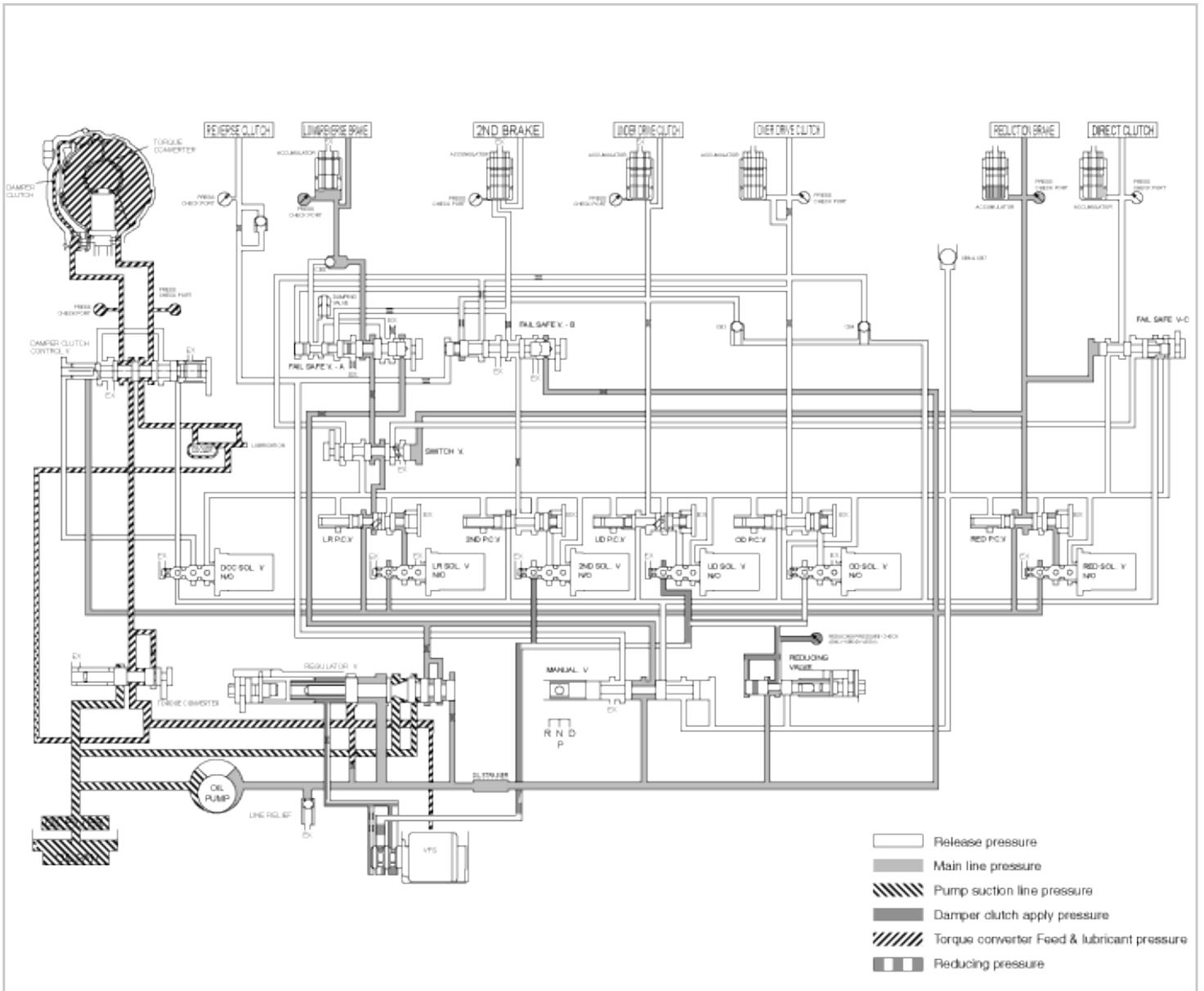
(● : Locked when driving)

### FUNCTIONS OF CLUTCHES AND BRAKES

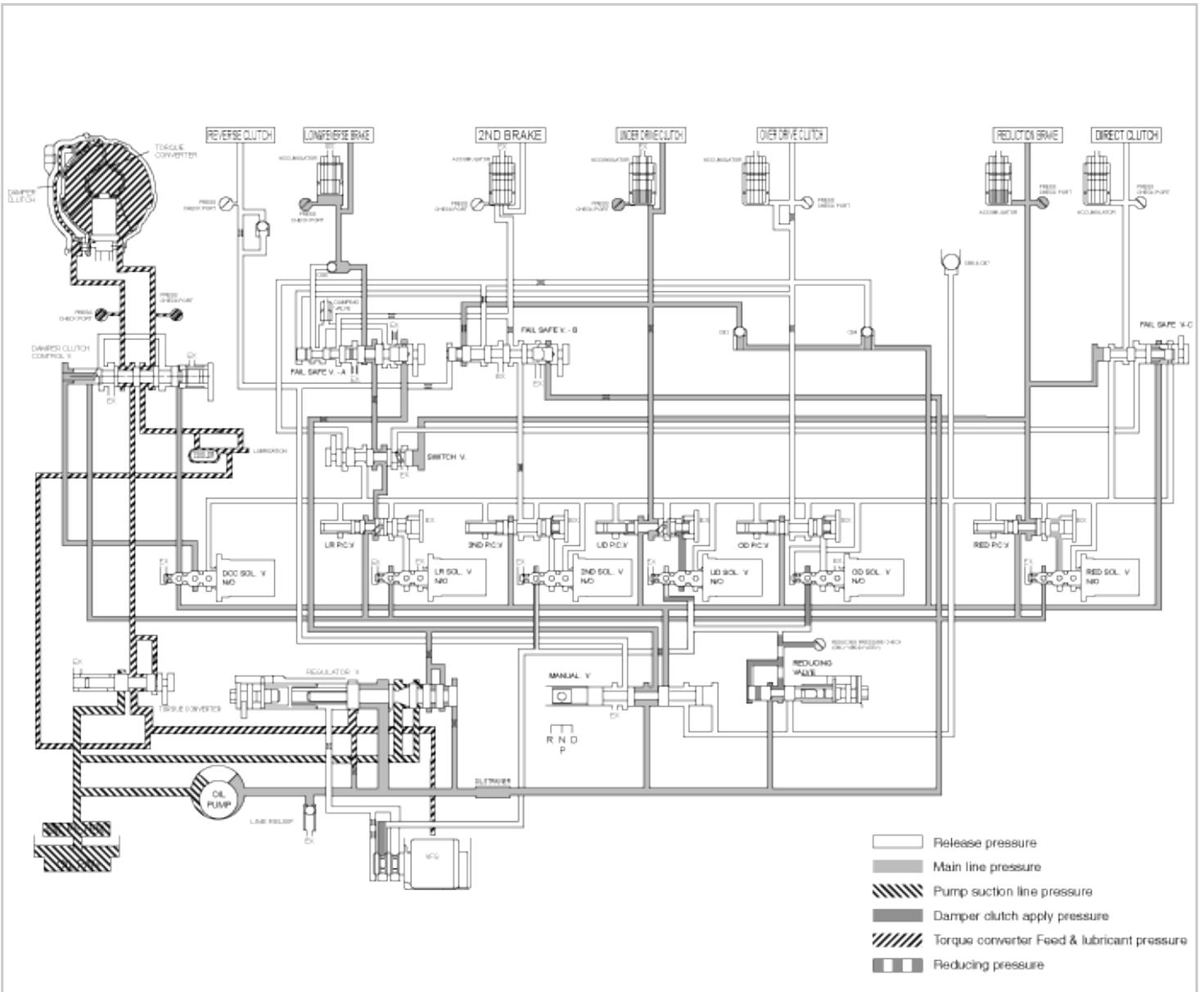
Element	Sign	Function
Underdrive clutch	UD	Connect the input shaft with the underdrive sun gear
Reverse clutch	REV	Connect the input shaft with the reverse sun gear
Overdrive clutch	OD	Connect the input shaft with the overdrive carrier
Direct clutch	DIR	Connect the direct sun gear with the direct carrier
Low& Reverse brake	LR	Fix the planetary gear and the overdrive carrier
2nd brake	2ND	Fix the reverse sun gear
Reduction brake	RED	Fix the direct sun gear
One way clutch 1	OWC 1	Control the rotational direction of the low&reverse ring gear
One way clutch 2	OWC 2	Control the rotational direction of the direct sun gear

### AUTOMATIC TRANSAXLE HYDRAULIC CIRCUIT

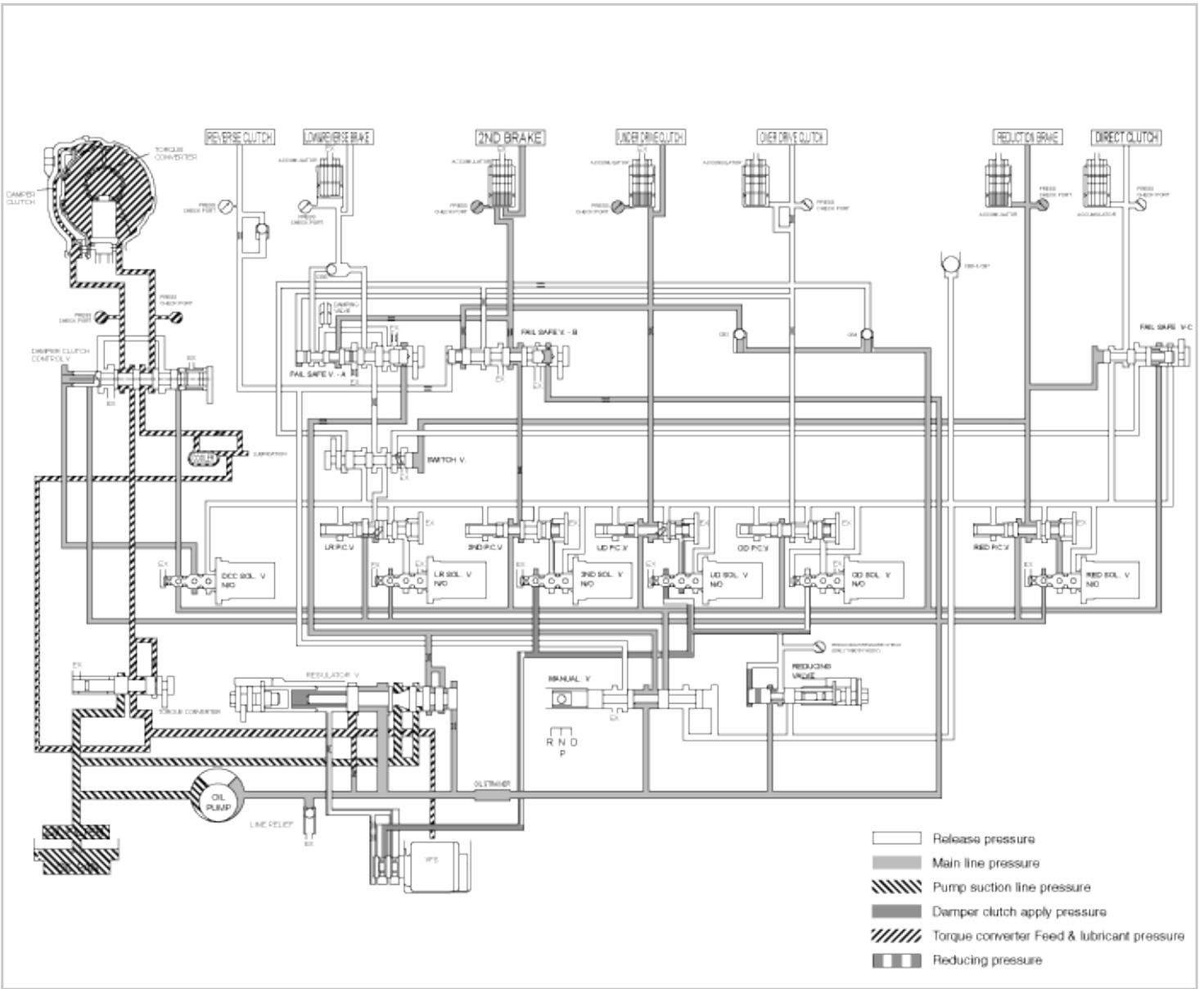
P/N



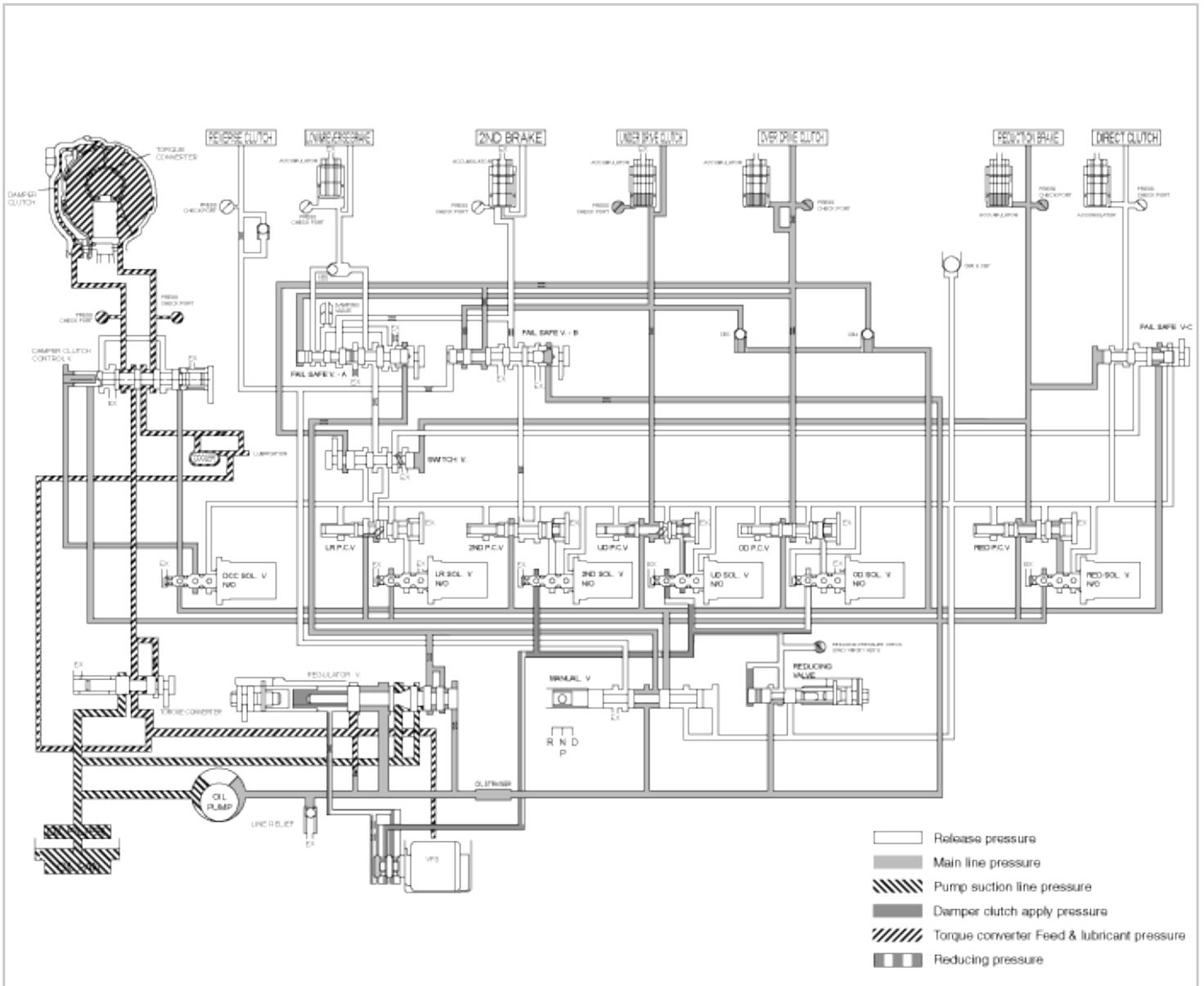
**D(1 RANGE)**



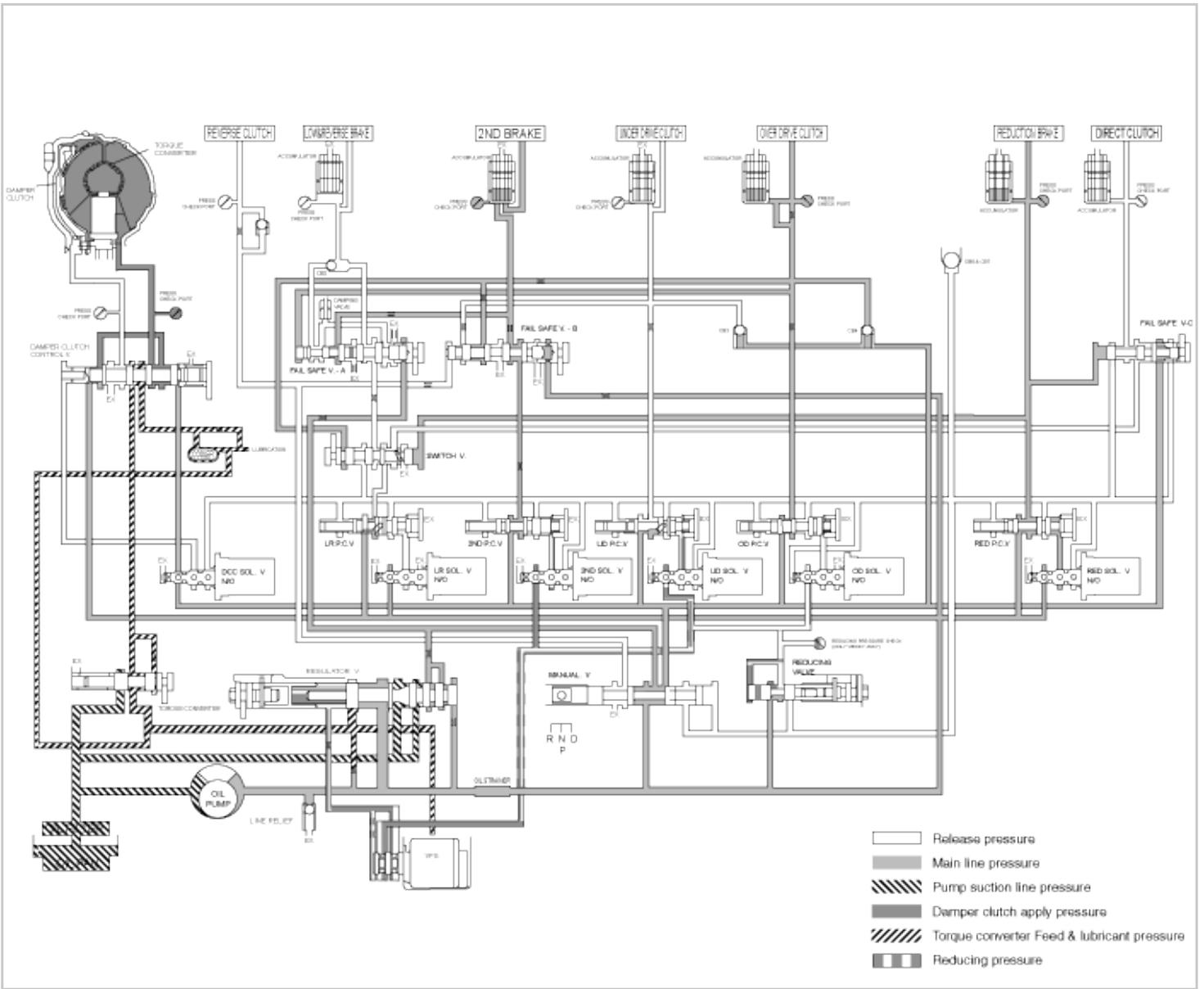
**D(2 RANGE)**



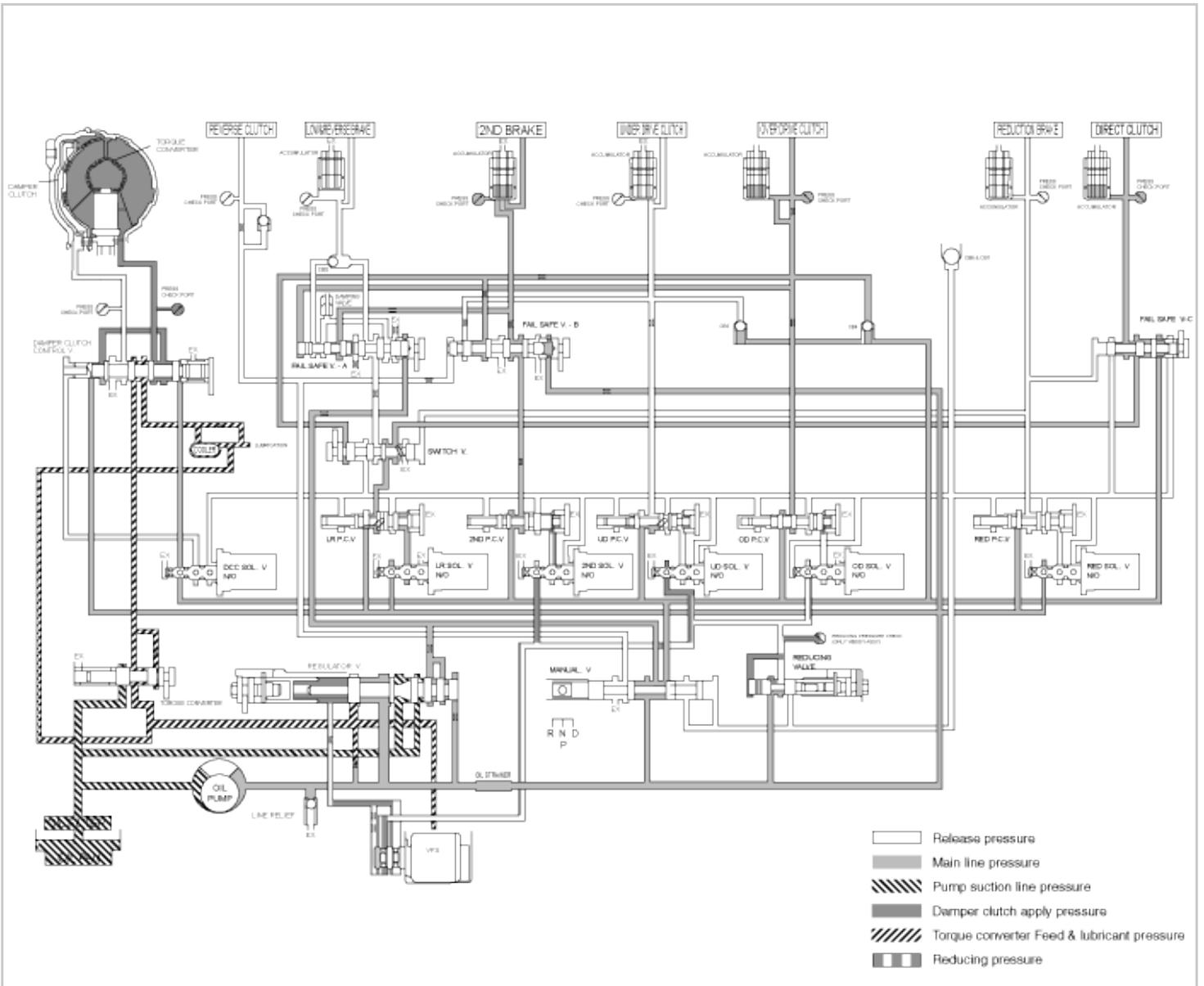
## D(3 RANGE)



