

Engine Mechanical System



Specifications

Description	Specifications	Limit
General		
Type	In-line, Double Overhead Camshaft	
Number of cylinder	4	
Bore	86mm (3.385in)	
Stroke	86mm (3.385in)	
Total displacement	1998cc (121.92cu.in.)	
Compression ratio	9.0 : 1	
Firing order	1-3-4-2	
Valve timing		
Intake valve		
Opens (ATDC / BTDC)	ATDC 11° ~ BTDC 34°	
Closes (ABDC)	ABDC 67° ~ ABDC 22°	
Exhaust		
Opens (BBDC)	BBDC 54° ~ BBDC 14°	
Closes (ATDC)	BTDC 10° ~ ATDC 30°	
Valve		
Valve length		
Intake	113.18mm (4.4559in.)	112.93mm (4.4460in)
Exhaust	105.79mm (4.1649in.)	105.54mm (4.1551in)
Stem O.D.		
Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle	45.25° ~ 45.75°	
Margin		
Intake	1.02mm (0.0401in.)	
Exhaust	1.09mm (0.0429in.)	
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.)
MLA		
MLA outer diameter	31.964 ~ 31.980mm (1.2584 ~ 1.2590in.)	
Cylinder head tappet bore inner diameter	32.000 ~ 32.025mm (1.2598 ~ 1.2608in.)	

MLA to tappet bore clearance	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
Valve seat		
Width of seat contact		
Intake	1.16 ~ 1.46mm (0.0457 ~ 0.0575in.)	
Exhaust	1.35 ~ 1.65mm (0.0531 ~ 0.0649in.)	
Seat angle	44.75° ~ 45.10°	
Valve guide		
Length	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	
Inner diameter	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Valve spring		
Free length	47.44mm (1.8677in.)	
Load	19.0 ± 0.6kg/35.0mm (41.88 ± 1.32lb/1.3779in.)	
Square	39.8 ± 1.2kg/26.0mm (87.74 ± 2.64lb/1.0236in.)	
Out of squareness	1.5° MAX.	
Valve clearance		
Cold (20°C[68°F])		
Intake	0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust	0.21 ~ 0.38mm (0.0082 ~ 0.0149in.)	0.25 ~ 0.45mm (0.0098 ~ 0.0117in.)
Cylinder head		
Flatness of gasket surface	Max. 0.05mm (0.0019in.)	
Flatness of manifold mounting surface	Max. 0.10mm (0.0039in.)	
Cylinder block		
Cylinder bore	86.00 ~ 86.03mm (3.3853 ~ 3.3871in.)	
Out-of-round and taper of cylinder bore	Less than 0.05mm (0.0019in.)	
Clearance with piston (To set limits to new parts)	0.020 ~ 0.040mm (0.0007 ~ 0.0015in.)	
Piston		
O.D (To set limits to new parts)	87.97 ~ 88.00mm (3.4635 ~ 3.4647in.)	
Ring groove width		
No.1	1.535 ~ 1.550mm (0.0604 ~ 0.0610in.)	1.26mm (0.0496in.)
No.2	1.230 ~ 1.250mm (0.0484 ~ 0.0492in.)	1.26mm (0.0496in.)
Oil ring	2.01 ~ 2.025mm (0.0791 ~ 0.0797in.)	2.05mm (0.0807in.)
Piston ring		

Side clearance				
No.1			0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)	0.1mm (0.004in.)
No.2			0.04 ~ 0.08mm (0.0015 ~ 0.0031in.)	0.1mm (0.004in.)
Oil ring			0.06 ~ 0.14mm (0.0023 ~ 0.0055in.)	0.2mm (0.008in.)
End gap				
No.1			0.15 ~ 0.25mm (0.0059 ~ 0.0098in.)	0.6mm (0.0236in.)
No.2			0.37 ~ 0.42mm (0.0145 ~ 0.0165in.)	0.7mm (0.0275in.)
Oil ring side rail			0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin				
Piston pin outer diameter			21.997 ~ 22.000mm (0.8660 ~ 0.8661in.)	
Piston pin hole inner diameter			22.030 ~ 22.070mm (0.8673 ~ 0.8688in.)	
Piston pin hole clearance			0.003 ~ 0.010mm (0.0001 ~ 0.0004in.)	
Connecting rod small end inner diameter			22.005 ~ 22.011mm (0.8663 ~ 0.8666in.)	
Connecting rod				
Bend			0.05mm (0.0020in.) or less	
Twist			0.1mm (0.004in.) or less	
Connecting rod big end to crankshaft side clearance			0.100 ~ 0.250mm (0.0039 ~ 0.010in.)	0.35mm (0.0138in.)
Connecting rod bearing				
Oil clearance (To seat limits to new parts)			0.025 ~ 0.043mm (0.0009 ~ 0.0016in.)	0.05mm (0.0078in.)
Camshaft				
Cam height	Intake		43.80mm (1.7244in.)	
	Exhaust		45.00mm (1.7716in.)	
Journal O.D.	Intake	No.1	∅ 30mm (1.1811in.)	
		No.2, 3, 4, 5	∅ 24mm (0.9449in.)	
	Exhaust	No.1	∅ 36mm (1.4173in.)	
		No.2, 3, 4, 5	∅ 24mm (0.9449in.)	
Bearing oil clearance	Intake	No.1	0.022 ~ 0.057mm (0.0008 ~ 0.0022in.)	0.09mm (0.0035in.)
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
	Exhaust	No.1	0 ~ 0.032mm (0 ~ 0.0012in.)	
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
End play			0.04 ~ 0.16mm (0.0015 ~ 0.0062in.)	0.20mm (0.0047in.)
Crankshaft				
Pin O.D.			47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)	
Journal O.D.			51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)	
End play			0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)	
Crankshaft bearing				
Oil clearance			0.020 ~ 0.038mm (0.0007 ~ 0.0014in.)	

Cooling method		Water-cooled, pressurized. Forced circulation with water pump	
Engine oil			
Oil quantity	Total	6.0L (6.34US qt, 5.27Imp qt)	When replacing a short engine or a block assembly
	Oil pan	5.0L (5.28US qt, 4.41Imp qt)	
	Drain and refill	5.3L (5.60US qt, 4.66Imp qt)	Including oil filter
Oil grade	Recommendation	5W-30 / ACEA A5	If not available, refer to the recommended API or ILSAC or ACEA classification
	Classification	API SL, SM or above ILSAC GF3, GF4 or above ACEA A3 or A5	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System".
Oil pressure (at 1000rpm)		127kPa (1.3kg/cm ² , 18.49psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Radiator			
Type		Pressurized corrugated fin type	
Radiator cap			
Main valve opening pressure		83 ~ 110kpa (12 ~ 16psi, 0.83 ~ 1.1kg/cm ²)	
Vacuum valve opening pressure		-7kpa (-100psi, -0.07kg/cm ²) or less	
Thermostat			
Type		Wax pellet type with jiggle valve	
Valve opening temperature		82°C (177°F)	
Full-opening temperature		95°C (201°F)	
Coolant pump		Centrifugal type impeller	
Drive belt			
Type		V-ribbed belt	
Engine coolant temperature sensor			
Type		Heat-sensitive thermistor type	
Resistance		2.31 ~ 2.59KΩ at 20°C (68°F)	
Air cleaner			
Type		Dry type	
Element		Paper type	
Exhaust pipe			
Muffler		Expansion resonance type	
Suspension system		Rubber hangers	

Service Standards

Standard value	
Antifreeze	Mixture ratio of anti-freeze in coolant
Ethylene glycol base for aluminum	50%

Tightening Torques

Item	N.m	kgf.m	lb-ft
Ladder frame bolt (M8 x 55)	27.4 ~ 31.3	2.8 ~ 3.2	20.2 ~ 23.1
Oil pump bolt (BSM)	9.8 + 19.6 + 29.4	1.0 + 2.0 + 3.0	7.2 + 14.4 + 21.7
Timing chain cover bolt (M8)	18.6 ~ 22.5	1.9 ~ 2.3	13.7 ~ 16.6
Timing chain cover bolt (M6)	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Oil pan bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Engine support bracket bolt (LH/RH)	49.0 ~ 63.7	5.0 ~ 6.5	36.1 ~ 47.0
Camshaft bearing cap bolt (M6)	10.8 ~ 12.7	1.1 ~ 1.3	7.9 ~ 9.4
Camshaft bearing cap bolt (M8)	27.4 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head bolt	34.3 + 90° + 90°	3.5 + 90° + 90°	25.3 + 90° + 90°
Engine hanger bolt	27.5 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head cover bolt	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Crankshaft pulley bolt	166.6 ~ 176.4	17.0 ~ 18.0	122.9 ~ 130.1
Connecting rod bearing cap bolt	19.6 + 90°	2.0 + 90°	14.4 + 90°
Main bearing cap bolt	14.7 + 29.4 + 120°	1.5 + 3.0 + 120°	10.8 + 21.6 + 120°
Flywheel bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Drive plate bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Timing chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
CVVT bolt	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
BSM chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
P/S pump bracket bolt	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Tensioner ASSY intergrated bracket bolt	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Water temp. control nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4

Water inlet pipe nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temp. control bolt	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.4
Oil level gauge assembly bolt	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Ignition coil bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Intake manifold bolt	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Intake manifold nut	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Intake manifold stay bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold heat protector bolt	18.6 ~ 27.4	1.9 ~ 2.8	13.7 ~ 20.2
Exhaust manifold nut	49.0 ~ 53.9	5.0 ~ 5.5	36.1 ~ 39.7
Exhaust manifold stay bolt (M8)	18.6 ~ 27.4	1.9 ~ 2.8	18.6 ~ 20.2
Exhaust manifold stay bolt (M10)	49.0 ~ 53.9	5.0 ~ 5.5	36.1 ~ 39.8
Muffler bolt	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Crankshaft position sensor bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oxygen sensor	39.2 ~ 49.0	4.0 ~ 5.0	28.9 ~ 36.1
Knock sensor	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
Camshaft position sensor	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oil pressure switch	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Oil filter	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6

Engine Mechanical System

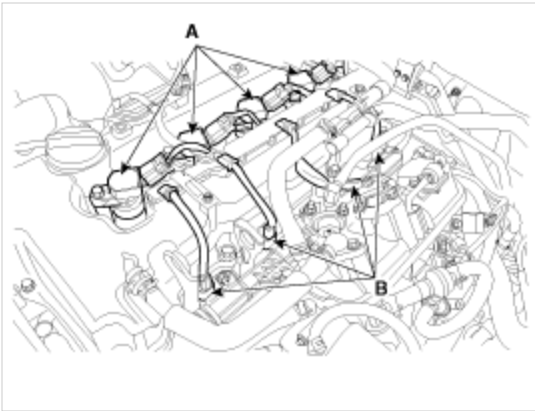


Compression Pressure Inspection

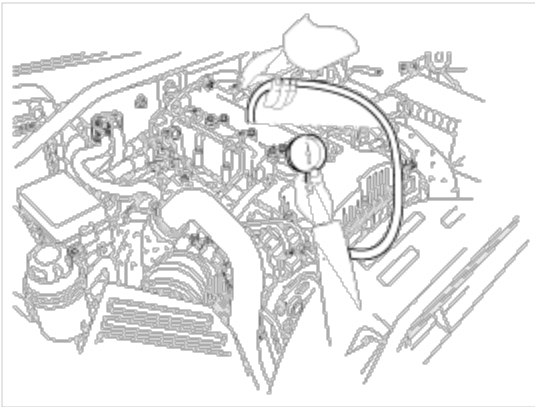
NOTICE

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. Disconnect the injector connectors (A), ignition coil connectors (B) and ignition coils.



