

General

SPECIFICATIONS

Item	Specification		
	Standard value ([] Base diameter)	Limit	Remedy
General			
Type	In line 6 cylinder 4cycle common rail		
Cylinder bore	103mm		
Cylinder stroke	118mm		
Displacement	5,899cc		
Compression pressure ratio	17 : 1		
Firing order	1-5-3-6-2-4		
Max. output	200PS/2,500rpm (Aerotown)		
	225PS/2,500rpm (Aerotown)		
	230PS/2,500rpm (HD120)		
	255PS/2,500rpm (HD120)		
Max. torque	65kgf.m/1,600rpm (Aerotown)		
	70kgf.m/1,600rpm (Aerotown)		
	80kgf.m/1,600rpm (HD120)		
	86kgf.m/1,600rpm (HD120)		
	95kgf.m/1,600rpm (HD120)		
Compression pressure (at 200rpm)	26kg/cm ² or more (Within 4kg/cm ² each cylinder)	20kg/cm ²	Adjust
Cylinder block			
Cylinder bore	102.985~103.015mm		
Tosion of upper cylinder block	0.05mm		
Flatness of upper cylinder block	0.07mm		
Cylinder bore			
Inner diameter	102.985~103.015mm		Repair or replace oversize
Squareness	0.05mm		
Cylindricity	0.012mm		
Cylinder head			
Flatness of cylinder head bottom	0.07mm (Head whole bottom) 0.02mm (150×150) 0.01mm (50×50)		Repair or replace.
Height from top to bottom of cylinder head	136.7~136.9mm		

Item	Specification		
	Standard value ([] Base diameter)	Limit	Remedy
Piston			
Piston outer diameter	102.863~102.881mm		Correct or replace with oversize
Clearance between cylinder bore gradeA or B and piston grade A	0.114~0.145mm		
Clearance between cylinder bore grade B or C and piston grade B	0.111~0.143mm		
Protrusion of piston	-0.309~0.259mm		Replace
Piston pin			
Outer diameter of piston pin	43.994~44.000mm		
Clearance between piston pin and piston pin hole	0.014~0.028mm	0.05mm	Replace
Clearance between piston pin and connecting rod end bush	0.030~0.046mm	0.1mm	Replace
Clearance between piston ring and piston ring groove			
No. 1 piston ring	0.120~0.160mm	0.20mm	Replace
No. 2 piston ring	0.090~0.130mm	0.17mm	
Oil ring	0.030~0.070mm	0.15mm	
Piston ring end gap			
No. 1 piston ring	0.25~0.35mm	1.0mm	Replace
No. 2 piston ring	0.60~0.75mm	1.0mm	
Oil ring	0.20~0.40mm	1.0mm	
Crankshaft			
Out of cylindricity of pin and journal	0.005mm		
No.2, No.6 journal distortion (measured at No.1,No.7 journal)	0.07mm		
No.3, No.5 journal distortion (measured at No.1, No.7 journal)	0.11mm		
No.4 journal distortion (measured at No.1, No.7 journal)	0.15mm		
Crankshaft endplay	0.100~0.292mm	0.4mm	Replace thrust bearing.
Connecting rod			
Connecting rod distortion (measured length 50mm)	0.025mm	-	Replace.
Connecting rod twist (measured length 50mm)	0.05mm	-	
Connecting rod endplay	0.15~0.40mm	0.6mm	

Item	Specification		
	Standard value ([] Base diameter)	Limit	Remedy
Crankshaft bearing			
Oil clearance	0.048~0.110mm	0.15mm	Replace.
Free length	92.0~93.0mm	-	
Bearing crush (measured load 7.5kN)	45.821~45.861mm	-	
Connecting rod bearing			
Oil clearance	0.032~0.091mm	0.2mm	Replace.
Free length	80.0~81.0mm	-	
Bearing crush (measured load 6kN)	39.8395~39.8795mm	-	
Flywheel			
Height of friction surface	69.5mm (HD120, Aerotown)	68.5mm	Replace.
Friction surface runout	0.1mm	0.2mm	
Valve timing (at 1mm lift)			
Intake valve open (ATDC)	4°		
Intake valve close (ABDC)	5°		
Exhaust valve open (BBDC)	30°		
Exhaust valve close (BTDC)	2°		
Valve			
Intake valve length	147mm		
Exhaust valve length	147mm		
Outer diameter of intake valve stem	6.965~6.980mm	6.85mm	
Outer diameter of exhaust valve stem	6.935~6.950mm	6.85mm	
Intake valve face angle	24°25'~24°45'		
Exhaust valve face angle	34°25'~34°45'		
Thickness(margin) of Intake valve head	2.3mm	2mm	
Thickness(margin) of exhaust valve head	2.1mm	1.8mm	
Intake valve clearance (at cold)	0.2mm		
Exhaust valve clearance (at cold)	0.6mm		
Gap between valve stem and valve guide			
Intake	[7] 0.02~0.05mm	0.15mm	Replace.
Exhaust	[7] 0.05~0.08mm	0.2mm	
Valve guide length			

Item	Specification		
	Standard value ([] Base diameter)	Limit	Remedy
Intake	63.2~63.5mm		
Exhaust	63.2~63.5mm		
Valve recess			
Intake	0.3~0.7mm	1.5mm	
Exhaust	0.3~0.7mm	1.5mm	
Valve seat width			
Intake	1.4~2.2mm	2.8mm	Replace.
Exhaust	1.3~2.1mm	2.7mm	
Valve spring			
Free height	57.4mm	53mm	Replace.
Load installed	367±18 (N)	300N	
Winding direction	To the right		
Out of squareness	Below 1.5°		
Camshaft			
Intake cam long diameter	46.8824mm		
Intake cam short diameter	40.6mm		
Intake cam lift	6.2824mm		
Exhaust cam long diameter	47.335mm		
Exhaust cam short diameter	40.6mm		
Exhaust cam lift	6.735mm		
Camshaft endplay	0.080~0.255mm	0.35mm	Replace thrust plate.
Clearance between camshaft journal and bushing	0.024~0.077mm	0.15mm	Replace.
Timing gear backlash			
Crank gear~idler AB	0.036~0.196mm		Repair or replace.
Idler AB~air compressor	0.036~0.196mm		
Idler AB~idler E	0.036~0.196mm		
Idler AB~idler C	0.036~0.196mm		
Idler C~ Idler D	0.036~0.100mm		
Camshaft gear~idler D	0.036~0.100mm		
Idler E ~ Fuel pump	0.036~0.196mm		
Idler gear endplacy	0.05~0.15mm	0.25mm	Replace thrust plate.
Gap between idler bushing and idler shaft	0.030~0.071mm	0.1mm	Replace bushing.

CCV SYSTEM

Specification

Item	Description
CCV type	Cyclone

* CCV : Closed Crankcase Ventilation

EGR valve

Items	Description
Valve	Flap type
Control	Electric type DC motor

Tightening torque

Items	Tightening torque(kgf.m(N.m, lb-ft))
Crankshaft pulley bolt	10(98.1, 72.3)+80°
Water pump assembly mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Air compressor bolt/nut	9~12(88.3~117.7, 65.1~86.8)
Alternator mounting bolt(Upper)	7.5~8.5(73.5~83.4, 54.2~61.5)
Alternator mounting bolt(Lower)	7.5~8.5(73.5~83.4, 54.2~61.5)
Auto tensioner mounting bolt	5~6(49~58.8, 36.2~43.4)
Idler pulley mounting bolt	4~5(39.2~49, 28.9~36.2)
Idler gear mounting bolt(A/B, C, D, E)	2.2~3.3(21.6~32.4, 15.9~23.9)
Fuel supply pump gear mounting bolt	6~7(58.8~68.6, 43.4~50.6)
Oil pan mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Cam sensor plate mounting bolt	1.9~2.8((18.6~27.5, 13.7~20.3)
Camshaft cap bolt	2(19.6, 14.5)+ 90°
Injector clamp bolt	3(29.4, 21.7)
Rocker arm shaft bolt	2.5(24.5, 18.1)+ 90°
High pressure fuel pipe mounting bolt	4~5(39.2~49, 28.9~36.2)
Rocker cover mounting bolt	2.3~2.9(22.6~28.4, 16.6~21)
Flywheel housing mounting bolt(M14)	13~18(127.5~176.5, 94~130.2)
Flywheel housing mounting bolt	5~6.5(49~63.7, 36.2~47)
Flywheel bolt	14(137.3, 101.3)+ 120°
Check valve	3~3.5(29.4~34.3, 21.7~25.3)
Connecting rod bolt	4(39.2, 28.9)+ 100°
Oil pan drain plug mounting bolt	8~9(78.4~88.3, 57.9~65.1)
Oil pump gear mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil out pipe mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil filter housing assembly mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)

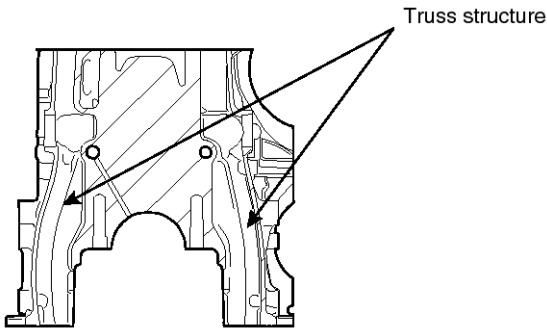
Items	Tightening torque(kgf.m(N.m, lb-ft))
Oil cooler mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Cooling fan coupling mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Exhaust manifold mounting nut	5~6.5(49~63.7, 36.2~47)
EGR valve mounting bolt	0.9~1.4(8.8~13.7, 6.5~10.1)
Reed valve housing mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Main bearing cap bolt	17(166.7, 123)+ 110°
Cylinder head bolt	10(98.1, 72.3)+ 90°+90°
Intake coupler mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil drain pipe mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Water drain plug	6~10(58.8~98.1, 43.4~72.3)

OUTLINE

CYLINDER BLOCK

1. Outline/Structure/Operation
 - High rigidity CGI material application
 - Truss structure application
2. Main features
 - Durability enhancement and light weight with high rigidity CGI material application
 - Block stiffness enhancement due to truss structure used by oil return passage
 - Reliability improvement in leak by integrating rear plate to block
3. Main improvement
 - Durable reliability improvement
 - NVH improvement

[CGI Cylinder block]

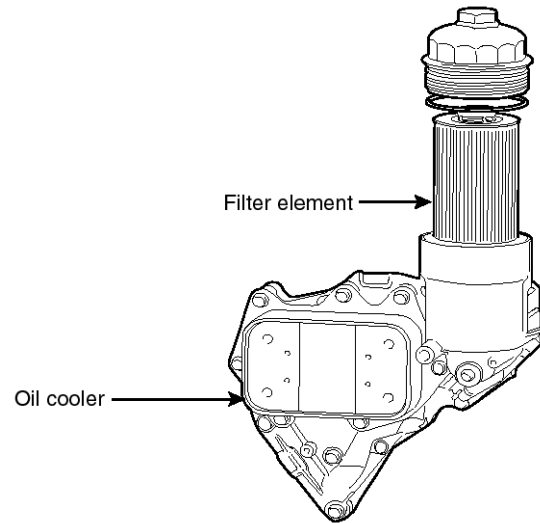


SDGEM9001L

OIL SYSTEM

1. Outline/Structure/Operation
 - Replaceable oil filter type and front engine layout
 - Built-out aluminum oil cooler adoption
2. Main features
 - Replacement cost reduction and serviceability with the application of replaceable oil filter
 - Heat exchange efficiency improvement due to the application of aluminum material

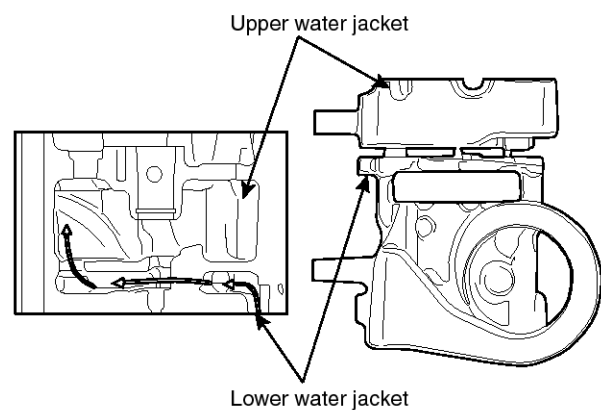
3. Main improvement
 - Oil filter serviceability
 - Oil cooler size reduction and light weight



SDGEM9002L

CYLINDER HEAD

1. Outline/Structure/Operation
 - Intake/exhaust port connecting intake/exhaust manifold and combustion chamber to exchange intake/exhaust gas is installed
2. Main features
 - Upper/lower water jacket separation type
 - Cooling performance maximization by minimizing temperature deviations among cylinders
 - Intake manifold one unit



SDGEM9003L

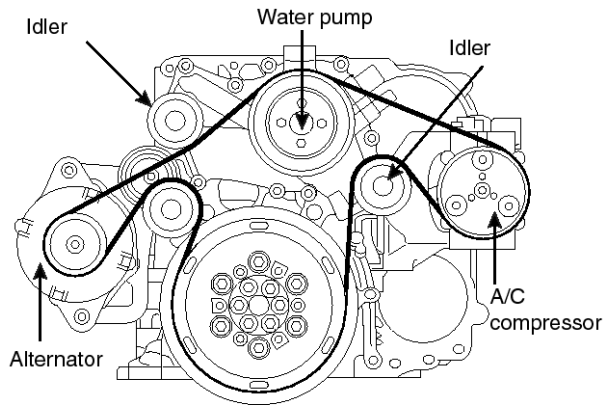
BELT SYSTEM

1. Outline/Structure/Operation

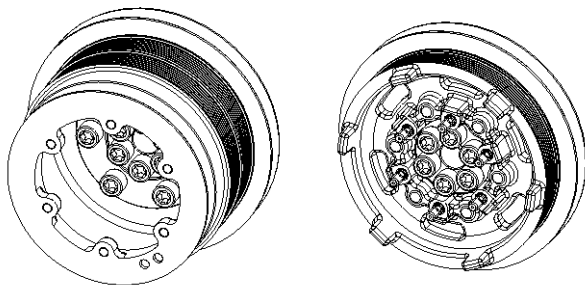
- This is the system to drive accessory parts(alternator, air conditioner, water pump) attached to the engine.

2. Main features

- V-ribbed belt : Belt durability improvement
- Automatic belt tension adjustment



SDGEM9004L



[AEROTOWN]

[HD120]

SDGEM9073L

MOVING SYSTEM

1. Outline/Structure/Operation

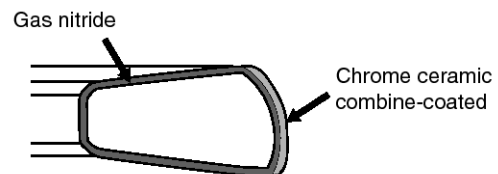
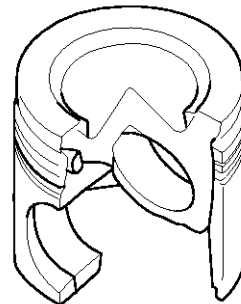
- This is the system to convey power to transmission after converting reciprocating motion to rotating motion due to combustion.

2. Main features

- Improved piston durability with application of high rigidity aluminum material
- Durability and wear resistance improvement with application combine-coated with chrome ceramic in outer surface of piston ring #1

3. Main improvement

- Piston durability
- Piston ring #1 durability and wear resistance



SDGEM9006L

VALVE TRAIN

1. Outline/Structure/Operation

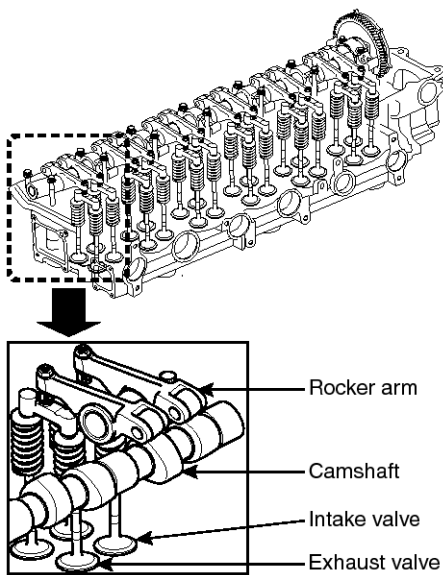
- This is the system to make intake/exhaust valve open or close to the proper timing after converting rotating motion of cam shaft to linear motion of valve.

2. Main features

- Center pivot SOHC 4 valves
- Roller bearing adoption
- Multi-groove adoption

3. Main improvement

- Valve train stiffness
- Durable reliability



SDGEM9007L

GEAR TRAIN

1. Outline/Structure/Operation

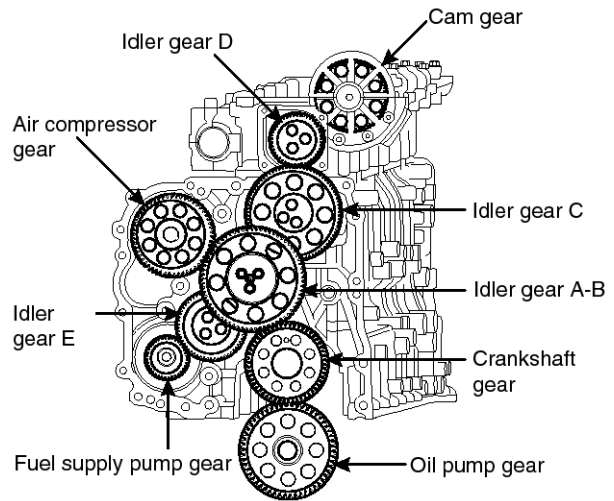
- Gear train system to convey power to each accessory and camshaft

2. Main features

- Rear gear train
- Small module to reduce noise
- Alloy steel plus cementation

3. Main improvement

- NVH reduction
- Durable reliability



SDGEM9008L

ROCKER COVER

1. Outline/Structure/Operation

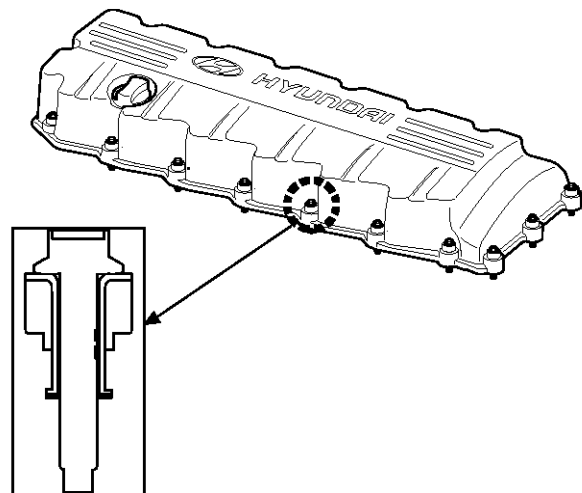
- Component to isolate outside parts so that moving parts such as camshaft, valve and rocker arm ect. placed on cylinder head can operate smoothly

2. Main features

- Material : Plastic
- Full Floating and side bolt type

3. Main improvement

- Light weight
- NVH reduction
- Non-leak reliability



[Tightening bolt]

SDGEM9009L

ACCESSORIES

1. Outline/Structure/Operation

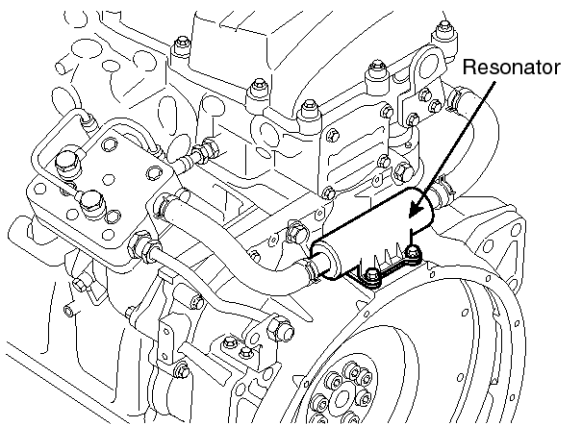
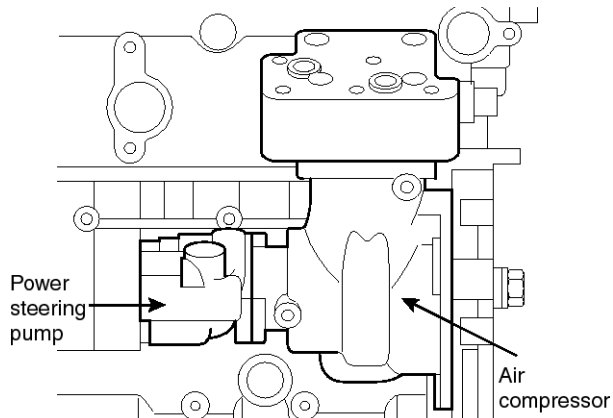
- System to supply brake force and air necessary for vehicle

2. Main features

- Driven with crankshaft with ratio of 1 to 1
- Driven together with power steering pump
- Silencer adoption to reduce noise

3. Main improvement

- Durable reliability
- NVH reduction



SDGEM9010L

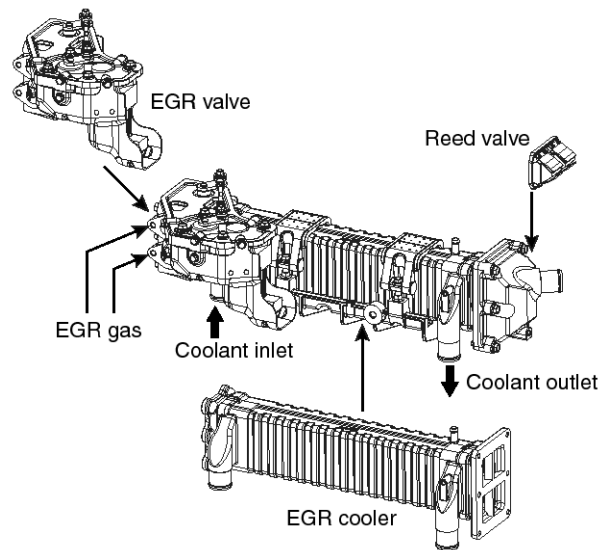
EGR SYSTEM

1. Outline

- System to reduce NOx generation by recirculating exhaust gas

2. Main features and structure

- Dual flow for securing high EGR rate
- Reed valve for securing high EGR rate
- EGR valve of DC motor type
- EGR cooler of high efficient oval tube type/ inner pin type