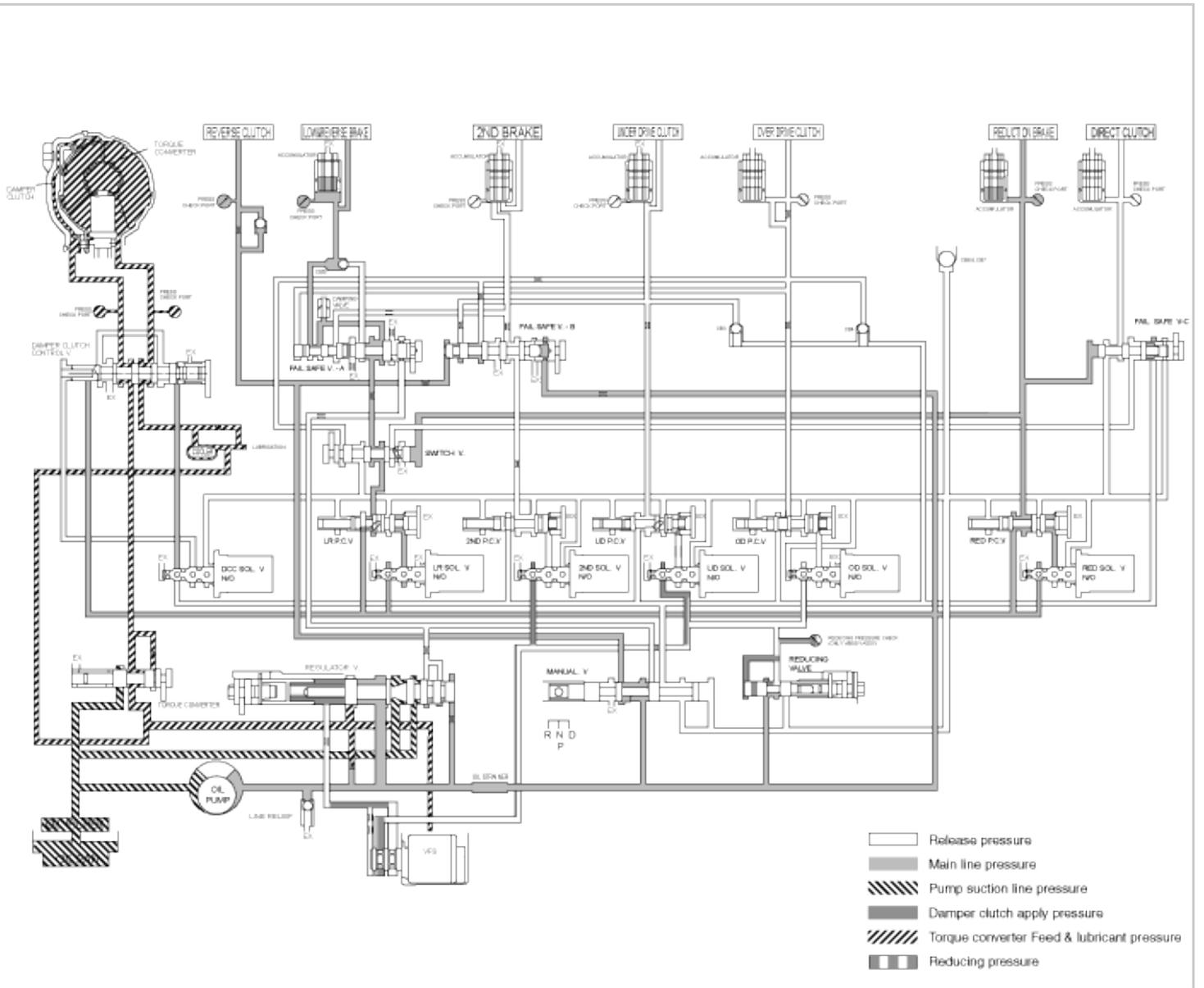
**D(4 RANGE)**



## D(5 RANGE)



## R RANGE





## SERVICE ADJUSTMENT PROCEDURE

### Automatic transaxle fluid

#### INSPECTION

1. Drive the vehicle until the fluid reaches normal operating temperature [70~80°C].
2. Place the vehicle on a level surface.
3. Move the selector lever through all gear positions. This will fill the torque converter and the hydraulic system with fluid and move the selector lever to the "N" (Neutral) or "P"(Park) position.
4. Before removing the oil level gauge, wipe all contaminants from around the oil level gauge. Then take out the oil level gauge and check the condition of the fluid.

#### NOTICE

If the fluid smells as if it is burning, it means that the fluid has been contaminated by fine particles from the bushes and friction materials, a transaxle overhaul may be necessary.

5. Check that the fluid level is at the HOT mark on the oil level gauge. If the fluid level is low, add automatic transaxle fluid until the level reaches the "HOT" mark.

Auto transaxle fluid:

DIAMOND ATF SP-III, SK ATF SP-III

Quantity : 10.7ℓ(Diesel), 10.9ℓ(Gasoline)

#### NOTICE

Low fluid level can cause a variety of abnormal conditions because it allows the pump to take in air along with fluid. Air trapped in the hydraulic system forms bubbles, which are compressible. Therefore, pressures will be erratic, causing delayed shifting, slipping clutches and brakes, etc. Improper filling can also raise fluid level too high. When the transaxle has too much fluid, gears churn up foam and cause the same conditions which occur with low fluid level, resulting in accelerated deterioration of automatic transaxle fluid. In either case, air bubbles can cause overheating, and fluid oxidation, which can interfere with normal valve, clutch, and brake operation. Foaming can also result in fluid escaping from the transaxle vent where it may be mistaken for a leak.

6. Insert the oil level gauge securely.

#### NOTICE

When new, automatic transmission fluid should be red. The red dye is added so the assembly plant can identify it as transmission fluid and distinguish it from engine oil or antifreeze. The red dye, which is not an indicator of fluid quality, is not permanent. As the vehicle is driven the transmission fluid will begin to look darker. The color may eventually appear light brown.

### REPLACEMENT

If you have a fluid changer, use this changer to replace the fluid. If you do not, replace it using the following procedure.

1. Disconnect the hose which connects the transmission and the oil cooler.
2. Start the engine and let the fluid drain out.

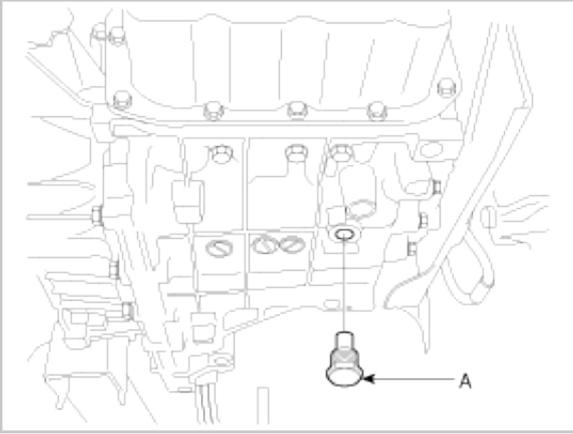
Running conditions : "N" range with engine idling.

#### CAUTION

The engine should be stopped within one minute after it is started. If the fluid has all drained out before then,

the engine should be stopped at that point.

3. Remove the drain plug(A) from the bottom of the transmission case to drain the fluid.



4. Install the drain plug via the gasket, and tighten it to the specified torque.

TORQUE :

40 ~ 50Nm (400 ~ 500 kgf.cm, 29 ~ 36 lb-ft)

5. Pour the new fluid in through the oil filler tube.

**CAUTION**

Stop pouring if the full volume of fluid cannot be poured in.

6. Repeat the procedure in step (2).

**NOTICE**

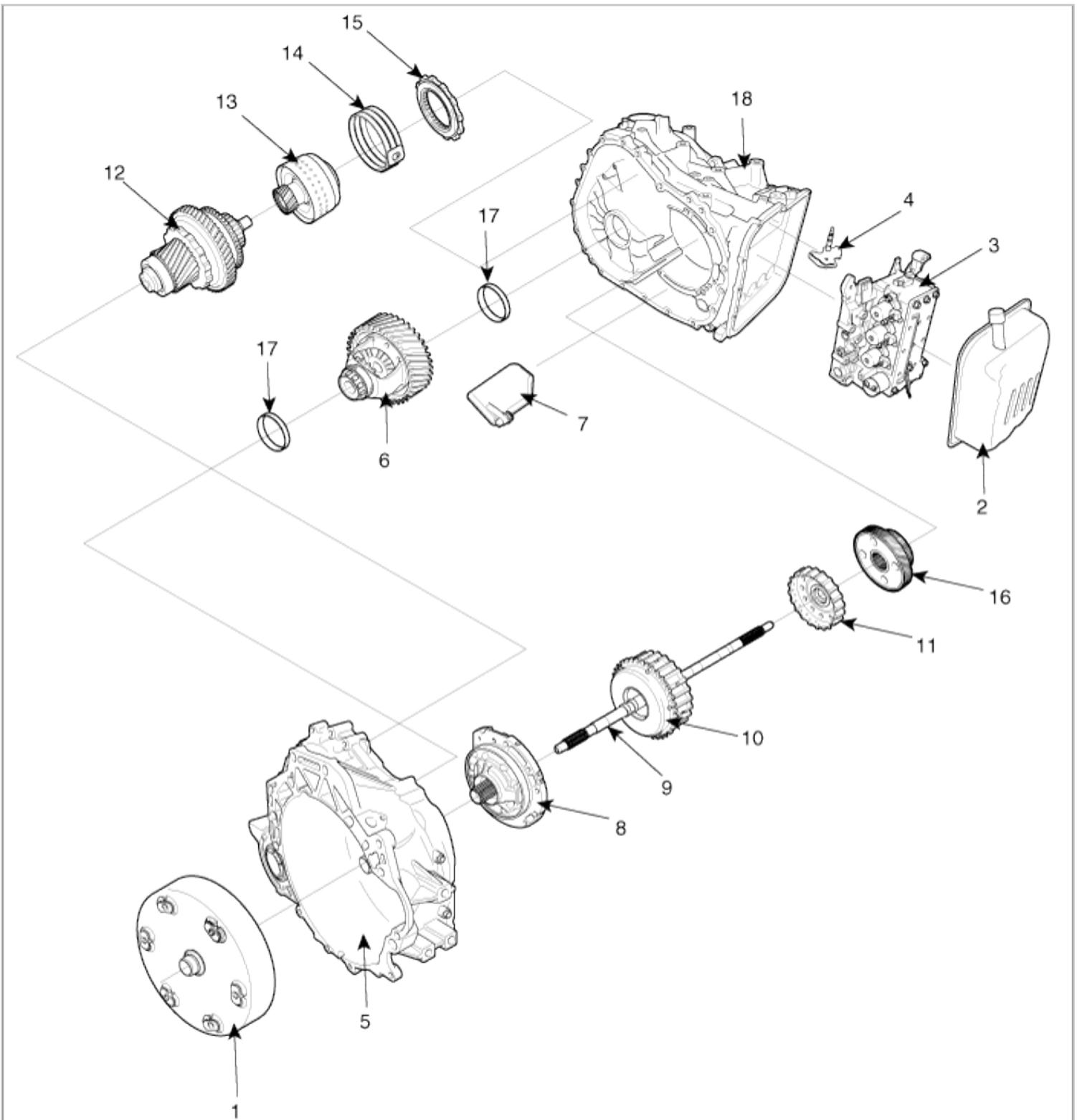
Check the old fluid for contamination. If it has been contaminated, repeat the steps (5) and (6).

7. Pour the new fluid in through the oil filler tube.
8. Reconnect the hose which was disconnected in step (1) above and firmly replace the oil level gauge.(In case of this "replace", this means after wiping off any dirt around the oil level gauge, insert it into the filler tube.)
9. Start the engine and run it at idle for 1~2 minutes.
10. Move the select lever through all positions, and then move it to the "N" position.
11. Drive the vehicle until the fluid temperature rises to the normal temperature (70~80°C), and then check the fluid level again. The fluid level must be at the HOT mark.
12. Firmly insert the oil level gauge into the oil filler tube.

# **Automatic Transaxle**

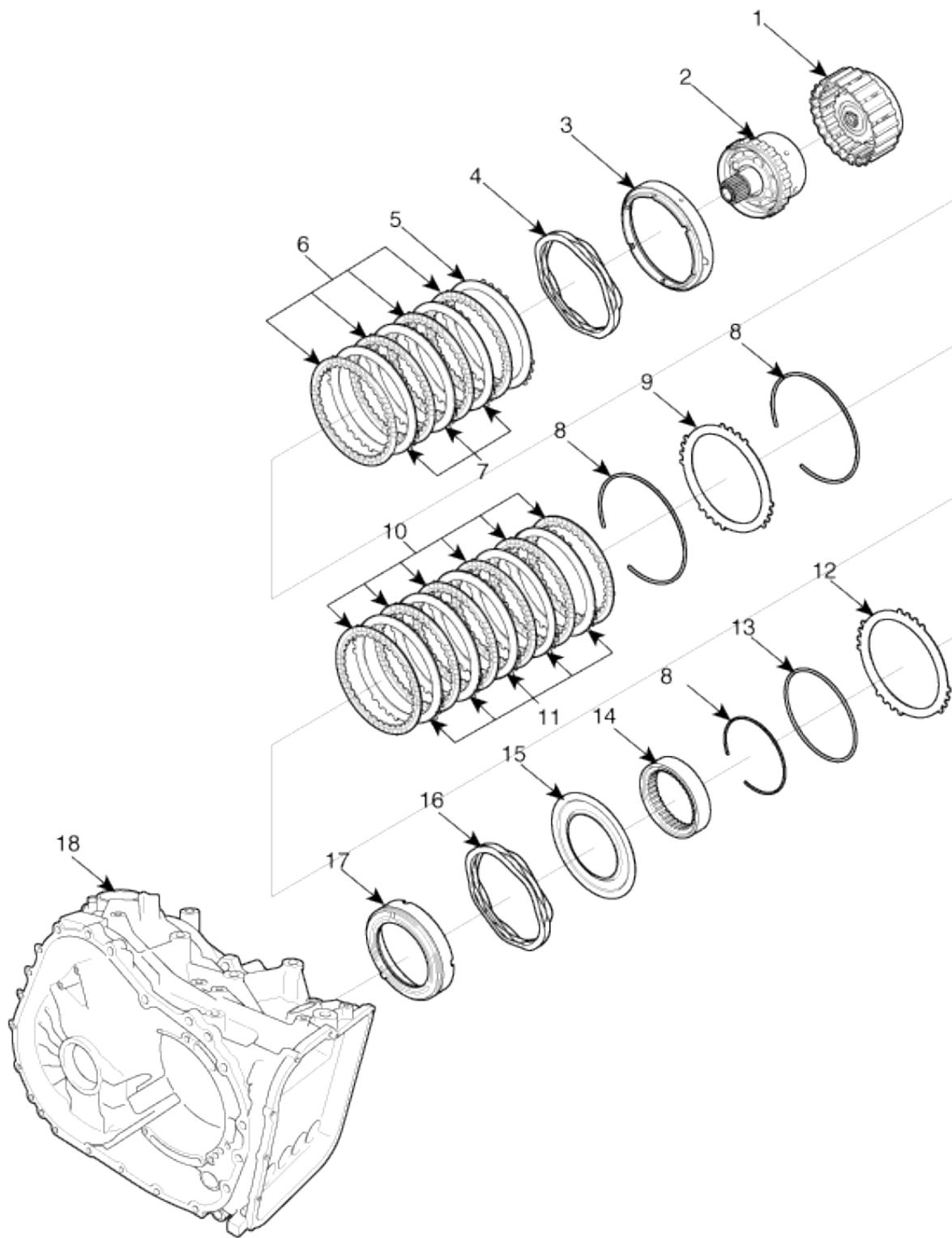


**COMPONENTS (1)**



- |                                  |                                       |                               |
|----------------------------------|---------------------------------------|-------------------------------|
| 1. Torque converter              | 7. Main oil filter                    | 13. Direct clutch assembly    |
| 2. Valve body cover              | 8. Oil pump                           | 14. Reduction brake band      |
| 3. Valve body assembly           | 9. Input shaft                        | 15. One way clutch            |
| 4. Manual control shaft assembly | 10. Underdrive clutch assembly        | 16. Transfer drive gear       |
| 5. Converter housing             | 11. Underdrive clutch hub             | 17. Differential bearing case |
| 6. Differential assembly         | 12. Direct planetary carrier assembly | 18. Transaxle case            |

**COMPONENTS (2)**



- 1. Reverse sun gear
- 2. Planetary gear assembly
- 3. 2nd brake retainer
- 4. 2nd brake return spring
- 5. 2nd brake pressure plate
- 6. 2nd brake discs

- 7. 2nd brake plates
- 8. Snap ring
- 9. Brake reaction plate
- 10. Brake discs
- 11. Brake plates
- 12. Low&Reverse brake pressure plate

- 13. Wave spring
- 14. Oneway clutch inner race
- 15. Brake spring retainer
- 16. Low&Reverse brake return spring
- 17. Low&Reverse brake piston
- 18. Transaxle case



## REMOVAL

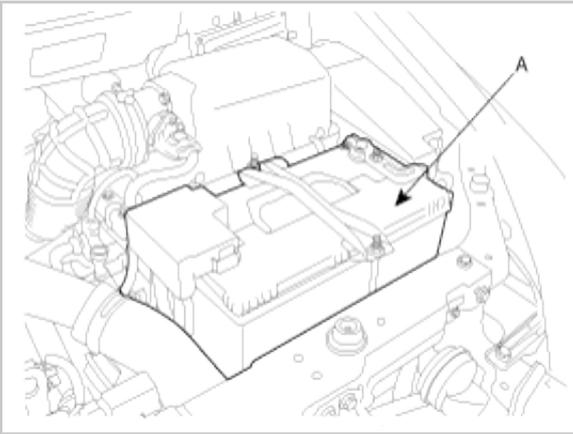
### CAUTION

- a. Use a cover not to damage the vehicle surface.
- b. Disconnect connectors carefully not to be damaged.

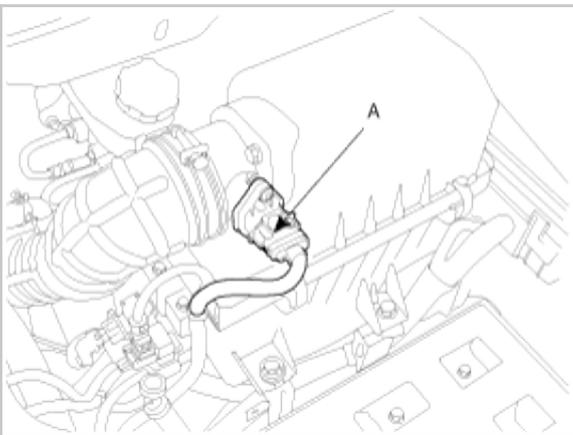
### NOTICE

- a. Mark wires or hoses for identification.