3. Remove spark plugs.
Using a 16mm plug wrench, remove the 4 spark plugs.
4. Check cylinder compression pressure.
 - A. Insert a compression gauge into the spark plug hole.



- B. Fully open the throttle.
- C. While cranking the engine, measure the compression pressure.

NOTICE

Always use a fully charged battery to obtain engine speed of 200 rpm or more.

- D. Repeat steps (a) through (c) for each cylinder.

NOTICE

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

Compression pressure :

1,283kPa (13.0kgf/cm², 185psi)

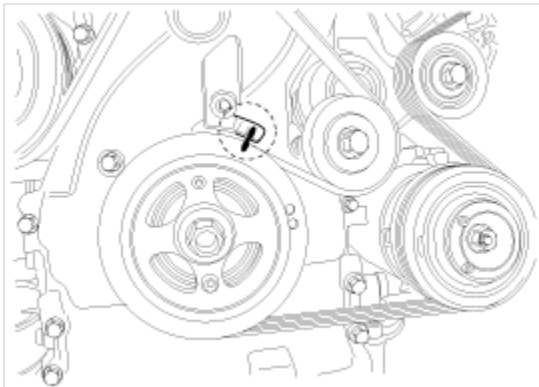
Minimum pressure :1,135kPa (11.5kgf/cm², 164psi)**Difference between each cylinder :**100kPa (1.0kgf/cm², 15psi) or less

- E. 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.
- If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
 - If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.
5. Reinstall spark plugs.
6. Connect the injector connectors and ignition coil connectors.

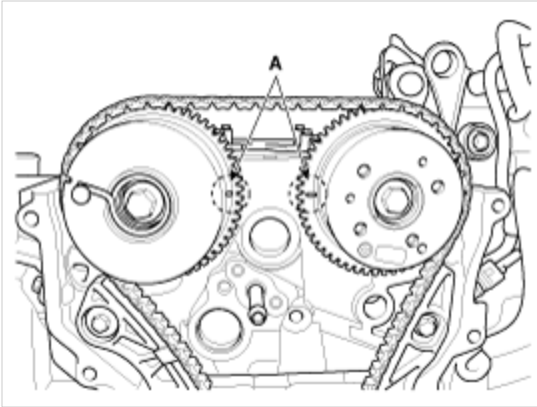
Valve Clearance Inspection And Adjustment**NOTICE**

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C (68°F)) and cylinder head is installed on the cylinder block.

1. Remove the cylinder head cover. (Refer to Timing system)
2. Set No.1 cylinder to TDC/compression.
 - A. Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.

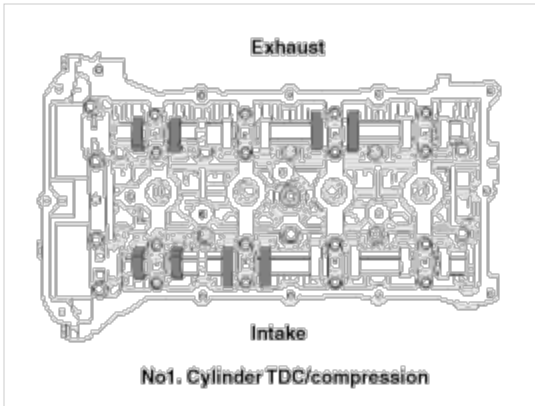


- B. Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft one revolution (360°)



3. Inspect the valve clearance.

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



- 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]

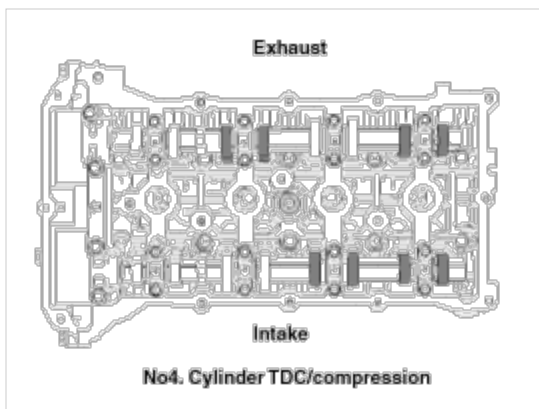
Limit

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

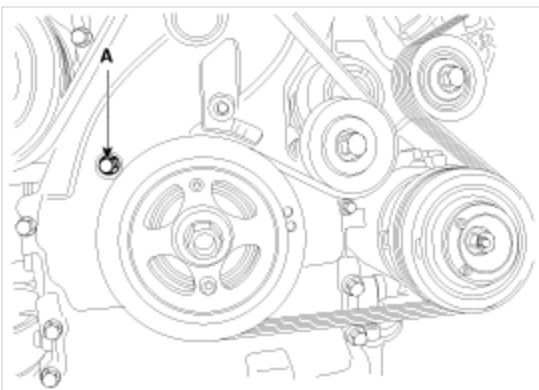
Exhaust : 0.25 ~ 0.45mm (0.0098 ~ 0.0177in.)

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

C. Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearance.



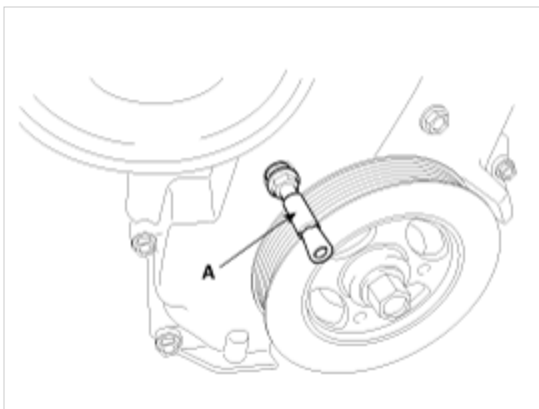
4. Adjust the intake and exhaust valve clearance.
 - A. Set the No.1 cylinder to the TDC/compression.
 - B. Marks on the timing chain and camshaft timing sprockets.
 - C. Remove the service hole bolt(A) of the timing chain cover.



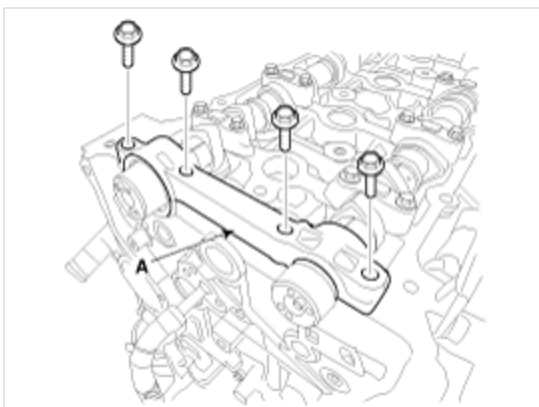
CAUTION

The bolt must not be reused once it has been assembled.

- D. Insert the SST(A) (09240-2G000) in the service hole of the timing chain cover and release the ratchet.



E. Remove the front camshaft bearing cap(A).



F. Remove the exhaust camshaft bearing cap and exhaust camshaft.

G. Remove the intake camshaft bearing cap and intake camshaft.

⚠ CAUTION

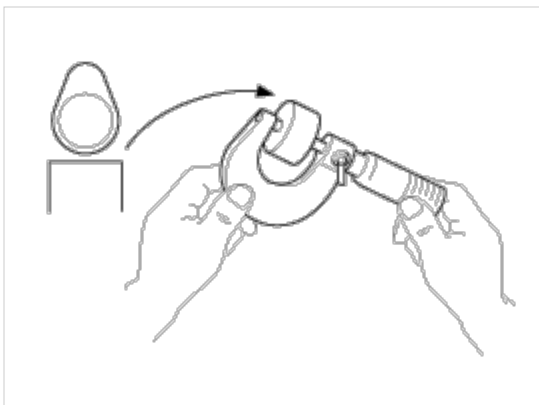
When disconnect the timing chain from the camshaft timing sprocket, hold the timing chain.

H. Tie down timing chain so that it doesn't move.

⚠ CAUTION

Be careful not to drop anything inside timing chain cover.

I. Measure the thickness of the removed tappet using a micrometer.



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

Valve clearance (Engine coolant temperature : 20°C)

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

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

NOTICE

Shims are available in 47size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1452in.)

L. Place a new tappet on the cylinder head.

M. Hold the timing chain, and install the intake camshaft and timing sprocket assembly.

N. Align the matchmarks on the timing chain and camshaft timing sprocket.

O. Install the intake and exhaust camshaft.

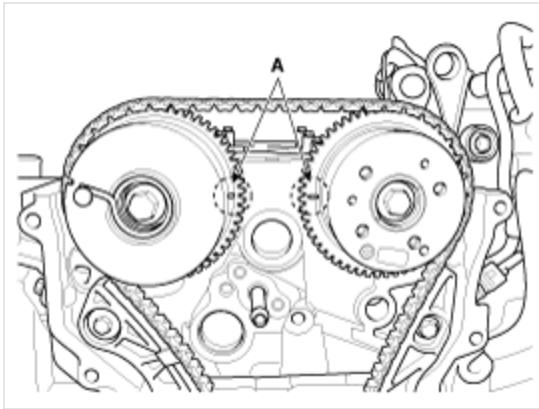
P. Install the front bearing cap.

Q. Install the service hole bolt.

Tightening torque :

11.8 ~ 14.7N.m (1.2 ~ 1.5kgf.m, 8.7 ~ 10.8lb-ft)

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



S. Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C)

[Specification]

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

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

Engine Mechanical System



Troubleshooting

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings	Replace the crankshaft and bearings as required.
	Loose or improperly engine flywheel	Repair or replace the flywheel 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	<ul style="list-style-type: none"> Faulty cylinder head gasket or other damage to the cylinder head and engine block cooling system. Coolant consumption may or may not cause the engine to overheat. 	<ul style="list-style-type: none"> Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. Repair or replace as required.
Engine misfire with excessive oil consumption	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
		<ul style="list-style-type: none"> Inspect the cylinder for a loss of compression. Repair or replace as required.