SDGEM9011L

FUEL INJECTION SYSTEM

1. Outline/Structure/Operation

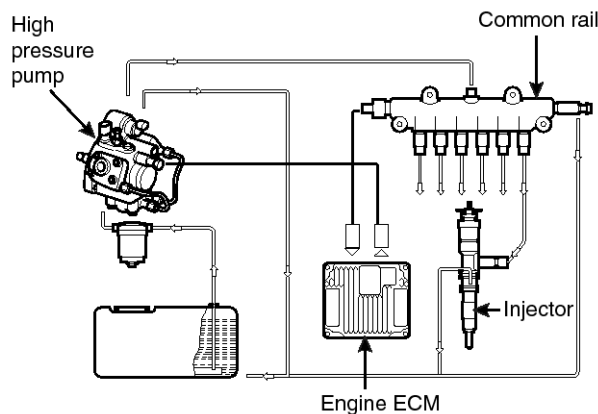
- System pressure : 1800 bar
- High pressure fuel pump : HP4
(Fuel amount control valve and fuel temperature sensor assembly)
- Common rail : Forging type
(Fuel pressure sensor and fuel pressure limit valve assembly)
- Injector : G2
- Engine computer : ECM (32 bits precision control)

2. Main features

- Emission gas reduction by ultra-pressure and multi-fuel injection
- Weight reduction with application of aluminum pump housing

3. Main improvement

- Output improvement by high pressurization, emission gas reduction



SDGEM9012L

PARTICULATE MATTER CATALYST(PMC)

1. Outline

- System to reduce SOF ingredient of HC, CO, PM among emission gases by DOC equipped with the inside of muffler and collect and generate PM ingredient from filter by using NO₂ generated by DOC

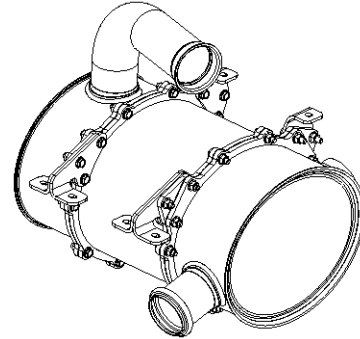
2. Main features

- Mechanical durability is superior to ceramic carrier with application of metal carrier.
- Back pressure is lower than that of DPF as a PM reduction system.
(Open flow method)

- Purification of emission gas(HC, CO, PM)

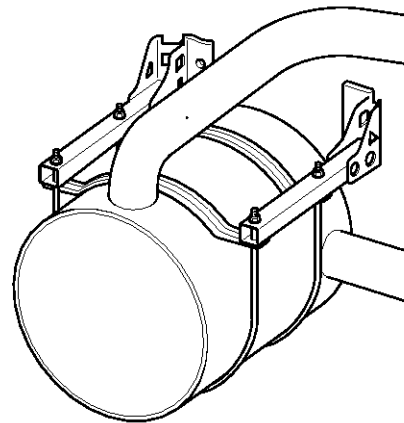
* PMC : Particulate Matter Catalyst

[AEROTOWN]



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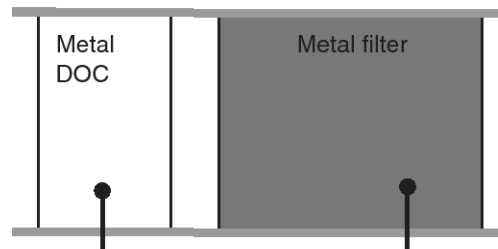
[HD120]



2NO+O₂ 2NO₂

C + 2NO₂ CO₂+N₂

C + O₂ CO₂



Metal plate

- Catalyst coating section

- NO NO₂

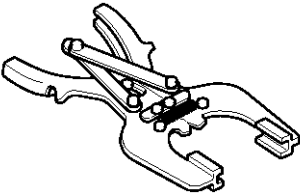
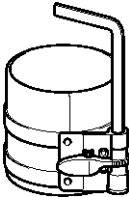
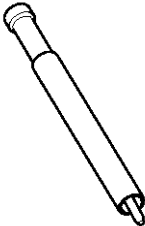
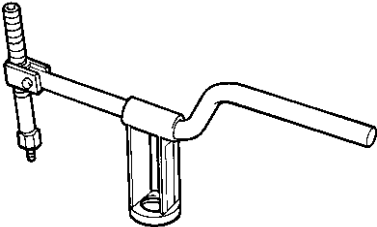
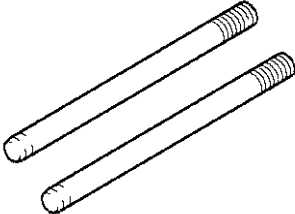
Metal part filter

- PM collection and combustion

- Open flow type

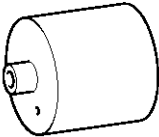
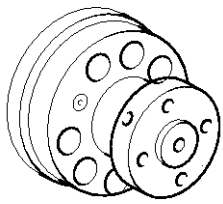
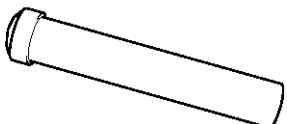
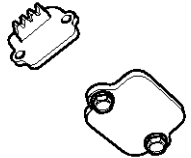
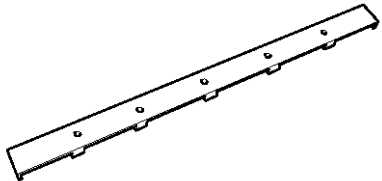
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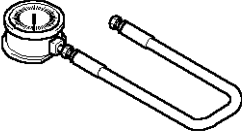
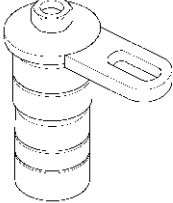
SPECIAL TOOLS

Tools(Number and name)	Shape	Use
09222-83200 Piston ring installer		Installation or removal of piston ring
09222-88200 Piston guide clamp		Installation of piston
09222-48200 Valve stem seal installer		Installation of valve stem seal
09222-84600 Valve spring compressor		Installation or removal of valve cotter
09231-48000 Flywheel guide bar		Guider when installing or removing fly-wheel

EM-14

Engine Mechanical System

Tools(Number and name)	Shape	Use
09231-48100 Oil seal installer		Installer of front oil seal
09231-48200 Oil seal installer		Installer of rear oil seal
09221-48000 Oil seal installer		Installation of oil seal (High pressure pipe passage in the cylinder head)
09231-52000(HD120, AEROTOWN) Flywheel stopper	 SDGEM7582D	Flywheel fixture when installing or removing adapter pulley, flywheel
09245-52000 Installer or remover of rocker arm shaft		Installation or removal of rocker arm shaft

Tools(Number and name)	Shape	Use
09351-8Y000 Pressure gauge		Measurement of nozzle pressure
09353-48000 Pressure gauge adapter (Use with 09351-8Y000)		Measurement of nozzle pressure

TROUBLESHOOTING

Problems	Possible causes	Maintenance
Engine overheat	Engine coolant • Lack of engine coolant • Defective thermostat • Engine coolant overflows due to leak of exhaust gas into cooling system. • Engine coolant leaks from cylinder head gasket • Defective cooling pump	• Add as required. • Replace thermostat. • Repair. • Replace gasket. • Repair or replace.
	Radiator • Clogged with rust or scale • Clogged with ferrous oxide due to exhaust gas leak into cooling system • Clogged radiator core due to dirt or foreign material • Defective radiator cap pressure valve	• Flush radiator. • Wash coolant passage and repair exact exhaust gas leak. • Flush radiator. • Replace radiator cap.
	Abnormal combustion • Poor fuel • Poor nozzle injection condition	• Use good quality fuel. • Replace nozzle.
	Others • Poor engine oil • Malfunctional oil pump • Lack of oil • Brake pulling	• Replace proper engine oil. • Repair or replace. • Add as required • Repair or adjust.E
Excessive oil consumption	Piston, cylinder liner and piston ring • Worn out piston ring and cylinder liner • Worn, seized or damaged piston ring • Improper piston ring • Poor-tamed piston ring • Improper oil(Too low viscosity) • Piston ring mismatch(Reverse) • In line with gaps of piston ring	• Replace related parts. • Replace the set. • Replace related parts. • Replace related parts. • Replace proper oil. • Replace piston ring. • Reassemble piston ring.
	Valve and valve guide • Worn out valve stem • Worn out valve guide. • Incorrect valve stem seal • Excessive lubricants to rocker arm	• Replace valve and valve guide. • Replace cylinder head sub-assembly. • Replace stem seal. • Inspect clearance between rocker arm and shaft.
	Excessive oil supply • Defective oil level gauge • Excessive oil	• Replace oil level gauge. • Adjust oil level.
	Others • Overcooled engine(Wear due to low temperature) • Oil leak from other parts	• Inspect cooling system, warm-up before driving. • Repair

Problems	Possible causes	Maintenance
Seized piston	Operation - Sudden engine stop after high speed driving - Climbing the heel with improper gear	- Operate engine properly. - Select the proper gear.
	Oil - Lack of oil - Contaminated oil - Improper oil - High oil temperature - Low oil pressure - Defective oil pump - Low oil performance due to worn out oil pump - Air suction to oil strainer	- Add as required. - Replace oil. - Replace with proper engine oil. - Repair. - Repair. - Repair oil pump. - Replace oil pump. - Add oil or repair oil strainer
	Abnormal combustion	Refer to "Engine overheat".
	Engine coolant	Refer to "Engine overheat".
Low output	Injection pump	Refer to "Fuel injection pump".
	Intake Clogged air cleaner	Clean element or replace element.
	Overheat	Refer to "Engine overheat".
	Fuel and nozzle - Poor nozzle injection condition - Clogged nozzle due to carbon - Worn or seized nozzle - Air inflow to fuel system - Clogged fuel filter - Poor fuel use	- Replace nozzle. - Clean nozzle. - Replace nozzle. - Bleed air from fuel system and repair. - Replace element. - Use good fuel.
	Abnormal combustion	Refer to "Engine overheat".
	Piston, cylinder liner and piston ring	Refer to "Engine overheat".
	Others Damaged turbine or blower	Replace turbine, blower or turbocharger.

Problems	Possible causes	Maintenance
Hard to start the engine	Electrical system - Battery discharge - Starter circuit fault - Loose battery cable or open circuit (Poor cable connection) - Damaged glow plug	- Charge battery. - Repair starter circuit. - Tighten battery terminal bolt or replace battery cable. - Replace.
	Injection pump	Refer to "Fuel injection pump".
	Air cleaner Clogged element	Clean or replace element.
	Fuel system - Empty fuel in the fuel tank - Clogged fuel line - Air inflow to fuel system through fuel line connection part - Clogged fuel filter - Loose connection part of high pressure pipe - Fuel mixed with water	- Supply fuel and bleed air from fuel system. - Flush fuel line. - Tighten connection part of fuel line. - Replace element. - Tighten sleeve nut of high pressure line. - Clean fuel tank
	Nozzle Stuck nozzle	Replace nozzle.
	Oil system Too high oil viscosity	Use proper oil viscosity or warm up oil after installing oil heater.
	Others - Seized piston - Stuck bearing - Low compression pressure - Damaged or worn out ring gear - Bad adjustment or damage of accelerator cable	- Replace related parts. - Replace related parts. - Adjust. - Replace ring gear or starter pinion. - Adjust or replace accelerator cable.
Rough idle	Injection pump	Refer to "Fuel injection pump".
	Nozzle - Poor nozzle injection condition - Carbon deposits on the tip of nozzle - Stuck needle valve	- Replace nozzle. - Remove carbon deposits. - Replace nozzle.
	Engine proper - Wrong valve clearance - Poor contact of valve seat - Too low idle speed - Big compression pressure difference each cylinder	- Adjust valve clearance. - Replace the related parts. - Warm up the engine. - Overhaul engine and check.

Problems	Possible causes	Maintenance
Emission gas leaks	Cylinder head gasket • Aged gasket • Damaged • Bad adjustment	• Replace gasket. • Replace gasket. • Replace gasket.
	Cylinder head bolt • Loose bolt • Stretched bolt • Wrong tightening torque or order	• Tighten bolt. • Replace bolt. • Tighten correctly.
	Cylinder block • Cracked • Deformed surface • Corrosion on inserting portion of cylinder liner(Inadequate projection amount of cylinder liner)	• Replace cylinder block. • Repair or replace • Replace cylinder liner or cylinder block.
	Cylinder head • Crack • Deformed surface	• Replace cylinder head. • Repair or replace.
	Cylinder liner • Crack • Corrosion • Inadequate projection amount of cylinder liner	• Replace cylinder liner. • Replace cylinder liner. • Replace cylinder liner.
	Others • Incorrect injection timing	• Adjust injection timing.

ADJUSTMENT

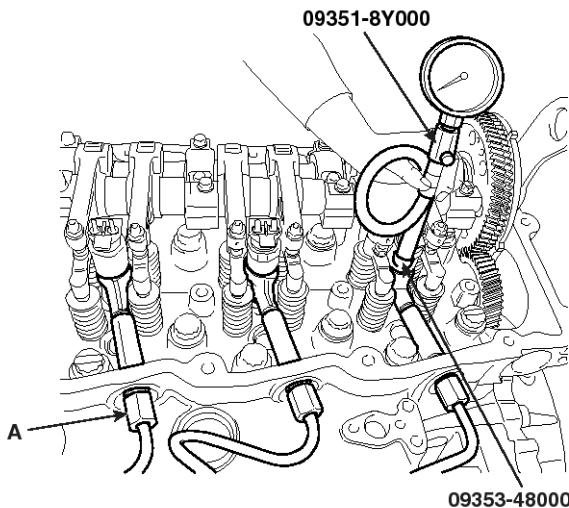
COMPRESSION PRESSURE

1. Make sure that engine oil, starter motor and battery are normal before checking.
2. Start the engine and warm it up until the engine coolant temperature reaches 80 to 90°C.
3. Stop the engine and remove the ECM fuse.
4. Remove all injectors from the cylinder head.

CAUTION

Be careful that dirt or foreign matter does not get into injector installing hole.

5. Crank the engine and remove foreign matter from cylinder.
6. Install compression gauge adaptor(09353-48000) with gasket and connect compression pressure gauge(09351-8Y000).



SDGEM7014D

7. Crank the engine and measure compression pressure.

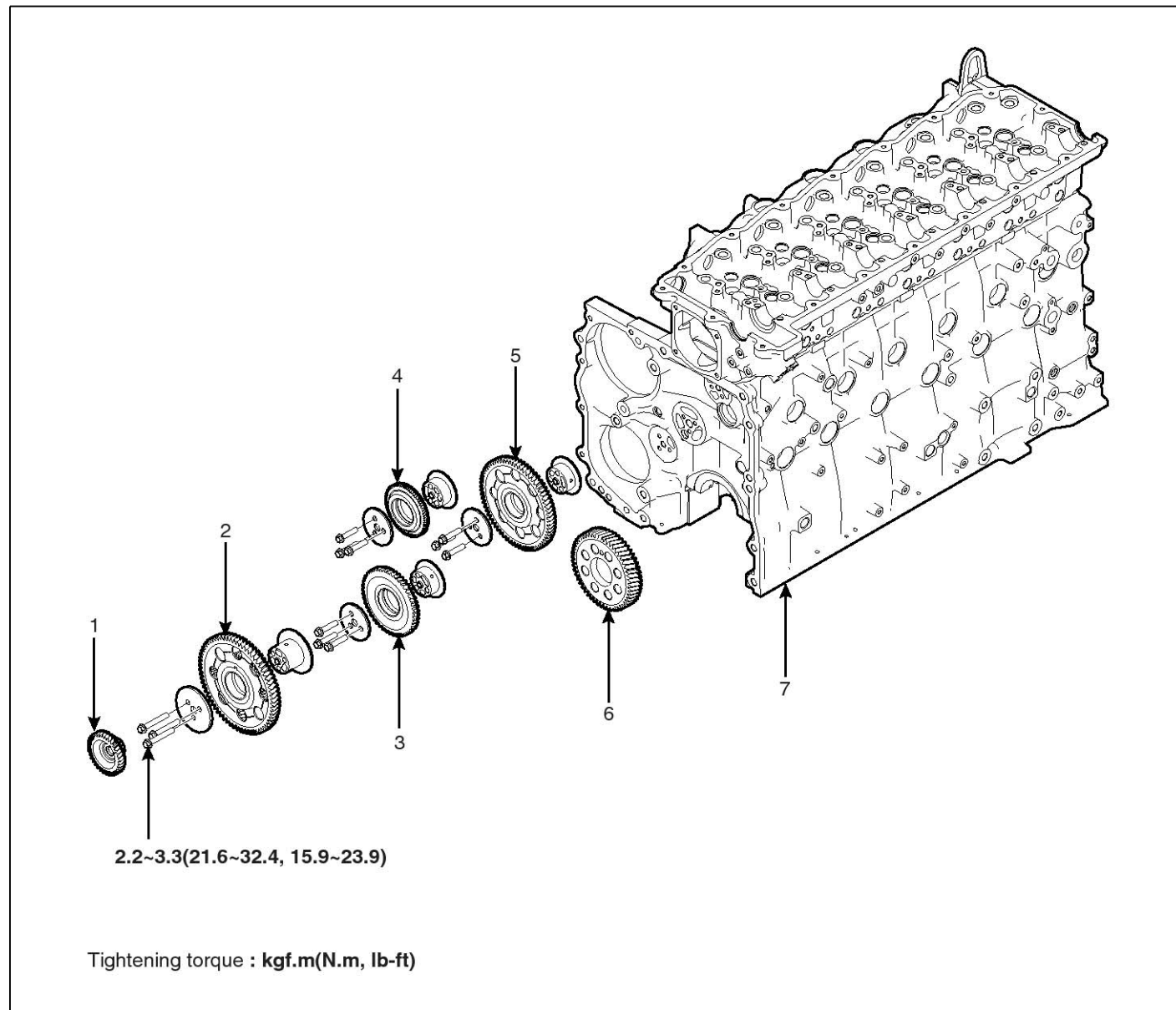
CAUTION

- a. Be careful that fuel does not inject.
- b. Take care when measuring as compression pressure changes according to engine speed.
- c. Measure all cylinders as wear differs from each cylinder.

Timing System

Timing Gear Assembly

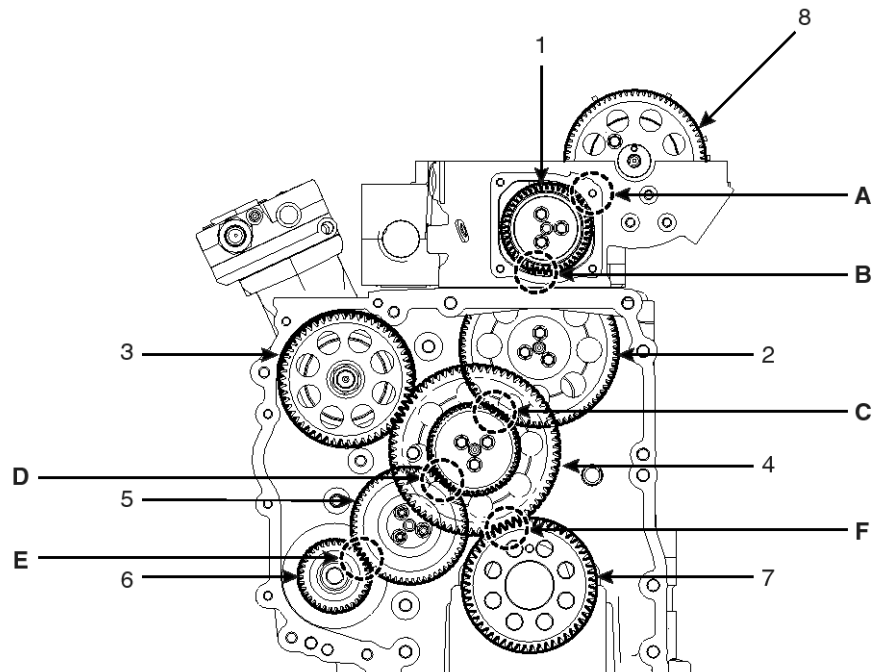
COMPONENTS



SDGEM9014L

1. Fuel supply pump gear
2. Idler gear A-B
3. Idler gear E
4. Idler gear D

5. Idler gear C
6. Crankshaft gear
7. Cylinder block



A



B



C



D



E



F

SDGEM9015L

1. Idler gear D
2. Idler gear C
3. Air compressor gear
4. Idler gear A-B

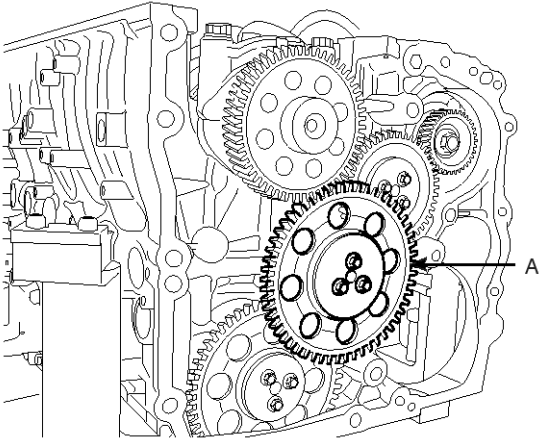
5. Idler gear E
6. Fuel supply pump gear
7. Crankshaft gear
8. Camshaft gear

REMOVAL

⚠ CAUTION

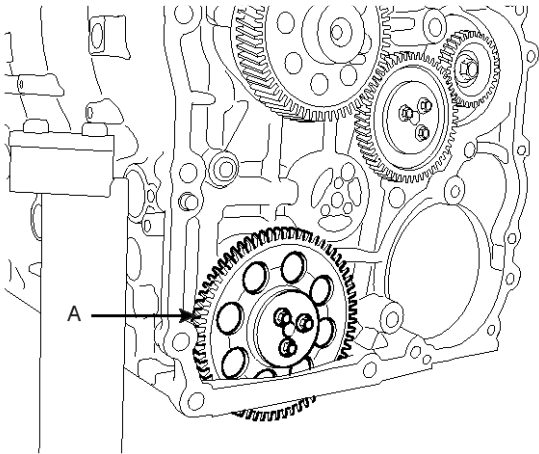
Check the compression TDC of #1 cylinder piston.
And then remove the gear.