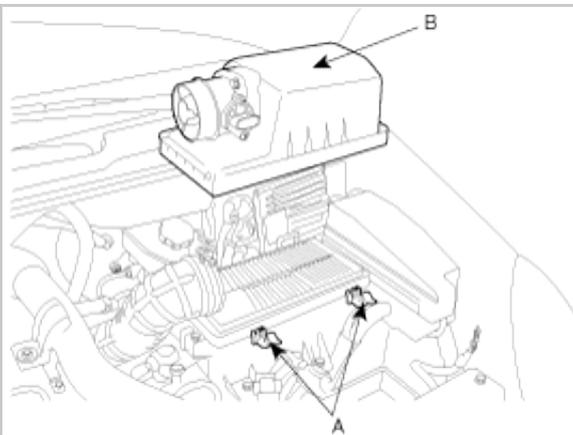
1. Remove the battery (A).



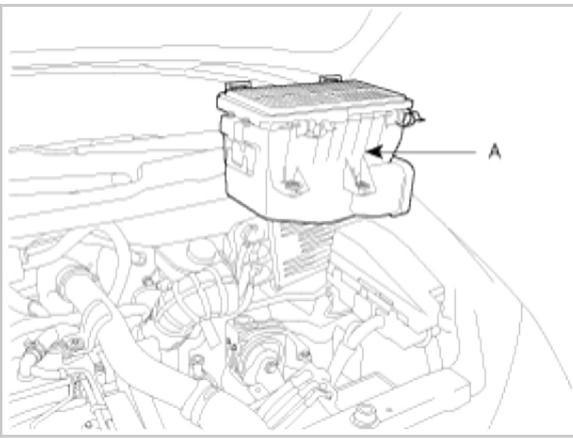
2. Disconnect the AFS connector (A).



3. Remove the air cleaner upper cover (B) by loosening the clips (A).

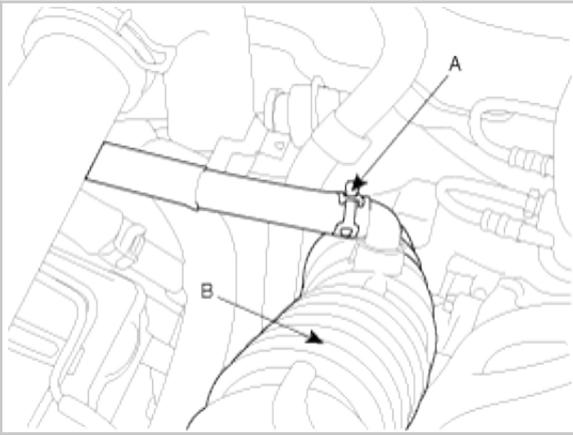


4. Remove the air cleaner assembly (A).

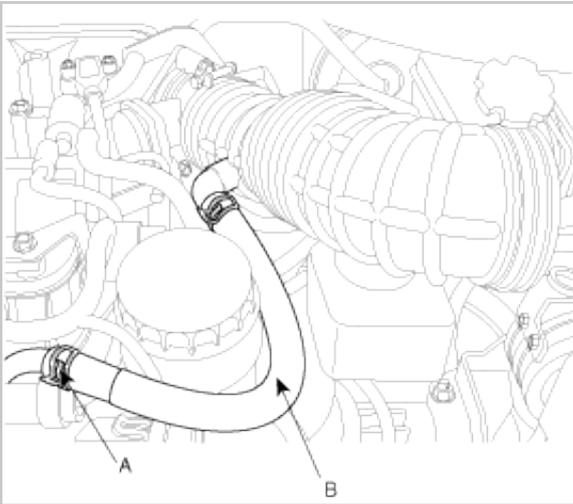


5. Disconnect the air cleaner hose (B) by loosening the clamp (A).

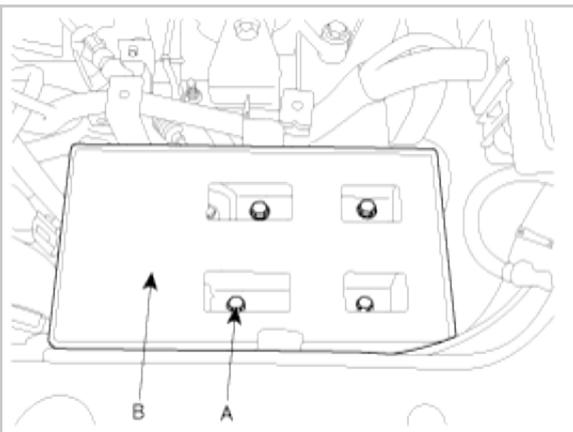
**[2.9 DSL]**



**[3.8 GSL]**

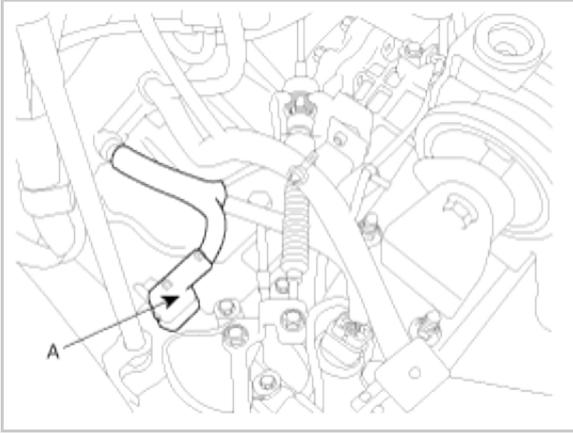


6. Remove the battery tray (B) by removing the four mounting bolts (A).



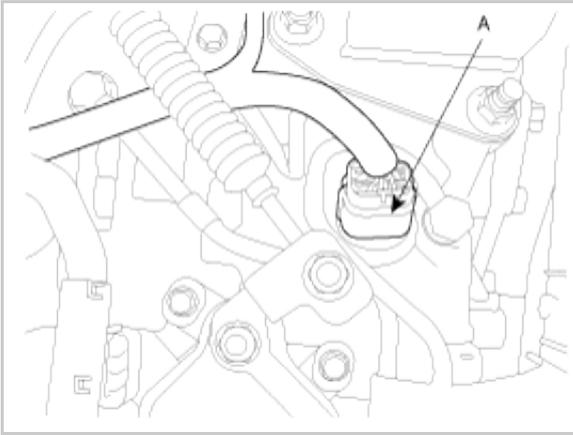
7. Disconnect the transaxle wire harness connectors.

(1) Remove the inhibitor switch connector (A).

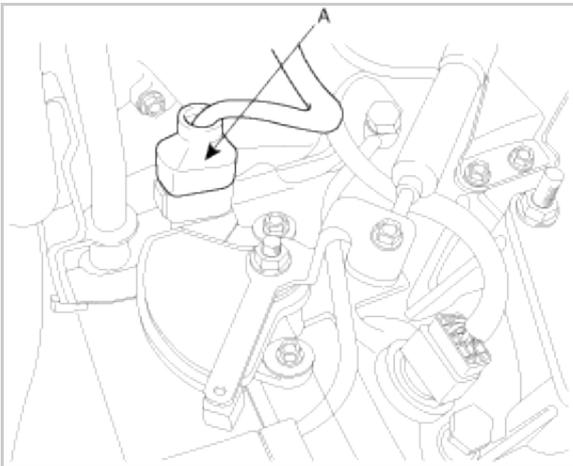


(2) Remove the solenoid valve connector (A).

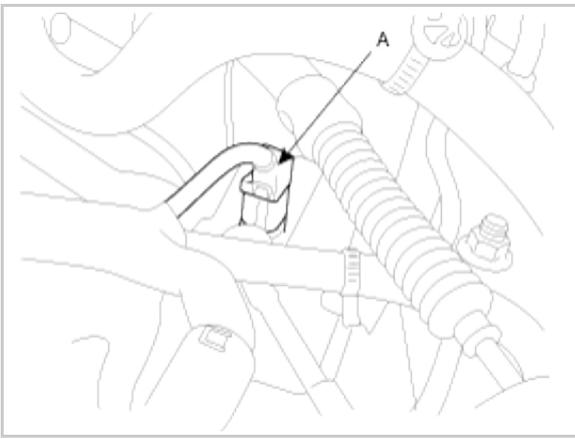
**[2.9 DSL]**



**[3.8 DSL]**



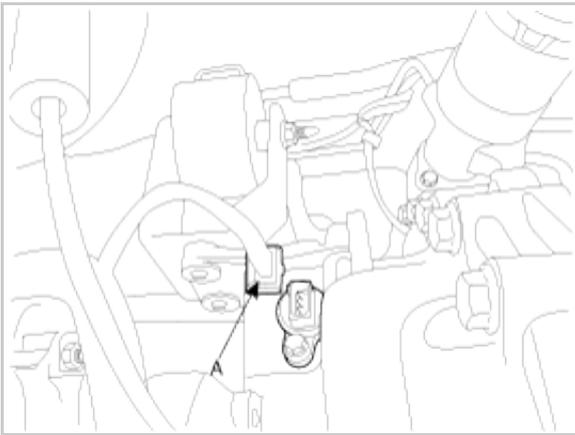
(3) Remove the input speed sensor connector (A).



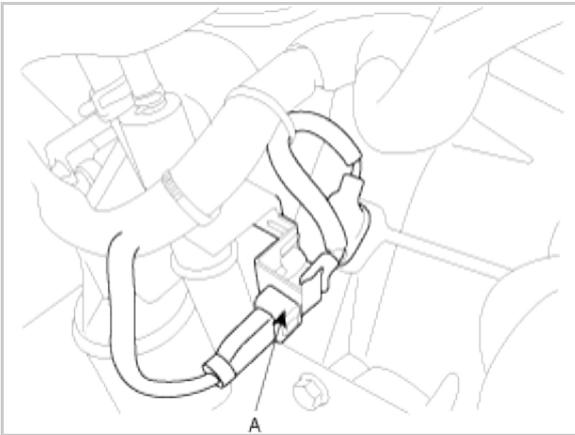
(4) Remove the output speed sensor connector (A).



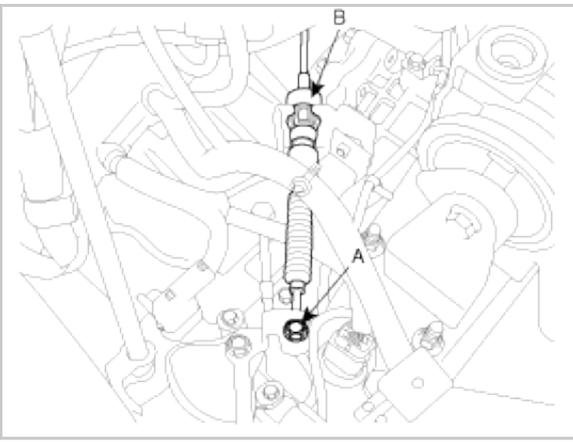
(5) Remove the vehicle speed sensor connector (A).



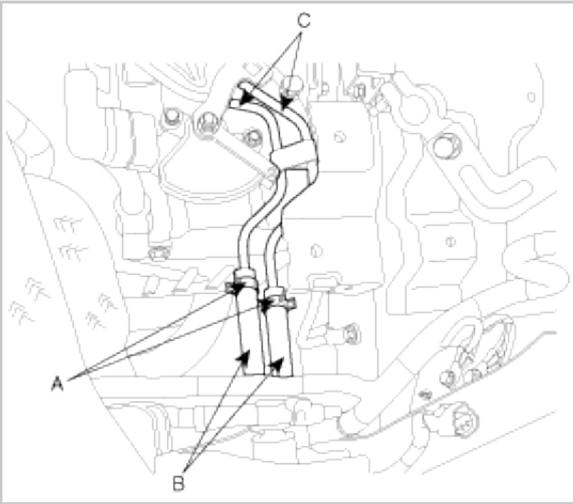
(6) Remove the CKP sensor connector (A).



8. Remove the shift cable by removing the bolt (A) and clip (B).

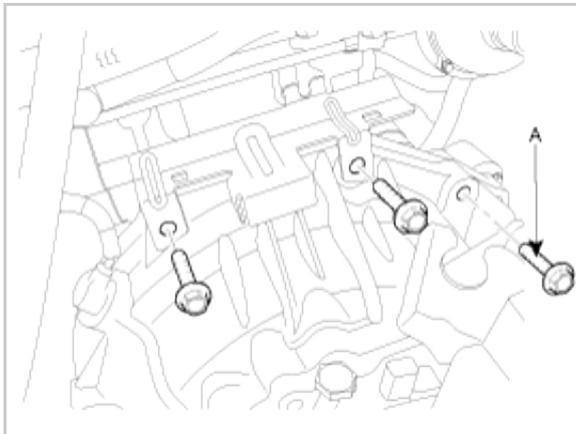


9. Disconnect the transaxle oil cooler hoses (A) from the tubes (C) by loosening the clamps (B).

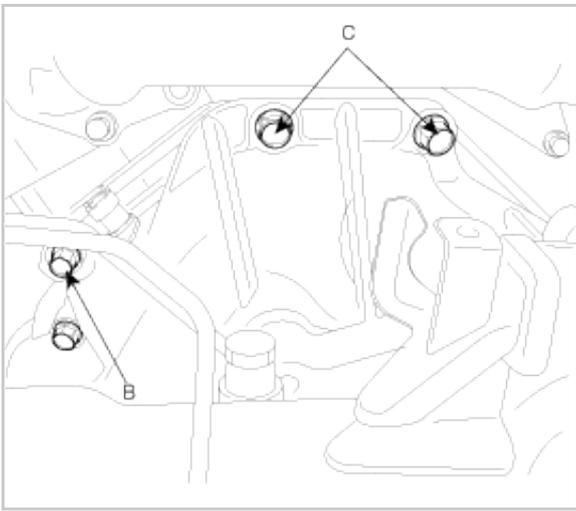


10. Remove the transaxle mounting bolts (A).

**[2.9 DSL]**

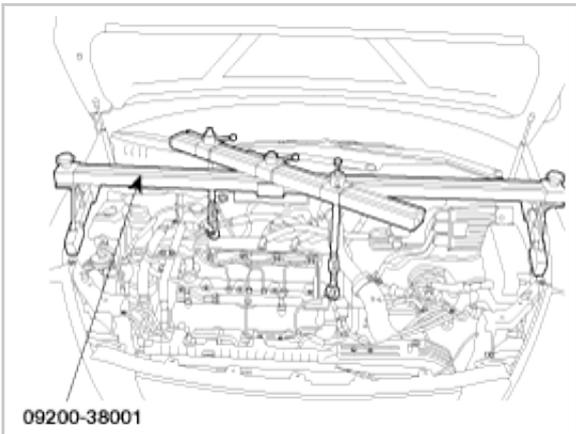


**[3.8 GSL]**

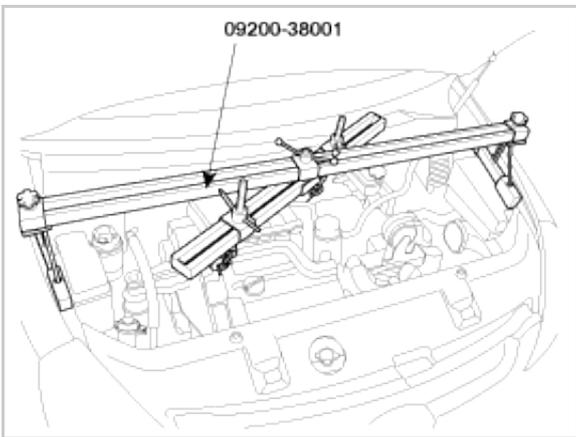


11. Using the SST(09200-38001), hold the engine and transaxle assembly safely.

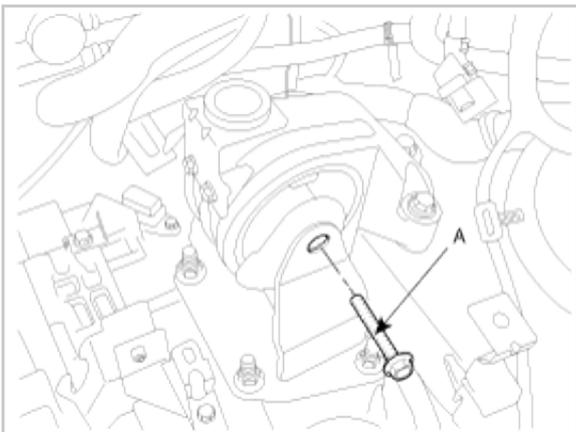
**[2.9 DSL]**



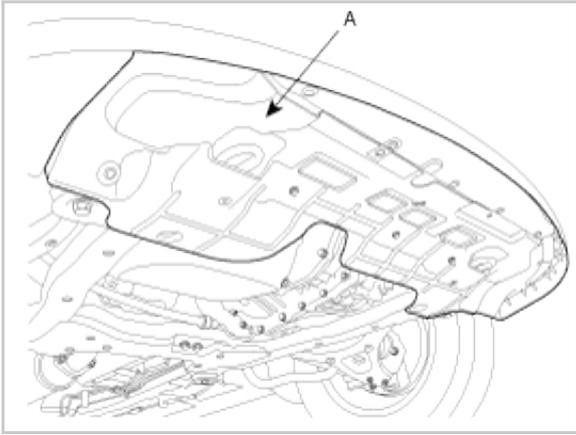
**[3.8 GSL]**



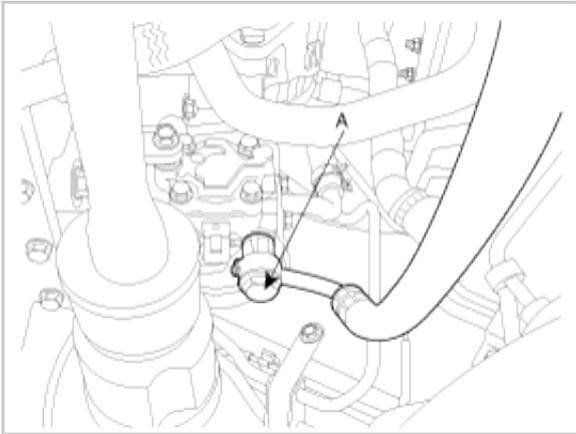
12. Remove the transaxle insulator mounting bolt (A).



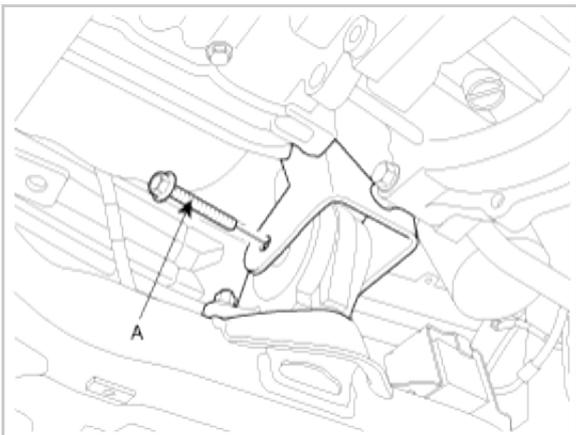
13. Remove the front wheels.
14. Remove the power steering column joint bolt. (see ST group)
15. Lift up the vehicle.
16. Remove the under cover (A).

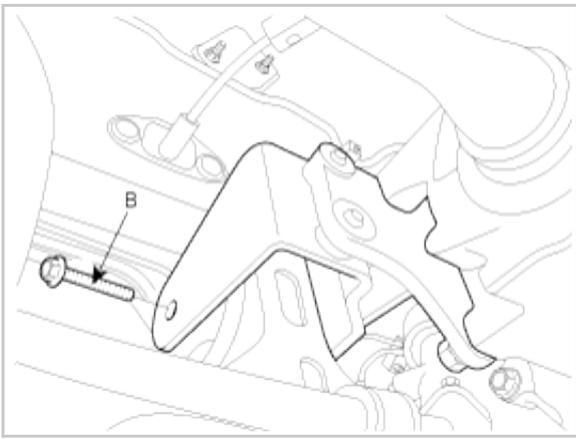


17. Drain transaxle oil.
18. Drain power steering oil through the return tube. (see ST group)
19. Disconnect the power steering pressure tube (A) from the power steering oil pump.



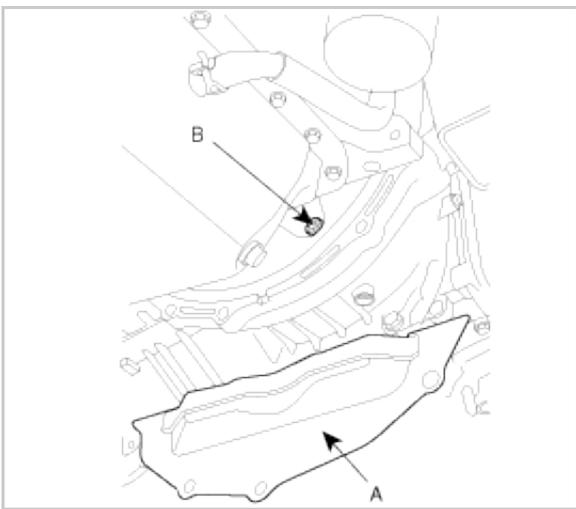
20. Disconnect the lower arm, the tie rod end ball joint, the stabilizer bar link from the front knuckle. (see SS group)
21. Remove the roll stopper mounting bolts (A,B).