	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity	<ul style="list-style-type: none"> • Drain the oil. • Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	<ul style="list-style-type: none"> • Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Upper engine noise, regardless of engine speed.	Low oil pressure	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	<ul style="list-style-type: none"> • Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair or replace 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 or replace as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required
Lower engine noise, regardless of engine speed	Low oil pressure	Repair or required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	Damaged oil pan, contacting the oil pump screen.	<ul style="list-style-type: none"> • Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	<ul style="list-style-type: none"> • Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	<ul style="list-style-type: none"> • Inspect the piston, piston pin and cylinder bore. • Repair or replace as required.
	Excessive piston pin-to-piston clearance	<ul style="list-style-type: none"> • Inspect the piston, piston pin and the connecting rod. • Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required. <ul style="list-style-type: none"> • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. <ul style="list-style-type: none"> • The crankshaft bearings. • The crankshaft main journals. • The cylinder block
		<ul style="list-style-type: none"> •

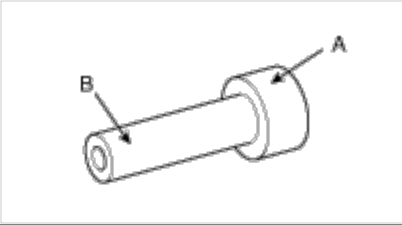
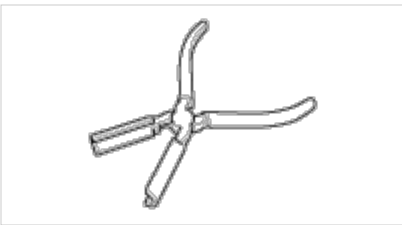
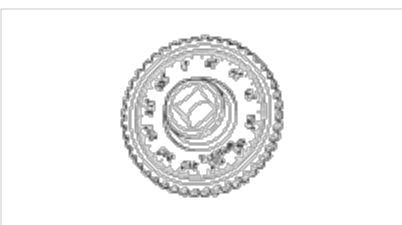
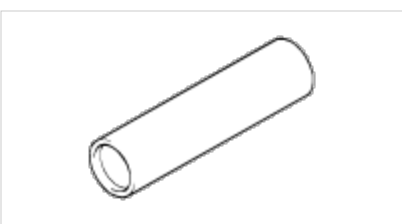
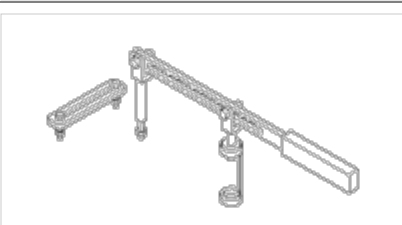
	Incorrect piston, piston pin and connecting rod installation	Verify the piston pins and connecting rods are installed correctly. • Repair as required.
Engine noise under load	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and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

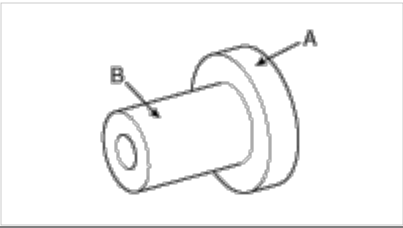
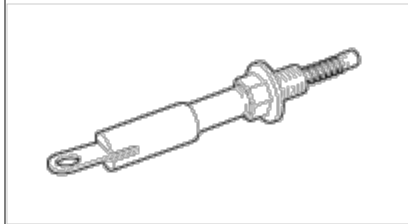
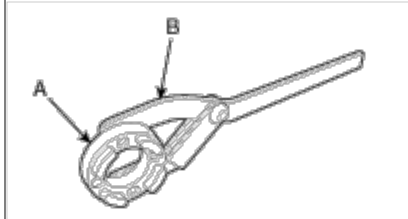
Engine Mechanical System



Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100)		Installation of the front oil seal A : 09214-3K000 B : 09231-H1100

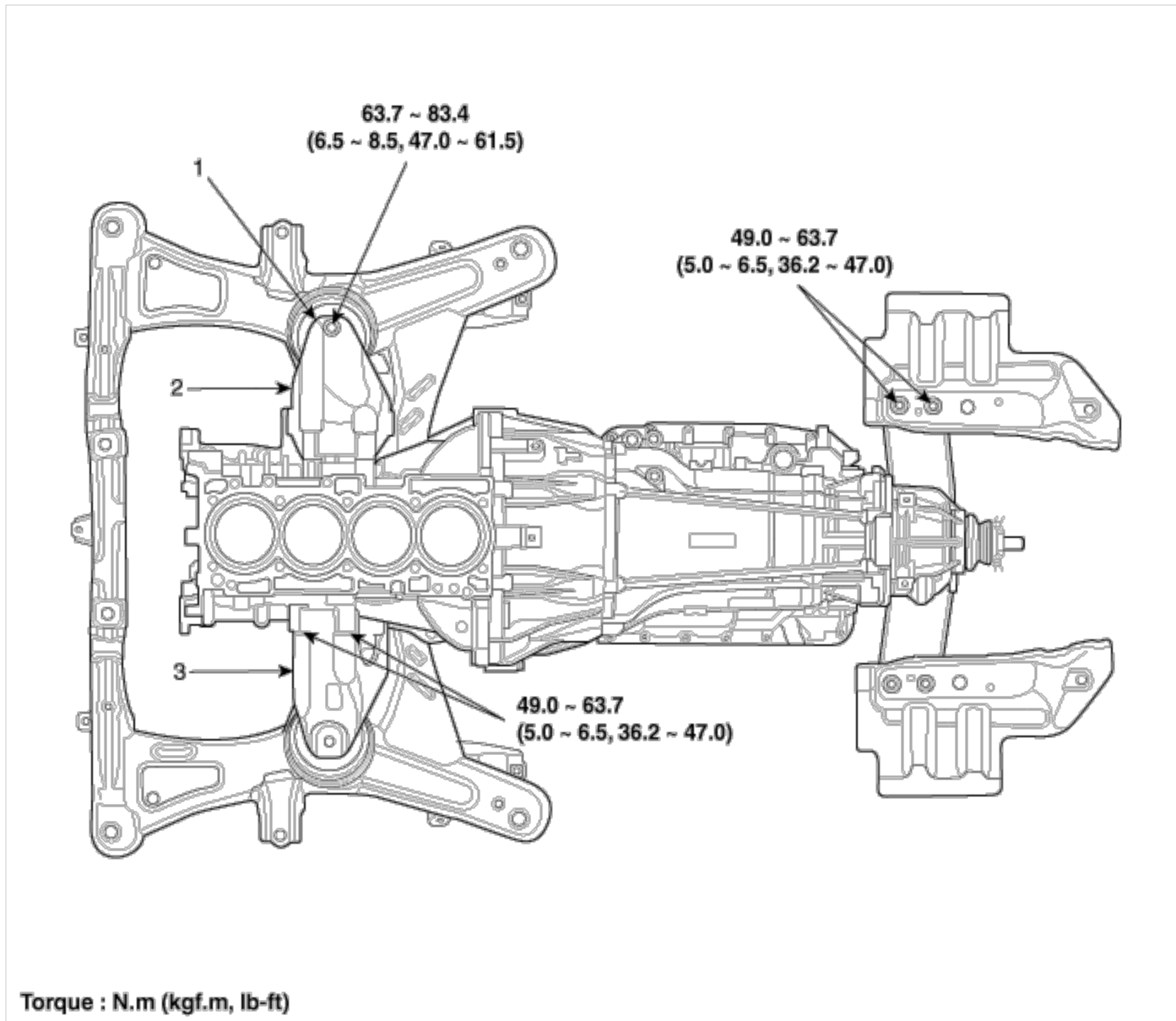
		
Valve stem seal		Removal of the valve stem seal
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method of adjustment.
Valve stem oil seal installer (09222-4A000)		Installation of the valve stem oil seal
Valve spring compressor & holder (09222-3K000) (09222-3K100)		Removal and installation of the intake or exhaust valve 09222-3K100 (holder)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09214-3K100 B : 09231-H1100

		
<p>Timing chain tensioner ratchet holder (09240-2G000)</p>		<p>Timing chain tension release. In vehicle inspection and adjustment of valve clearance.</p>
<p>Crankshaft pulley adapter (09231-2M100) Crankshaft pulley adapter holder (09231-2J210)</p>		<p>Removal and installation of crankshaft pulley from the vehicle A : 09231-2M100 B : 09231-2J210 (Holder)</p>

Engine Mechanical System



Components



1. Engine mounting bracket
2. Engine support bracket RH

3. Engine support bracket LH





Installation

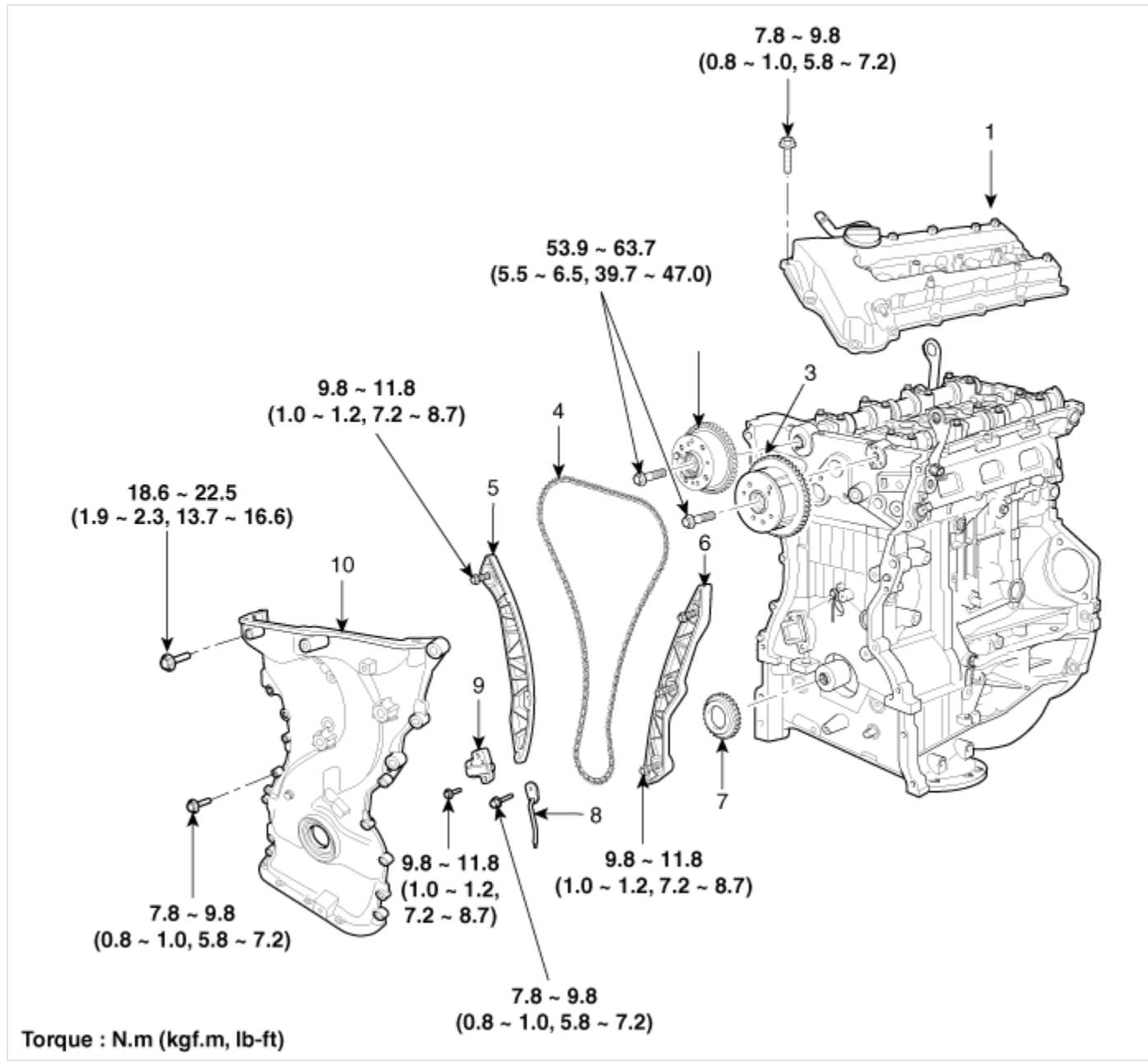
Installation is in the reverse order of removal.

Perform the following :

- Adjust a shift cable.
- Adjust a throttle cable.
- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill power steering fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- Place a heater control knob on "HOT" position.
- Inspect for fuel leakage.
- After assemble 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.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.
- Clean battery posts and cable terminals and assemble.