1. Remove idler gear D.
2. Remove idler gear A-B(A).



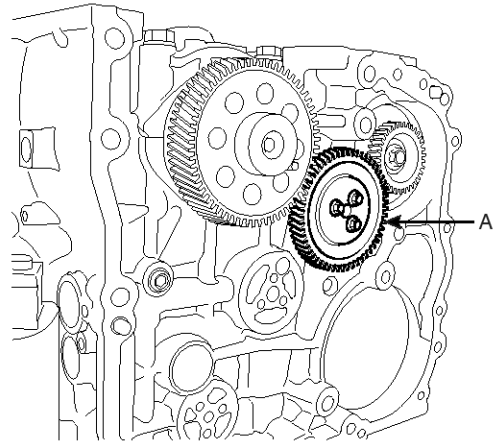
SDGEM7565D

3. Remove idler shaft, washer thrust and bolt and remove idler gear C(A).



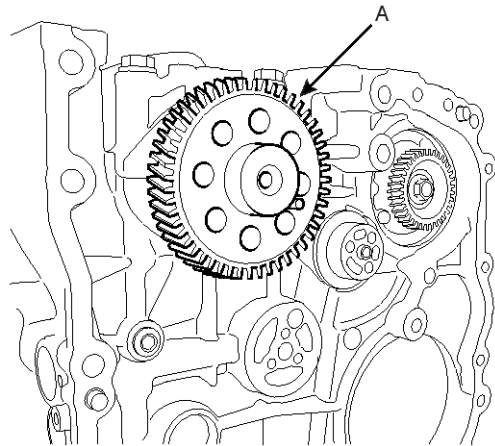
SDGEM7566D

4. Remove idler shaft, washer thrust and bolt and remove idler gear E(A).



SDGEM7567D

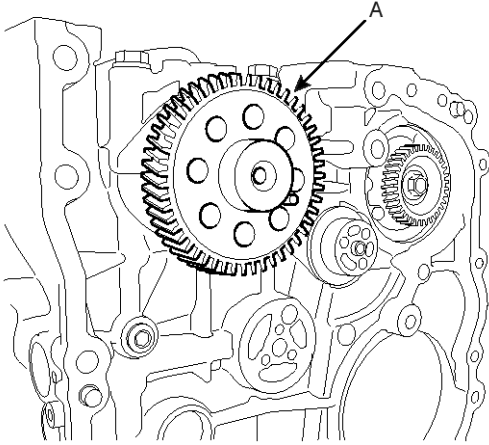
5. Remove crankshaft gear (A).



SDGEM7568D

INSTALLATION

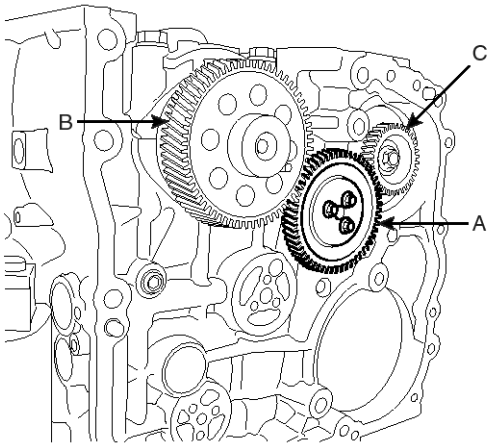
1. Install crankshaft gear (A). Position crankshaft gear that the piston of cylinder No.1 is at the TDC of compression stroke.



SDGEM7017D

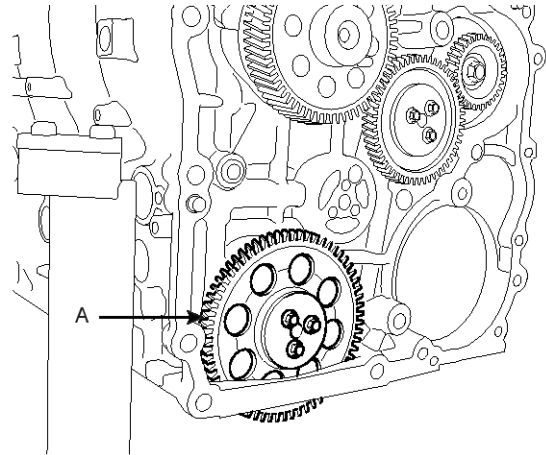
2. Using idler shaft, washer and bolt, install idler gear E(A).

When installing idler gear E(A), align and install the inscribed marks of crankshaft gear B and fuel supply pump gear C.



SDGEM7018D

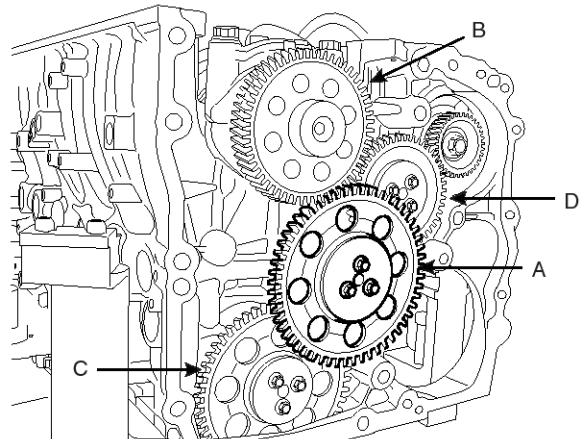
3. Using idler shaft, washer thrust and bolt, install idler gear C(A).



SDGEM7019D

4. Using idler shaft, washer thrust and bolt, install idler gear A-B(A).

When installing idler gear A-B(A), align and install the inscribed marks of crankshaft gear(B), idler gear(C) and idler gear E(D).



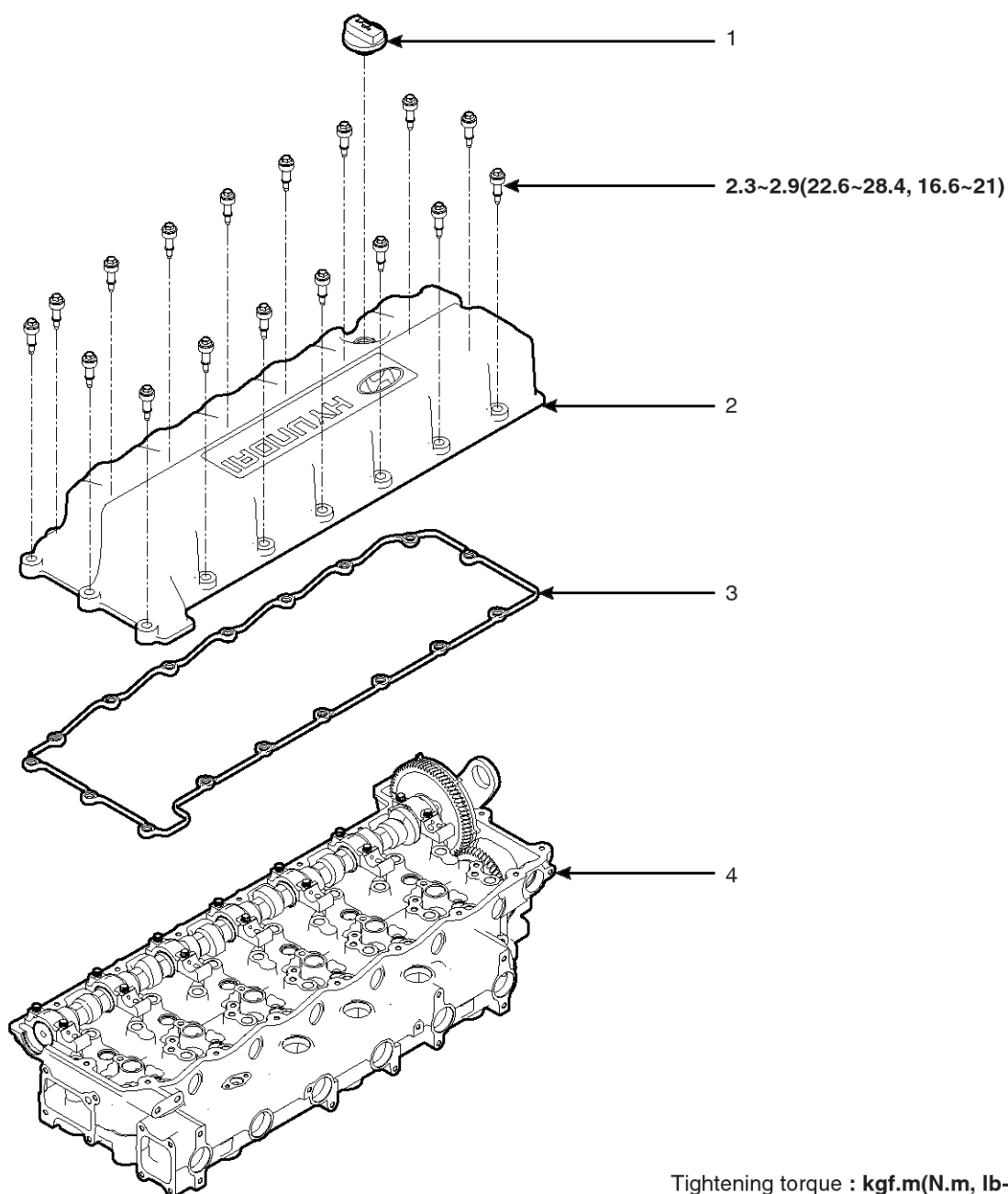
SDGEM7020D

5. Using idler shaft, washer thrust and bolt, install idler gear D.

When installing idler gear D, align and install the inscribed marks of idler gear C and camshaft gear.

Cylinder Head Assembly

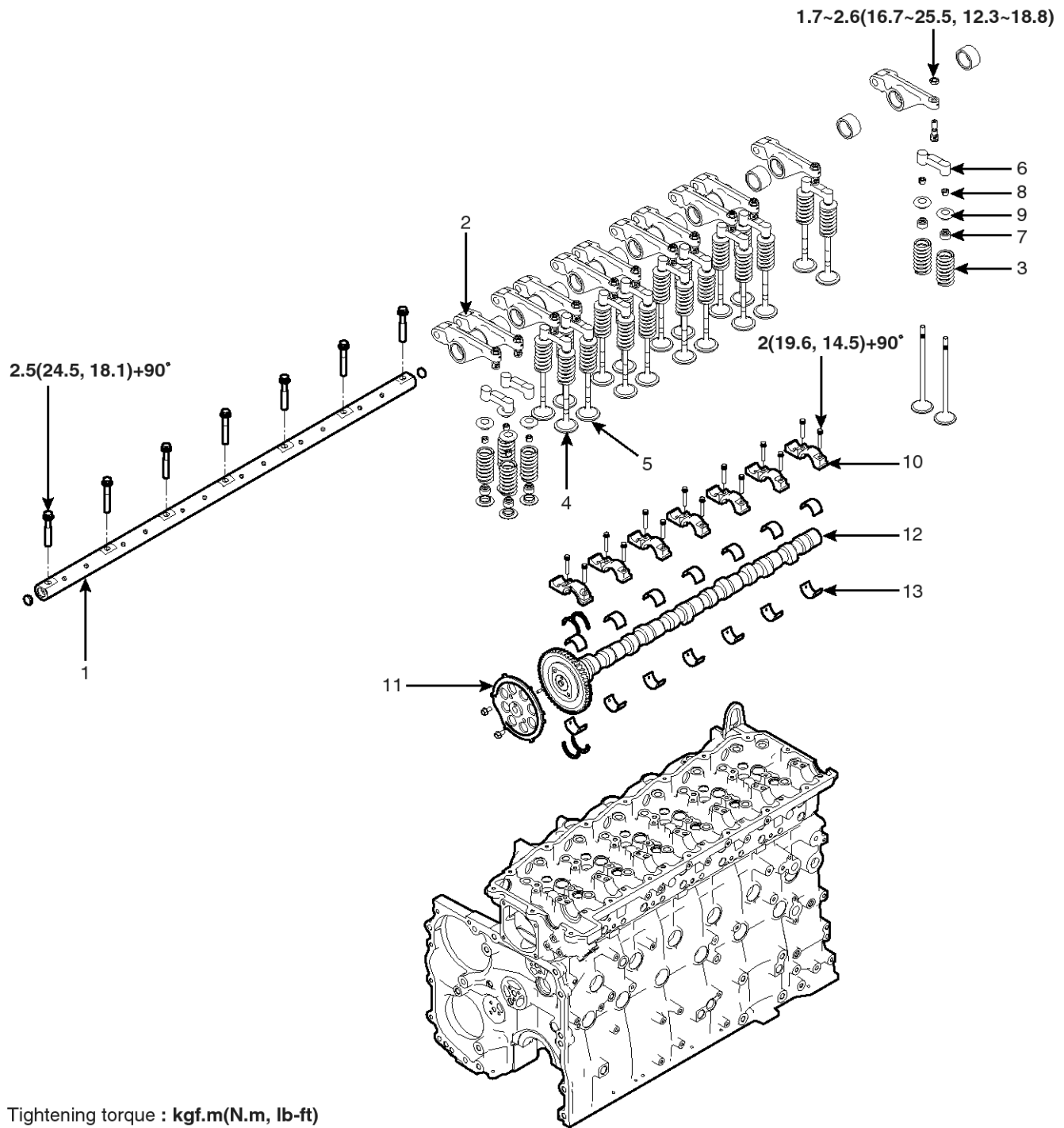
COMPONENTS



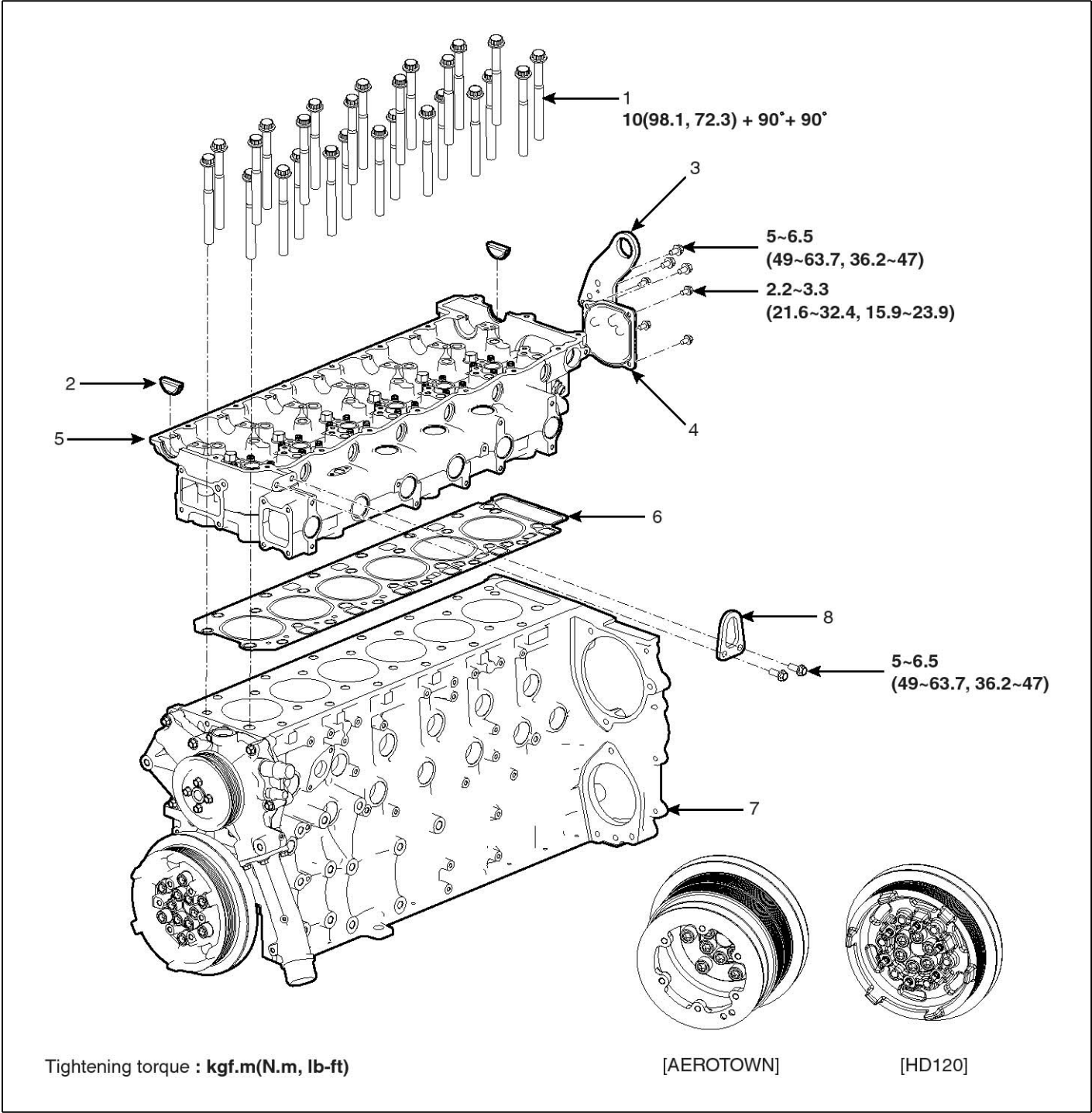
SDGEM9016L

- 1. Oil filler cap
- 2. Rocker cover

- 3. Rocker cover gasket
- 4. Cylinder head assembly



SDGEM9017L



SDGEM9018L

1. Cylinder head bolt

2. Semi circular packing

3. Rear hanger
4. Rear cover assembly

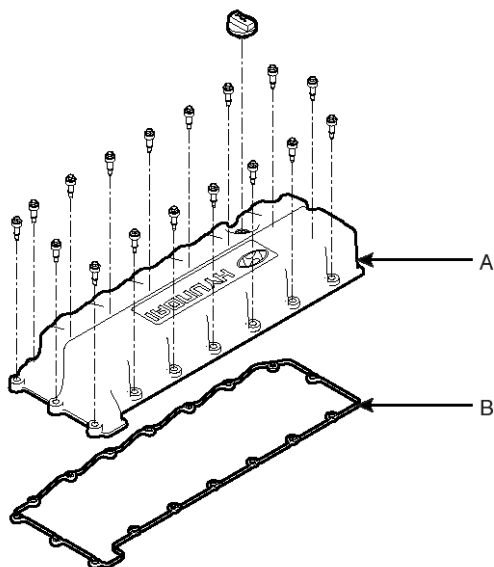
5. Cylinder head assembly

6. Cylinder head gasket
7. Cylinder block

8. Front hanger

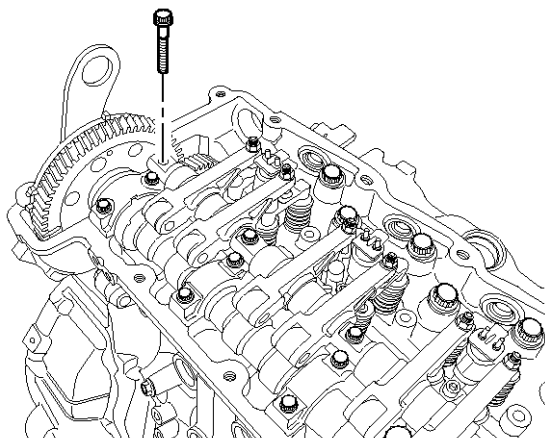
REMOVAL

1. Remove rocker cover(A) and gasket(B).



SDGEM7029D

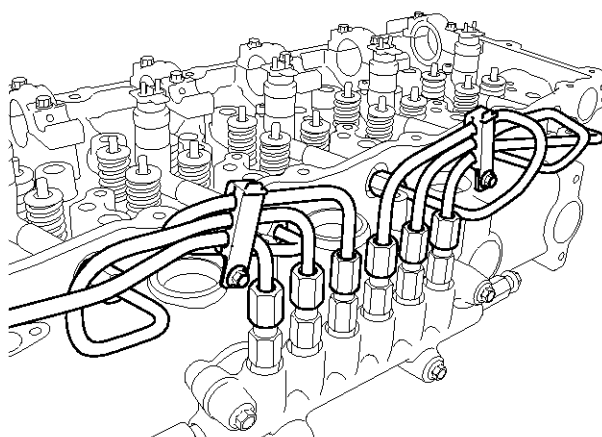
2. Remove rocker arm assembly.



SDGEM7030D

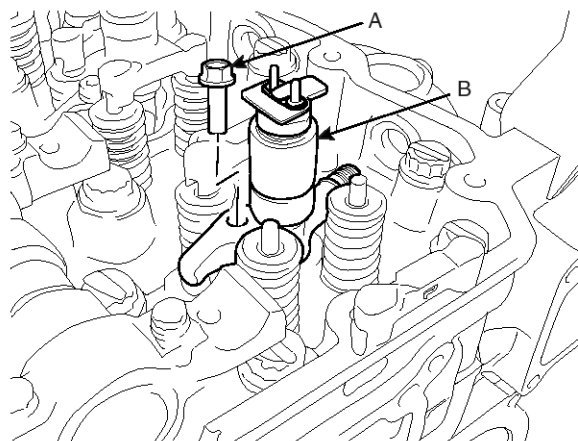
3. Disconnecting injector earth, remove injector wiring.

4. Remove high pressure fuel pipe.



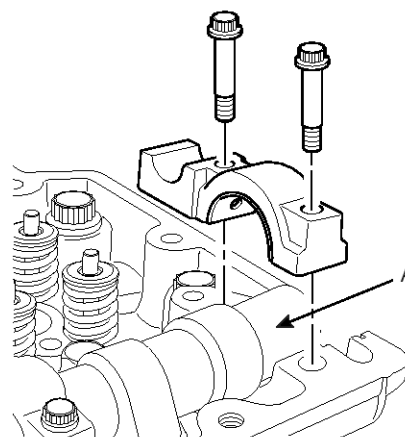
SDGEM7556D

5. Loosening injector clamp bolt (A), remove injector (B).



SDGEM7039D

6. Remove camshaft gear assembly(A) from cylinder head.



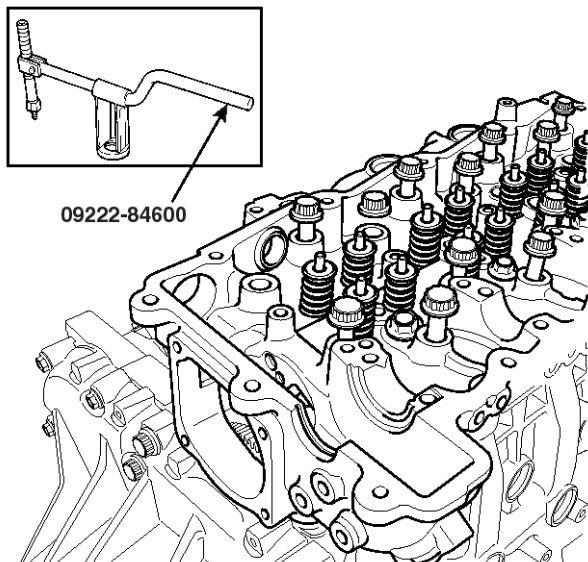
SDGEM7034D

- Remove cylinder head assembly from cylinder block with cylinder head gasket.

CAUTION

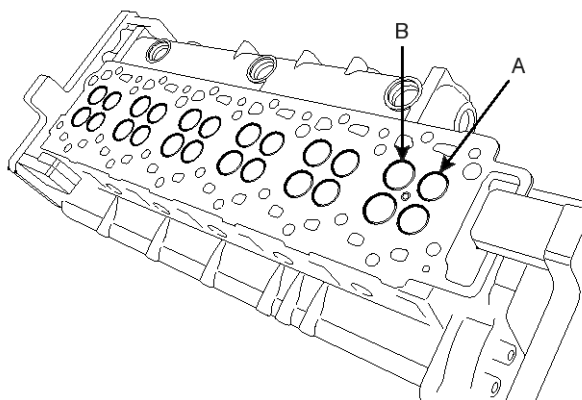
Never reuse cylinder head gasket.