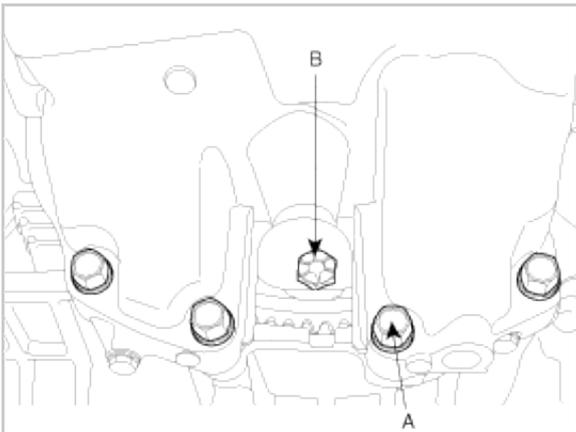


22. Remove the mounting bolts from the sub frame by supporting the sub frame with a jack. (see SS group)
23. Remove drive shaft from transaxle. (See DS group).
24. Install a jack for supporting the transaxle assembly.
25. Remove the plate (A) and the drive plate bolts (B).

### [2.9 DSL]



### [3.8 GSL]



26. Lifting the vehicle up and lowering the jack slowly, remove the transaxle assembly.

## INSTALLATION

Installation is in the reverse order of removal.

Perform the following :

- a. Adjust the shift cable.
- b. Refill the transaxle with fluid.
- c. Refill the radiator with engine coolant.
- d. Bleed air from the cooling system with the heater valve open.

e. Clean the battery posts and cable terminals with sandpaper, assemble them, and apply grease to prevent corrosion.

1. Lowering the vehicle or lifting up a jack, install the transaxle assembly.

2. Tighten the transaxle under mounting bolts.

---

TORQUE:

65~85 Nm(650~850 kgf.cm, 47.0~61.5 lb-ft)

---

3. Install the starter motor. (see EE group).

---

TORQUE:

65~85 Nm(650~850 kgf.cm, 47.0~61.5 lb-ft)

---

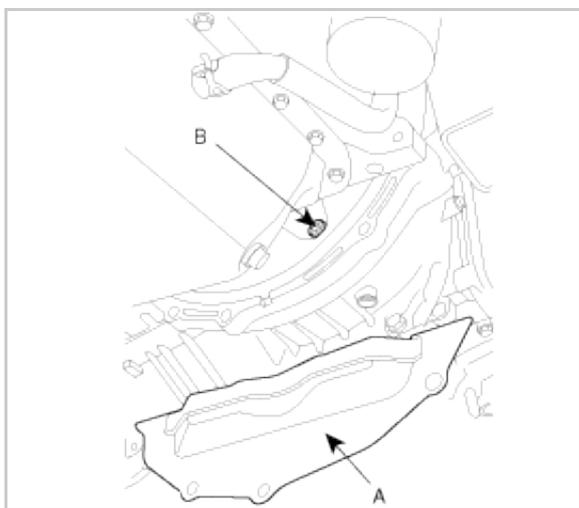
4. Install the drive plate bolts (B) by turning the timing gear and the plate (A).

---

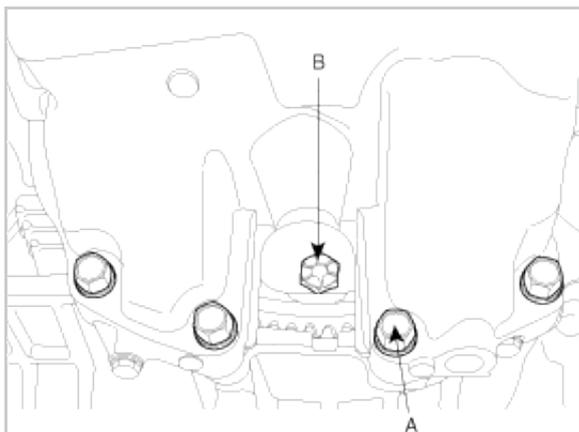
TORQUE:46~53 Nm(460~530 kgf.cm, 33.3~38.3 lb-ft)

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### [2.9 DSL]



### [3.8 GSL]



5. After removing a jack, insert the drive shafts. (see DS group)

6. Install the sub frame. (see SS group).

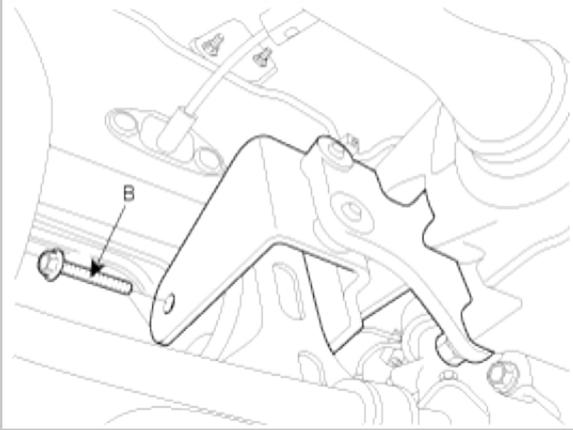
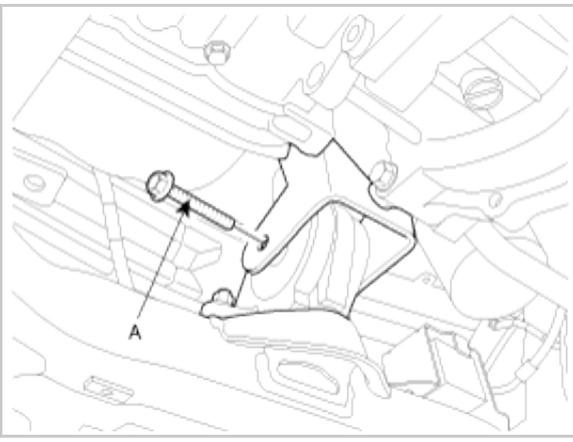
7. Tighten the roll stopper mounting bolts (A,B)

---

TORQUE:

90~110 Nm(900~1100 kgf.cm, 65.1~79.5 lb-ft)

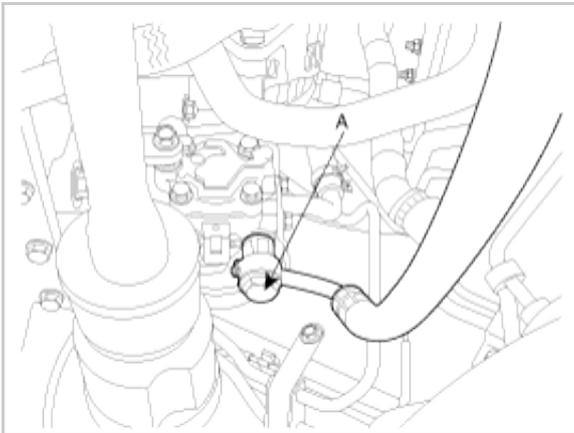
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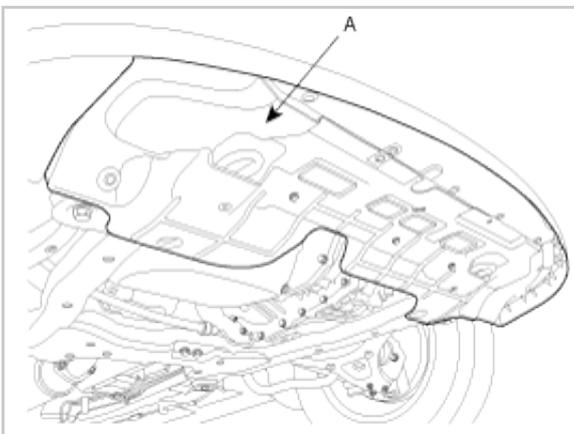
8. Connect the return tube with a clamp. (see ST group)

9. Connect the lower arm, the tie rod end ball joint, the stabilizer bar link to the front knuckle. (see SS group)

10. Connect the power steering pressure tube (A) to the power steering oil pump.



11. Install the under cover (A).



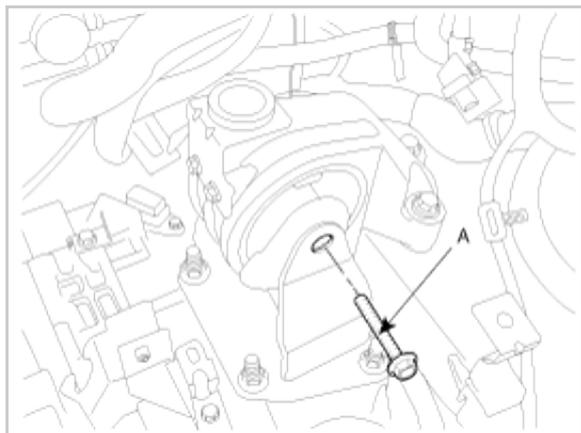
12. Install the steering column joint bolt. (see ST group).

13. Install the front wheels and tires.

14. Tighten the transaxle insulator mounting bolt (A).

TORQUE:

90~110 Nm(900~1100 kgf.cm, 65.1~79.5 lb-ft)

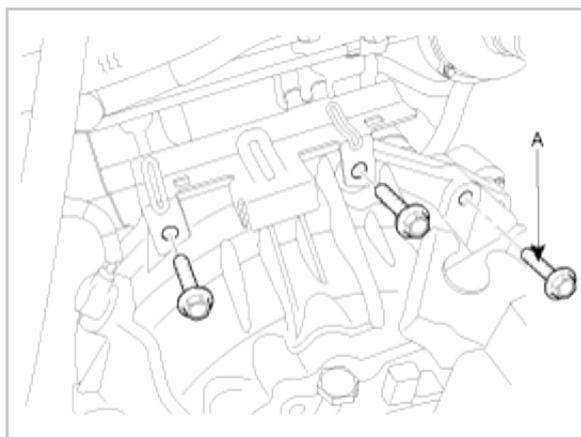


15. Tighten the transaxle mounting bolts (A).

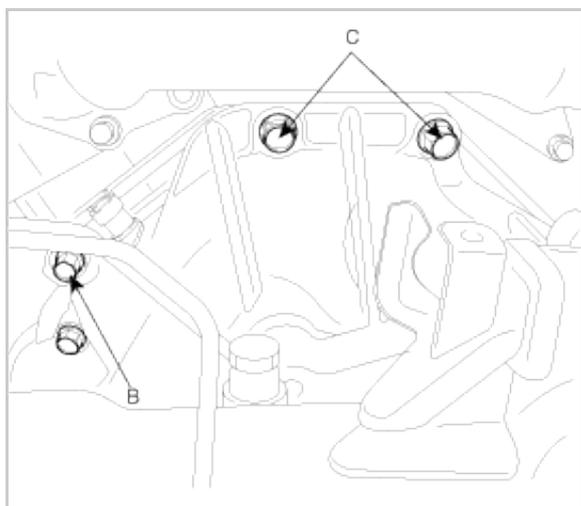
TORQUE:

65~85 Nm(650~850 kgf.cm, 47.0~61.5 lb-ft)

### [2.9 DSL]

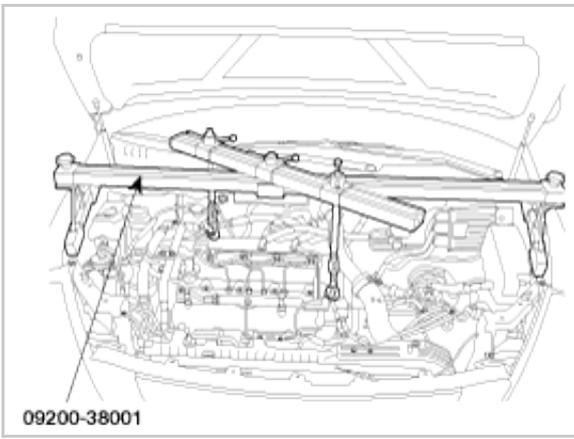


### [3.8 GSL]

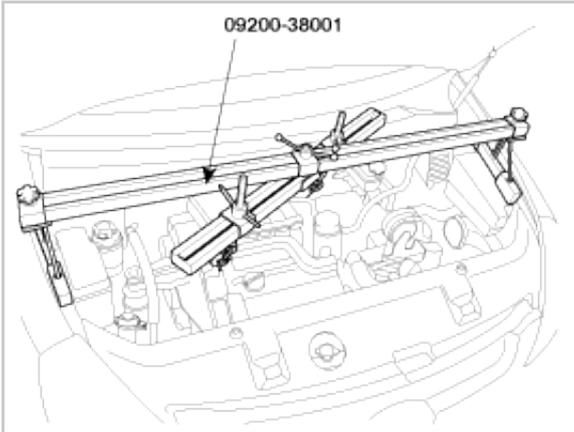


16. Remove the SST (09200-38001) holding the engine and transaxle assembly.

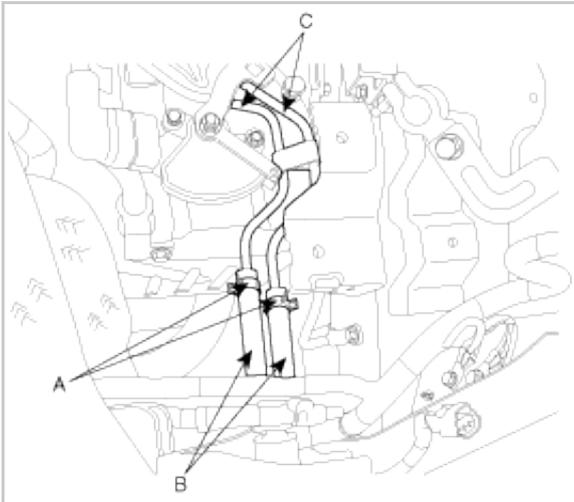
### [2.9 DSL]



### [3.8 GSL]



17. Connect the transaxle oil cooler hoses (A) to the tubes (C) by fastening the clamps (B).



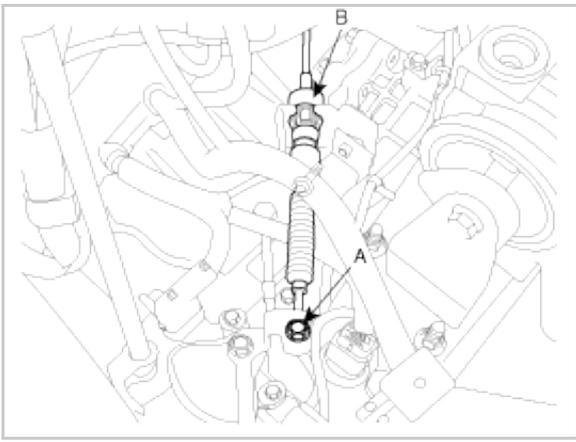
18. Install the shift cable by tightening the bolt (A) and clip (B).

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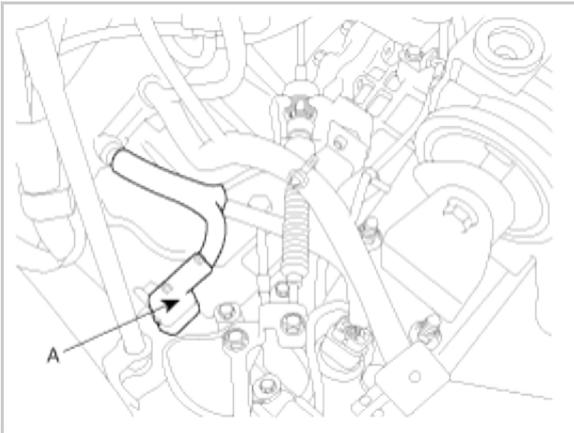
TORQUE:

10~14 Nm(100~140 kgf.cm, 7.2~10.1 lb-ft)

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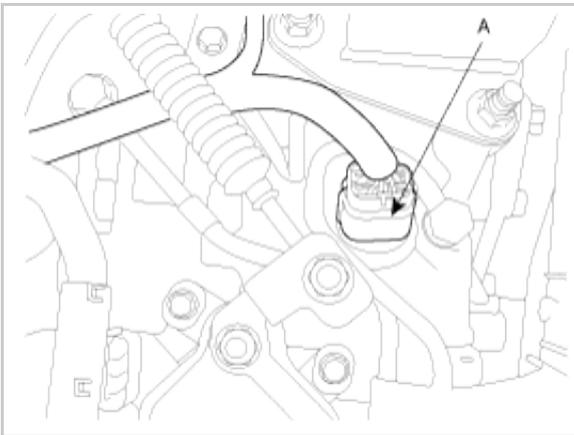


19. Connect the transaxle wire harness connectors.  
(1) Install the inhibitor switch connector (A).

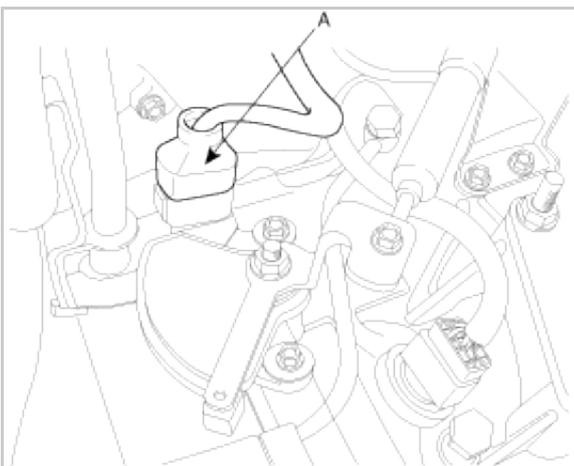


- (2) Install the solenoid valve connector (A).

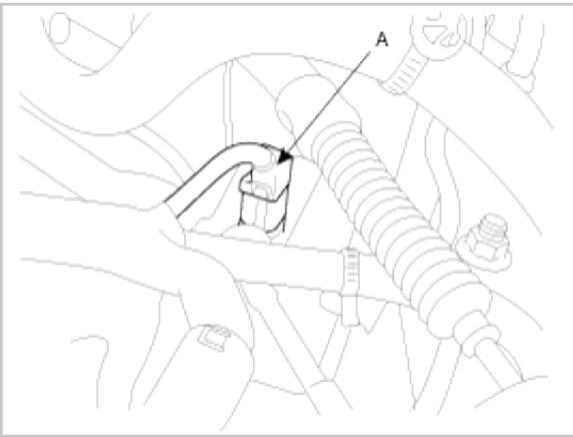
**[2.9 DSL]**



**[3.8 GSL]**



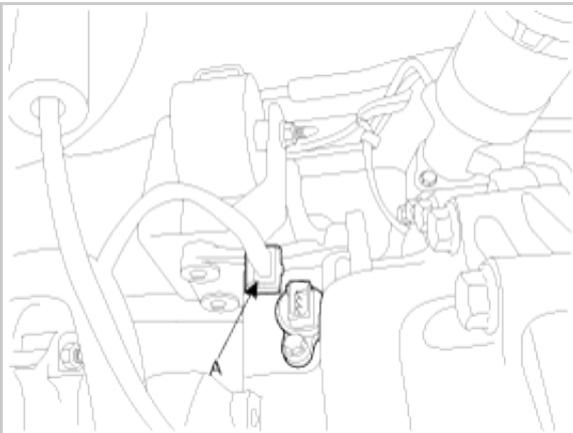
(3) Install the input speed sensor connector (A).



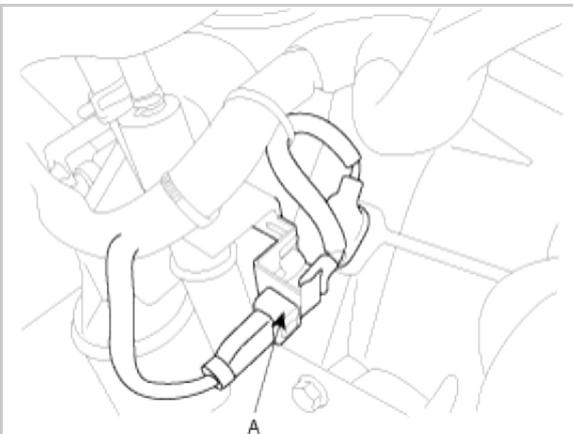
(4) Install the output speed sensor connector (A).



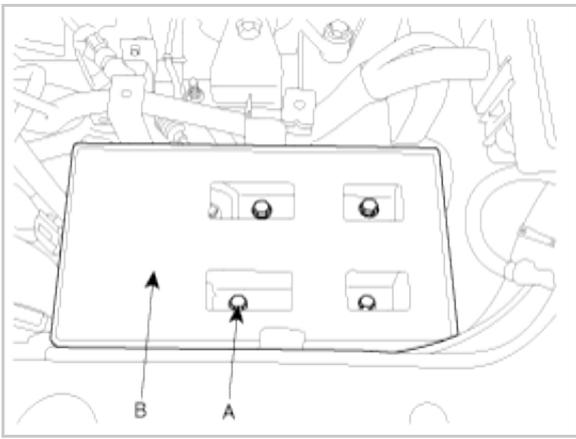
(5) Install the vehicle speed sensor connector (A).



(6) Install the CKP sensor connector (A).