Components



1. Cylinder head cover	5. Timing chain tensioner arm	8. Oil jet
2. Exhaust CVVT assembly	6. Timing chain tensioner guide	9. Timing chain tensioner
3. Intake CVVT assembly	7. Crankshaft sprocket	10. Timing chain cover
4. Timing chain		

Engine Mechanical System

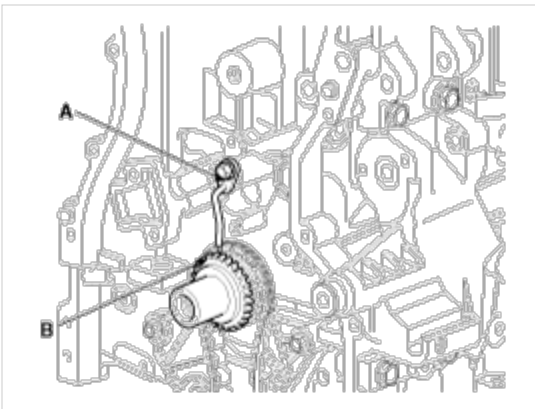


Installation

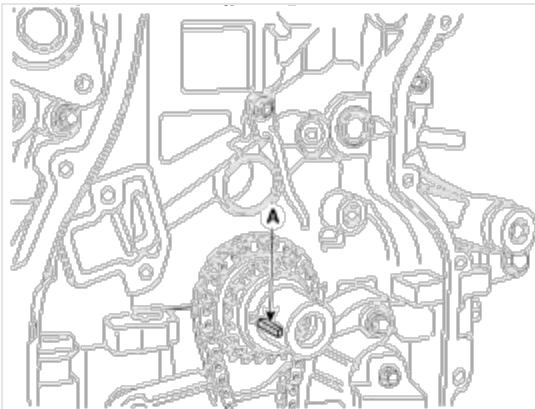
1. Install the timing chain oil jet (A) and crankshaft sprocket (B).

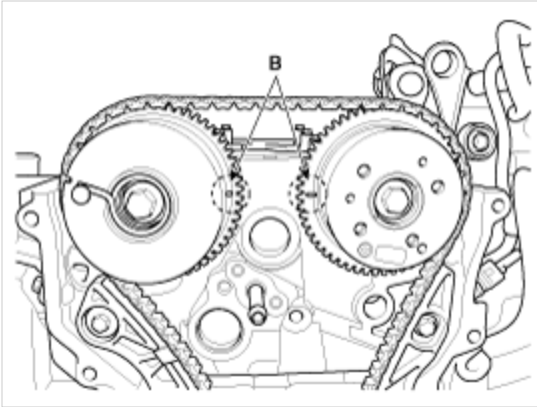
Tightening torque :

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



2. Set the crankshaft so that the key (A) of crankshaft will be aligned with the mating surface of main bearing cap. Put the intake and exhaust camshaft assembly so that the TDC marks (B) of the intake and exhaust CVVT sprockets will be aligned with the top surface of cylinder head. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.

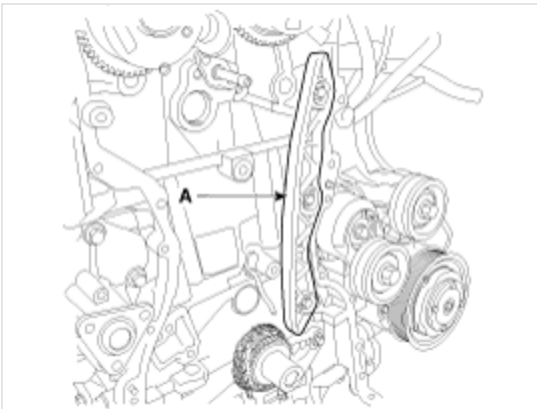




3. Install the timing chain guide (A).

Tightening torque :

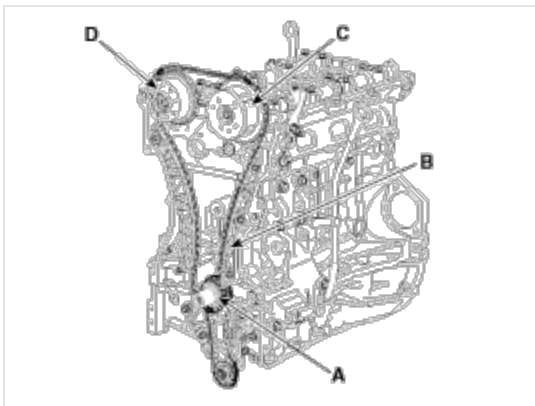
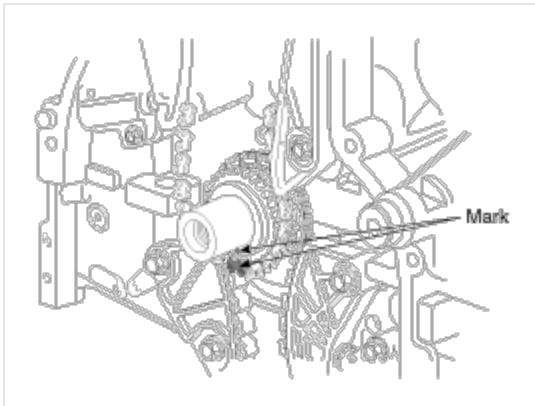
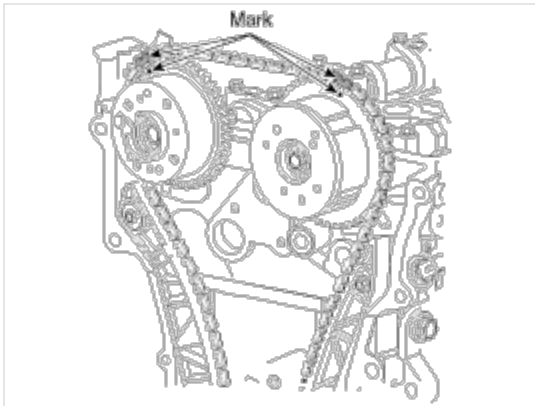
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



4. Install the timing chain.

To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure. Crankshaft sprocket (A) -> Timing chain guide (B) -> Intake CVVT assembly (C) -> Exhaust CVVT assembly (D).

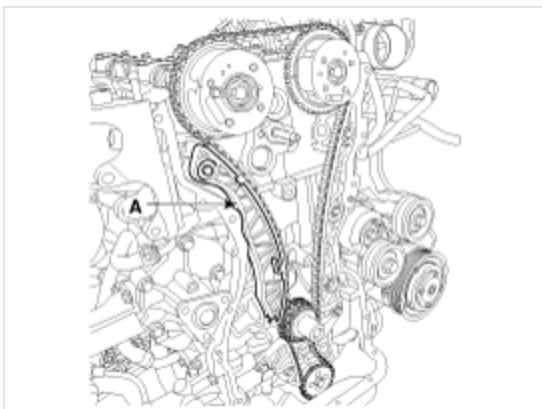
The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.



5. Install the timing chain tensioner arm (A).

Tightening torque :

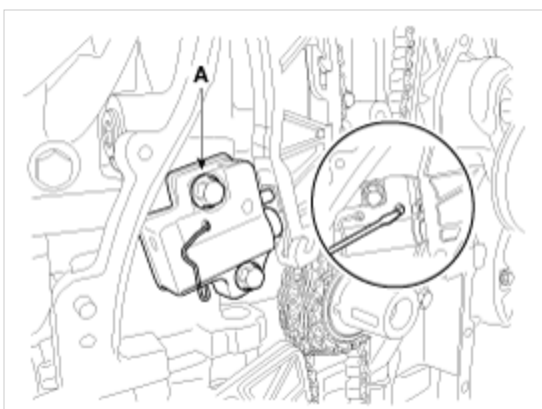
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



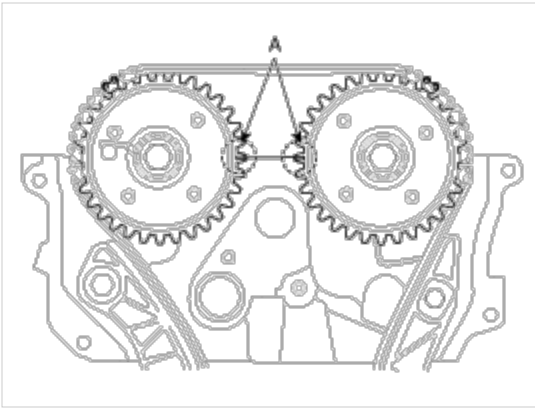
6. Install the timing chain auto tensioner (A) and remove the set pin.

Tightening torque :

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



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

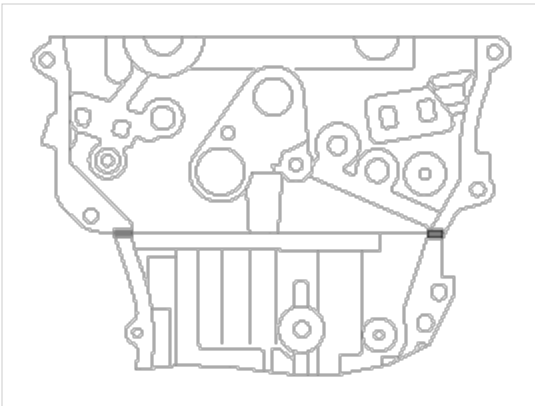


8. Install timing chain cover.

- A. Using a gasket scraper remove all the old packing material from the gasket surfaces.
- B. The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and ladder frame) must be free of engine oil and ETC.
- C. Before assembling the timing chain cover, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on the gap between cylinder head and cylinder block.

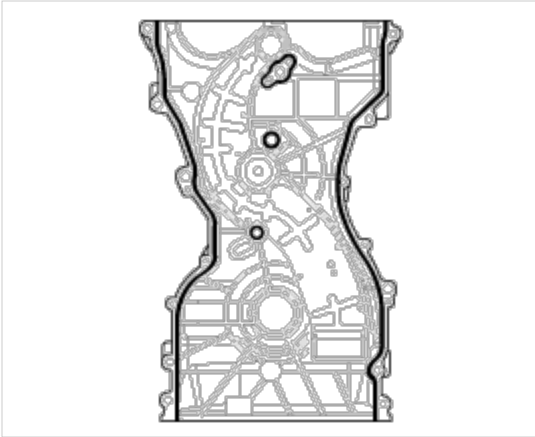
The part must be assembled within 5 minutes after sealant was applied.

Bead width : $2.5\pm 0.5\text{mm}$ ($0.098\pm 0.019\text{in.}$)



- D. After applying liquid sealant Loctite 5900H on timing chain cover. The part must be assembled within 5 minutes after sealant was applied. Sealant should be applied without discontinuity.

Bead width : 3.0mm (0.12in.)

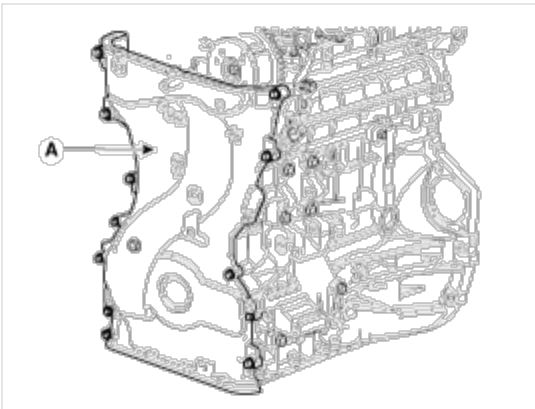


E. The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover to be in exact position.

Tightening torque :

M6 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

M8 : 18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

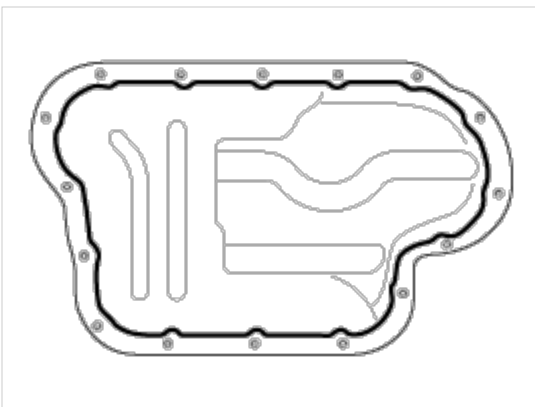


F. The firing and/or blow out test should not be performed within 30 minutes after the timing chain cover was assembled.

9. Install the 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 Loctite 5900H or THREEBOND 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.