- Using SST(09222-84600), remove valve spring, retainer upper and valve cotter.



SDGEM7037D

- Remove exhaust valve (A) and intake valve (B).

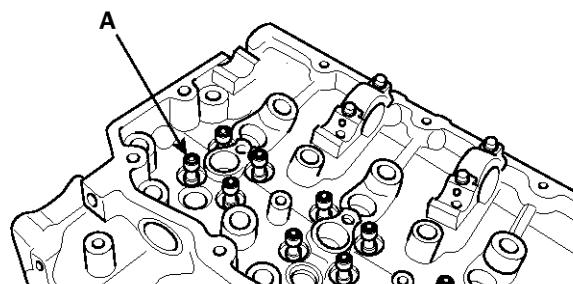


SDGEM7036D

- Remove valve stem seal (A).

CAUTION

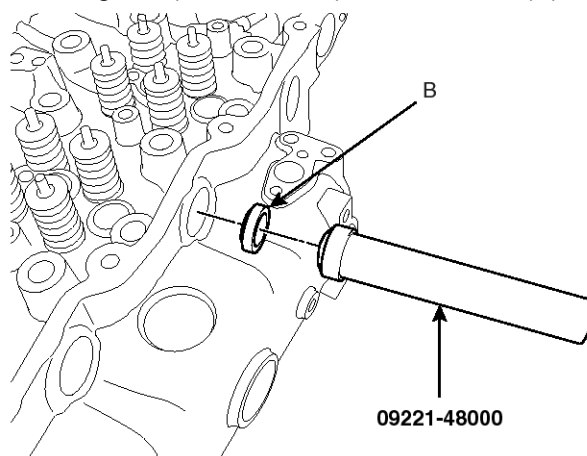
Do not use the used valve stem seal.



SDGEM7590D

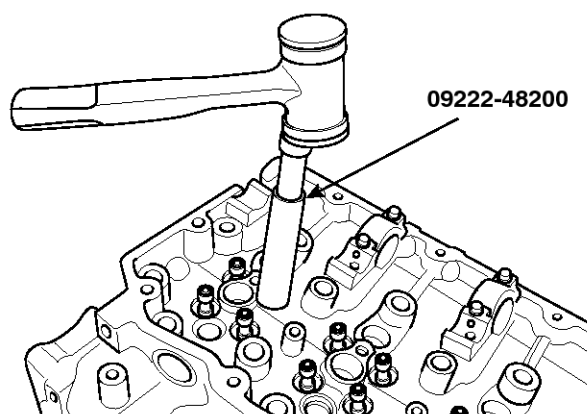
INSTALLATION

- Using SST(09221-48000), install oil seal (B).



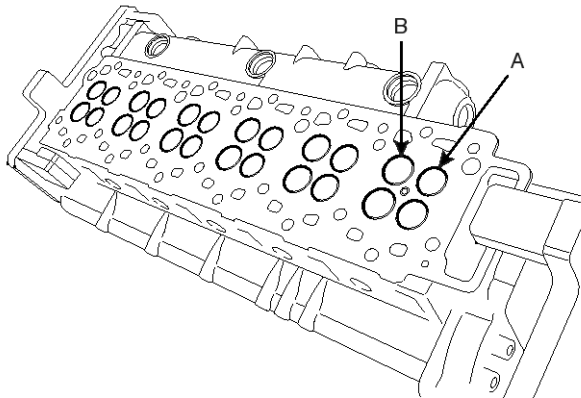
SDGEM7595D

- Using SST(09222-48200), install valve stem seal.



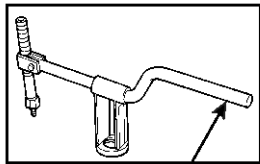
SDGEM7139D

3. Install exhaust valve (A) and intake valve (B) from cylinder head bottom.

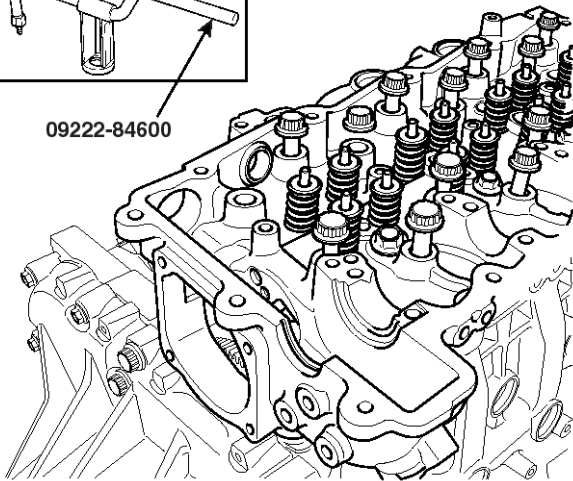


SDGEM7036D

4. Using SST(09222-84600), assemble valve spring, retainer upper and valve cotter. Assemble first intake and next exhaust.



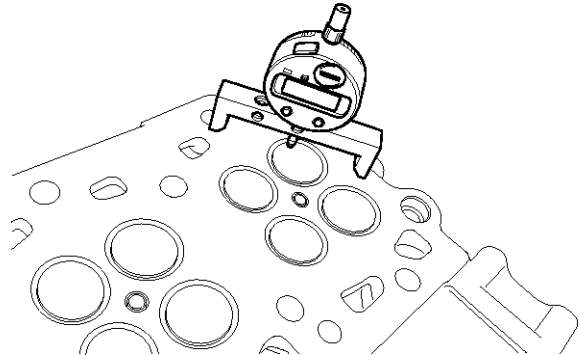
09222-84600



SDGEM7037D

5. Using dial guage after assembling, check cylinder head valve face recess.

Valve recess : 0.3~0.7 mm (4 positions standard)



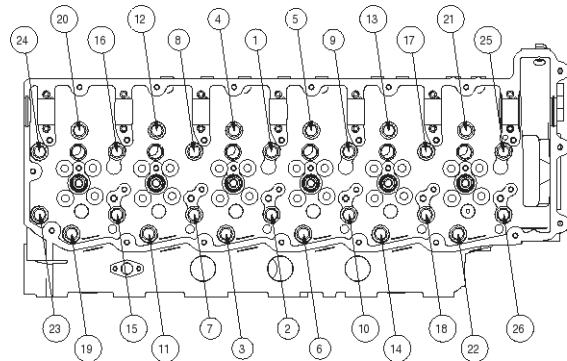
SDGEM7140D

6. Install cylinder head gasket to cylinder block upper surface.
7. Tighten cylinder head bolts (1 to 26) diagonally from center to outside to the specified torque.

Cylinder head bolt : 10 kgf.m(98.1 N.m, 72.3 lb-ft) + 90° + 90°

CAUTION

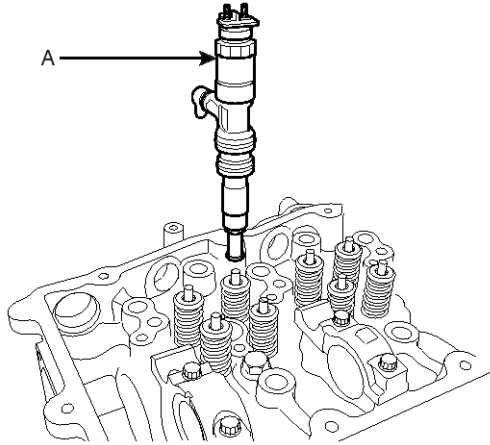
Never reuse cylinder head bolt.



SDGEM7583D

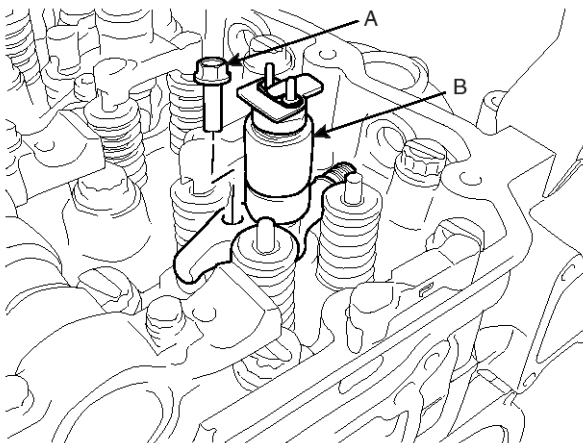
8. Install injector (A).

- 1) Insert injector gasket.
- 2) After applying oil to injector rubber seal, insert injector clamp to injector and install them to seat fully.



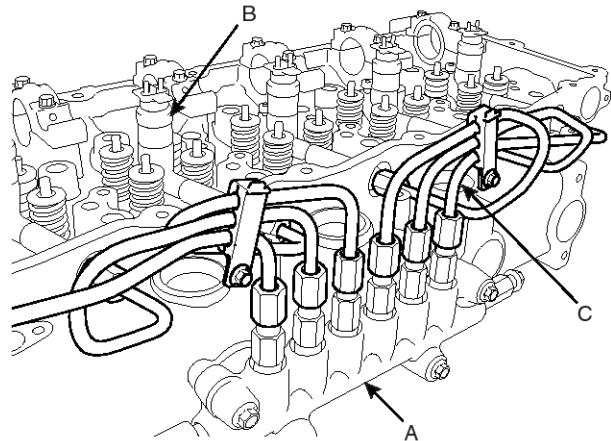
SDGEM7038D

3) Using injector clamp bolt (A), install injector (B).



SDGEM7039D

9. Install high pressure pipe (C) to common rail assembly (A) and injector (B).



SDGEM7042D

10. Applying engine oil to lower and upper bearing, install with thrust bearing.

Install camshaft gear assembly to cylinder head.

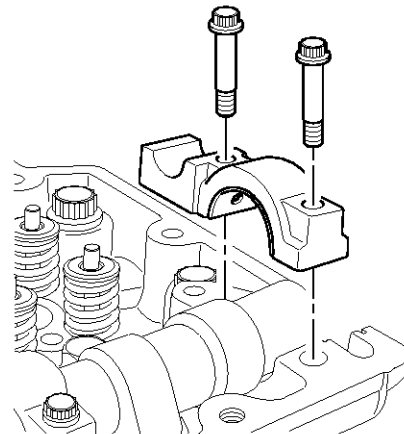
Camshaft cap bolt : 2 kgf.m(19.6 N.m, 14.5 lb-ft) + 90°

⚠ CAUTION

Never reuse camshaft cap bolt.

📢 NOTICE

At installing camshaft caps, install those from center to outside in sequence to the specified torque.

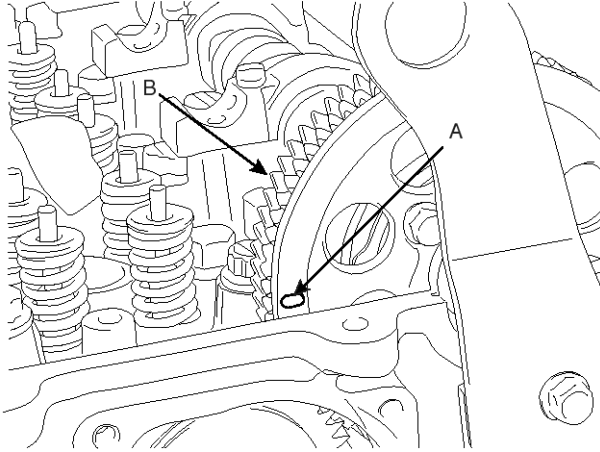


SDGEM7141D

11. At installing camshaft, align and install the inscribed mark of sensor plate and upper surface of cylinder head.

NOTICE

Insert 0.08mm of feeler gauge between camshaft gear (B) and idler gear D, idler gear D and idler gear C and install camshaft gear assembly.



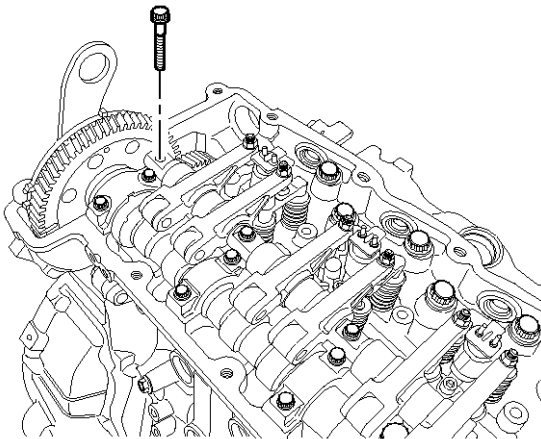
SDGEM7142D

12. Install rocker arm assembly. Using the special tool (09245-52000), align and install rocker arms from center to outside.

Rocker shaft bolt : 2.5 kgf.m (24.5 N.m, 18.1 lb-ft) + 90°

CAUTION

Never reuse rocker shaft bolt.



SDGEM7143D

13. Install injector wiring.

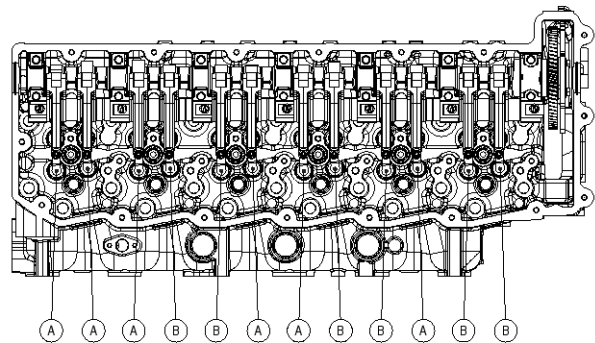
14. Adjust valve clearance. (At cold)

Valve clearance : Intake 0.2mm, Exhaust 0.6mm

How to adjust valve clearance :

Position the piston of cylinder No.1 at the TDC of compression stroke and adjust the valve clearance of valve A.

Rotate crankshaft 360° and adjust valve clearance of valve B.

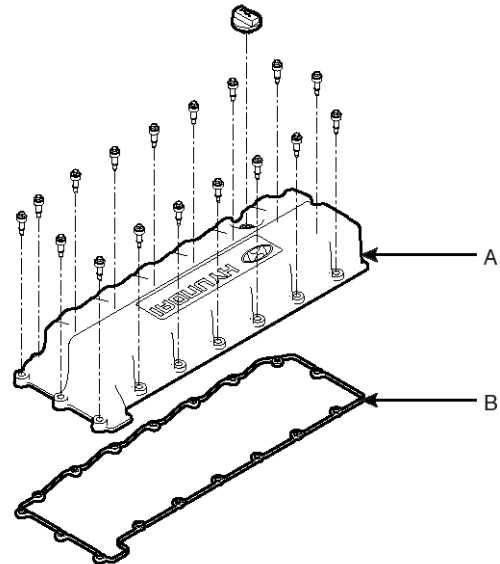


SDGEM7596D

15. Install rocker cover (A) and gasket (B).

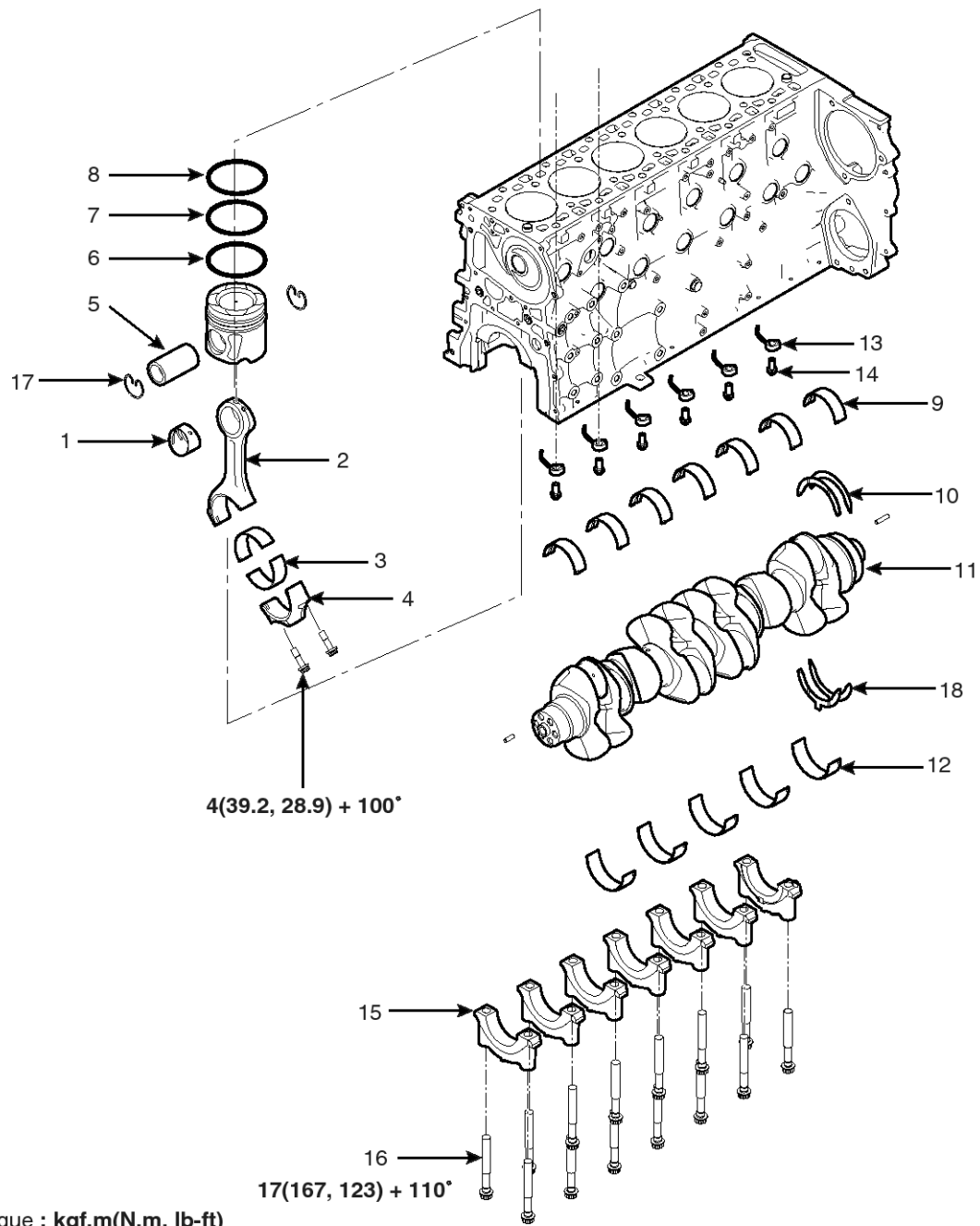
CAUTION

Before installing gasket, apply liquid gasket to the upper surface of the semi circular packing.



SDGEM7029D

Cylinder Block COMPONENTS



SDGEM9019L

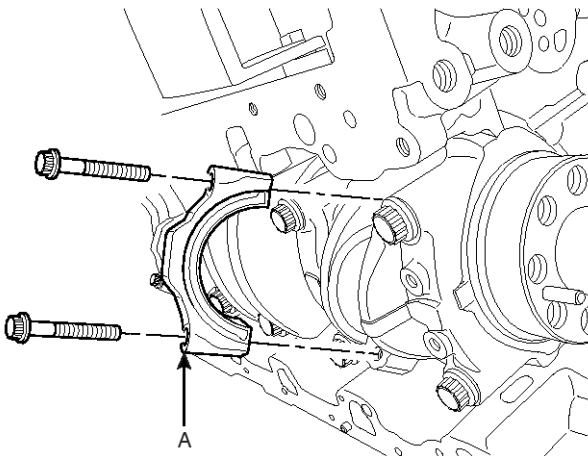
- | | | | |
|---------------------------|--------------------------|-------------------------|--------------------------|
| 1. Connecting rod bushing | 6. Oil ring | 11. Crankshaft assembly | 16. Min bearing cap bolt |
| 2. Connecting rod | 7. 2nd piston ring | 12. Lower main bearing | 17. Snap ring |
| 3. Connecting rod bearing | 8. 1st piston ring | 13. Oil jet | 18. Lower thrust bearing |
| 4. Connecting rod cap | 9. Upper main bearing | 14. Check valve | |
| 5. Piston pin | 10. Upper thrust bearing | 15. Main bearing cap | |

REMOVAL

1. Separate transmission from engine.
2. Remove accessories from engine.
3. Remove cylinder head assembly.
4. Remove flywheel and flywheel housing.
5. Remove timing gear.
6. Remove oil pan assembly.
7. Remove oil pump assembly.
8. Remove crankshaft gear.
9. Remove connecting rod cap (A) and then piston.

NOTICE

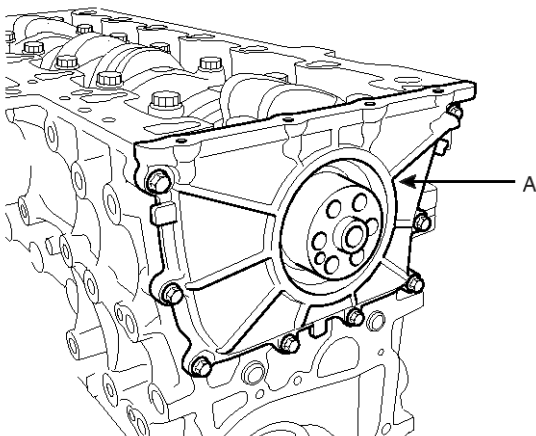
1. Connection rod cap surface might not be smooth for durability. Do not mistake it for poor parts.
2. Mark connecting rod and cap with an identification not to mis-assemble later.



SDGEM7044D

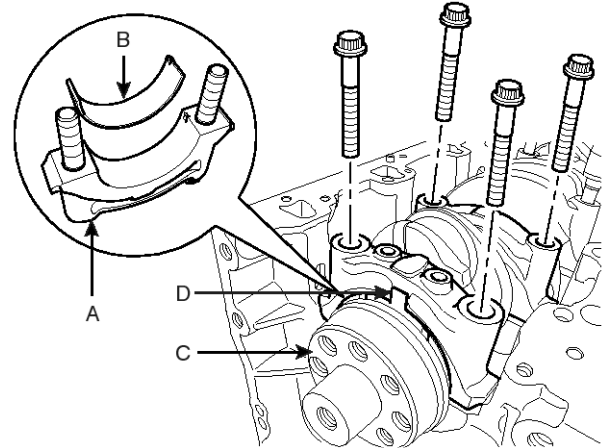
10. Remove piston and connecting rod assembly from cylinder block.