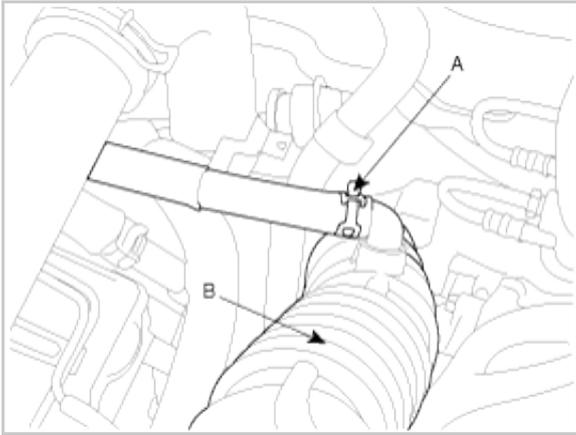


20. Install the battery tray (B) by tightening the four mounting bolts (A).

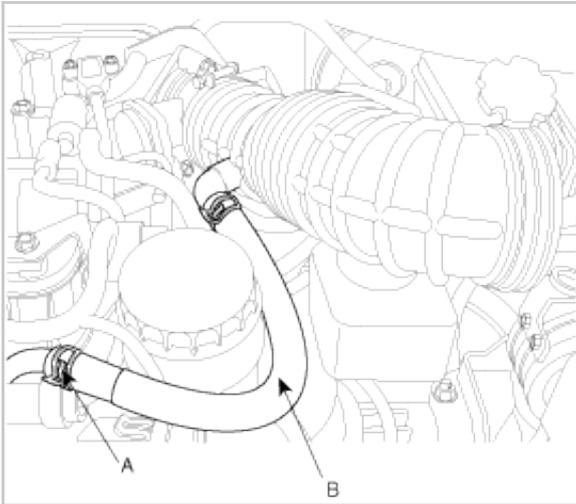


21. Connect the air cleaner hose (B) by fastening the clamp (A).

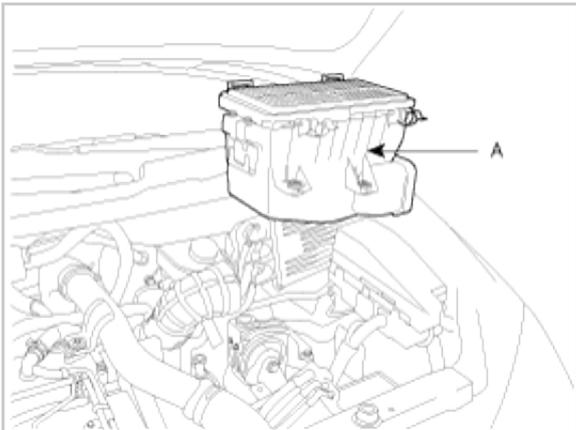
**[2.9 DSL]**



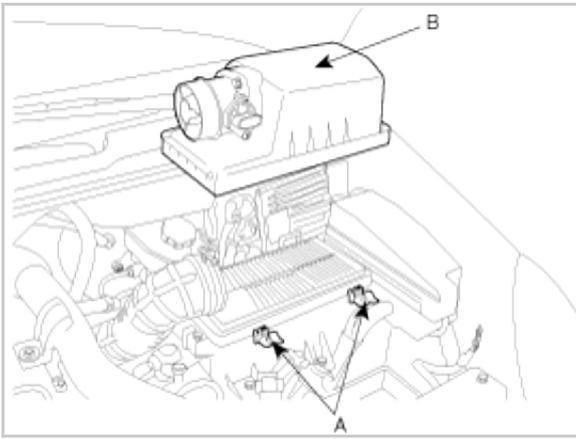
**[3.8 GSL]**



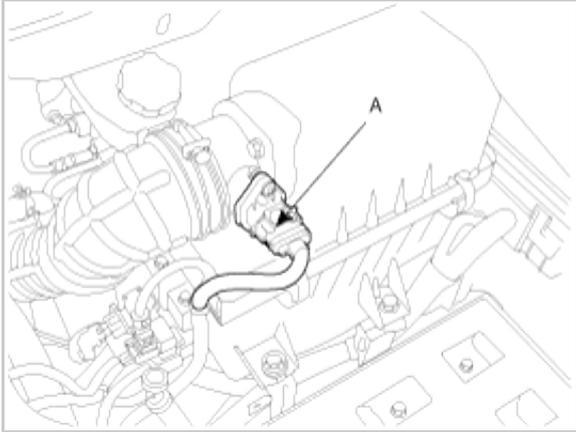
22. Install the air cleaner assembly (A).



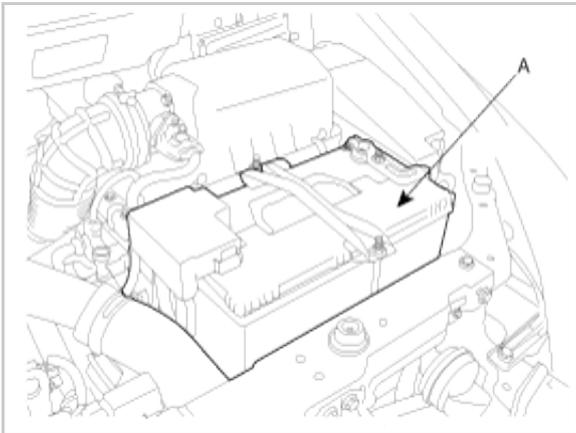
23. Install the air cleaner upper cover (B) by fastening the clips (A).



24. Connect the AFS connector (A).



25. Install the battery (A).



# **Automatic Transaxle Control System**

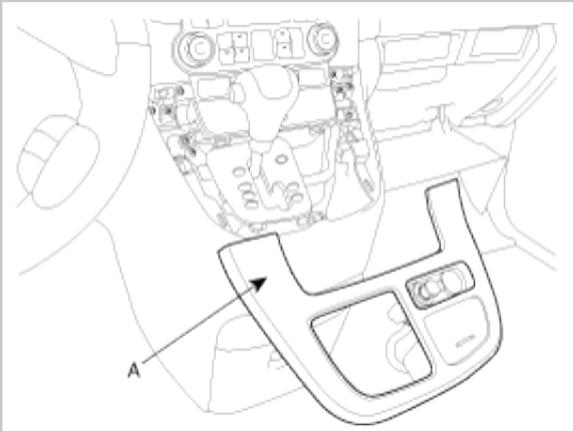
Shift Lever



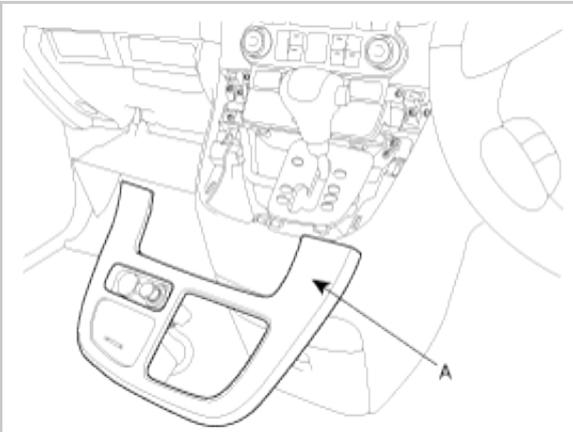
## REMOVAL

1. Remove the console upper cover(A). (see BD group).

**[LHD]**

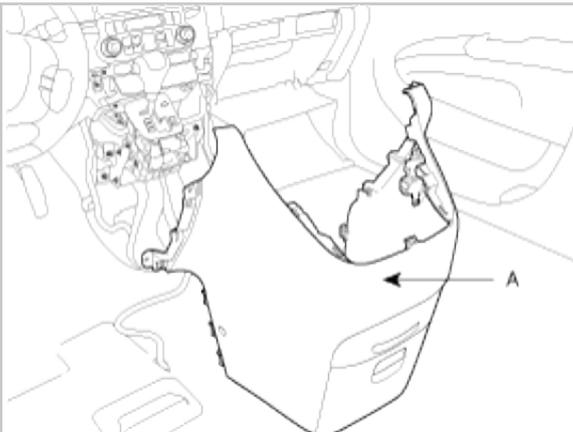


**[RHD]**

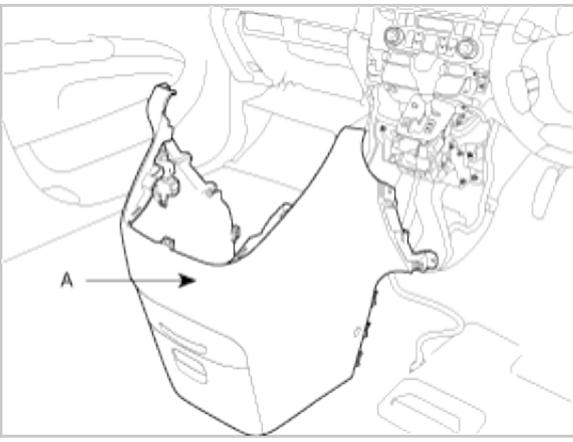


2. Remove the front console cover (A). (see BD group).

**[LHD]**

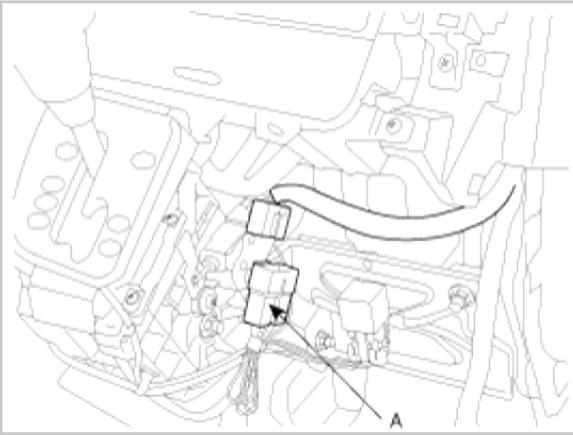


**[RHD]**

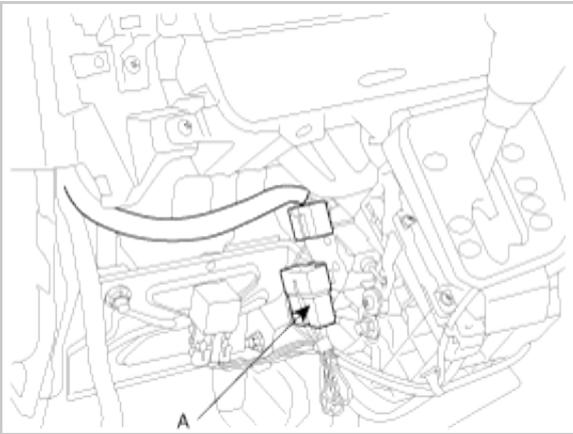


3. Disconnect the connector (A).

**[LHD]**

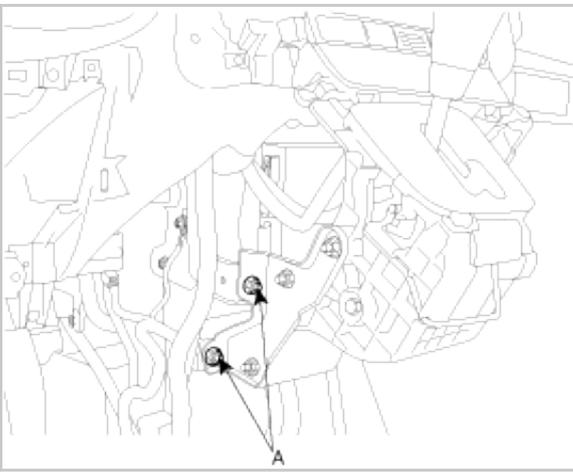


**[RHD]**

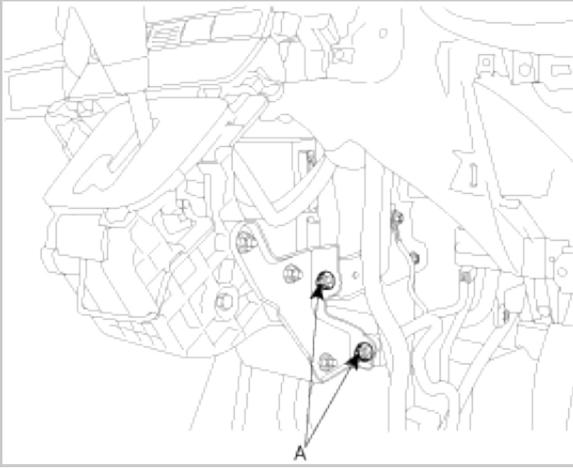


4. Remove the shift lever assembly mounting nuts (A).

**[LHD]**

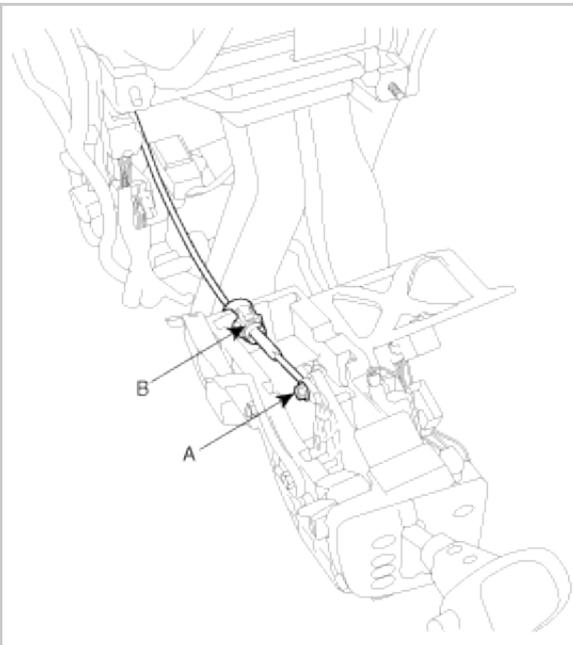


**[RHD]**

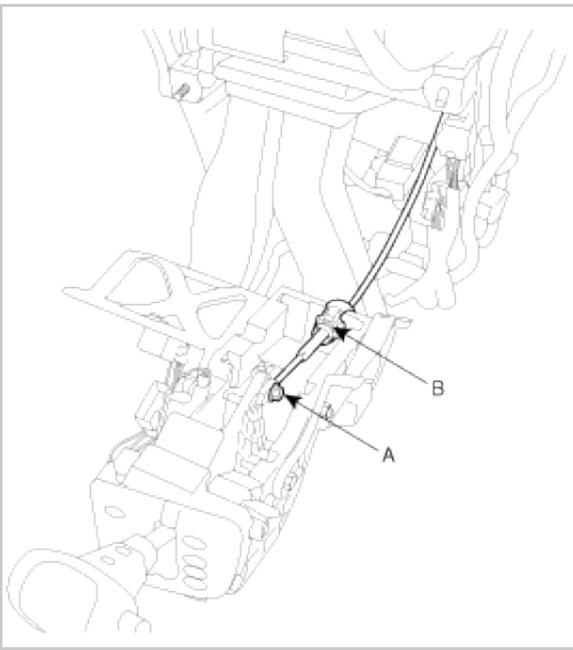


5. Remove the shift cable mounting nut (A) and cap (B).

**[LHD]**



**[RHD]**



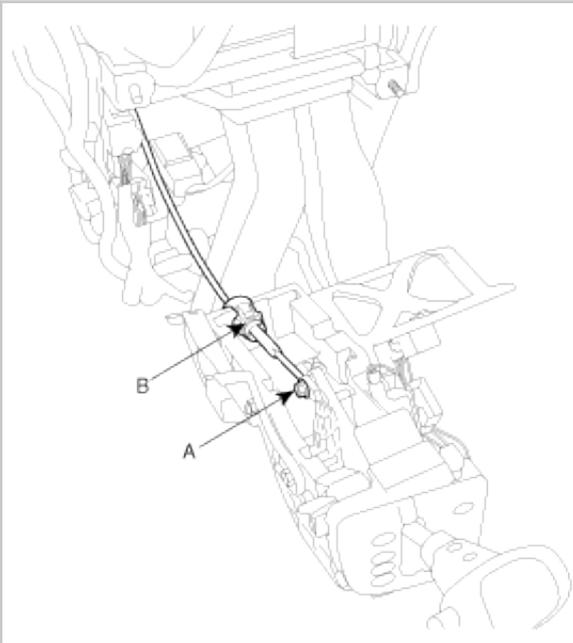
## INSTALLATION

1. Install the shift cable mounting nut (A) and cap (B).

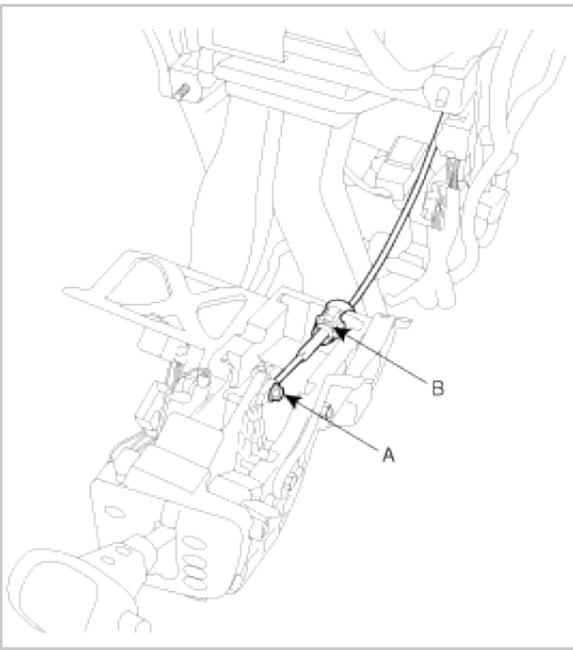
### TORQUE:

10~14 Nm(100~140 kgf.cm, 7.3~10.2 lb-ft)

### [LHD]



### [RHD]



2. Install the shift lever assembly mounting nuts (A).

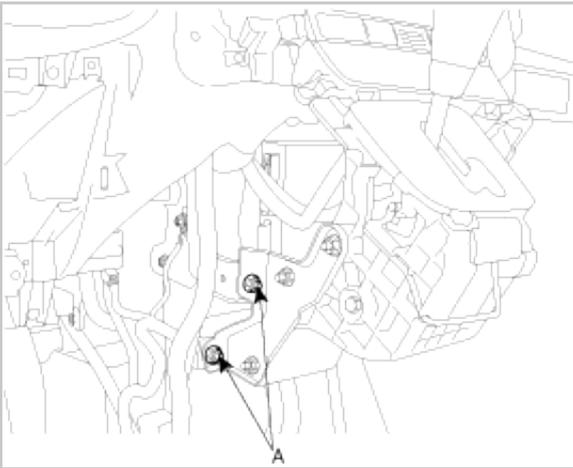
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TORQUE:

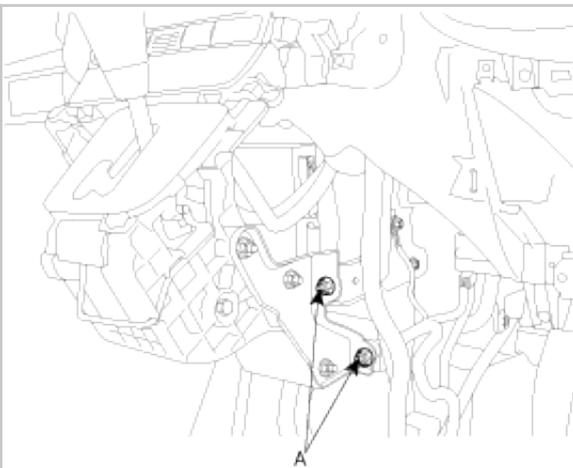
19~24 Nm(190~240 kgf.cm, 13.8~17.5 lb-ft)