⚠ CAUTION

- When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

C. Install the oil pan (A).

Uniformly tighten the bolts in several passes.

Tightening torque :

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

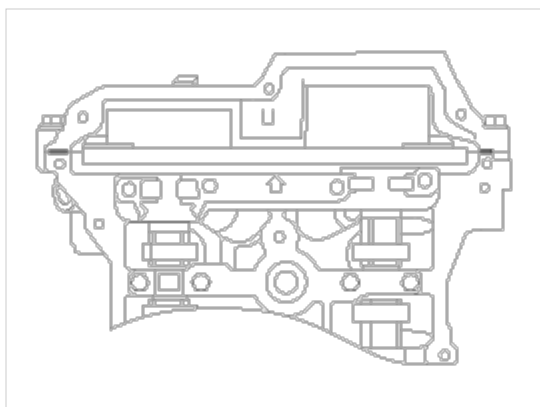
D. After assembly, wait at least 30 minutes before filling the engine with oil.

10. Install the cylinder head cover.

A. The hardened sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

B. After applying sealant (Loctite 5900H, Three Bond 1217H, it should be assembled within 5 minutes.

Bead width :2.5±0.5mm (0.098±0.019in.)



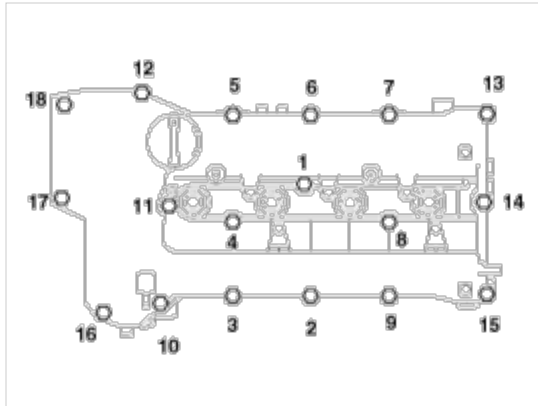
C. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

D. Install the cylinder head cover bolts as following method.

Tightening torque :

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

Step 2 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



CAUTION

Do not reuse cylinder head cover gasket.

11. Install the crankshaft pulley (D).

Tightening torque :

166.7 ~ 176.5N.m (17 ~ 18kgf.m, 122.9 ~ 130.2lb-ft)

NOTICE

Fix the crankshaft using the SST (09231-2M000, 09231-2J210) when installing the crankshaft pulley bolt.

12. Install the water pump pulley (B) and Idler (C).

Tightening torque :

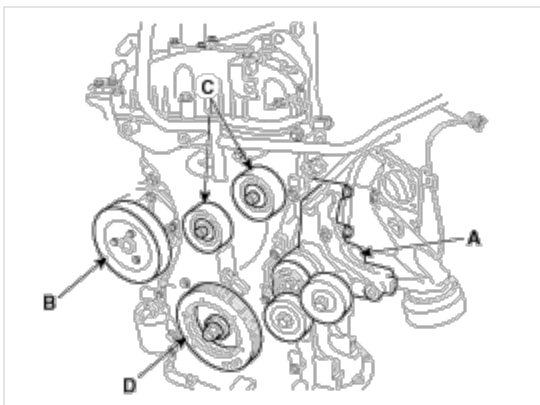
B: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

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

13. Install the tensioner bracket assembly (A).

Tightening torque :

39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)

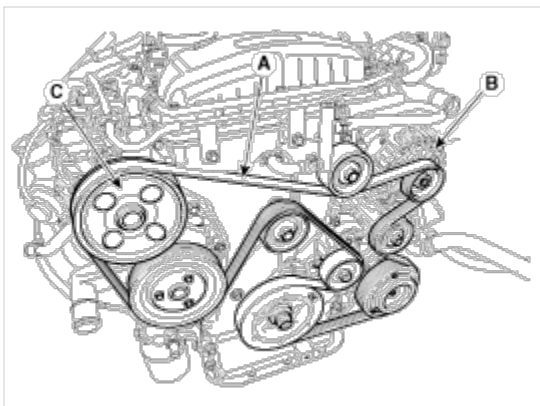


14. Install the alternator (B), power steering pump (C) and drive belt (A).

Tightening torque :

B: 49.0 ~ 63.7N.m (5.0 ~ 6.5kgf.m, 36.1 ~ 47.0lb-ft)

C: 16.6 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)

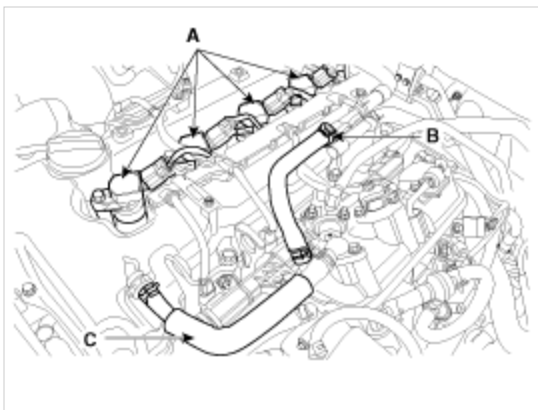


15. Install the ignition coil and connect the ignition coil connector (A).

Tightening torque :

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

16. Install the vacuum hose (B) and PCV hose (C).

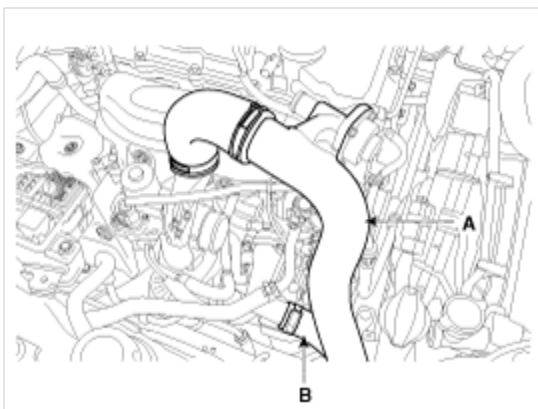


17. Install the intercooler inlet hose (A).

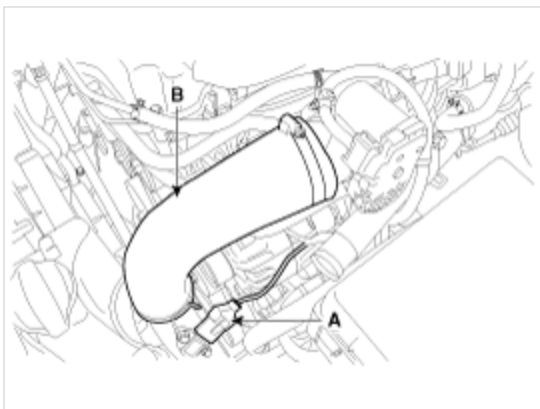
Tightening torque :

Bolt : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)

Clamp : 4.9 ~ 6.8N.m (0.5 ~ 0.7kgf.m, 3.6 ~ 5.1lb-ft)



18. Install the intercooler outlet hose (B) and connect the BPS connector (A).



19. Install the radiator upper hose (A).

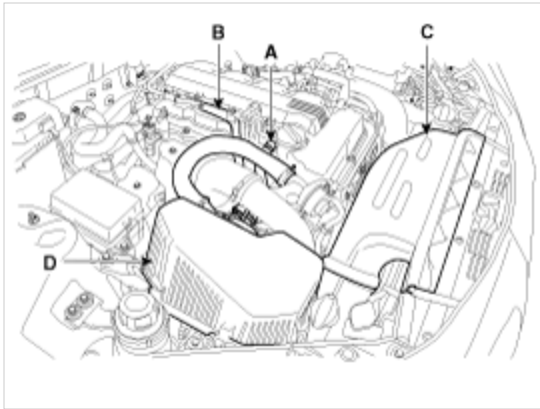


20. Install the air cleaner assembly (D) and air duct (C). And then connect the breather hose (A) and vacuum hose (B).

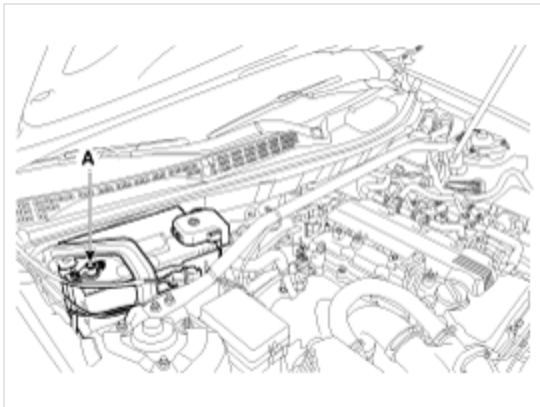
Tightening torque :

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

Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.1 ~ 3.6lb-ft)



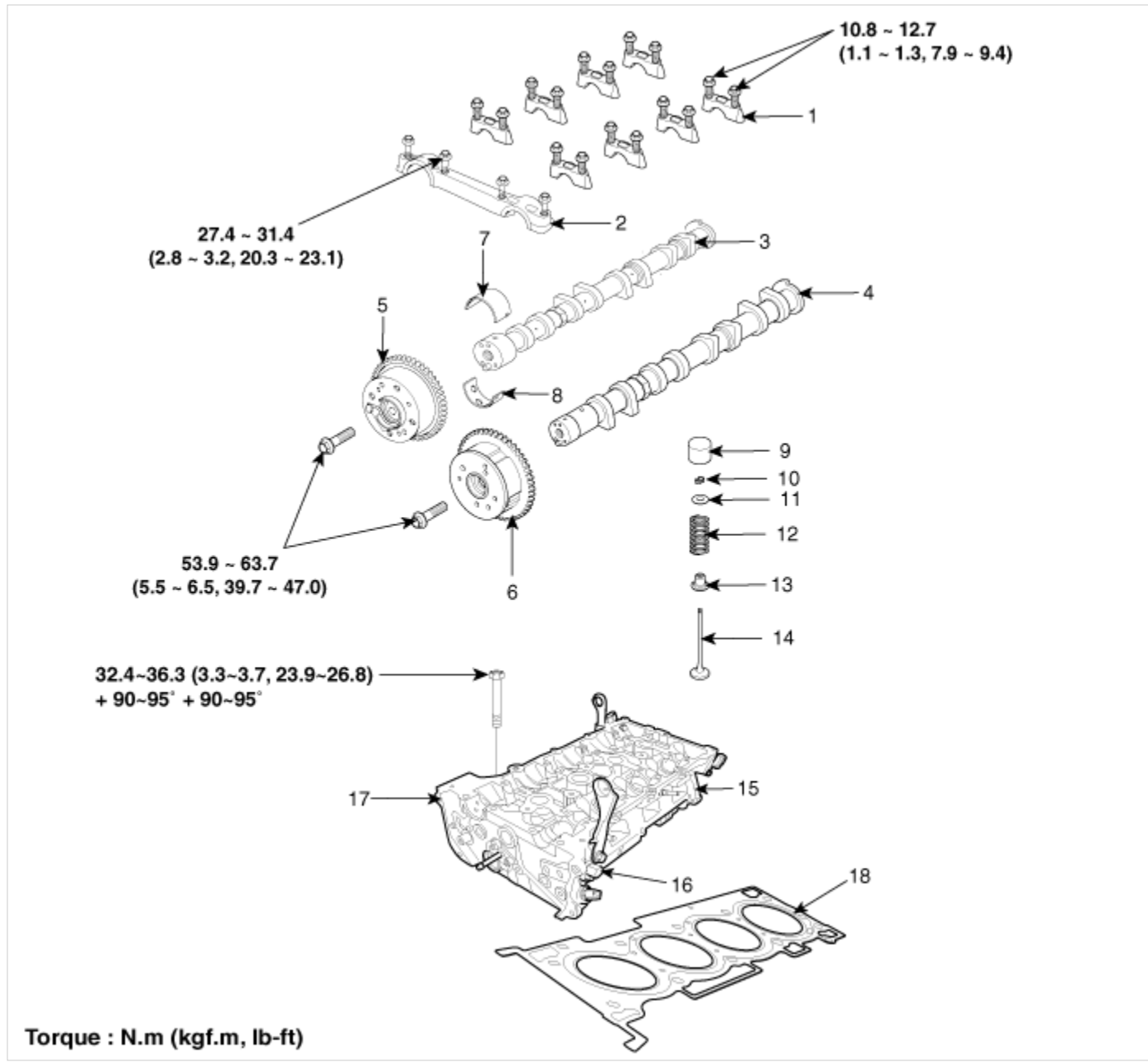
21. Connect the battery negative cable (A).