11. Remove front cover (A).



SDGEM7045D

12. Remove main bearing cap (A), lower main bearing (B) and lower thrust bearing (D) from crankshaft (C).

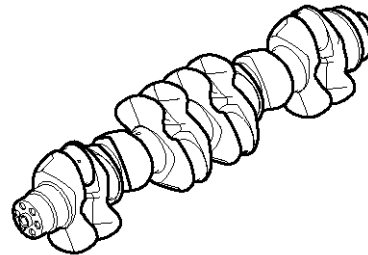


SDGEM7046D

13. Remove crankshaft from cylinder block.

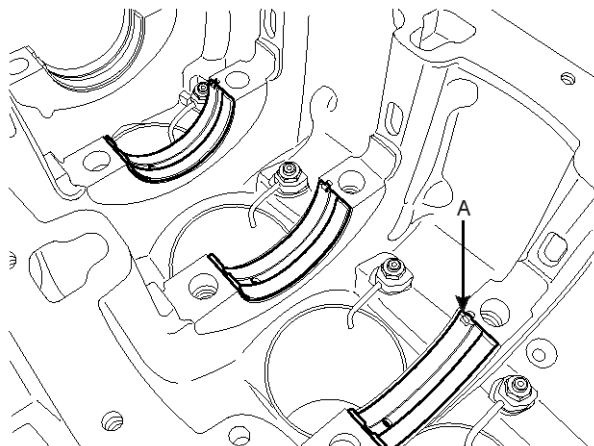
CAUTION

Be careful not to cause damage to crankshaft journal and cylinder block when carrying crankshaft.



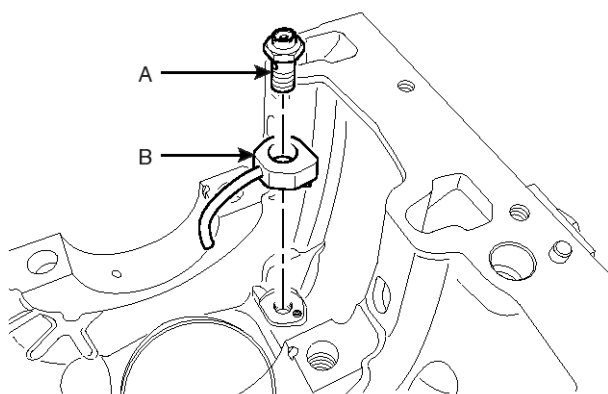
SDGEM7047D

14. Remove upper main bearing (A) and upper thrust bearing.



SDGEM7048D

15. Remove check valve (A) and oil jet (B) from cylinder block.

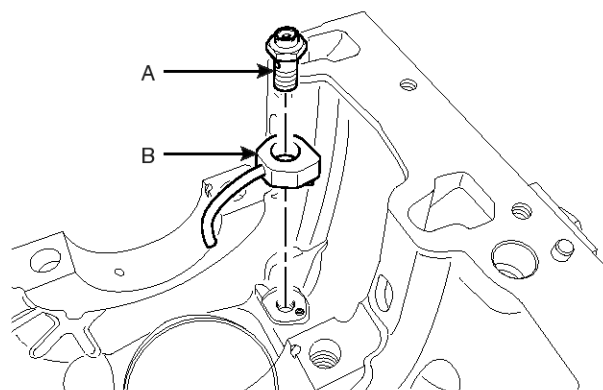


SDGEM7049D

INSTALLATION

1. Install check valve (A) and oil jet (B) to cylinder block.

Check valve : 3 ~ 3.5 kgf.m(29.4~34.3 N.m, 21.7~25.3 lb-ft)

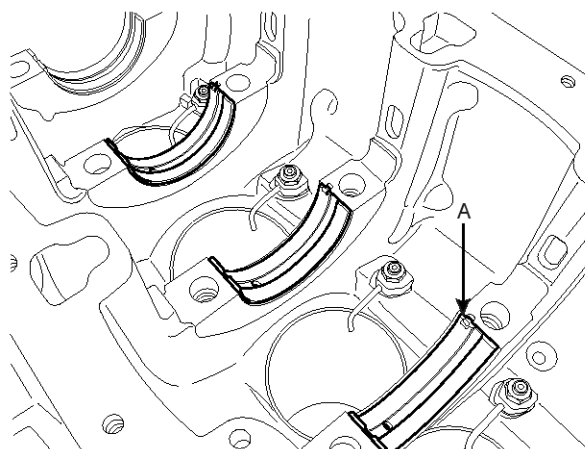


SDGEM7050D

2. Install upper main bearing (A).

⚠ CAUTION

Apply a small amount of oil to all bearing moving surfaces.

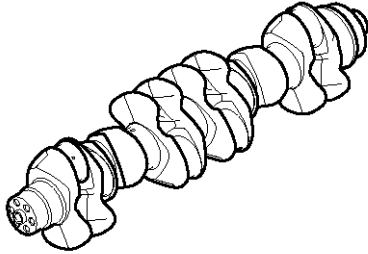


SDGEM7051D

3. Install crankshaft to cylinder block.

⚠ CAUTION

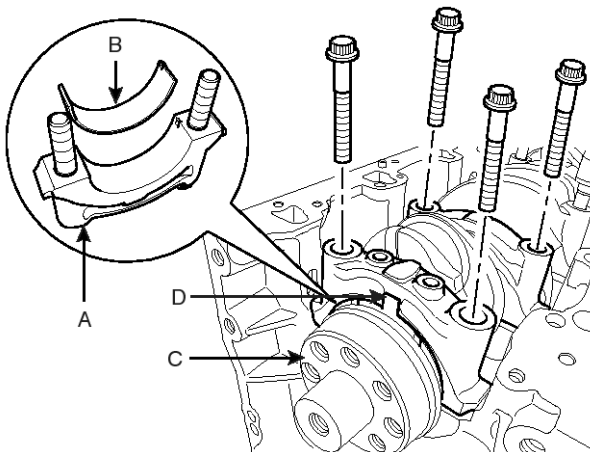
Be careful not to cause damage to crankshaft journal and cylinder block when handling crankshaft.



SDGEM7052D

4. Install upper thrust bearing to both sides of journal of crankshaft No.7.
5. Install lower main bearing (B) to main bearing cap (A) and then install to crankshaft (C). Install bearing cap No.7 with lower thrust bearing (D).

Main bearing cap bolt : 17 kgf.m(166.7 N.m, 123 lb-ft) + 110°



SDGEM7053D

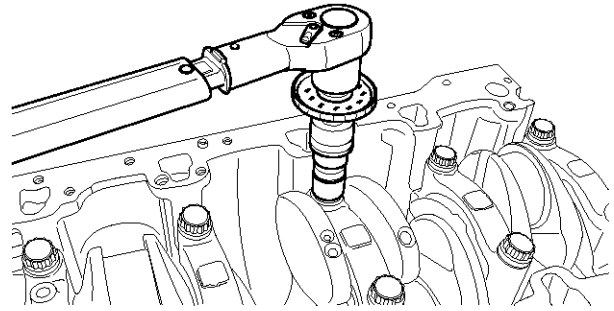
⚠ CAUTION

Never reuse main bearing cap bolt.

📌 NOTICE

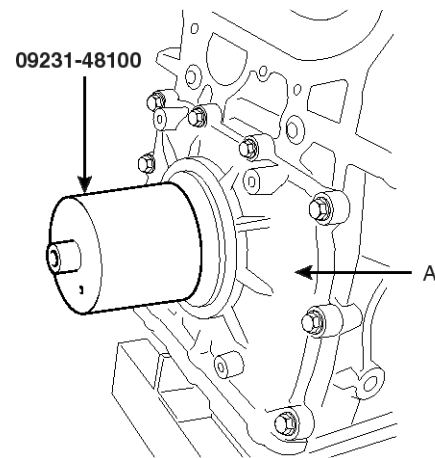
At installing bearing cap, install it from center to outside in sequence to the specified torque.

After main bearing cap bolt is installed, make sure that crankshaft rotates smoothly.



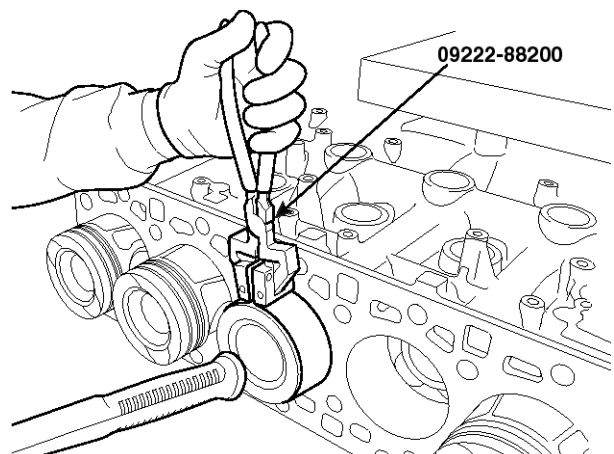
SDGEM7054D

6. Install front cover (A) with sealant applied and using the special tool(09231-48100), install front oil seal.



SDGEM7055D

7. Using the special tool (09222-88200), install piston and connecting rod assembly into cylinder block.



SDGEM7056D

NOTICE

Before installing piston and connecting rod assembly into cylinder block, apply a small amount of oil to piston ring groove and cylinder inside.

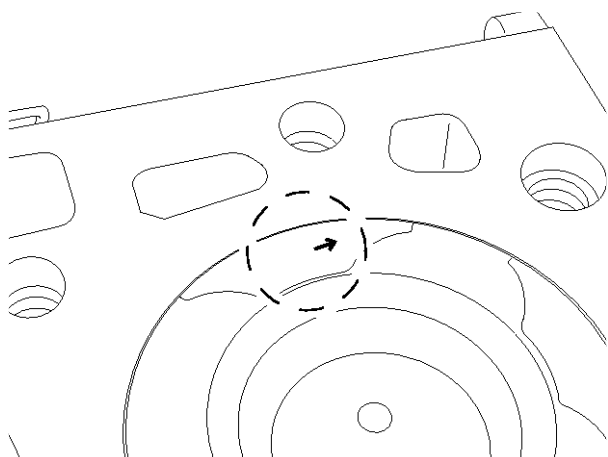
Use piston fit with cylinder block bore diameter grade.

*Cylinder block A, B : Piston A

*Cylinder block B, C : Piston B

CAUTION

Make sure that piston arrow mark "→" faces front.



SDGEM7058D

8. Tighten connecting rod bolt (A) to the specified torque. Install pistons in the sequence of No.1, 6, 2, 5, 3, 4.

Connecting rod cap bolt : 4 kgf.m(39.2 N.m, 28.9 lb-ft) + 100°

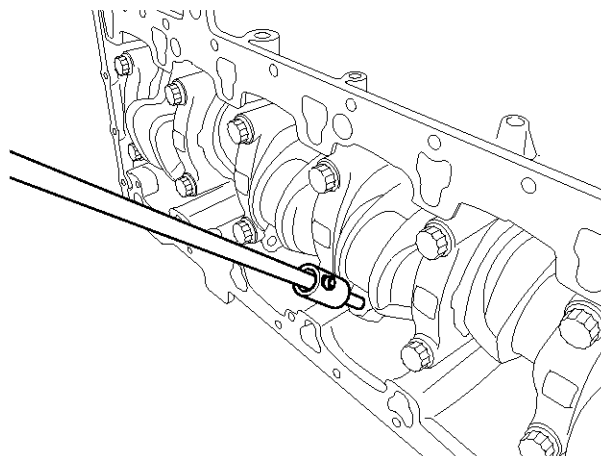
CAUTION

Never reuse connecting rod cap bolt.

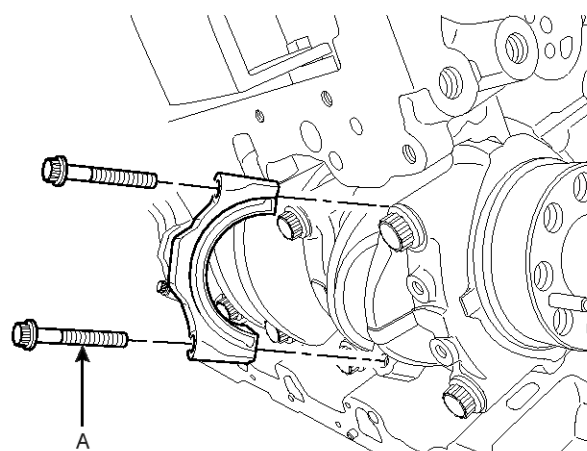
NOTICE

Connection rod cap surface might not be smooth for durability. Do not mistake it for poor parts.

Measure at the same position as crankshaft center line.



SDGEM7057D



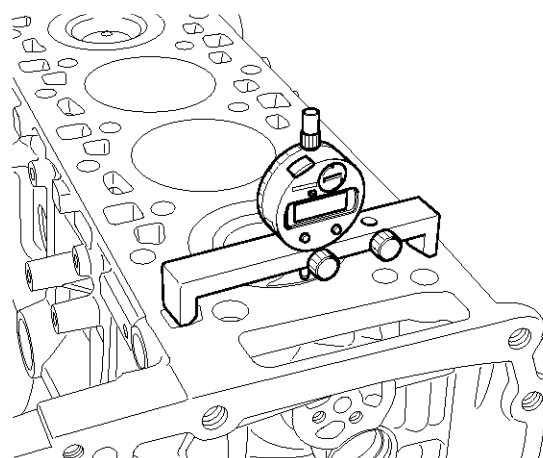
SDGEM7059D

9. Measure piston protrusion amount.

Protrusion amount : -0.309~0.259mm

NOTICE

Measure at the same position as crankshaft center line.

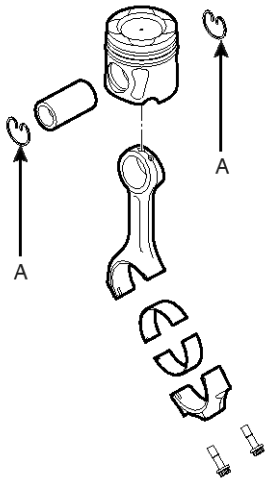


SDGEM7060D

10. Install crankshaft gear.
11. Install oil pump assembly.
12. Install oil pan assembly.
13. Install timing gear.
14. Install flywheel housing and flywheel.
15. Install cylinder head.
16. Install accessories into engine.

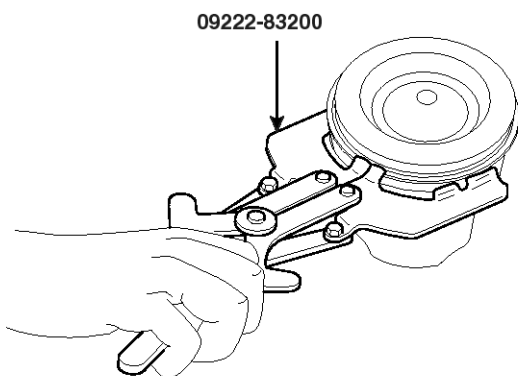
DISASSEMBLY

1. Using snap ring prier, remove piston pin snap ring (A) at both sides of piston pin.



SDGEM7061D

2. Remove piston pin and then remove connecting rod and piston.
3. Using the special tool(09222-83200), remove piston ring.

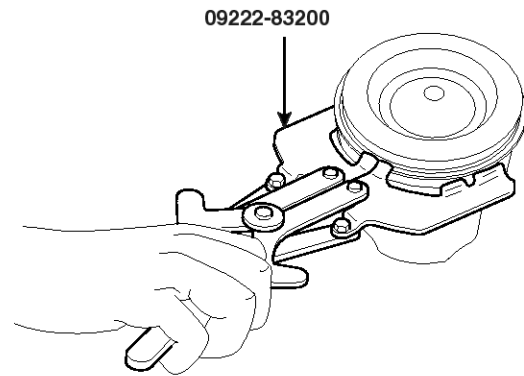


SDGEM7062D

REASSEMBLY

PISTON AND CONNECTING ROD ASSEMBLY

1. Using the special tool(09222-83200), assemble piston ring.

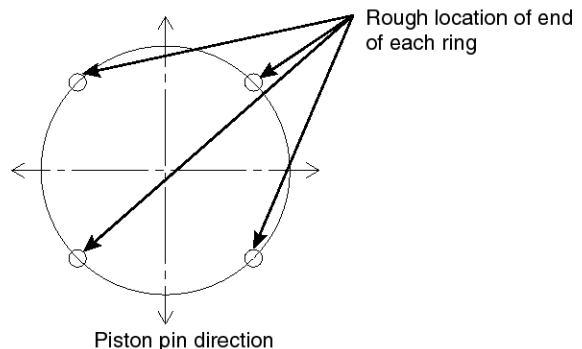


SDGEM7063D

NOTICE

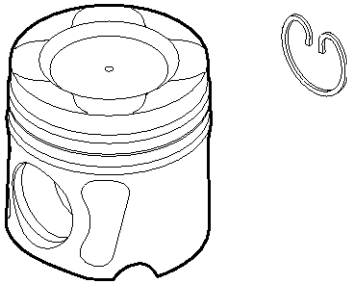
1. Piston ring No.1, 2
 - a. Face company mark of ring end upwards(cylinder head side) and assemble it.
 - b. Install the open end of ring No.2 to be in the 180 degree direction with the open end of ring No.1.
2. Oil ring

The open end of oil ring installs to be in the 180 degree direction with the open end of coil spring and the open end of ring No.2 installs to be in the 90 degree direction.
3. Make sure that piston ring moves smoothly when turning it to the left or right.
4. The position of open end of each ring is as follows:



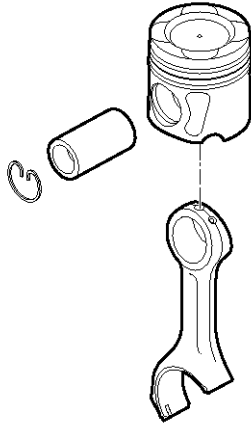
SDGEM9020L

2. Install snap ring to the one side (Opposite side company mark is shown) of piston pin hole.



SDGEM7065D

3. Align and install connecting rod and piston with front mark (company mark) and then install piston pin.



SDGEM7066D

4. Apply oil sufficiently to the periphery of piston pin, the holes of piston pin hole and connecting rod smaller end.
5. After installing piston pin, install snap ring of the opposite side.

CAUTION

1. When installing, be careful that the holes of connecting rod smaller end and piston pin and piston pin do not cause damage or scratch.
 2. Be sure to align and install snap ring with piston pin hole.
6. Install connecting rod bearing.

INSPECTION CYLINDER BLOCK

NOTICE

1. Before inspection or repair, clean each part to remove dust, oil, carbon and fur.
 2. Before cleaning cylinder block, check water leaks or damages.
 3. Using air brush, remove adhesives at each oil hole and check whether any hole is clogged.
1. In addition to the visual check about scratch, rust and corrosion, inspect the slight scratches with precipitant. Repair or replace it if needed.
 2. Using straight edge (A) and thickness gauge (B), measure the twist of cylinder block. Measure them by placing the straight edge as shown in the following figure.

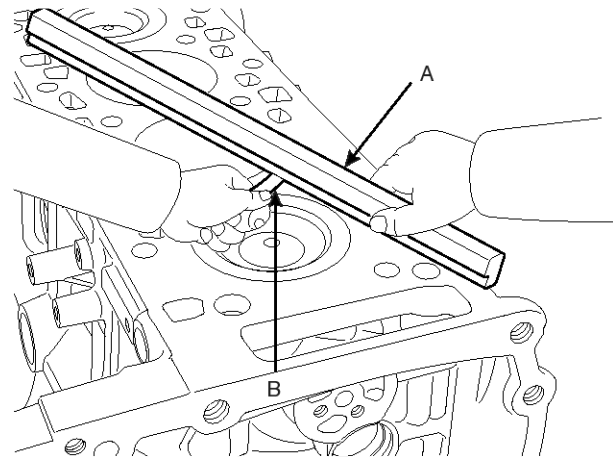
NOTICE

When measuring, the upper surface of cylinder block should be free from foreign materials such as gasket.

CAUTION

When grinding the cylinder block, grind it as the piston protrusion does not exceed the reference value.

Flatness figure of cylinder block
Reference : Below 0.07 mm



SDGEM7067D

3. Check the cylinder wall to see if it is cracked or damaged. If it is abnormal, repair (oversize) or replace the cylinder sleeve.
(Replace the sleeve.)
 - a. Remove the cylinder liner.

- b. Check that the inner diameter of cylinder block is within a range of a repair size.

If the inner diameter of cylinder block is within a range of a repair size, press the outer diameter repair size of a sleeve into the cylinder block.

- c. If the inner diameter of cylinder block is larger than a repair size, grind(honing or boring) the cylinder block and widen it with a repair oversize.

Press the outer diameter repair oversize of a sleeve into the cylinder block.

Item	I.D of cylinder block	Roughness (I.D of cylinder block)	O.D of sleeve
Repair size(mm)	Ø 106.938 ~ 106.96	Rz 12.5	Ø 107.15 ~ 107.18
Repair over-size(mm)	Ø 107.438 ~ 107.46	Rz 12.5	Ø 107.65 ~ 107.68

4. Measure the cylinder sleeve ID using the cylinder gauge. If it is excessively worn, repair it with oversize and replace piston and piston ring.

Clearance between piston and cylinder sleeve :
0.111 ~ 0.145 mm

CAUTION

1. When replacing piston, piston ring should be replaced together.
2. Replace with the piston fit with the cylinder sleeve diameter.

Cylinder (mm)	Grade	A	B	C
	Diameter	102.985 102.991	102.992 103.008	103.009 103.015
Piston (mm)	Grade	A		B
	Diameter	102.863 102.871		102.872 102.881

*Cylinder 'A' grade : Apply only the piston 'A' grade.

*Cylinder 'B' grade : Apply the piston 'A' or 'B' grade.

*Cylinder 'C' grade : Apply only the piston 'B' grade.

*At replacing the piston, apply to all cylinders with the same grade of piston.

3. Even though only one cylinder needs boring, all cylinder walls should be grinded with oversize at the same time.

Roughness(I.D of cylinder) : Rz 3~5

An angle of honing : $40 \pm 5^\circ$

4. Measure the cylinder I.D. worn the most seriously among the inner diameters of all cylinders and select the oversize based on the measurement value.

5. The oversizes are available for +0.25 and +0.5

Item	0.25 oversize	0.5 oversize
Cylinder(mm)	103.235~103.265	103.485~103.515
Piston(mm)	103.106~103.124	103.356~103.374

6. The connecting rod should be replaced with the new one which has identical weight and grade with the old one.

Cylinder (mm)	Grade	A	B	C
	Dia.	102.985 102.991	102.992 103.008	103.009 103.015
Piston (mm)	Grade	A		B
	Dia.	102.863 102.871		102.872 102.881
Clearance(mm)		0.114~0.145		0.111~0.143

SDGEM9064L

PISTON

1. Check each piston to see whether it is damaged.
2. Check whether the piston pin is installed correctly in the piston hole.