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**[LHD]**

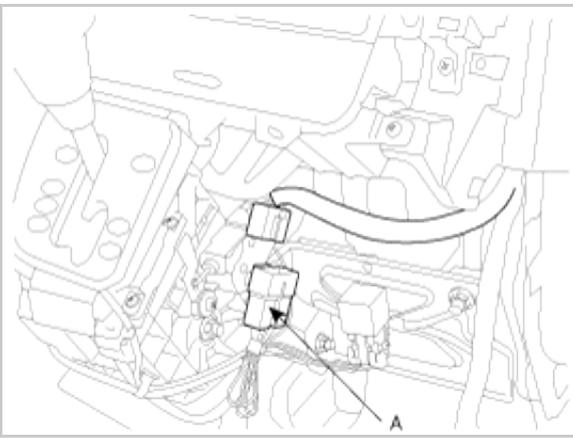


**[RHD]**

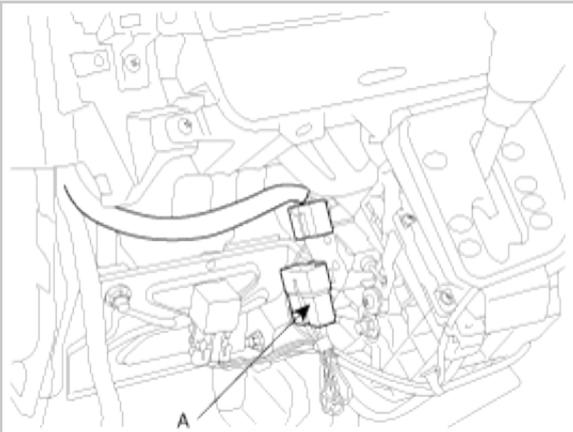


3. Connect the connector (A).

**[LHD]**

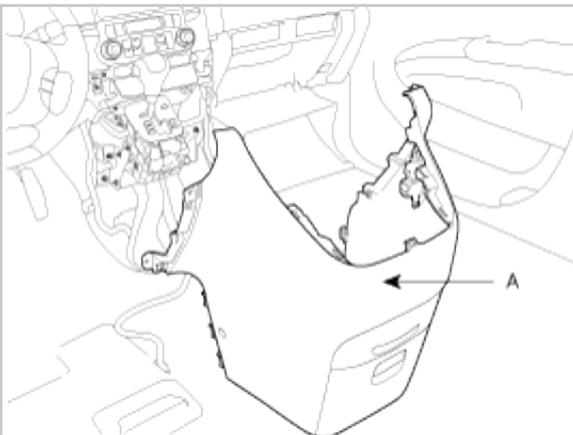


**[RHD]**

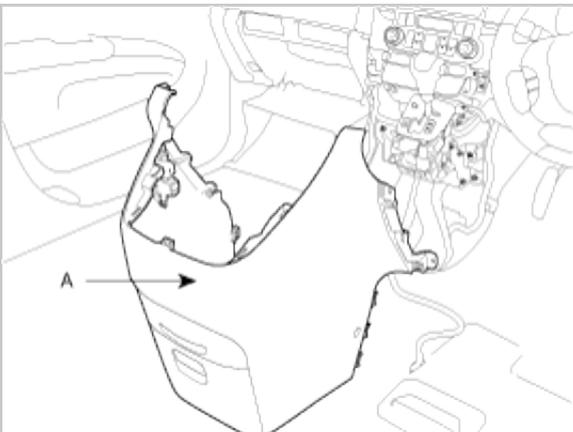


4. Install the front console cover (A). (see BD group)

**[LHD]**

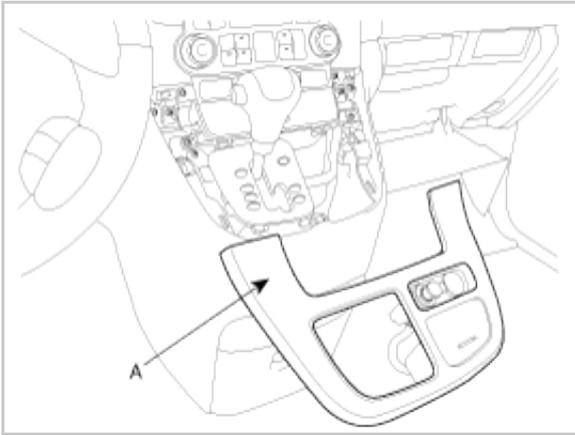


**[RHD]**

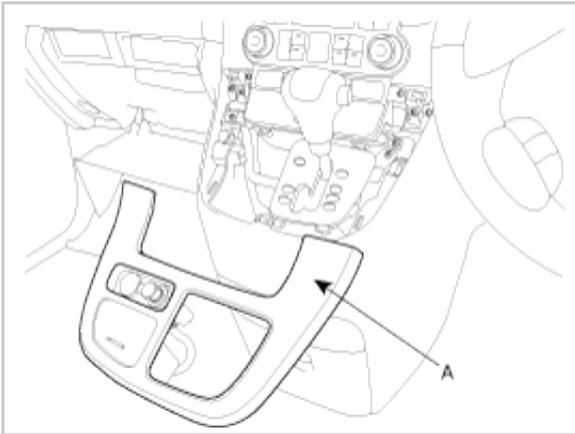


5. Install the console upper cover(A). (see BD group).

[LHD]



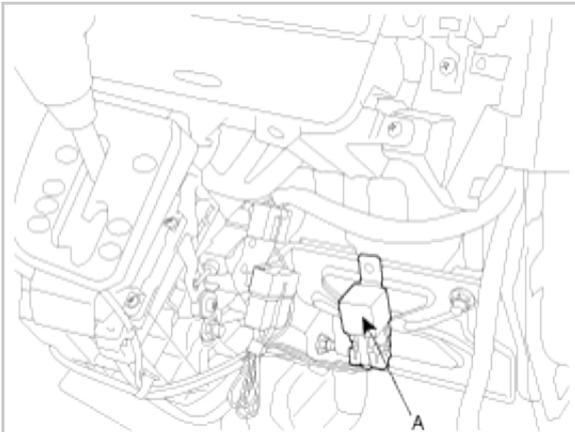
[RHD]



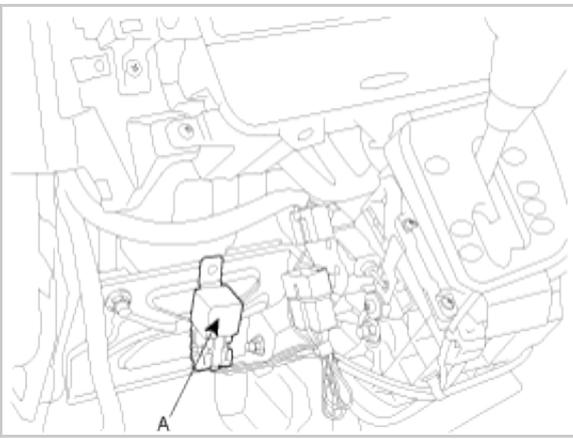
## DISASSEMBLY

1. Remove the power relay (A) from the bracket.

[LHD]

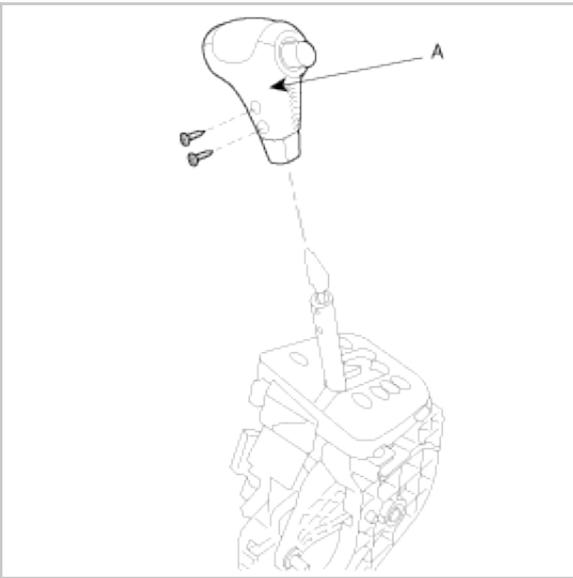


[RHD]

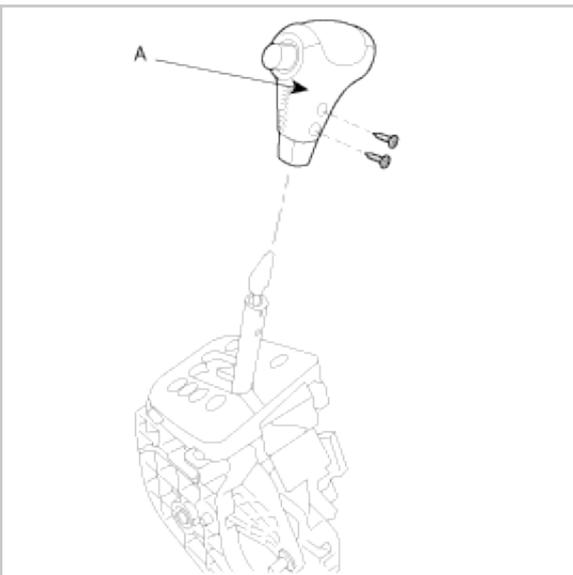


2. Remove both sides of the brackets.
3. Remove the shift lever knob (A) by removing the two screws.

**[LHD]**

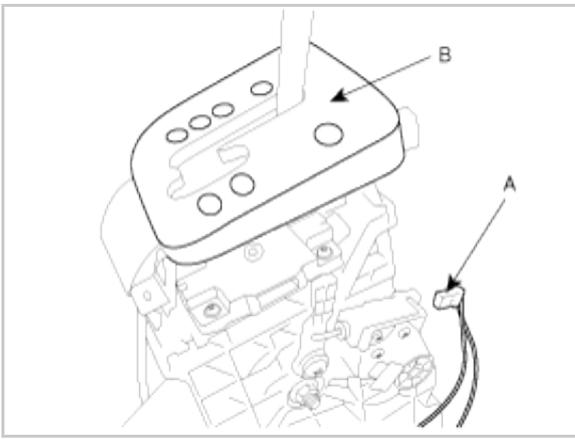


**[RHD]**

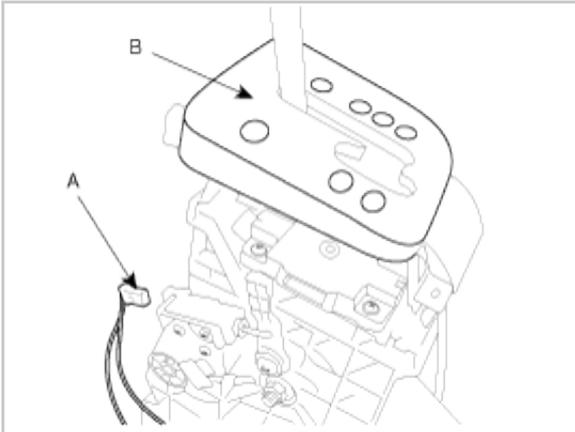


4. Disconnect the solenoid connector (A) and remove the indicator panel (B).

**[LHD]**

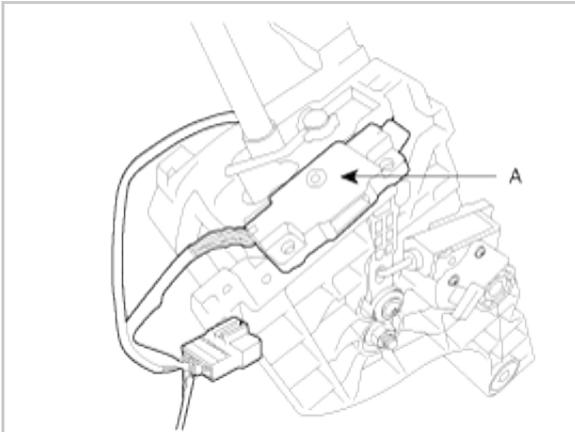


**[RHD]**

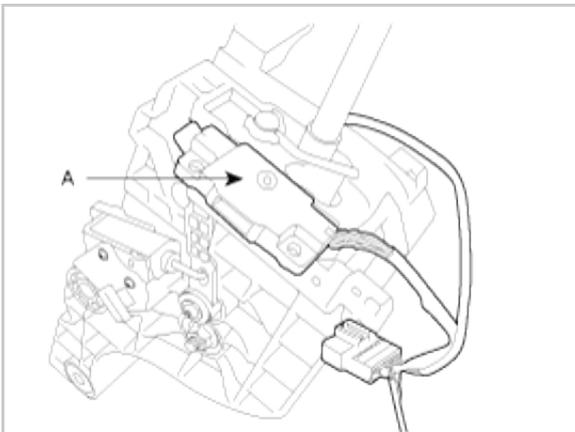


5. Remove the switch assembly (A) and 'P' position switch assembly.

**[LHD]**

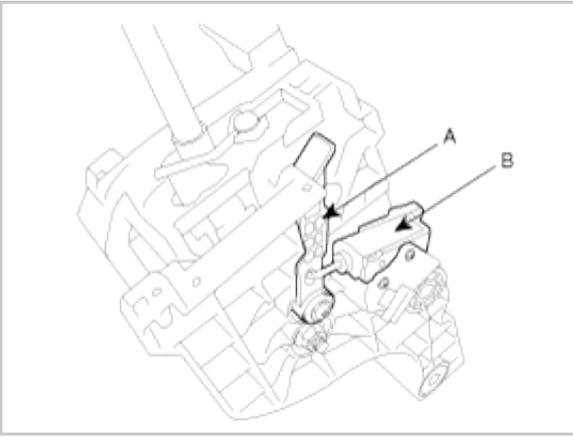


**[RHD]**

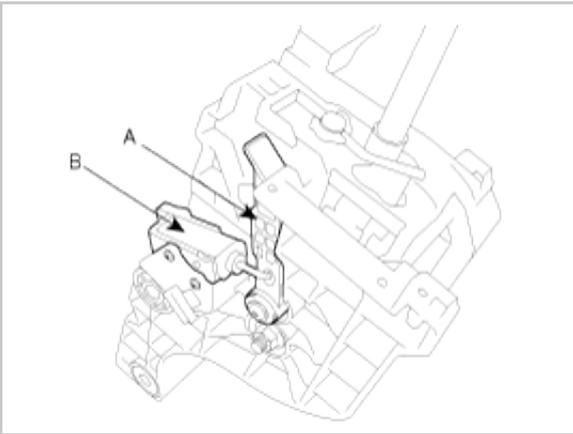


6. Remove the solenoid (B) and solenoid lever (A).

[LHD]

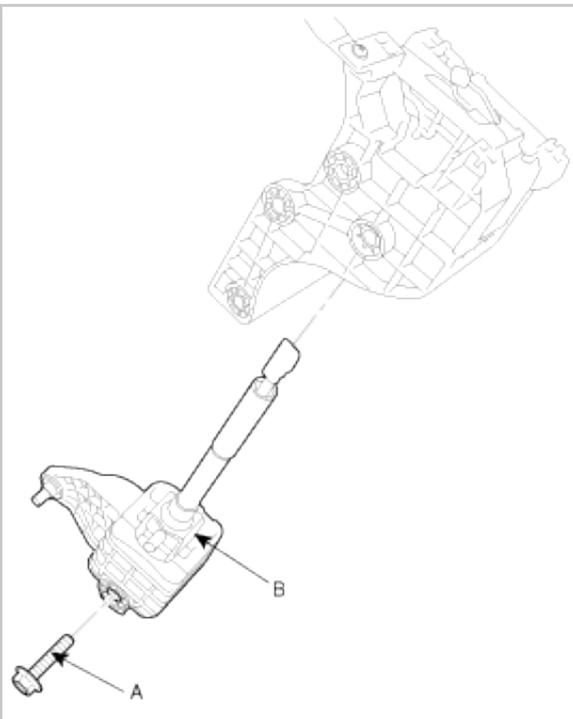


[RHD]

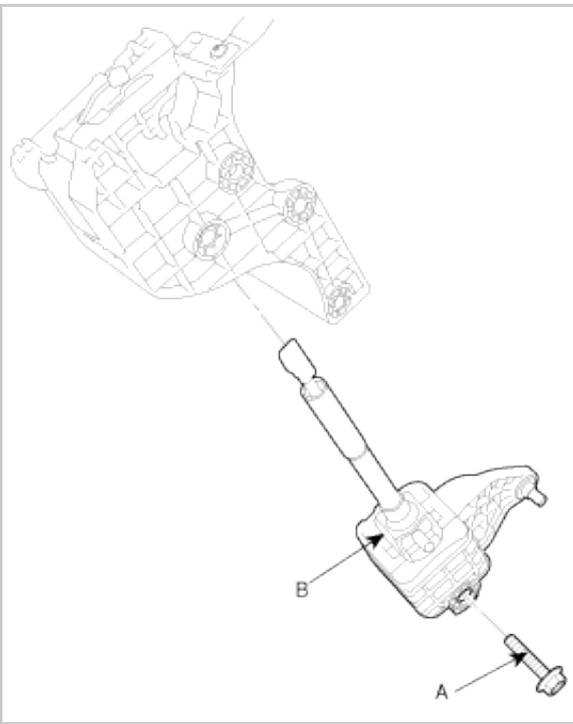


7. Remove the lever assembly (B) by the mounting bolt (A).

[LHD]

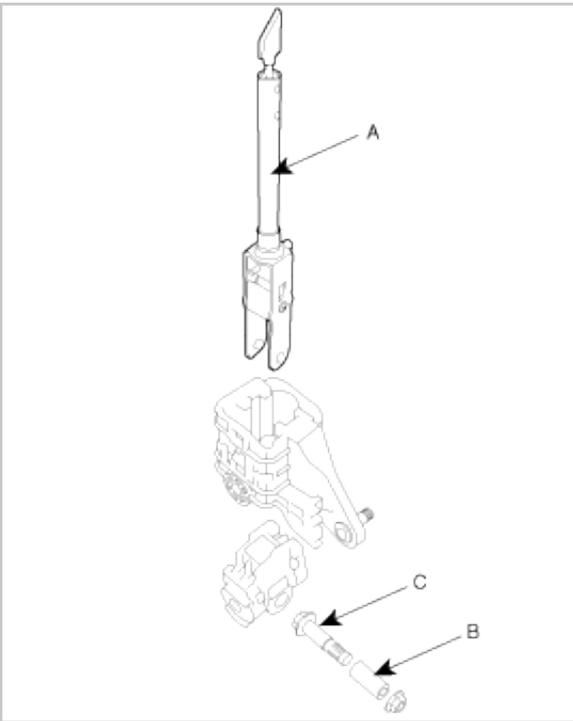


[RHD]

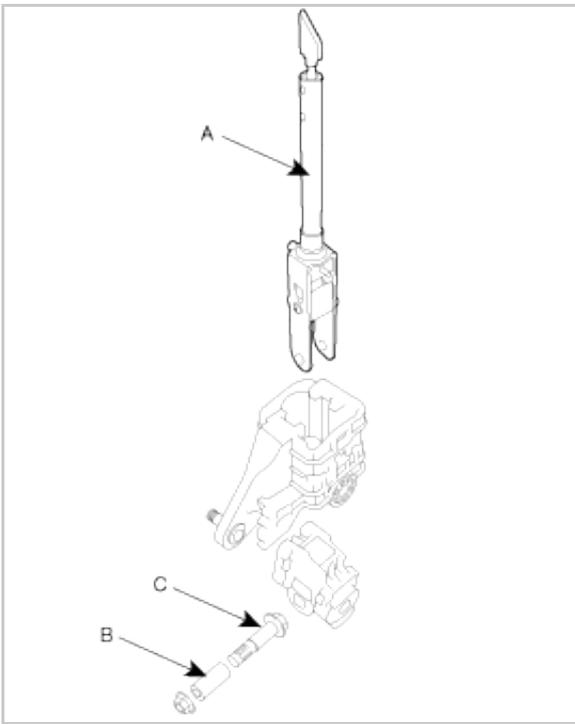


8. Remove the lever (A) and tube (B) by removing the bolt (C).

**[LHD]**



**[RHD]**



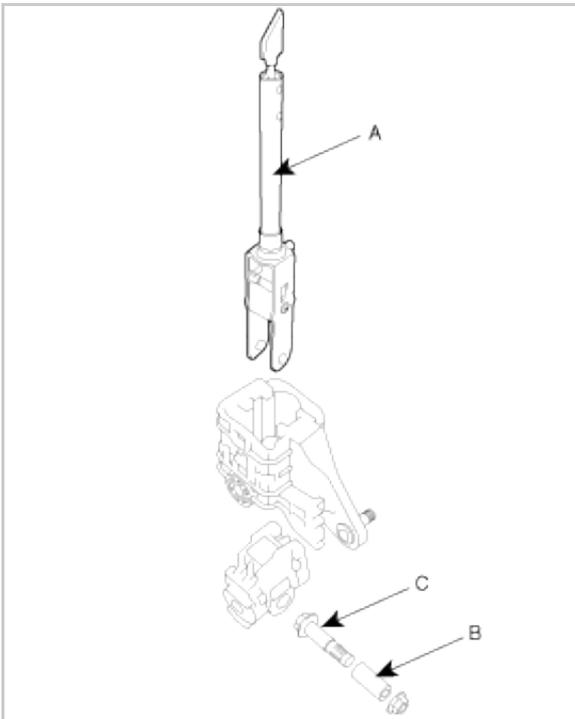
## REASSEMBLY

1. Grease the tube (B) and install the lever (A) by tightening the bolt (C).

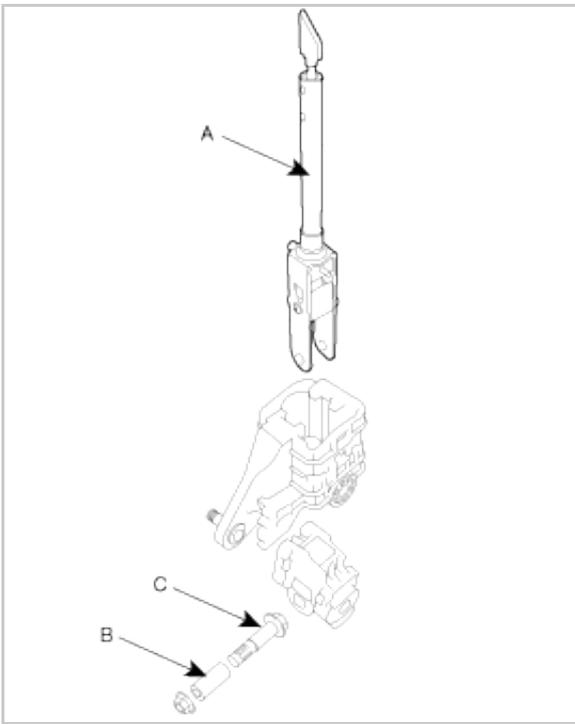
TORQUE:

8~12 Nm(80~120 kgf.cm, 5.8~8.7 lb-ft)