Engine Mechanical System



Components



1. Camshaft bearing cap	7. Exhaust camshaft upper bearing	13. Valve stem seal
2. Camshaft front bearing cap	8. Exhaust camshaft lower bearing	14. Valve
3. Exhaust camshaft	9. MLA	15. Cylinder head
4. Intake camshaft	10. Retainer lock	16. Intake OCV
5. Exhaust CVVT assembly	11. Retainer	17. Exhaust OCV
6. Intake CVVT assembly	12. Valve spring	18. Cylinder head gasket

Engine Mechanical System



Installation

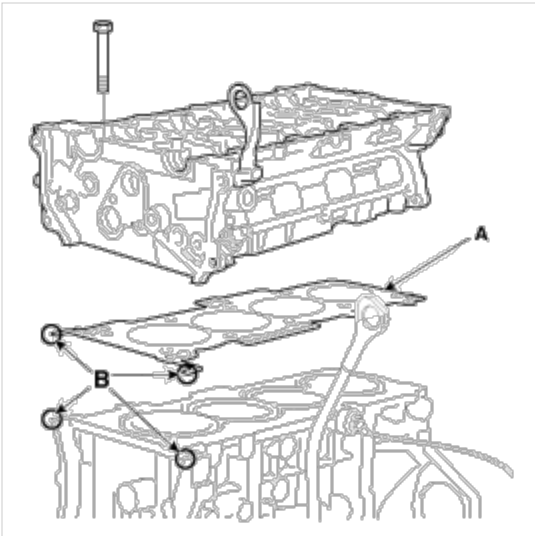
NOTICE

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

1. Install the cylinder head gasket(A) on the cylinder block.

NOTICE

- Be careful of the installation direction.
- Apply liquid gasket (Loctite 5900H) on the edge of cylinder head gasket upside and downside. (At the position 'B')
- After applying sealant, assemble the cylinder head in five minutes.



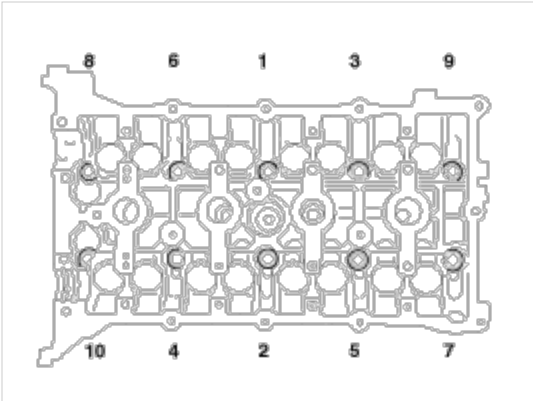
2. Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.

3. Install cylinder head bolts.

- A. Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.
- B. Using a hexagon wrench, install and tighten the 10 cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :

32.4~36.3Nm (3.3~3.7kgf.m, 23.9~26.8lb-ft) + 90~95° + 90~95°

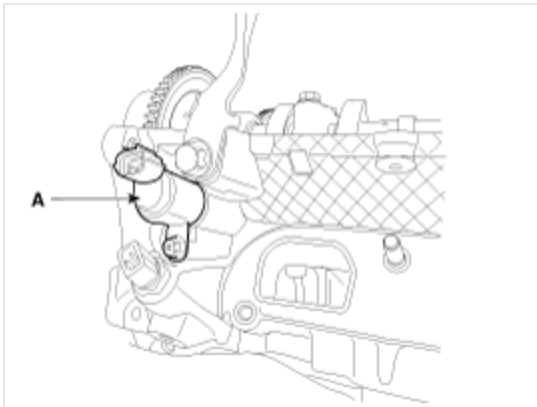
**NOTICE**

Always use new cylinder head bolt.

4. Install the OCV(A).

Tightening torque :

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

**CAUTION**

- Do not reuse the OCV when dropped.
- Keep the OCV filter clean.

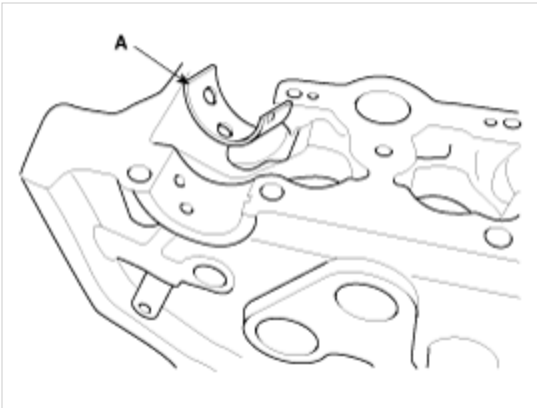
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine with holding the OCV yoke.

5. Install the camshafts.

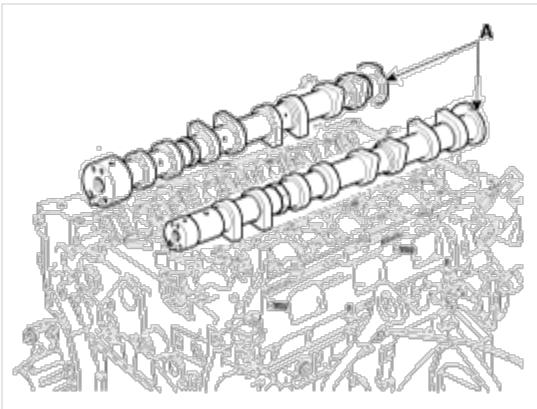
NOTICE

Apply a light coat of engine oil on camshaft journals.

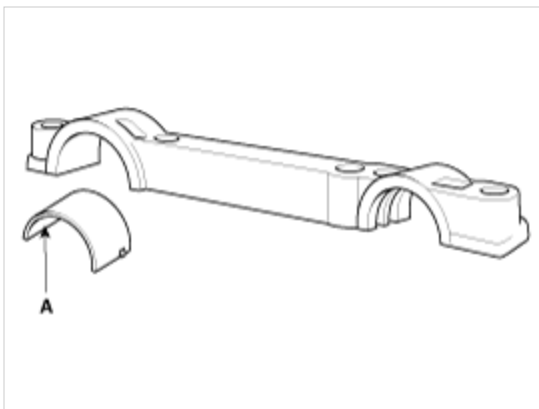
A. Install the exhaust camshaft lower bearing (A).



B. Install the camshafts (A).



C. Install the exhaust camshaft upper bearing (A).



D. Install camshaft bearing caps in their proper locations.

Tightening order.

Group A → Group B → Group C.

Tightening torque

Step 1

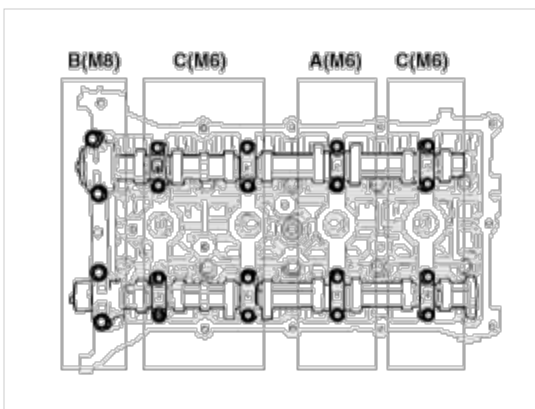
M6 : 5.9N.m(0.6kgf.m, 4.3lb-ft)

M8 : 14.7N.m(1.5kgf.m, 10.8lb-ft)

Step 2

M6 : 10.8 ~ 12.7N.m(1.1 ~ 1.3kgf.m, 7.9 ~ 9.4lb-ft)

M8 : 27.5 ~ 31.4N.m(2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)

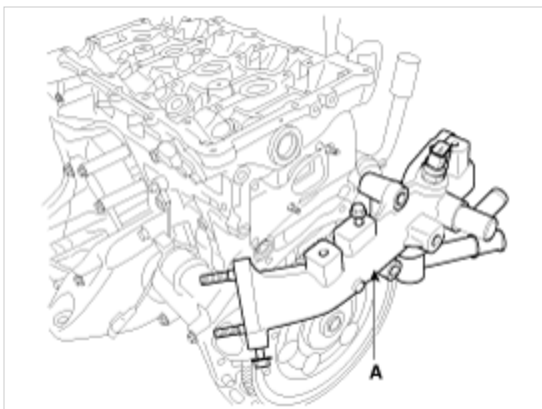


6. Install the water temperature control assembly (A) with a new gasket.

Tightening torque :

Bolts : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.4lb-ft)

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



CAUTION

- Assemble water temp control assembly and water inlet pipe to water pump assembly before nuts for assembling of water inlet pipe to be tightened.
- Always use a new O-ring.

7. Install the timing chain.

8. Check and adjust valve clearance.

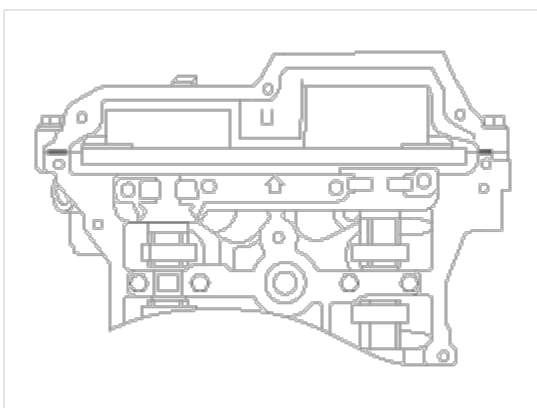
9. Install the cylinder head cover.

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

B. After applying sealant, it should be assembled within 5 minutes.

Bead width :2.5mm(0.1in.)