If any defect is found, replace the piston and piston pin as an assembly.

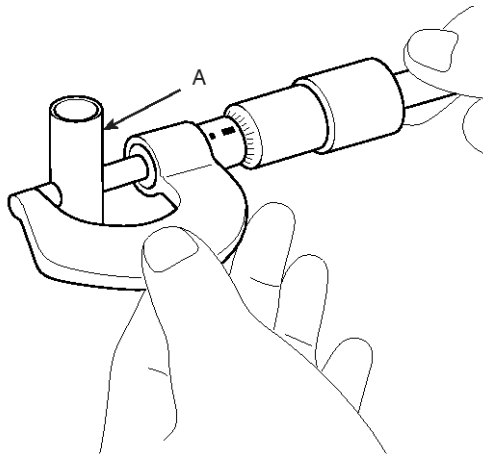
Piston pin should slide into the piston hole smoothly when it is pushed by hand.



SDGEM7070D

3. Measure the clearance between piston pin and piston pin hole by measuring piston pin (A) and piston pin hole.

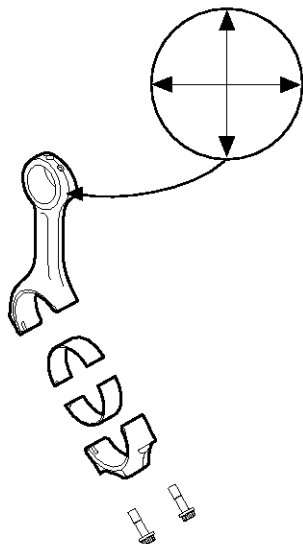
Inner diameter of piston pin hole : 44.014~44.022mm
Outer diameter of piston pin : 43.994~44.0mm
Clearance reference : 0.014~0.028mm
Clearance limit : 0.05mm



SDGEM7071D

4. Measure the clearance between piston pin and connecting rod smaller end.

Outer diameter of piston pin : 43.994~44.0mm
Inner diameter of connecting rod smaller end : 44.03~44.04mm
Clearance reference : 0.030~0.046mm
Clearance limit : 0.1mm



SDGEM7072D

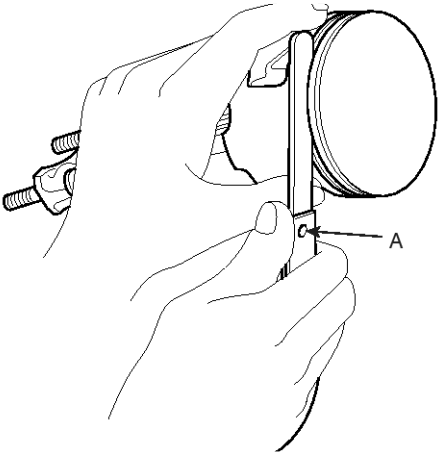
PISTON RING

1. Check the piston ring for any damage, unusual wear or breakage. If damaged, replace the ring.
2. When replacing the piston, replace the piston pin together.
3. Measure the clearance between piston ring and the wall of the ring groove.

NOTICE

Press the piston ring with a straight edge and measure it with a feeler gauge.

Piston ring	Reference	Limit
Piston ring No.1	0.120 ~ 0.160	0.2
Piston ring No.2	0.09 ~ 0.13	0.17
Oil ring	0.03 ~ 0.07	0.15



SDGEM7073D

CRANKSHAFT

1. Measure the endplay of crankshaft.

Crankshaft endplay

Reference : 0.1 ~ 0.292 mm

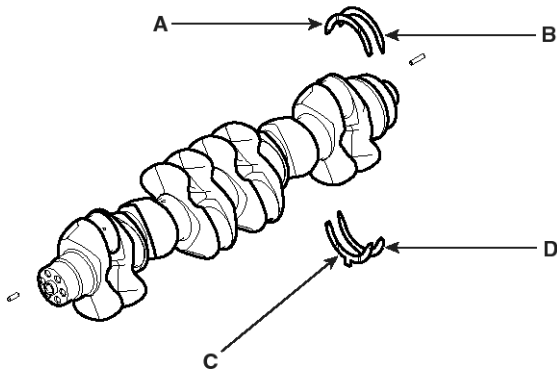
Limit : 0.4 mm

- a. If the endplay exceeds the limit, replace the thrust plate with the oversize.
- b. The oversizes of the thrust bearing are available for +0.15 and +0.3.
- c. The thrust bearing should be replaced with the same as oversize.

CAUTION

The size of A(C) should not be same as the size of B(D).

But, the oversize of A(B) should be same as the oversize of C(D).



SDGTSBEM9001D

2. Measure the oil gap of crankshaft main bearing.

- a. Remove the main bearing cap.
- b. Measure the oil gap of main bearing.
 - 1) Remove the oil or other foreign materials from main journal and main bearing surface.
 - 2) Place the plastic gauge along with the shaft direction of the main journal.
 - 3) Install the main bearing cap and tighten the bolt.

Tightening torque : 17 kgf.m(166.7 N.m, 123 lb-ft) + 110 °

- 4) Remove the main bearing cap and measure oil gap at each journal.

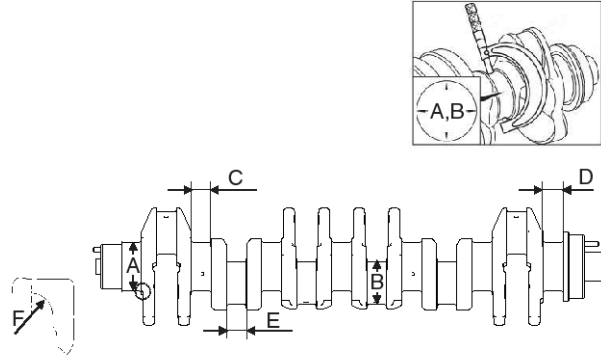
Reference : 0.048~0.11mm

Limit : 0.15mm

- 5) If the oil gap of the main bearing is excessively large, replace the main bearing.

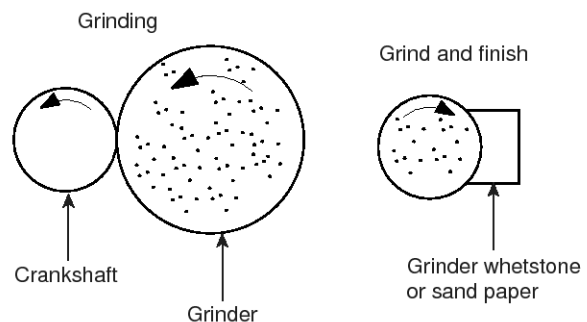
3. Measure roundness and flatness of the crankshaft journal and pin.

If the measurement exceeds the limit, grind it with undersize and replace the bearing with undersize.



SDGTSBEM9002D

- a. At grinding, the distance between a pin center and a journal center should not be changed.
- b. A width of journal and pin should not be changed.
- c. Lightly finish the fillet with specified radius R.
- d. Check grinding crack using a magnetic detector, and the surface hardness (HV 550), as well, if decreased.
- e. When grinding the crank shaft, the grinder and the crankshaft both rotate counterclockwise as seen from the front.
- f. Perform the finishing treatment of the crankshaft while rotating it to counterclockwise using a grinder whetstone or sand paper.



ECBEM5127A

<Dimensions of the crankshaft>

Unit : mm

Item	O.D of journal (A)	O.D of pin (B)	Width of journal(C,D)		Width of pin (E)	Fillet,R(F)	Roundness	Flatness	
			#1~#6	#7				Journal/pin	Pin (Based on journal #1, 7)
Standard	85.99~86.01	74.99~75.01	35~35.2	35~35.062	35~35.2	R2.5~R3	0.005	0.005	Ø0.01
0.25 Undersize	85.74~85.76	74.74~74.76	-	-	-	-			
0.5 Undersize	85.49~85.51	74.49~74.51	-	-	-	-			

4. Check to see if the crankshaft is bent.

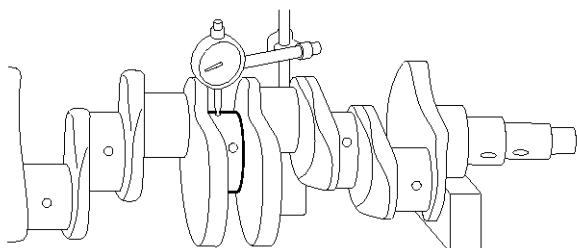
Install the dial gauge on crankshaft center journal and check the bending of the crankshaft.

Bending of crankshaft

Journal No.2, 6 play : 0.07mm

Journal No.3, 5 play : 0.11mm

Journal No.4 play : 0.15mm



SDGEM7074D

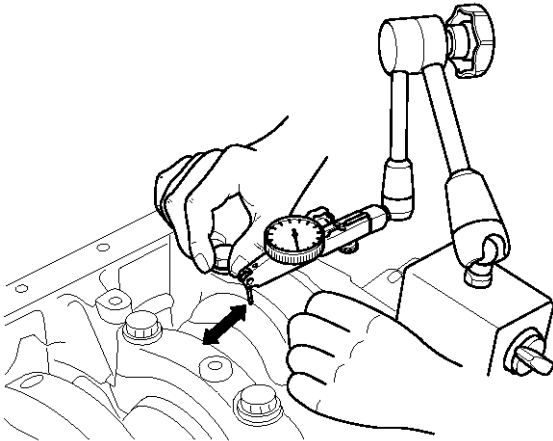
CONNECTING ROD BEARING

1. Before removing the connecting rod cap, measure the connecting rod endplay. If the gap exceeds the reference, replace the connecting rod.

Connecting rod endplay

Reference : 0.15 ~ 0.45 mm

Limit : 0.6 mm



SDGEM7075D

2. Measure the oil gap of connecting rod bearing.

- 1) Remove the connecting rod cap.
- 2) Measure the oil gap of the connecting rod bearing.
 - a. Remove the oil or other foreign materials from pin journal and connecting rod bearing surface.
 - b. Place the plastic gauge along with the shaft direction of the pin journal.
 - c. Install the connecting rod bearing cap and tighten the bolt.

Connecting rod cap bolt : 4 kgf.m(39.2 N.m, 28.9 lb-ft) + 100°

- d. Remove the connecting rod bearing cap and measure the oil gap at each pin journal.

Connecting rod oil gap

Reference : 0.032~0.091mm

Limit : 0.2mm

- e. If the oil gap is excessively large, replace the connecting rod bearing.

3. Length of connecting rod bearing

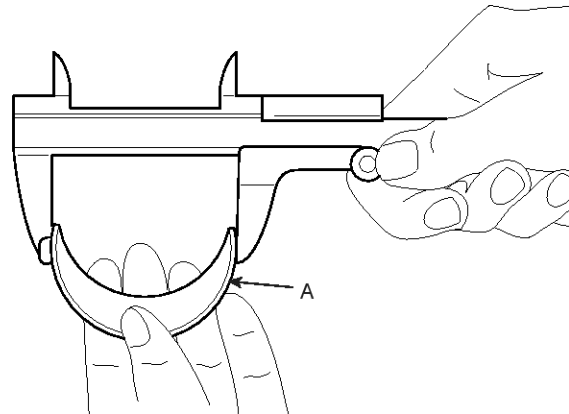
Length of the connecting rod bearing (A) is measured at the free state. If the measurement is below the limit, replace the upper and lower bearing.

Length of connecting rod bearing

Limit : Above 80.0~81.0mm

CAUTION

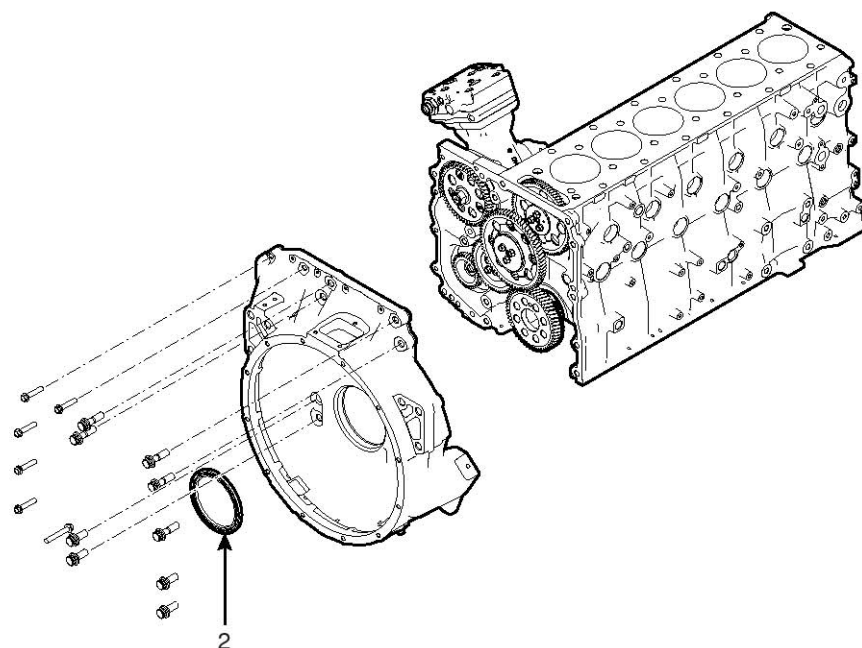
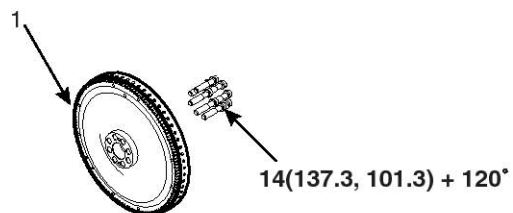
Bearing should not be artificially expanded to reuse.



SDGEM7076D

Flywheel

COMPONENTS



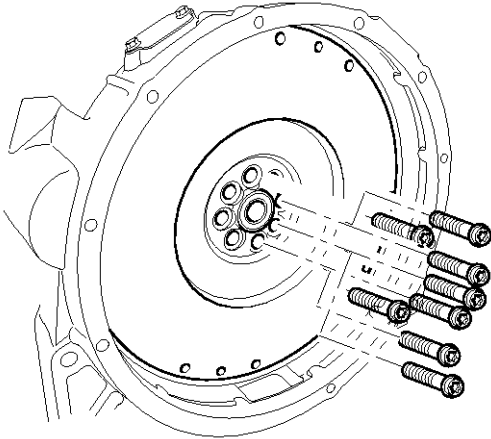
Tightening torque : **kgf.m(N.m, lb-ft)**

SDGEM9021L

1. Flywheel
2. Rear oil seal

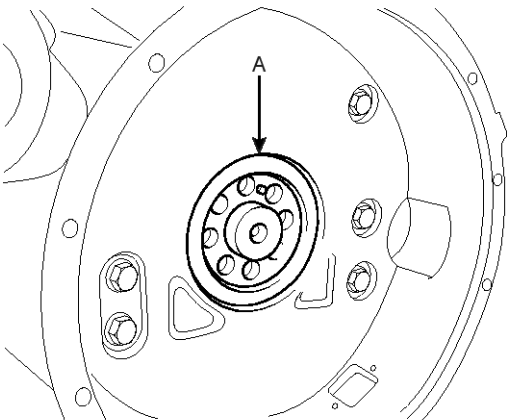
REMOVAL

1. Remove engine speed sensor.
2. Using the special tool(09231-52000 or 09231-52100) to the service window in flywheel housing, secure crankshaft.
3. Remove flywheel bolt.



SDGEM7078D

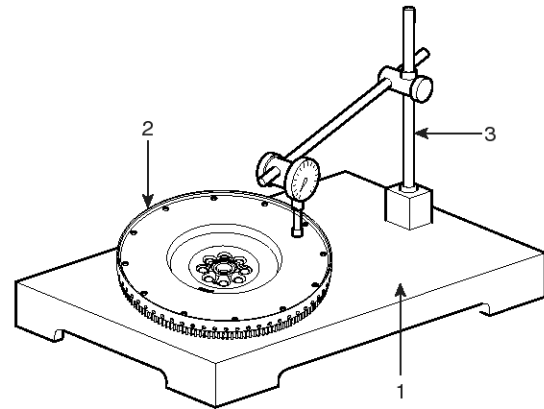
4. Install the special tool(09231-48000) to crankshaft.
5. Remove the special tool(09231-52000 or 09231-52100).
6. Remove flywheel.
7. Remove the special tool(09231-48000).
8. Remove rear oil seal (A).



SDGEM7079D

INSPECTION

1. Twist of friction surface
 - a. Put the flywheel(2) on a precision table(1) and set the dial indicator(3).



SDGTSBEM9003D

- b. Move the dial indicator through the diameter to check the twist.
- c. If the flatness of a friction surface is beyond the limit, grind it again or replace it.

Twist of friction surface

Basic value : Below 0.05 mm

Limited value : 0.2 mm

2. Grind the friction surface of the flywheel by a grinder.

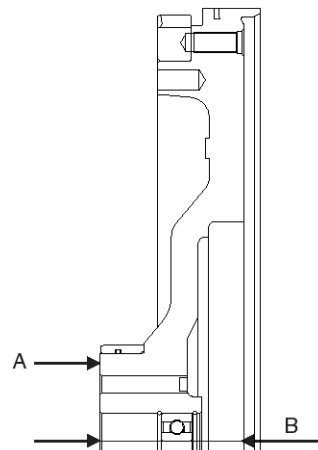
CAUTION

- a. After repairing the friction surface, the clearance between the friction surface and A should be within 0.1 mm.
- b. The height of the friction surface(dimension B) should not exceed the limit.

The height of the friction surface(B)

Basic value : 69.5 mm

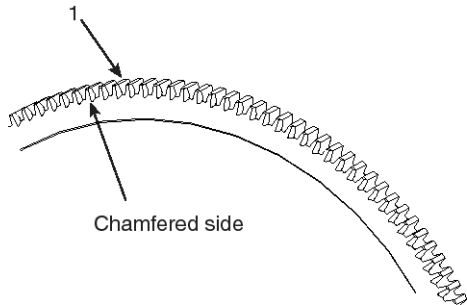
Limited value : 68.5 mm



SDGTSBEM9004D

3. Replacing the ring gear

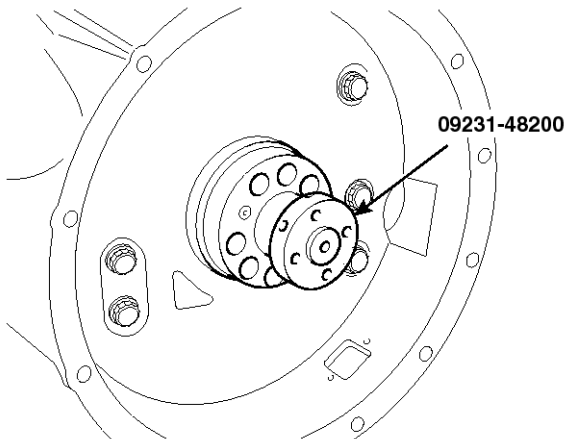
- Heat the ring gear(1) evenly using a torch. Holding it with a protective rod, evenly tap around the ring gear.
- Heat the ring gear using a heater(around 200 °C). Assemble the ring gear to the flywheel with the other side of teeth not chamfered.



SDGEM9063L

INSTALLATION

- Using the special tool(09231-48200), install rear oil seal.

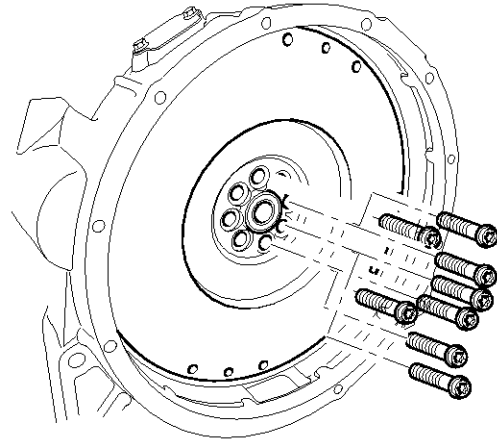


SDGEM7083D

- Install the special tool(09231-48000) to crankshaft.
- Install flywheel.

CAUTION

- Reassemble the flywheel after applying engine oil to the connected parts of flywheel oil seal.



SDGEM7084D

- Remove the special tool(09231-48000).
- Using the special tool(09231-52000 or 09231-52100) to the service window in flywheel housing, secure crankshaft.
- Tighten flywheel bolt.

Flywheel bolt :

14 kgf.m(137.3 N.m, 101.3 lb-ft) + 120°

CAUTION

Never reuse flywheel bolt.

Pay special attention for handling flywheel as it is heavy.

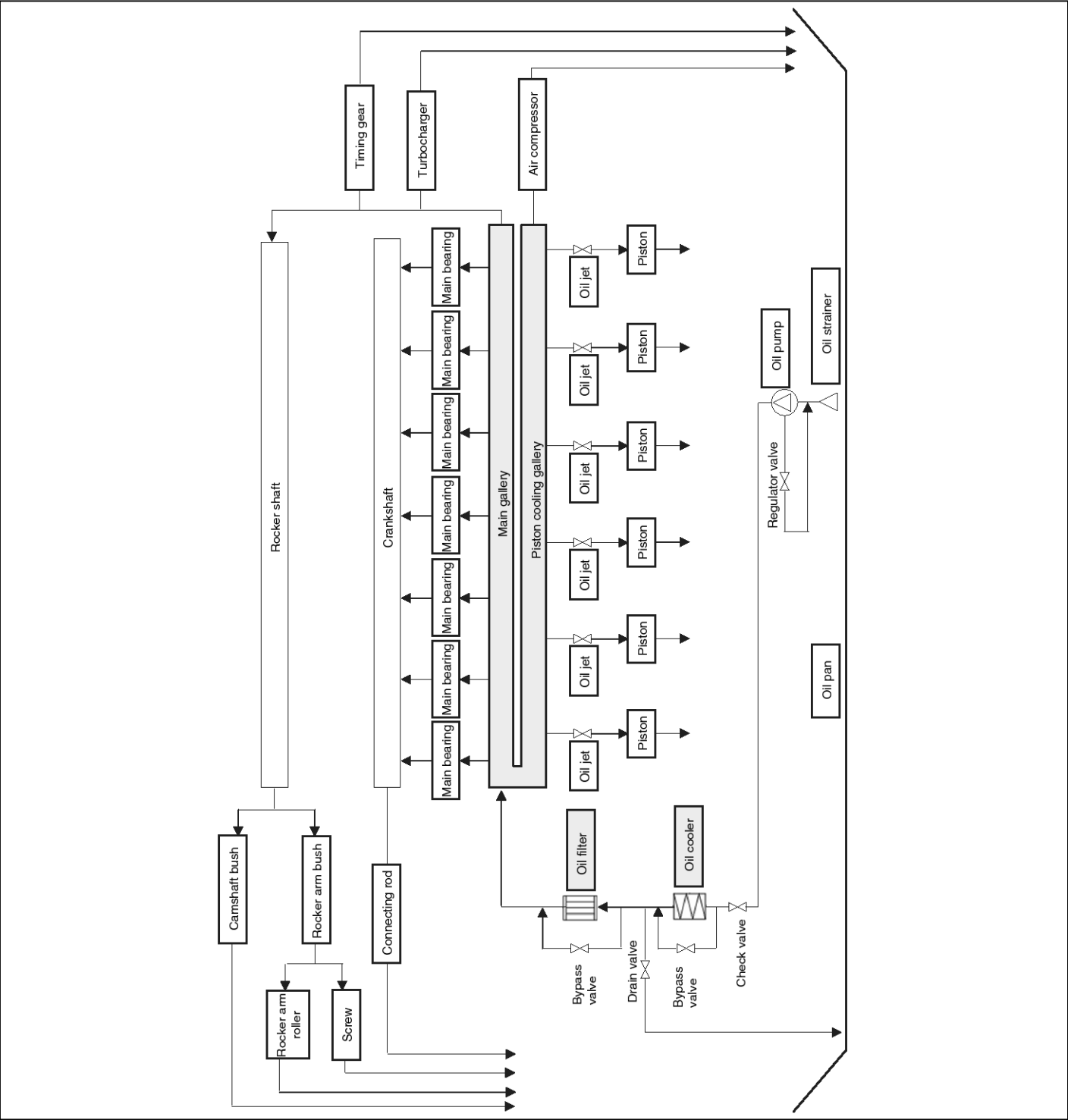
- Remove the special tool(09231-52000 or 09231-52100).
- Remove engine speed sensor.