### [LHD]



### [RHD]

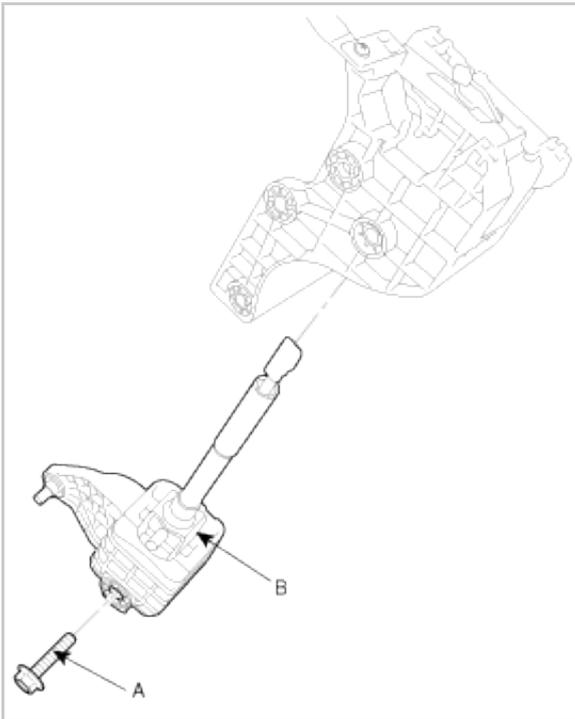


2. Install the lever assembly (B) by tightening the bolt (A).

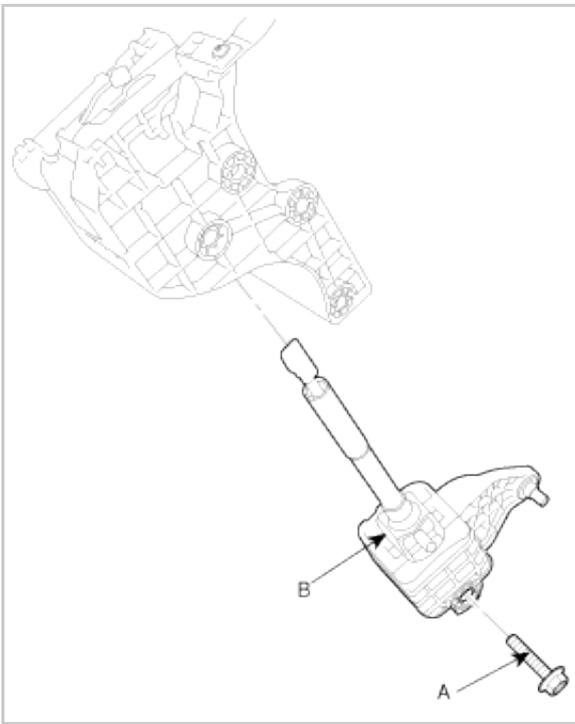
TORQUE:

8~12 Nm(80~120 kgf.cm, 5.8~8.7 lb-ft)

**[LHD]**

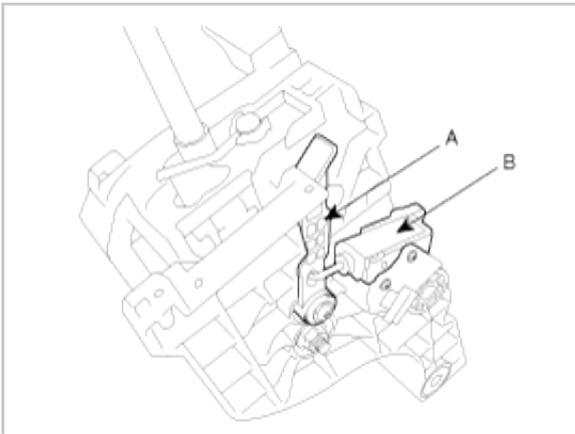


**[RHD]**

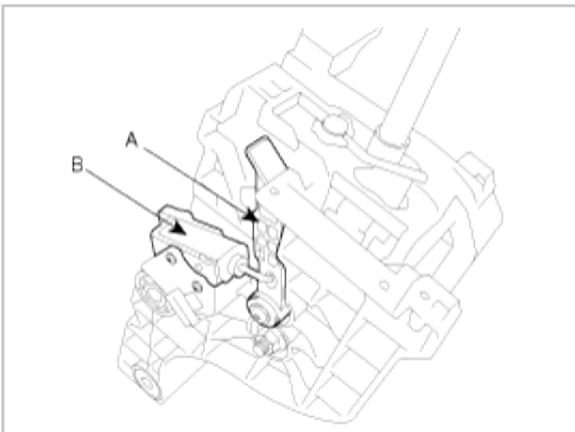


3. Install the solenoid (B) and solenoid lever (A).

**[LHD]**



**[RHD]**



4. Install the switch assembly (A) and 'P' position switch assembly.

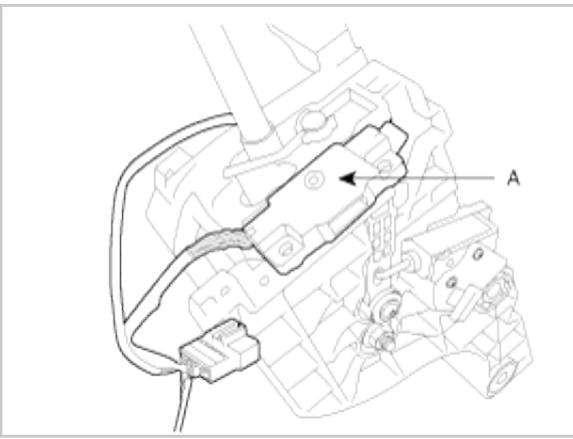
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TORQUE:

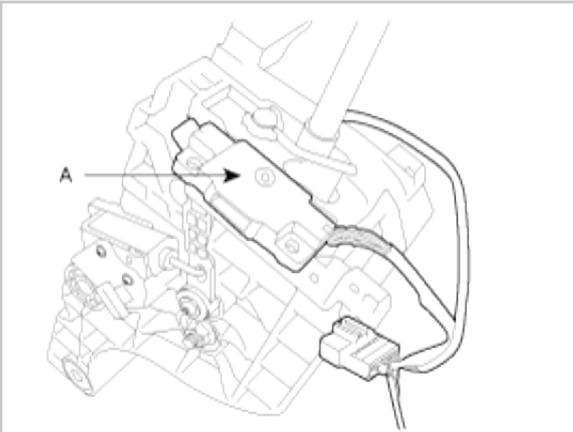
1.3~1.9 Nm(13~19 kgf.cm, 0.95~1.38 lb-ft)

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**[LHD]**

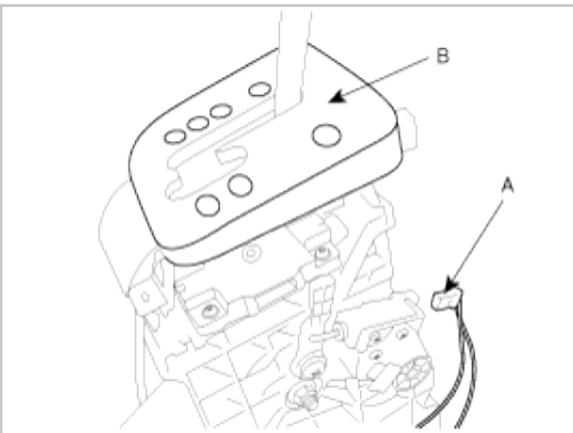


**[RHD]**

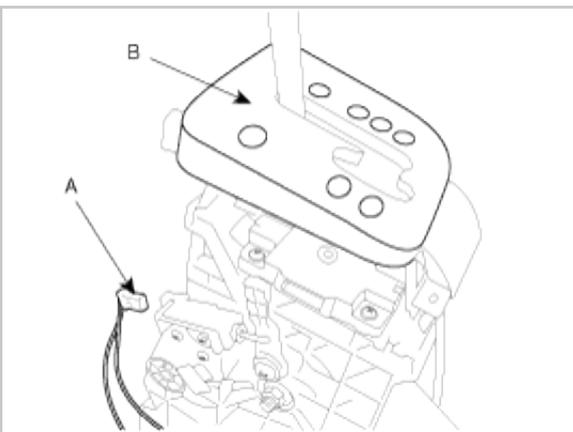


5. Connect the solenoid connector (A) and install the indicator panel (B).

**[LHD]**



**[RHD]**



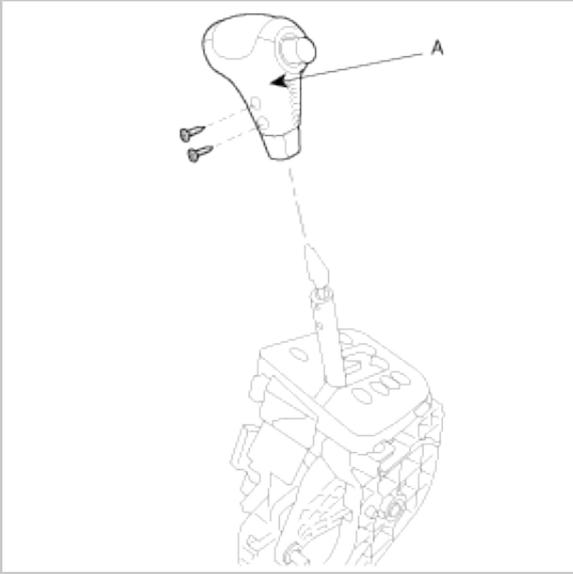
6. Install the shift lever knob (A) by tightening the two screws.

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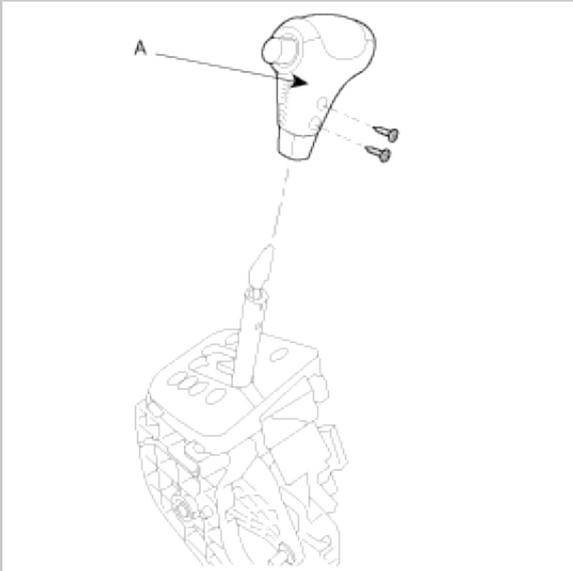
TORQUE:  
2~3 Nm(20~30 kgf.cm, 1.45~2.18 lb-ft)

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**[LHD]**



**[RHD]**



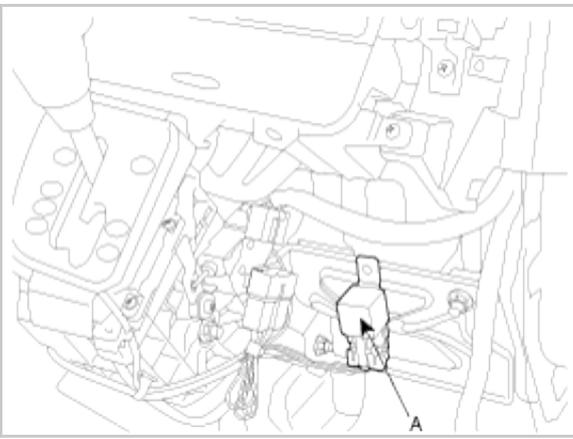
7. Install both sides of the brackets.
- 

TORQUE:  
16~23 Nm(160~230 kgf.cm, 11.6~16.7 lb-ft)

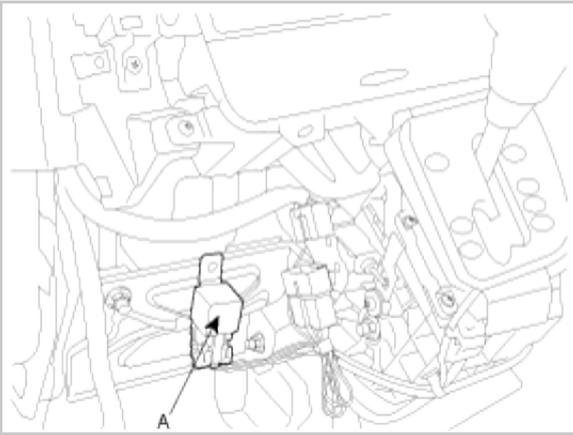
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8. Install the power relay (A) to the bracket.

**[LHD]**

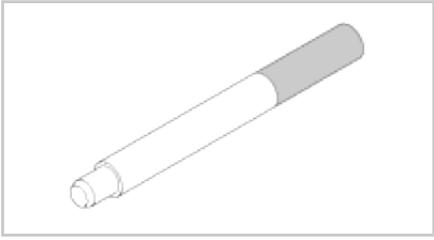


**[RHD]**



# **General Information**

**SPECIAL TOOLS**

<b>Tool (Number and Name)</b>	<b>Illustration</b>	<b>Use</b>
09411-43000 Clutch disc guide		Installation of the clutch disc

**SPECIFICATION**

Item	SPECIFICATION
Engine type	J2.9
Clutch operation	Hydraulic type
Clutch disc	Single dry with diaphragm
Clutch cover assembly	Self Adjusting Clutch

**TIGHTENING TORQUE**

Item	Nm	Kgf.cm	lb-ft
Clutch cover (6EA)	25~36	250~360	18.2~26.2
Clutch pedal bracket mounting	19~26	190~260	13.8~18.9
Regulator bolt	28~33	280~330	20.3~24
Connecting rod adjusting bolt	9~14	90~140	6.5~10.1
Clutch master cylinder mounting	12~16	120~160	8.7~11.6
Stopper bolt	8~10 or 14~20	80~100 or 140~200	5.8~7.27 or 10.1~14.5
Clutch pedal bolt/nut	25~34	250~340	18.1~24.7

**SERVICE STANDARD**

Item	Standard value
Clutch pedal stroke	150mm (5.91in)
Clutch pedal free play	6~13mm (0.24~0.51in)

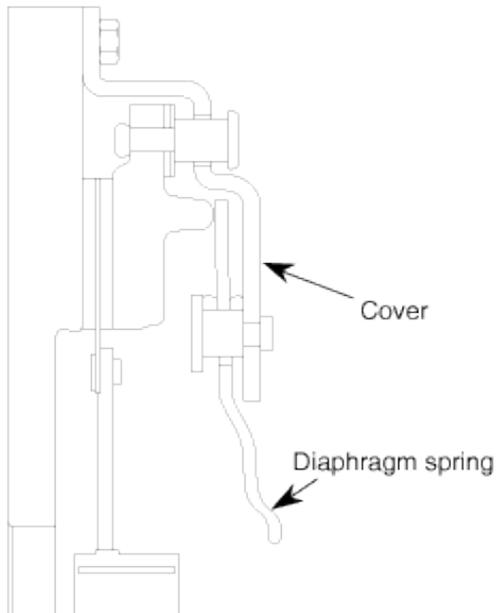
# **Clutch System**

## DESCRIPTION

### SELF ADJUSTING CLUTCH(S.A.C.) COVER

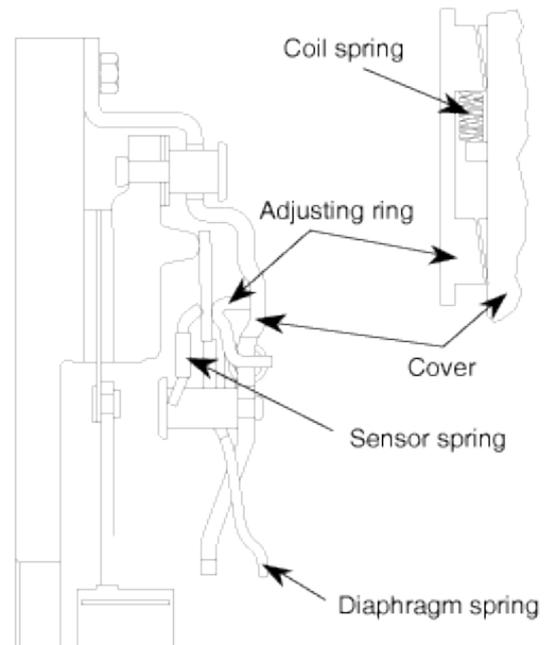
- As a clutch disc facing is worn away according to its durability, a cover weight is increasing and a clutch pedal pressure can be more needed.
- To make up for this defect, the self adjusting clutch system makes the requested pedal pressure minimized so that makes the maintenance cycle longer.

#### GENERAL CLUTCH COVER



- In a general clutch cover, the diaphragm spring increases the weight to the disc in proportion to abrasion.

#### SELF ADJUSTING CLUTCH COVER



- In a self adjusting clutch, the adjusting ring prevents the diaphragm spring from being raised to the transmission side in spite of abrasion.

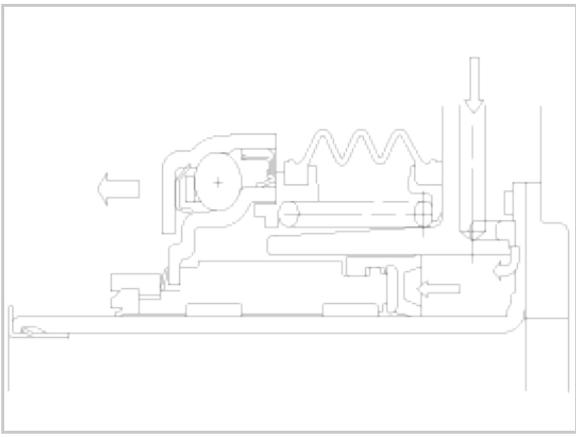
### CONCENTRIC SLAVE CYLINDER-C.S.C.

It improves working efficiency and lowers the number and the weight of part by unifying clutch release control parts(clutch release bearing ~ clutch release cylinder) in a manual transaxle.

## OPERATION

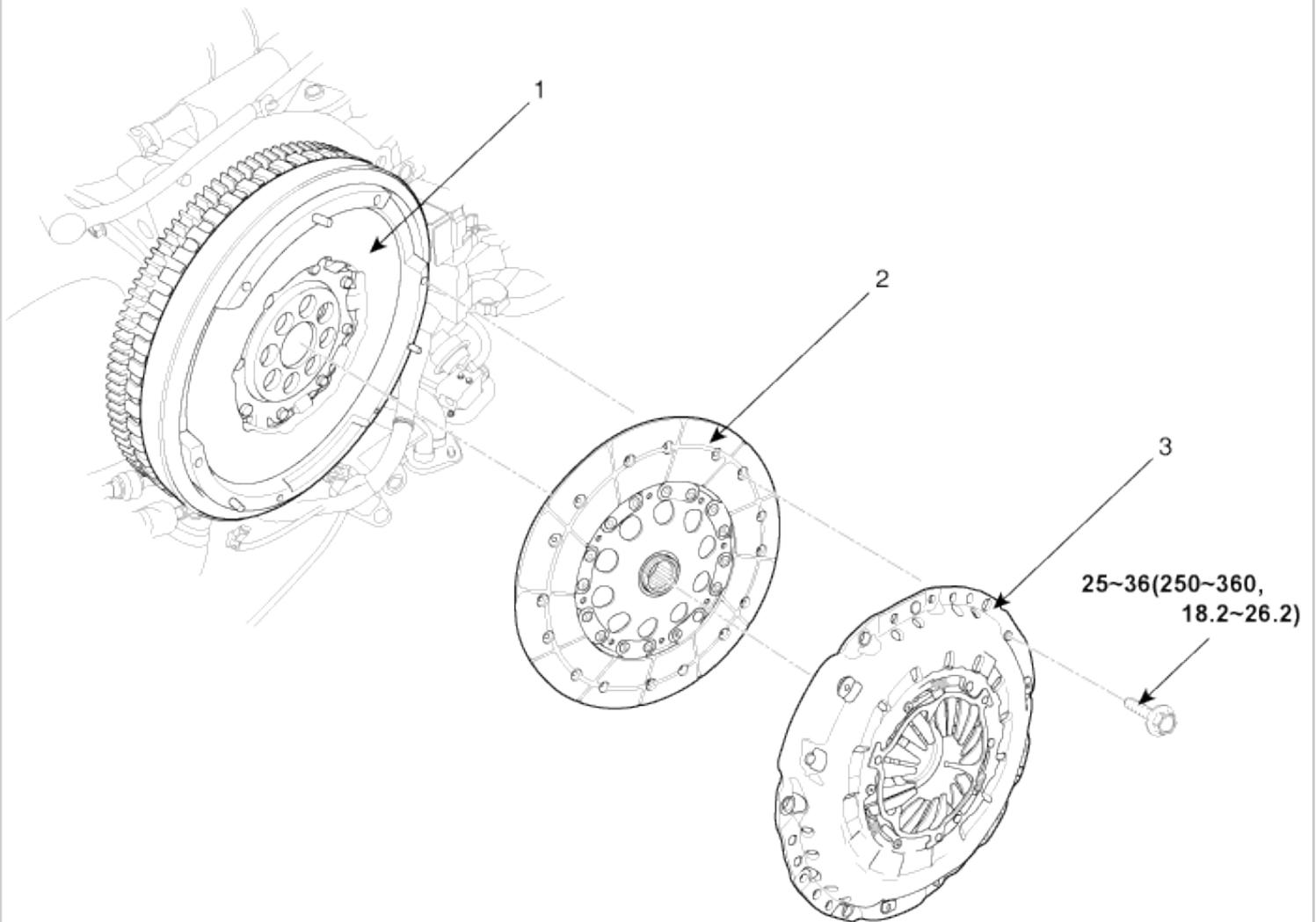
### CONCENTRIC SLAVE CYLINDER-C.S.C

When the clutch pedal is pressed, oil pressure is transmitted along the arrow directions shown below and that moves the clutch slave cylinder and the diaphragm spring of the clutch cover.