Sealant :LOCTITE 5900H, Three Bond 1217H



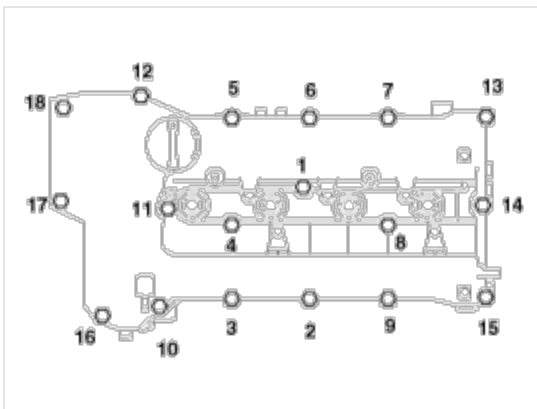
C. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

D. Install the cylinder head cover bolts as following method.

Tightening torque :

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

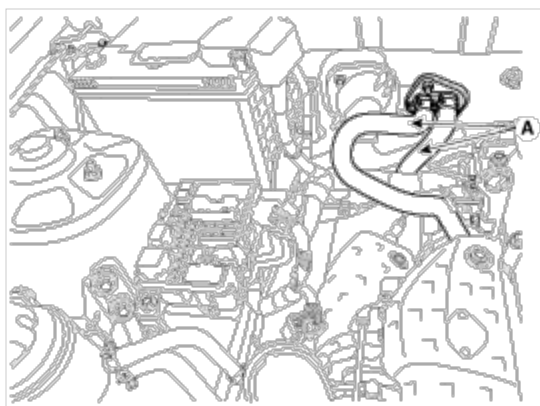
Step 2 : 7.8 ~ 9.8N.m(0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



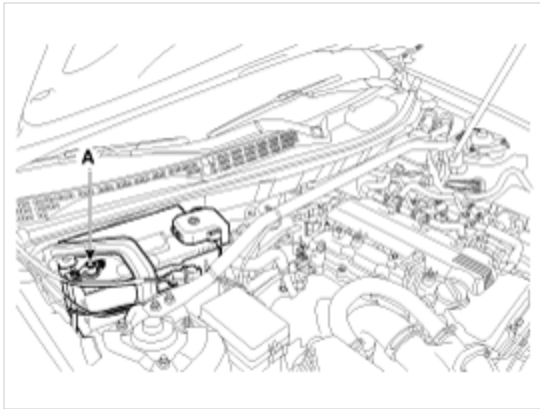
CAUTION

Do not reuse cylinder head cover gasket.

10. Install the intake & exhaust manifold. (Refer to Intake and exhaust system in this group)
11. Install the heater hoses (A).



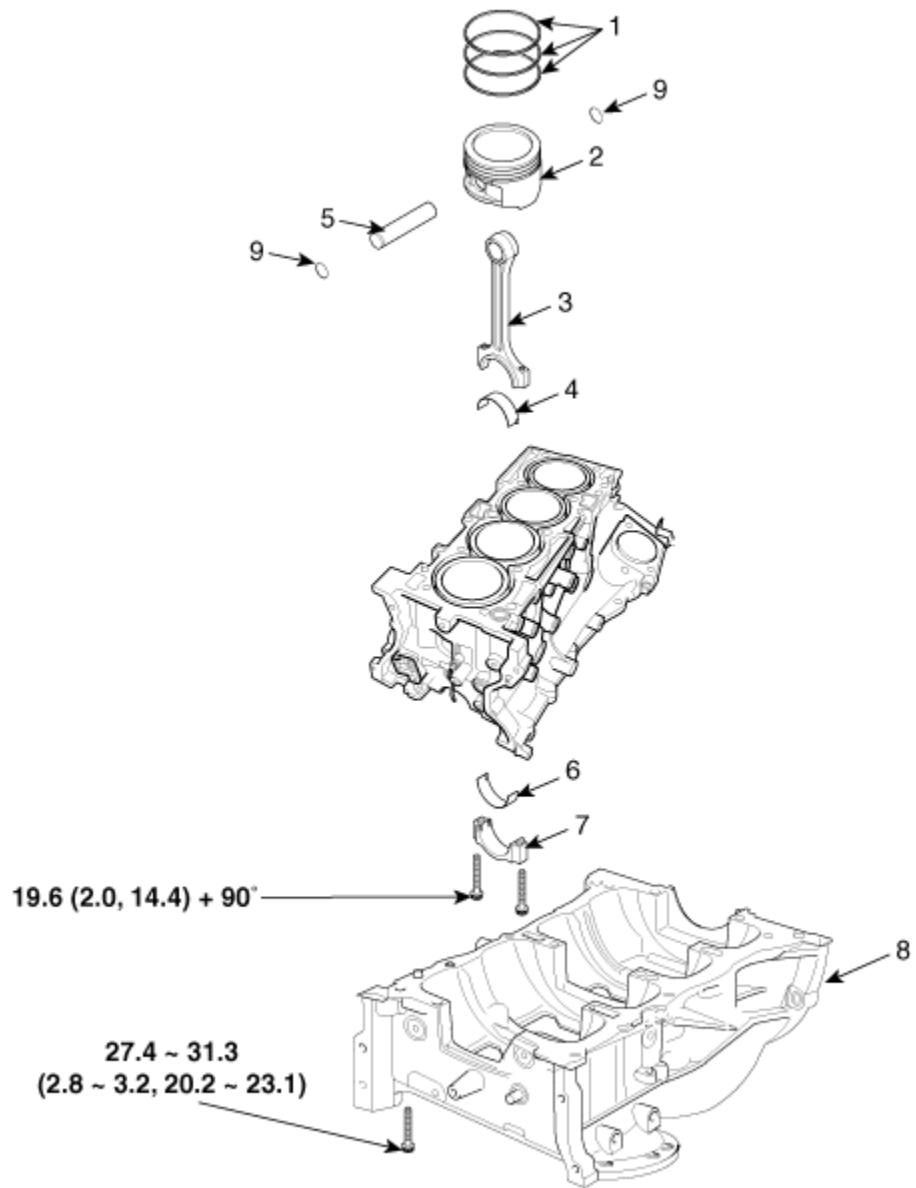
12. Connect the negative (-) battery terminal (A).



Engine Mechanical System



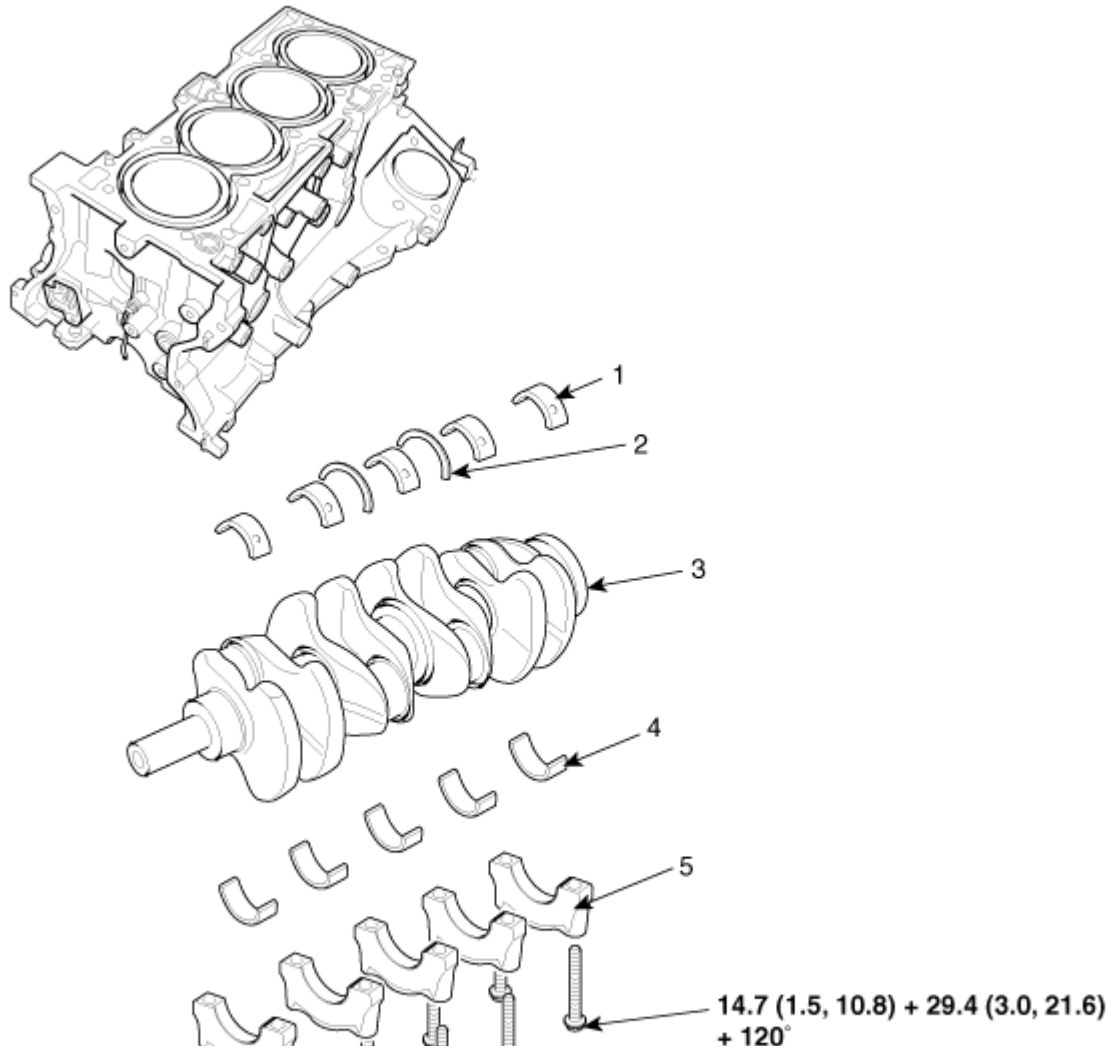
Components

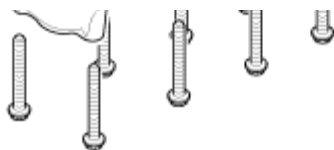


Torque : N.m (kgf.m, lb-ft)

1. Piston ring
2. Piston
3. Connecting rod
4. Connecting rod upper bearing

5. Piston pin
6. Connecting rod lower bearing
7. Connecting rod bearing cap
8. Ladder frame
9. Snap ring





Torque : N.m (kgf.m, lb-ft)

1. Crankshaft upper bearing
2. Thrust bearing
3. Crankshaft

4. Crankshaft lower bearing
5. Main bearing cap

Engine Mechanical System



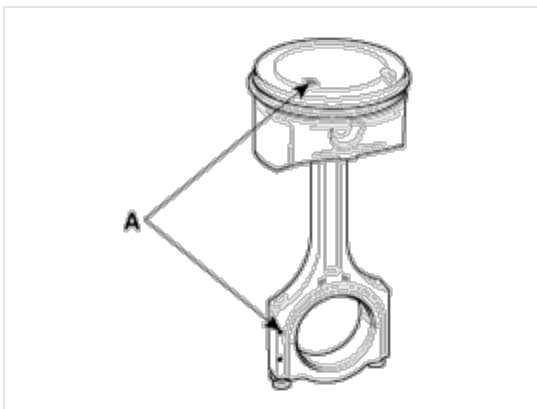
Reassembly

NOTICE

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

1. Assemble the piston and connecting rod.

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



(2) Before pressing the piston pin, apply a coat of lubricant oil to the piston pin outer and connecting rod.

CAUTION

- Apply heat to the piston (70°C) and then install the piston pin.
- Take care that piston pin is not to be damaged during pressing process.
- When replace the piston pin, check the piston pin outer diameter and connecting rod small end inner diameter as below.

Piston pin outer DIA. :

21.997mm ~ 22.000mm (0.8660 ~ 0.8661 in)

Connecting rod S/END inner DIA. :

22.005mm ~ 22.011mm (0.8663 ~ 0.8665 in)

- Take care that piston is not to be damaged during installing process. When replace the piston pin, check the gap as below.