Lubrication System

OUTLINE

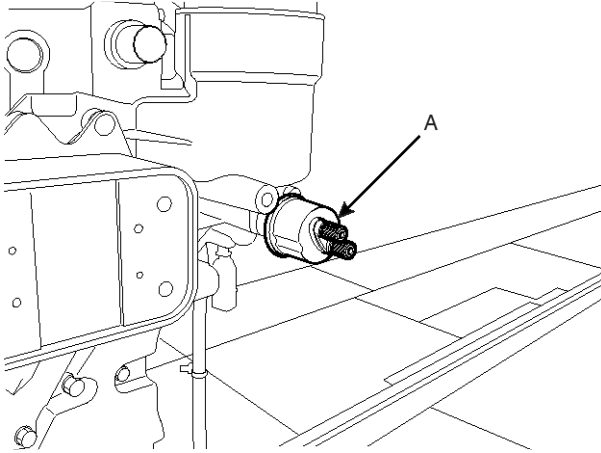
LUBRICATION CIRCUIT

The engine is lubricated by a gear-type oil pump that forces engine oil through the oil cooler and oil filter into the engine for lubrication of various engine parts.



OIL PRESSURE SWITCH

If the pressure of engine oil which is sent to the main oil gallery is below the specification, the built-in relay in the oil pressure switch (A) is closed, then the warning lamp in the instrument panel is on to inform the driver of abnormal pressure.

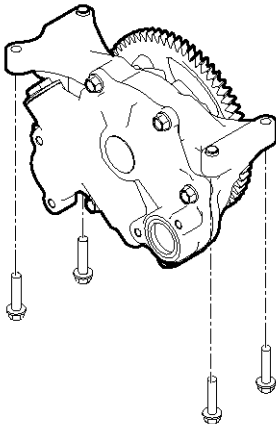


SDGEM7085D

OIL PUMP ASSEMBLY

The oil pump of a gear type is driven by the crankshaft rotation engaged with oil pump gear.

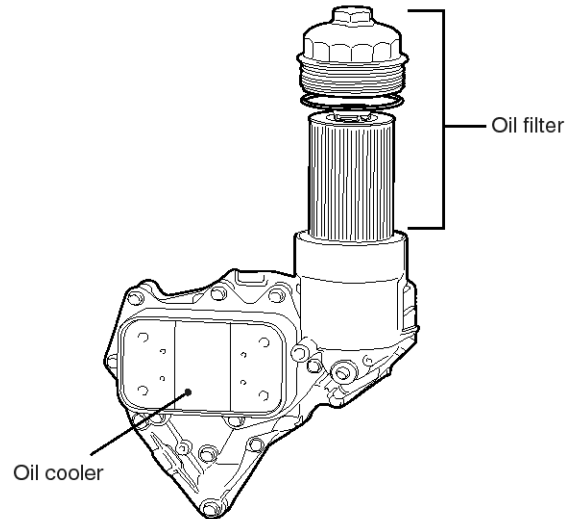
And the relief valve is installed to the oil pump so that it prevents the excessive pressure by bypassing the engine oil to oil pan when the oil pressure exceeds the specification.



SDGEM7086D

OIL COOLER

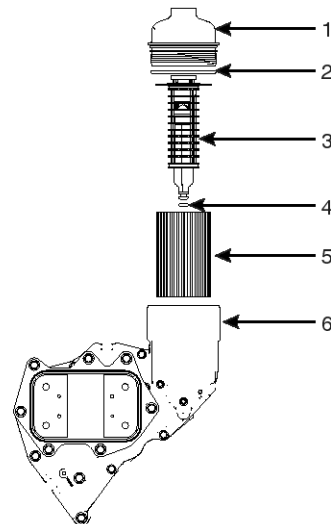
Oil cooler is installed on oil filter and is the equipment to exchange heat between oil fed from oil pump and coolant in the water jacket.



SDGEM9023L

OIL FILTER

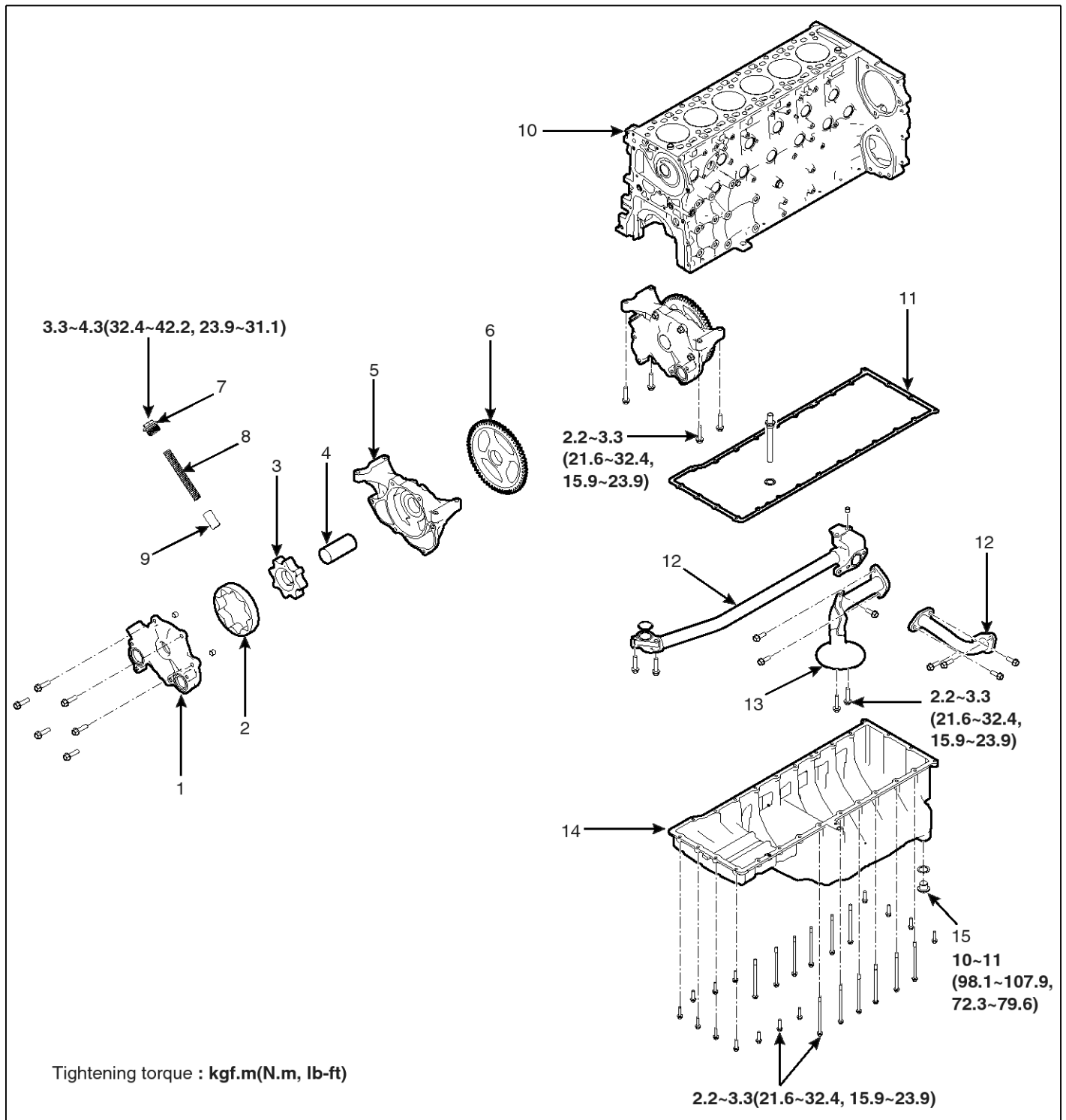
The oil filter is a current type paper element. Bypass valve is assembled to the bottom of the filter. If the element is loaded, valve opens so that engine oil goes to oil main gallery without passing through the element to prevent engine overload.



SDGEM9024L

1. Oil filter cap
2. Cap O-ring
3. Center rod assembly
4. Center rod O-ring
5. Element
6. Housing assembly

COMPONENTS



1. Oil pump case
2. Outer drive gear
3. Inner drive gear
4. Drive shaft
5. Oil pump cover

6. Head gear
7. Relief valve plug
8. Relief valve spring
9. Relief valve plunger
10. Crank case

11. Oil pan gasket
12. Oil pipe
13. Oil strainer
14. Oil pan
15. Drain plug

SPECIFICATIONS

Items	Specifications	Remarks
Lubrication type	Forced circulation by oil pump	
Oil pump type	Gear pump	
Relief valve	Plunger valve	
Oil filter (One unit)	Full flow filter	
Oil cooler	Celler plate type	
Oil jet	Plunger valve type	

LUBRICANTS

Item	Types	Oil grade	Oil viscosity(temperature applied)	Oil capacity
Engine oil	API classification grade or more SAE 10W-40	Grade CI-4 or more	1)0~40°C : SAE 30 2)Above -10°C: SAE 20W-40 3)Above -15°C: SAE 15W-40 4)Above -20°C: SAE 10W-40 5)-20~40°C : SAE 10W-30 6)-25~40°C : SAE 5W-30 7)Below 10°C: SAE 0W-30	- Oil pan: 20.5ℓ - With oil filter: 21ℓ - With oil cleaner(RRR-Oil filter): 23.5ℓ

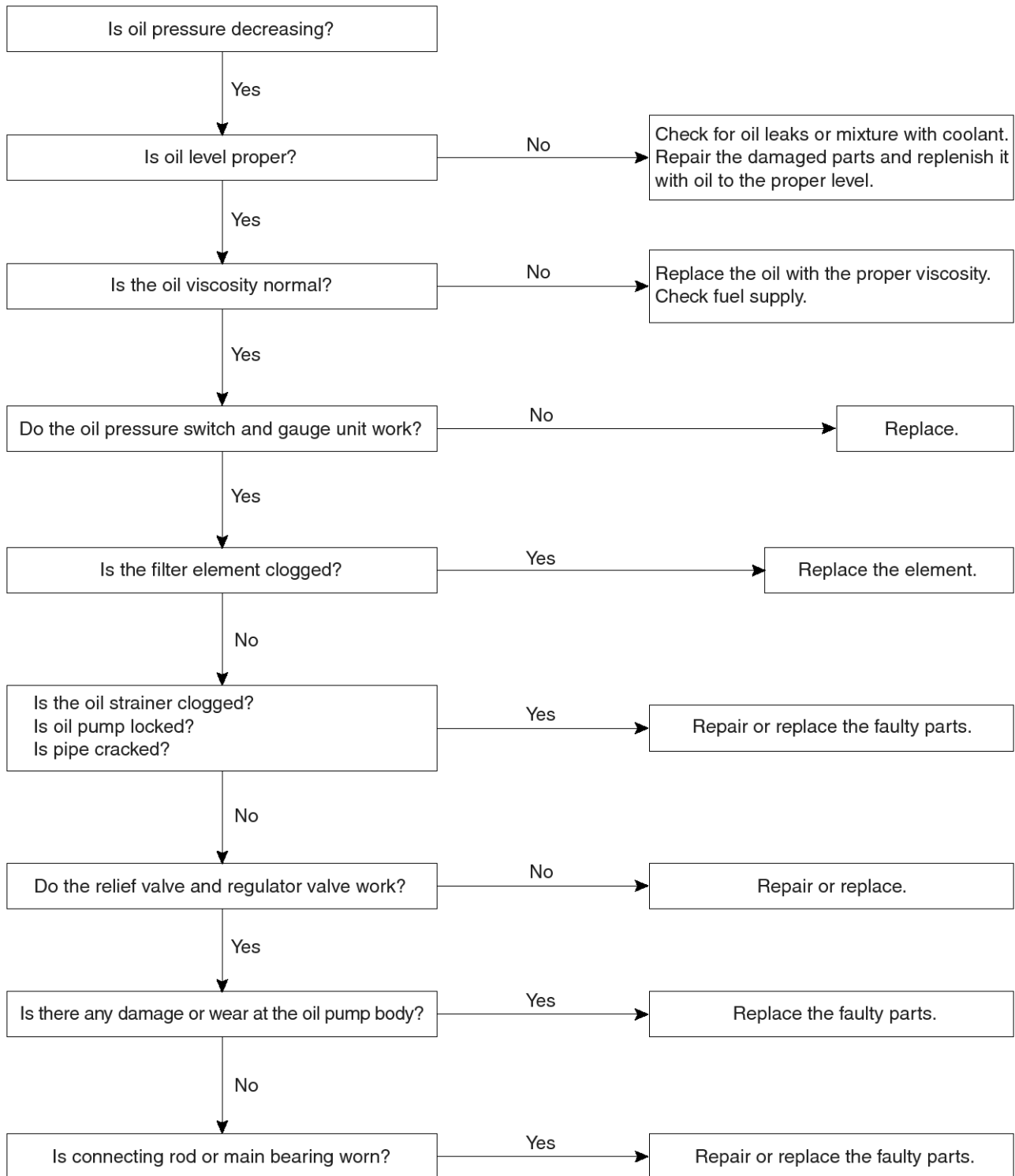
SERVICE STANDARDS

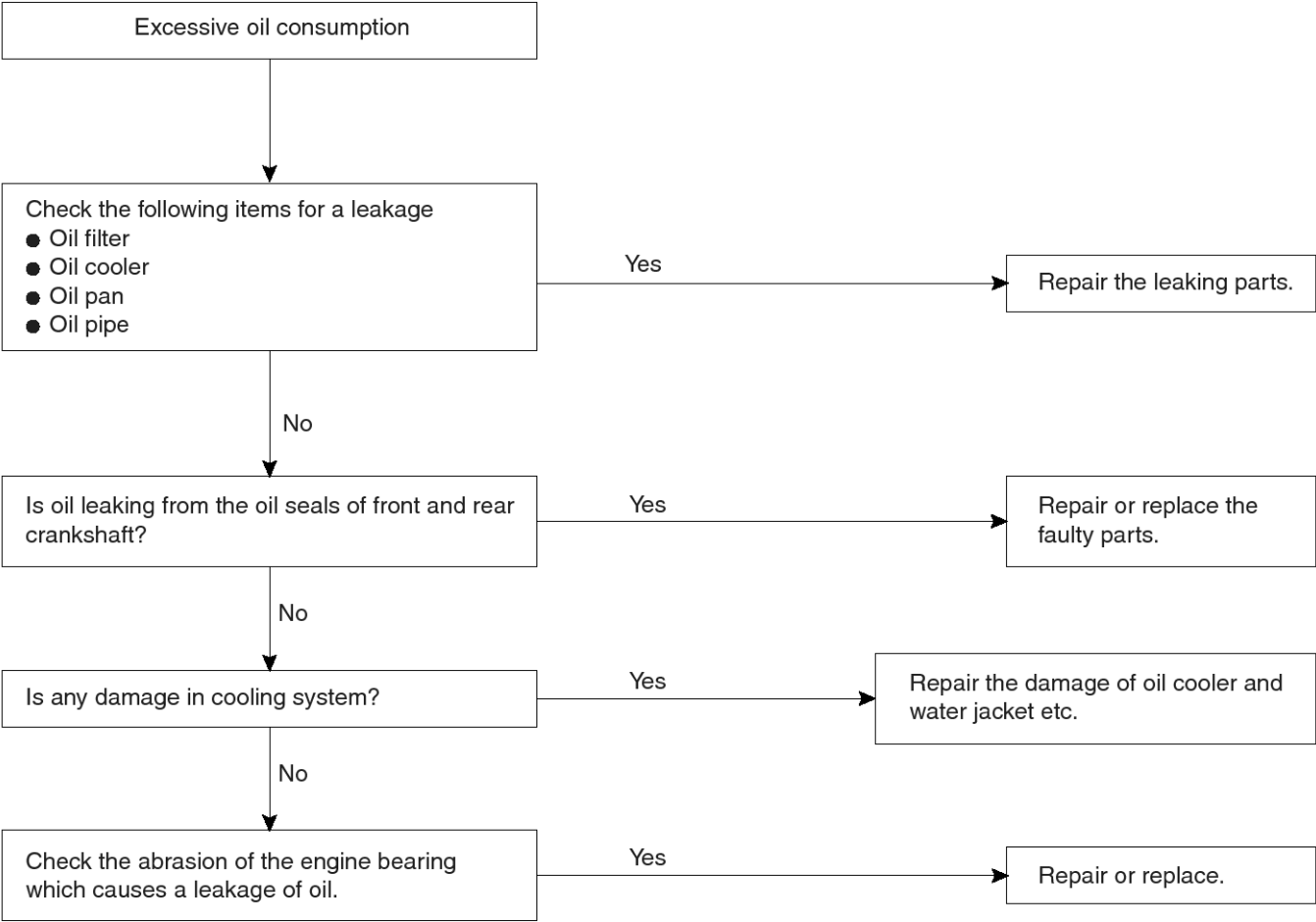
Items	Norminal value	Remarks
Clearance between oil pump gear and case	0.050~0.100mm	
Oil pump gear backlash	0.105~0.218mm	

TIGHTENING TORQUE

Items	Size	kgf.m(N.m , lb-ft)	Remarks
Oil pump cover bolt	M8×1.25	2~3(19.6 ~ 29.4 , 14.5 ~ 21.7)	8T
Oil cooler, oil filter bolt	M8×1.25	2.2~3.3(21.6 ~ 32.4 , 15.9 ~ 23.9)	
Oil filter cap	M36×4	2.25~2.75(22.1 ~ 27.0 , 16.3 ~ 19.9)	
Oil jet check valve	M12×1.25	3~3.5(29.4 ~ 34.3 , 21.7 ~ 25.3)	
Oil pump relief valve plug	M26×1.5	3.3~4.3(32.4 ~ 42.2 , 23.9 ~ 31.1)	
Oil pan oil drain plug	M26×1.5	10~11(98.1 ~ 107.9 , 72.3 ~ 79.6)	
Oil pan oil separator oil pipe	M24×1.5	6~8(58.8 ~ 78.4 , 43.4 ~ 57.9)	

TROUBLESHOOTING





ADJUSTMENT

ENGINE OIL INSPECTION

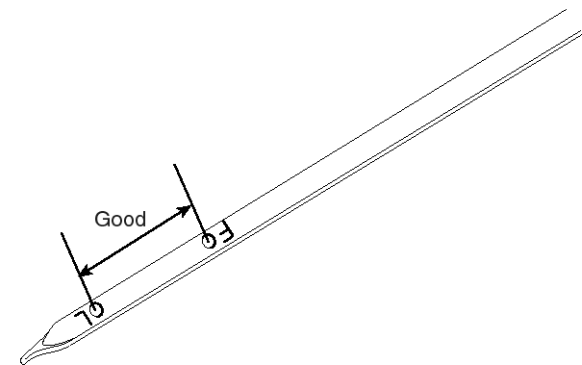
- 1. Park the vehicle on the flat surface.
- 2. Stop the engine.

NOTICE

- a. Warm up the engine for several minutes if the vehicle has not been inspected for a long period of time.
 - b. Stop the engine and wait for at least 15 minutes to measure the oil level.
3. If the oil level is below L mark of the gauge, refill the oil up to mark F.

NOTICE

When refilling, oil should be same kind with the one in the pan.



SDGEM9026L

4. Check the oil for pollution, mixture with coolant or fuel and viscosity.

ENGINE OIL CHANGE

- 1. Stop the engine after warming up and remove the oil filler cap on the cylinder head cover.
- 2. Loosen the drain plug of oil pan to drain engine oil.
- 3. Tighten the drain plug to the specified torque.

Tightening torque : 10~11 kgf.m(98.1~107.9 Nm, 72.3~79.6 lb-ft)

CAUTION

If oil drain plug is not tightened to the specified torque or gasket is reused, it may cause oil leakage or thread wear. Be sure to replace the gasket with new one at every oil change.

4. Fill the new engine oil into the oil filter.

NOTICE

Overfilling may cause oil saturation or pressure drop.

Oil capacity

Oil pan : 20.5ℓ

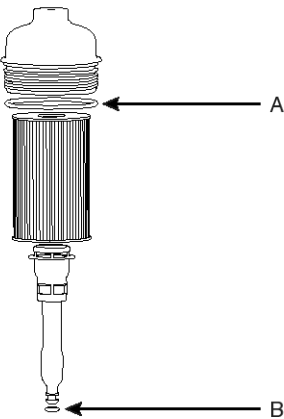
Total capacity : 21ℓ (Including oil filter)

With Oil cleaner(RRR Oil filter) : 23.5ℓ

- 5. Close oil filler cap.
- 6. Start the engine.
- 7. Stop the engine and check the oil level. Refill the engine oil if necessary.

OIL FILTER REPLACEMENT

- 1. Remove the oil filter using oil filter wrench.
- 2. Replace the element.
- 3. Replace O-ring (A), (B).



SDGEM7600D

- 4. Tighten the oil filter to the specified torque.
- 5. Start the engine and check the oil leakage.
- 6. Stop the engine and check oil level. Refill the engine oil as required.