# **Clutch Cover and Disc**

## COMPONENTS



**TORQUE : Nm (kgf.cm, lb-ft)**

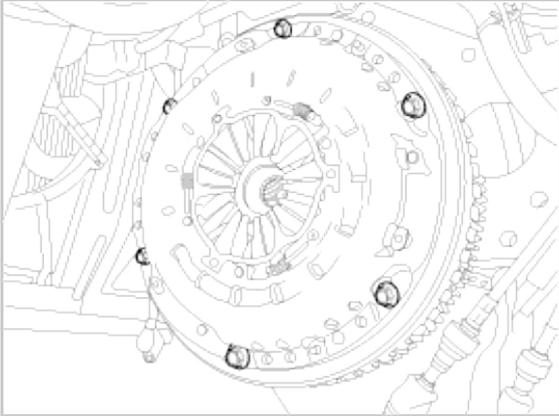
- 1. Engine flywheel
- 2. Clutch disc

- 3. Clutch cover



## REPLACEMENT

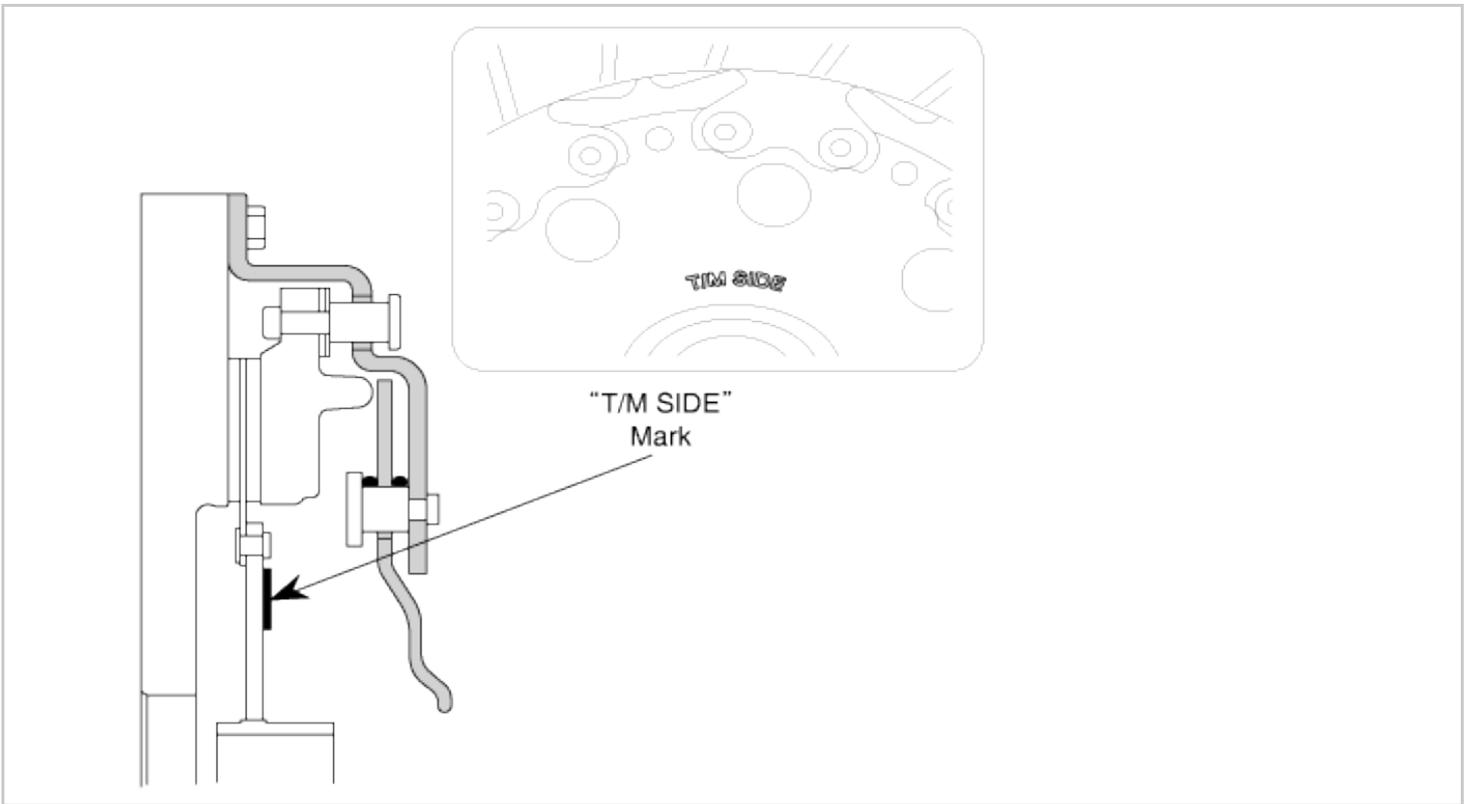
1. Remove a transaxle assembly (refer to 'MT'-group).
2. Remove the clutch cover bolts. Not to be bent or twisted, loosen them in diagonal directions.



3. Remove the clutch cover and disc.
4. Using the SST(09411-43000), install a clutch disc and cover.

### CAUTION

- a. Replace a clutch cover and disc as a set.
  - \* Possible problems when not following the caution
- a. When replacing only a disc, slip problem can occur because of the initial clamp load loss by the adjusting ring's unusual work.
- b. When replacing only a disc, it can be difficult to cut power because the thickness of the disc cannot be permitted.
- b. Apply grease on a disc spline part and transmission input shaft spline part as required.
  - \* Possible problems when not following
- a. When not applying: Excessively wear of splines and bad clutch operation
- b. When excessively applying: Scattered grease by centrifugal force contaminates the clutch disc. Loss of friction force can cause a slip
- c. The 'T/M SIDE' marked surface should face the transaxle.
  - If the surface face the opposite side, there can be an interference between a disc and a flywheel surface.



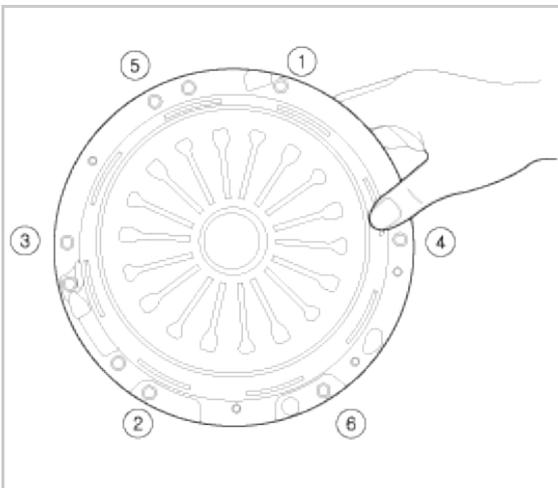
5. Tighten the clutch cover.

**TORQUE:**

24.5~35.3Nm (250~360kgf.cm, 18.1~26.0lb-ft) (6EA)

**CAUTION**

When installing the clutch cover, tighten the bolts in diagonal directions not to be bent or twisted.



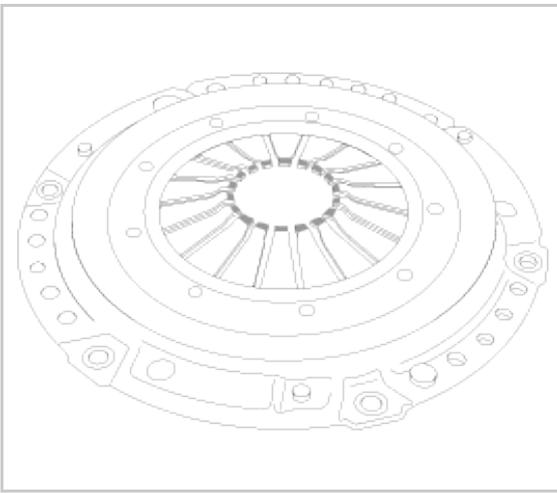
**CAUTION**

\* Possible problems when not following

- a. When tightening the bolt completely at a time: the clutch cover can be twisted and vibration can occur.
- b. On vehicles with self adjusting clutches, it is necessary to follow this caution.
- c. Not following tightening torque: There can be bad torque transmission in clutch and relaxation possibility of bolts.

**INSPECTION**

1. Inspect diaphragm spring wear which is in contact with a concentric slave cylinder bearing.

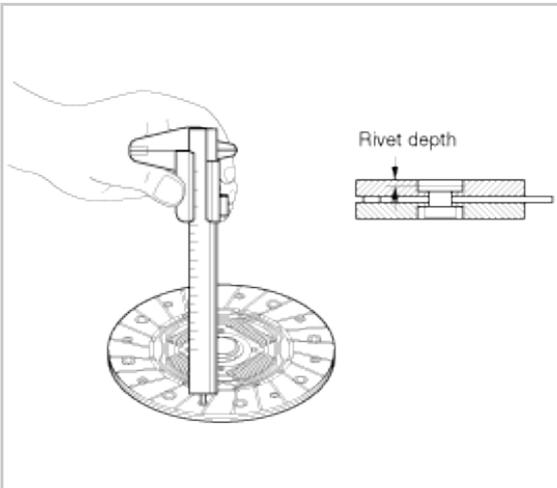


2. Check the clutch cover and disc surface for wear or crack.
3. Check the clutch disc lining for slipping or oil mark.
4. Measure the depth from a clutch lining surface to a rivet. If the measured value is less than the specification below, replace it.

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Specification: 0.3mm(0.0118inch)

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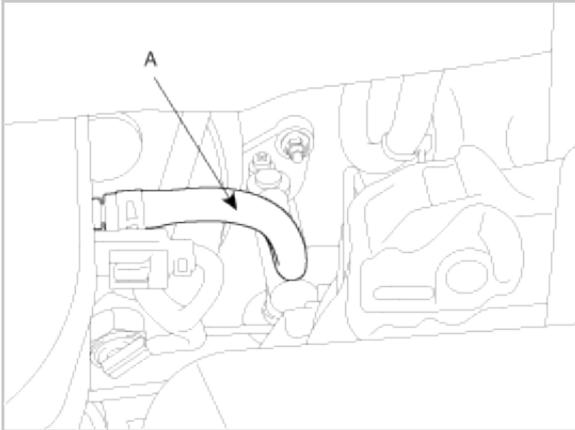
# **Clutch Master Cylinder**

## REMOVAL

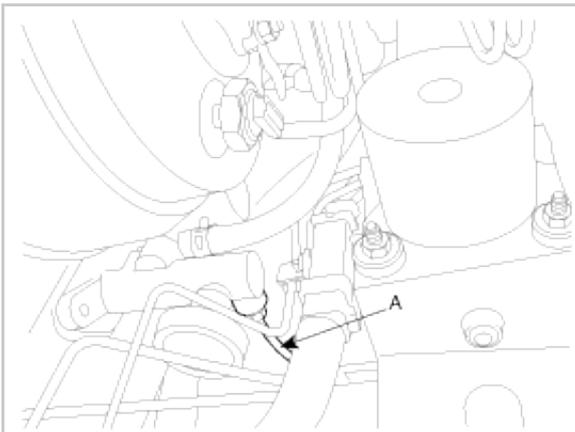
### NOTICE

Do not spill brake fluid on the vehicle; it may damage the paint if brake fluid does contact the paint, wash it off immediately with water.

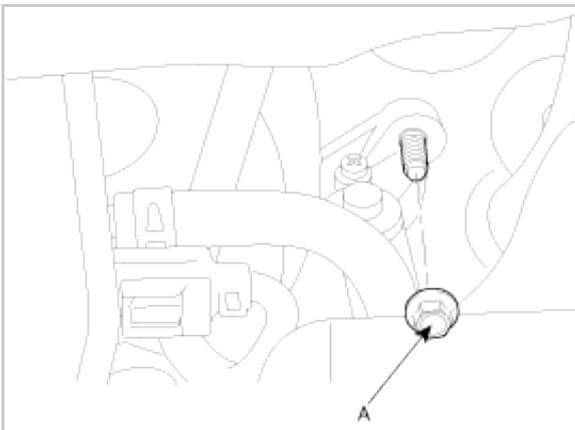
1. Remove the brake fluid from the clutch master cylinder reservoir with a syringe.
2. Clamp the clutch master cylinder hose(A). If there is no enough room for clamping, you can also clamp the hose from the brake master cylinder side.

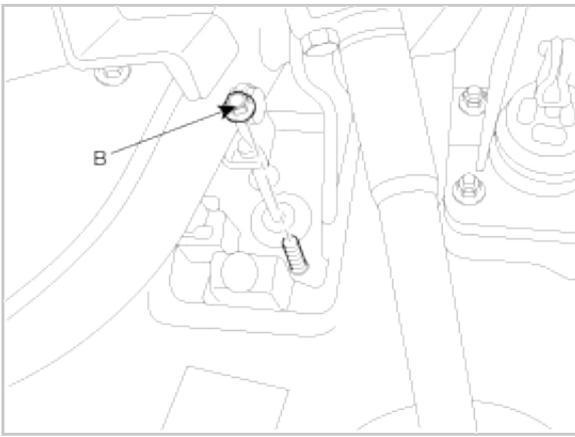


3. Disconnect the hose(A) from the cylinder by releasing the clutch master cylinder clamp.



4. Remove the clutch master cylinder mounting bolts(A,B).  
One is the engine room, the other near the clutch pedal assembly.





5. Remove the pin and washer which connect the clutch pedal with the clutch master cylinder.
6. Remove the clutch master cylinder. It can be helpful to do this step after removing the clutch pedal mounting bracket.

## INSTALLATION

Installation is in the reverse order of removal.  
After installation, bleed the clutch hydraulic system.

### CONCENTRIC SLAVE CYLINDER AIR BLEEDING PROCEDURE

1. After disconnecting a cap from the concentric slave cylinder air bleeder, insert a vinyl hose in the plug.
2. Loosening the plug screw, press and release the clutch pedal about 10 times.

#### NOTICE

Hold the air bleeder body not to rotate with a spanner(A). The holding is needed when the plug loosened or tightened.

3. Tighten the plug during the clutch pedal pressed. Afterwards, raise the pedal with a hand.

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TORQUE :  
25~29Nm (250~290Kgf.cm, 18.2~21.1lb-ft)

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4. After pressing the clutch pedal 3 times more, loosen the plug and retighten it with the pedal pressed. Raise it again, then.
5. Repeat the step 4 two or three times. (until there is no bubble in the fluid)

#### CAUTION

- a. Do not clamp the pipe of a concentric slave cylinder.
- b. Be careful not to damage O-rings.

# Clutch Pedal



## ADJUSTMENT PROCEDURE

### IGNITION LOCK SWITCH

1. Disconnect 2P-connector from a ignition lock switch.
2. Disconnect the ignition lock switch. (if you can install a tester with the switch fixed, this step can be omissible)
3. Check for continuity between terminals. (refer to the table below)

Clutch pedal position	Ignition lock switch	Continuity
Released	Released	NO
Pressed	Pressed	YES

If there is difference between what tested and the table above, replace the ignition lock switch with a new one.  
If not, install the ignition lock switch and adjust the clutch pedal.

#### TORQUE :

8~10Nm (80~100kgf.cm, 5.8~7.2lb-ft)

### Clutch pedal and Ignition lock switch

#### NOTICE

- a. Inspect a ignition lock switch.
- b. Remove the driver's seat mat to adjust a clutch pedal.
- c. No gap between a clutch master cylinder piston and push rod can cause clutch slip.

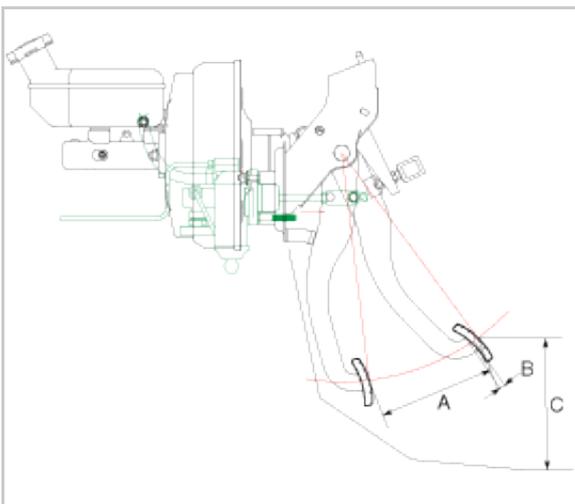
1. Loosen and draw out the bolt until it is off the pedal surface.
2. Push and pull a clutch master cylinder push rod to satisfy the specification below.

#### Specification:

Clutch pedal stroke(A) - 150mm(5.91in)

Clutch pedal free play(B) - 6~13mm(0.24~0.51in)

Clutch pedal distance - 234.7mm(9.24in)



3. With no pressure on a clutch pedal, tighten the bolt until it contacts on the pedal.
4. Fix the bolt with a nut.

#### TORQUE :

14~20Nm (140~200kgf.cm, 10.2~14.5lb-ft)

5. Press the clutch pedal to the seat ground.
6. Adjust the ignition lock switch position with the pedal a little(23~26mm) raised.
7. Install the ignition lock switch firmly.

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**TORQUE:**

8~10Nm (80~100kgf.cm, 5.8~7.2lb-ft)

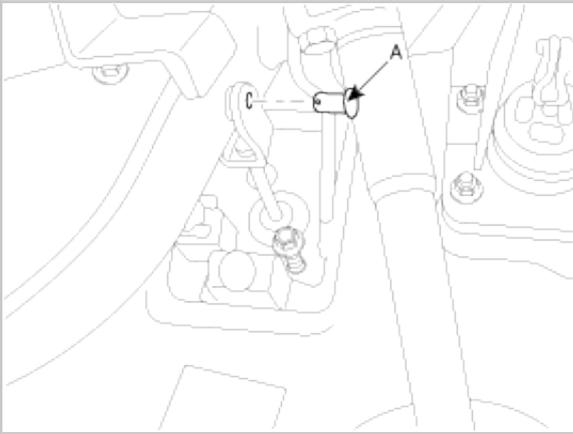
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## REPLACEMENT

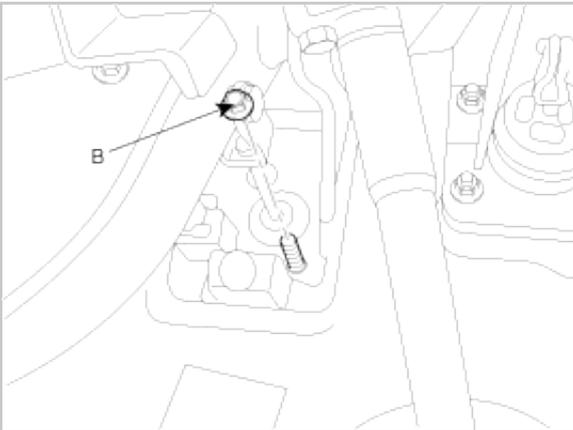
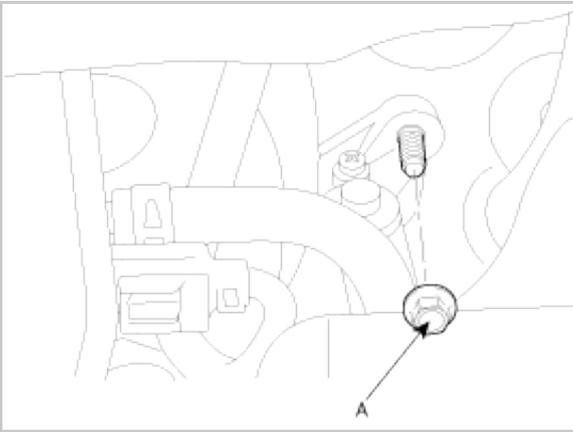
### NOTICE

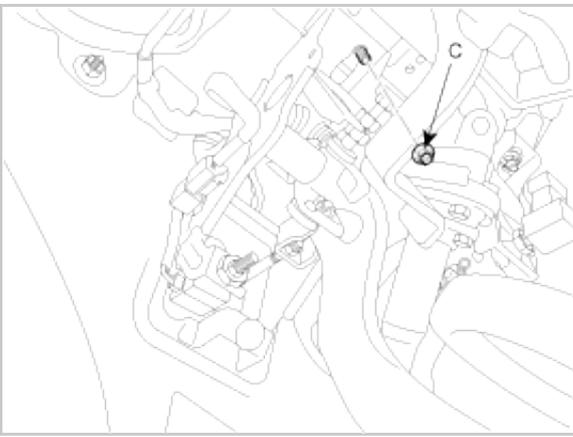
- a. Inspect the continuity of the ignition lock switch.
- b. Remove the floor mat before adjusting the clutch pedal.

1. Remove the ignition lock switch.
2. Remove the snap pin and the clevis pin(A) connecting the clutch master cylinder push rod and the clutch pedal.



3. Remove the clutch master cylinder mounting nut(A,B) and the clutch pedal mounting nut(C).





4. Remove the clutch pedal.
5. Install a new one by tightening the bolts of the clutch pedal bracket and master cylinder .

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**TORQUE :**

19~26 Nm(19~260 kgf.cm, 13.8~18.9 lb-ft)(Clutch pedal bracket)  
12~16 Nm(120~160 kgf.cm, 8.7~11.6 lb-ft)(Clutch master cylinder)

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6. Grease the clevis pin and insert it and the snap pin.
7. Adjust the clutch pedal and the ignition lock switch.