Connecting rod bushing gap :

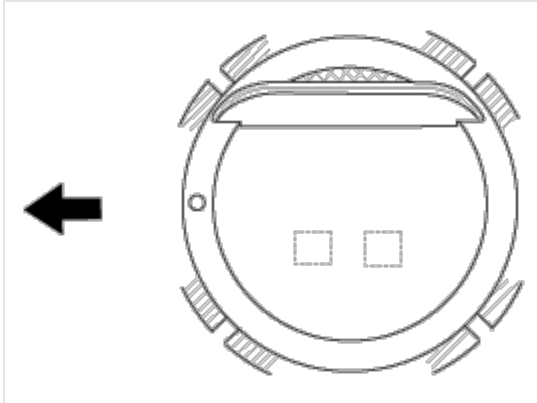
0.005mm ~ 0.014mm (0.00019 ~ 0.00055 in)

Piston pin BOSS gap :

0.003mm ~ 0.010mm (0.00012 ~ 0.00039 in) - Heat to 70°C

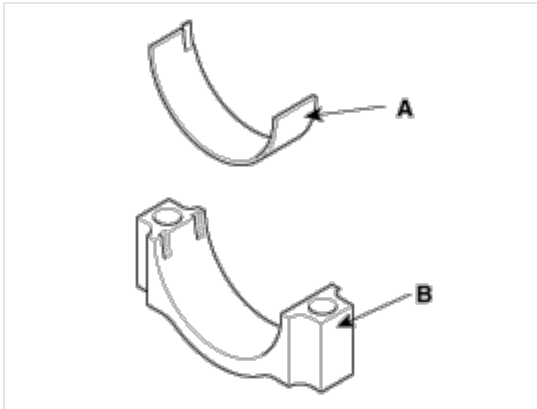
2. Install the piston rings.

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



3. Install the connecting rod bearings.

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

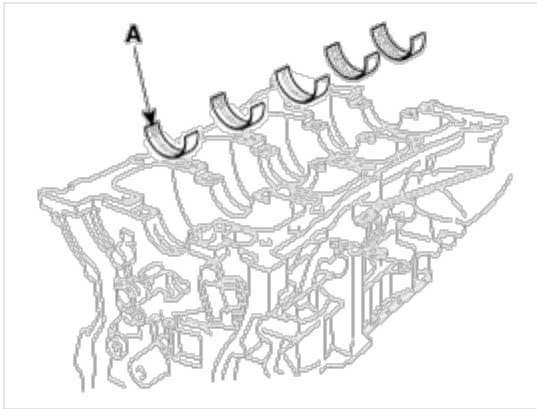


4. Install the main bearings.

NOTICE

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

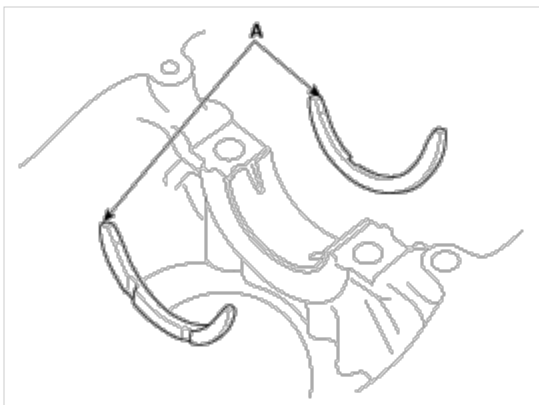
- (1) Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings(A).



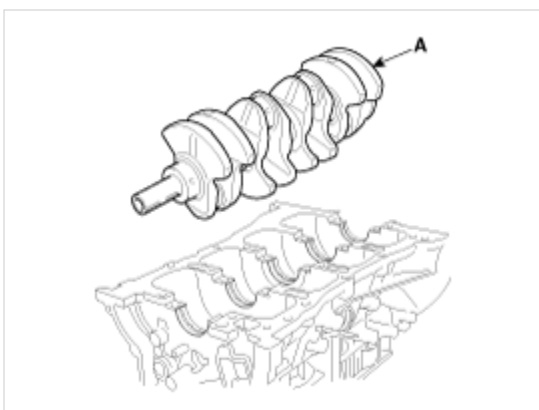
- (2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 5 lower bearings.

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



7. Place the main bearing caps on cylinder block.

8. Install the main bearing cap bolts.

Tightening torque

14.7Nm (1.5kgf.m, 10.8lb-ft) + 29.4Nm (3.0kgf.m, 21.6lb-ft) + 120°

CAUTION

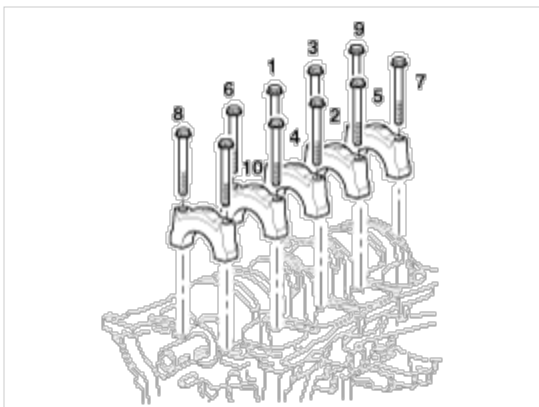
Always use new main bearing cap bolts.

NOTICE

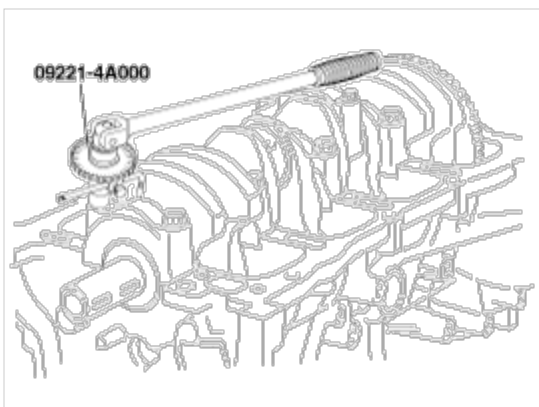
- The main bearing cap bolts are tightened in 2 progressive steps.
- If any of the bearing cap bolts is broken or deformed, replace it.

(1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.

(2) Install and uniformly tighten the 10 bearing cap bolts(A), in several passes, in the sequence shown.



(3) Retighten the bearing cap bolts by 120° in the numerical order shown. (Using the SST (09221-4A000))



(4) Check that the crankshaft turns smoothly.

9. Check crankshaft end play.

10. Install the piston and connecting rod assemblies.

NOTICE

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

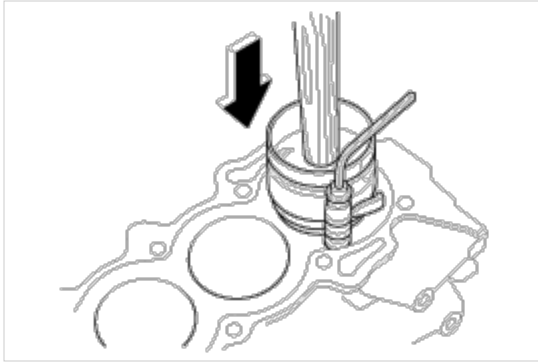
(1) Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts.

(2) 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.

(3) Stop after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.

NOTICE

Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



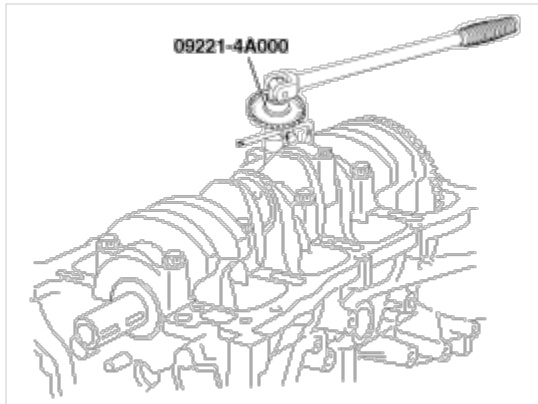
(4) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque

17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

NOTICE

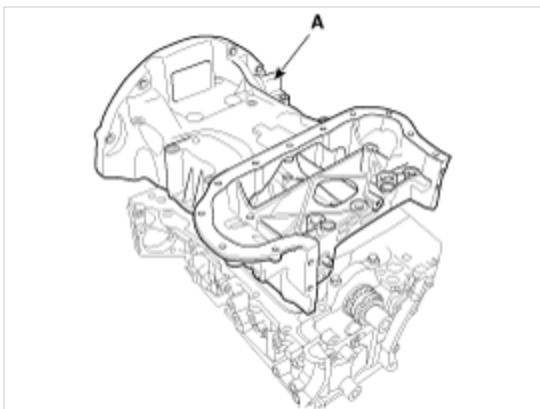
Always use new connecting rod cap bolts.



11. Install the ladder frame (A).

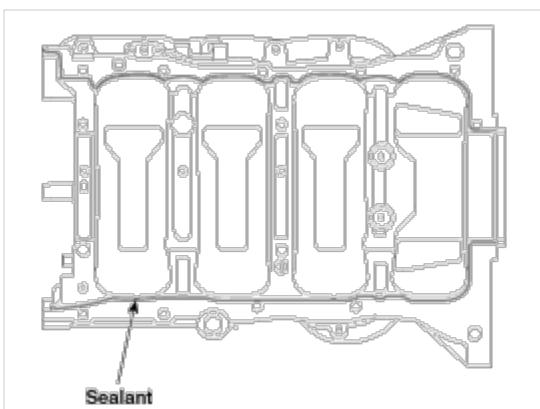
Tightening torque :

27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



NOTICE

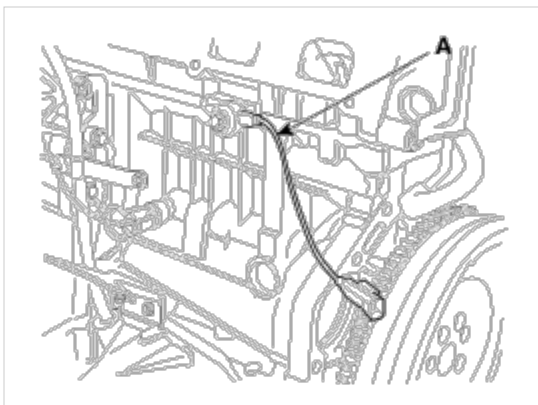
- Before assembling ladder frame, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied ladder frame.
- The part must be assembled within 5 minutes after sealant was applied.
- Apply sealant to the inner threads of the bolt holes.



12. Install the rear oil seal.
 - (1) Apply engine oil to a new oil seal lip.
 - (2) Using SST (09231-H1100, 09214-3K100) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
13. Install the oil pump.
14. Install the water pump.
15. Install the knock sensor(A).

Tightening torque

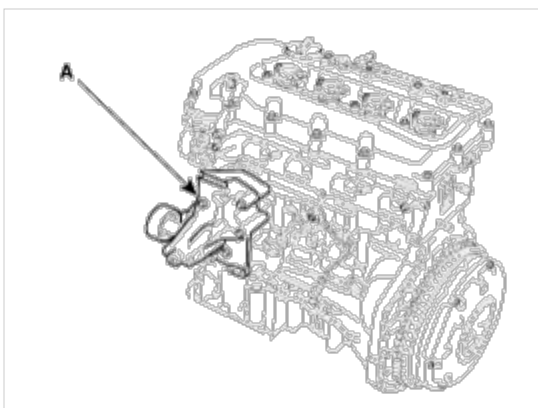
16.7 ~ 25.5N.m (1.7 ~ 2.6kgf.m, 12.3 ~ 18.8lb-ft)



16. Install the tensioner assembly integrated bracket(A).

Tightening torque

39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



17. Install the power steering pump bracket and power steering pump.
 18. Install the alternator.
 19. Install the A/C compressor.
 20. Install the cylinder head.
 21. Install the timing chain.
 22. Install the oil pan.

- (1) Using a razor blade and gasket scraper, remove all the old gasket material from the gasket surfaces.

NOTICE

Check that the mating surfaces are clean and dry before applying liquid gasket.

- (2) Apply liquid gasket as an even bead, centered between the edges of the mating surface.
 Use liquid gasket LOCTITE5900H or THREEBOND 1217H equivalent (MS721-40).