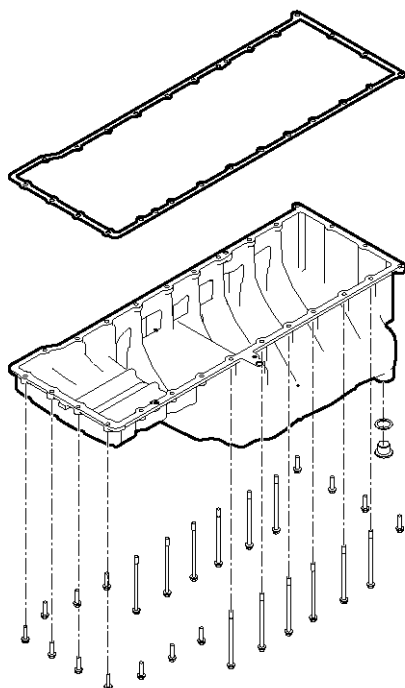
OIL PRESSURE CHECK

Remove regulator valve assembly and install pressure gauge. Warm up the engine until the temperature reaches 70~90°C. Measure the oil pressure at idle speed and max. speed. If the readings are below the limit, disassemble and check the lubrication system.

Item	Reference	Limit
No load min. rpm	1.5 kg/cm ²	0.5 kg/cm ²
No load max. rpm	3~5 kg/cm ²	2 kg/cm ²

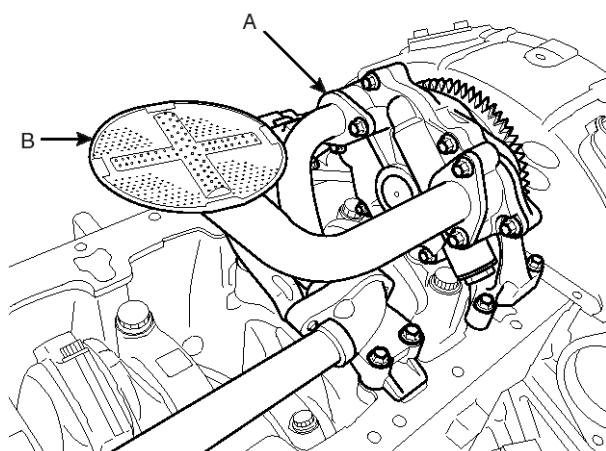
REMOVAL

1. Remove oil pan from cylinder block.



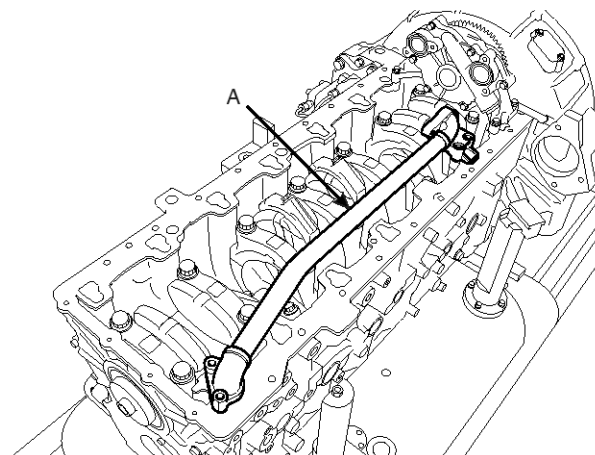
SDGEM7092D

2. Remove oil outlet pipe (A) and oil strainer (B).



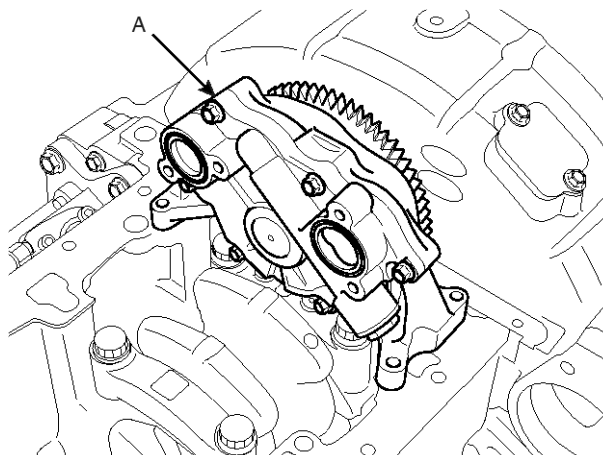
SDGEM7093D

3. Remove pipe (A).



SDGEM7094D

4. Remove oil pump assembly (A).

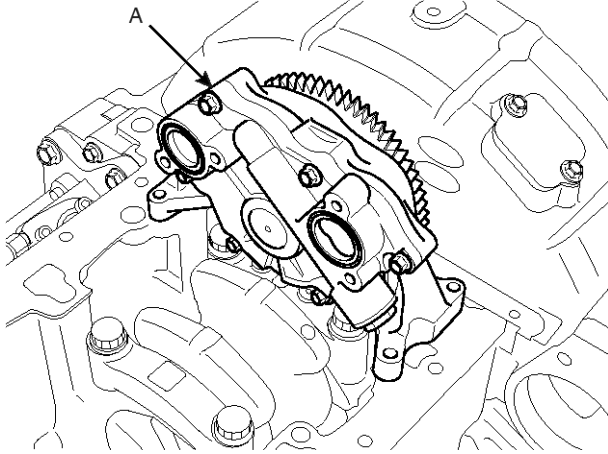


SDGEM7095D

INSTALLATION

1. Install two O-rings with grease applied and install oil pump assembly (A).

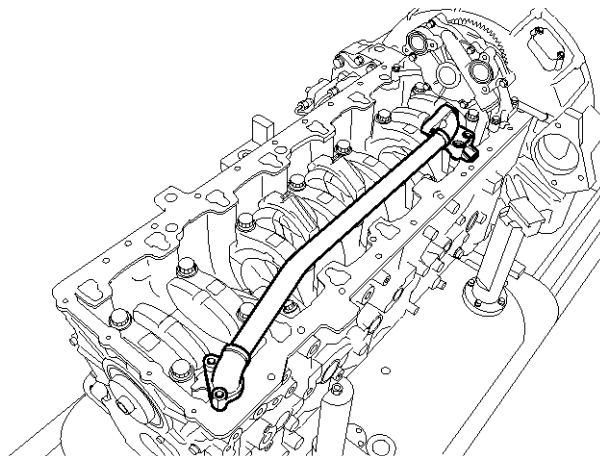
Oil pump assembly mounting bolt : 2.2~3.3 kgf.m (21.6~32.4 Nm, 15.9~23.9 lb-ft)



SDGEM7096D

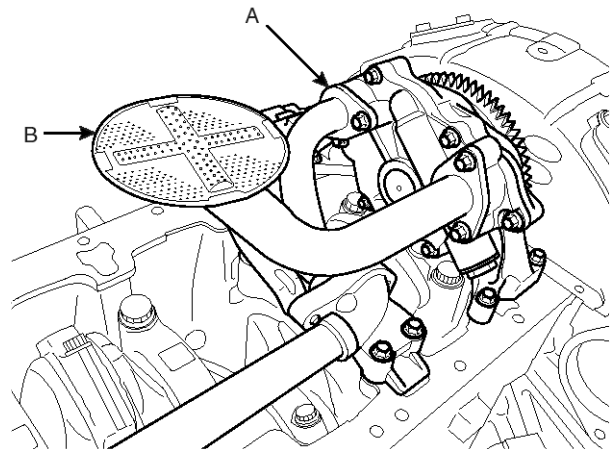
2. Install pipe with two O-rings.

Pipe mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 Nm, 15.9~23.9 lb-ft)



SDGEM7097D

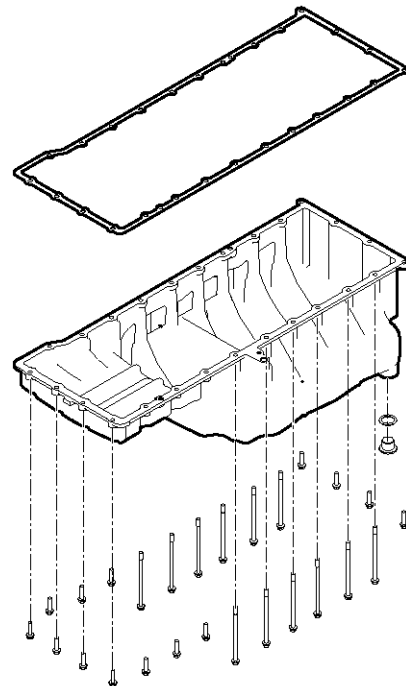
3. Install oil outlet pipe and oil strainer.



SDGEM7098D

4. Install the oil pan (A) after application of sealant to the mounting surface of oil pan gasket.

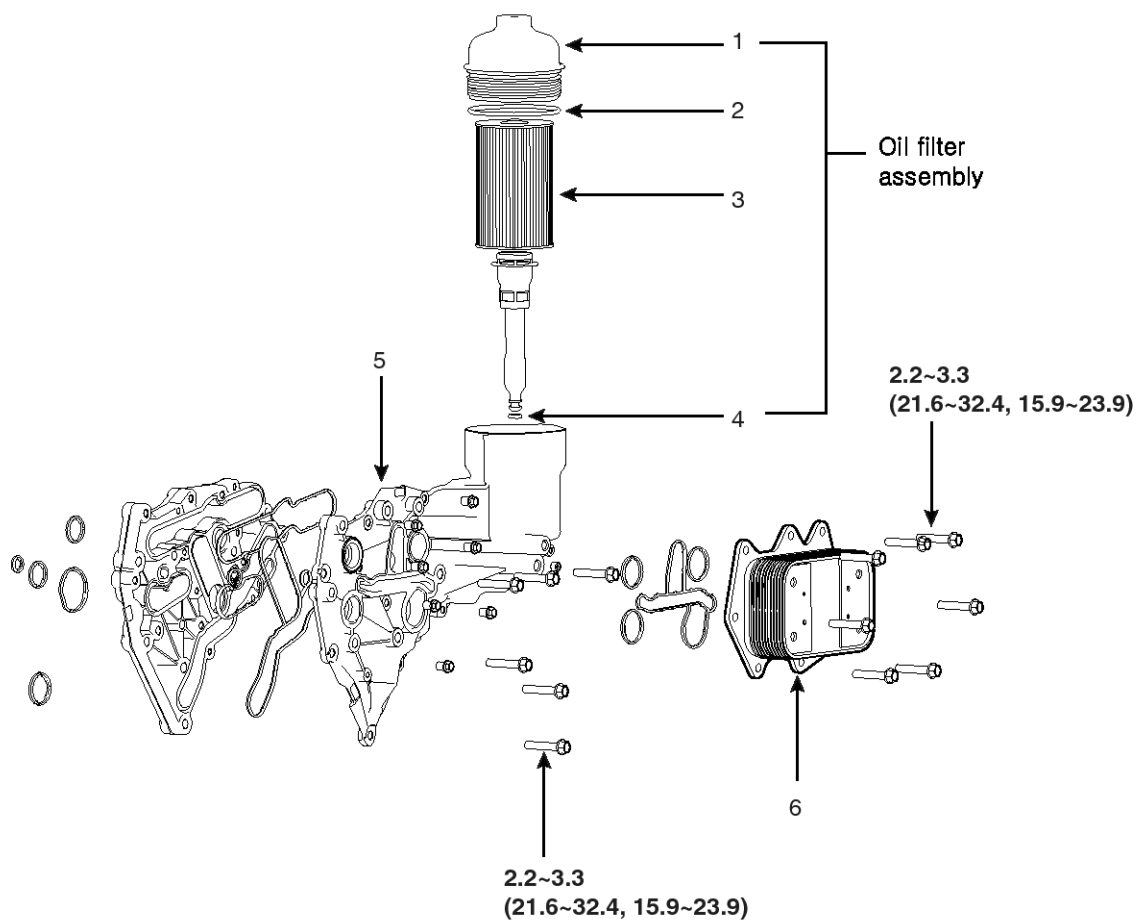
Oil pan mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 Nm, 15.9~23.9 lb-ft)



SDGEM7099D

Oil Cooler

COMPONENTS



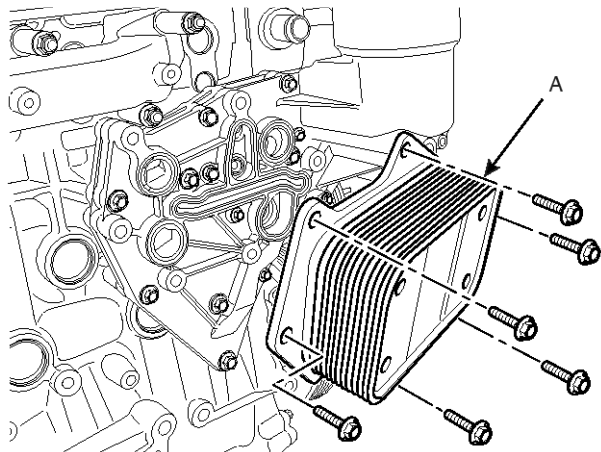
Tightening torque : **kgf.m(N.m, lb-ft)**

SDGEM9027L

1. Oil filter cap
2. Cap O-ring
3. Element
4. Center rod O-ring
5. Housing assembly
6. Oil cooler

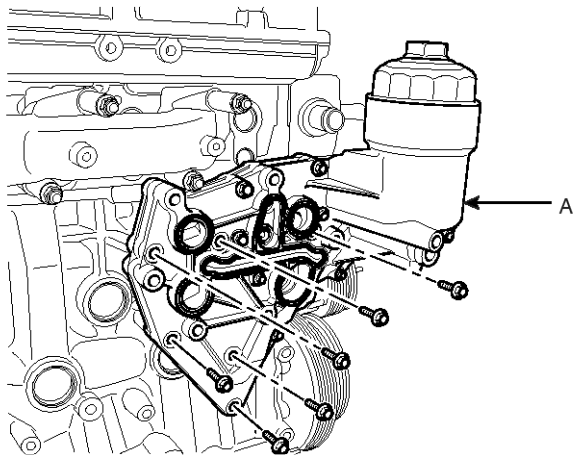
REMOVAL

1. Remove oil cooler (A) from housing assembly. .



SDGEM7101D

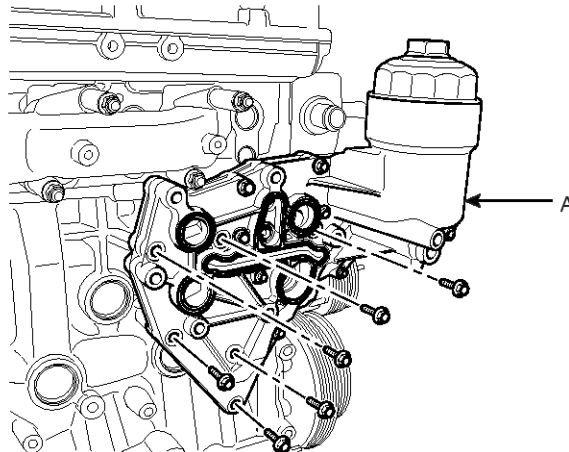
2. Remove oil filter assembly (A) from cylinder block.



SDGEM7102D

3. Replace with new O-ring and install oil filter assembly (A).

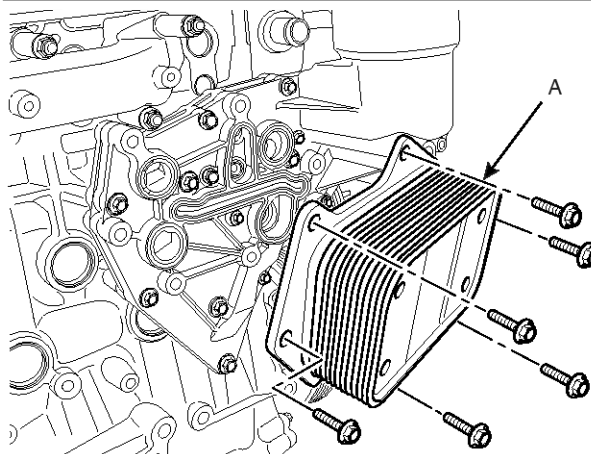
Oil filter assembly mounting bolt : 2.2~3.3 kgf.m (21.6~32.3 Nm, 16.7~ 23.8 lb-ft)



SDGEM7103D

4. Install oil cooler (A) to oil filter assembly.

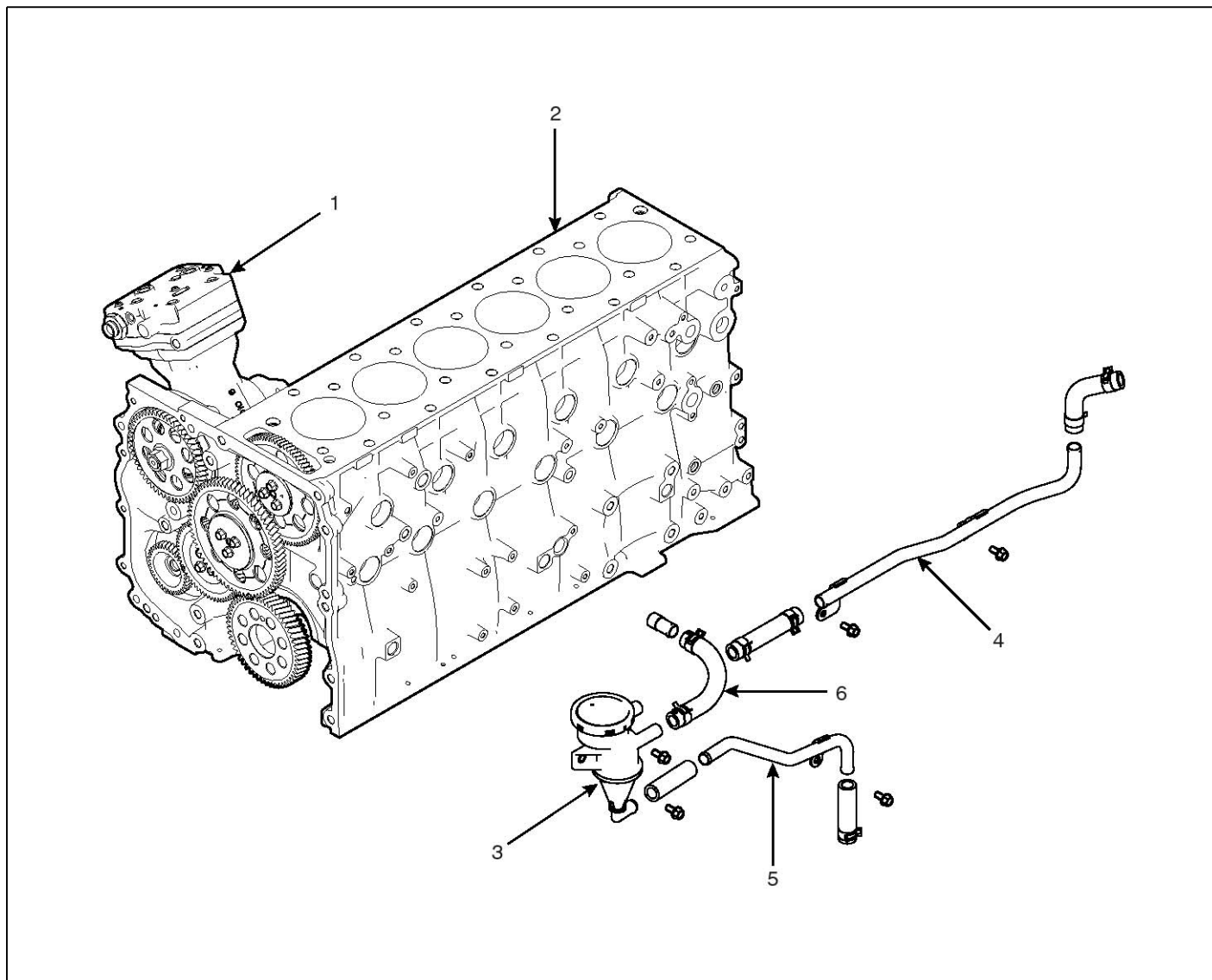
Oil cooler mounting bolt : 2.2~3.3 kgf.m(21.6~32.3 Nm, 16.7~ 23.8 lb-ft)



SDGEM7104D

Oil Separator

COMPONENTS



SDGEM9028L

1. Air compressor
2. Cylinder block
3. Oil separator
4. Breather pipe
5. Oil drain pipe
6. Blow-by hose

REPLACEMENT

1. Remove oil drain pipe connecting hose clamp.
2. Remove breather pipe.
3. Remove blow by hose and then oil separator.
4. Install it in the reverse order of removal.

Cooling System

GENERAL

COOLING SYSTEM

Water pump cools down the engine by circulating the coolant forcibly.

WATER PUMP

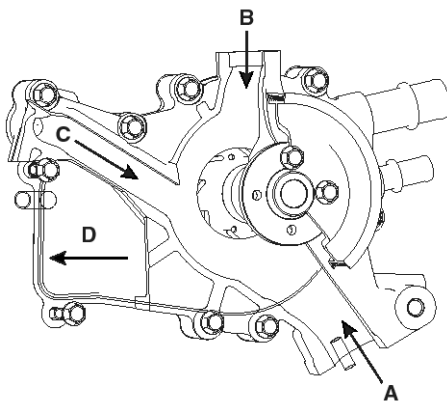
Water pump, a centrifugal type, is driven by the V-belt from the crankshaft pulley.

A unit seal between impeller and water pump is installed to prevent leakage of coolant.

There is a drain hole provided at the bottom of the water pump case, which prevents coolant from inflowing into bearing.

Water pump is mounted on the cylinder block.

An impeller, pressed fit into the one end of water pump shaft, has the combination blade which feeds coolant into the engine under pressure.



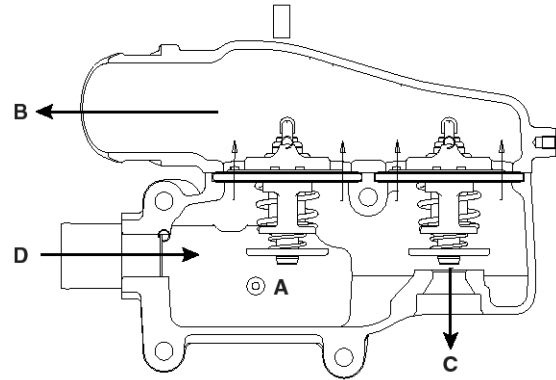
SDGEM9029L

- A : From radiator
- B : From thermostat
- C : From crank case(oil cooler)
- D : To crank case(water jacket)

THERMOSTAT

1. The thermostat, of a bottom bypass configuration, has a valve controlled by a special wax enclosed in a pellet.
2. The wax changes from solid to liquid as it is heated and controls coolant flow by changing its volume.

The change of valve position depending on the coolant temperature regulates the coolant flow amount inflowed into the radiator and water pump(bypass side), thus controlling coolant temperature.



SDGEM9030L

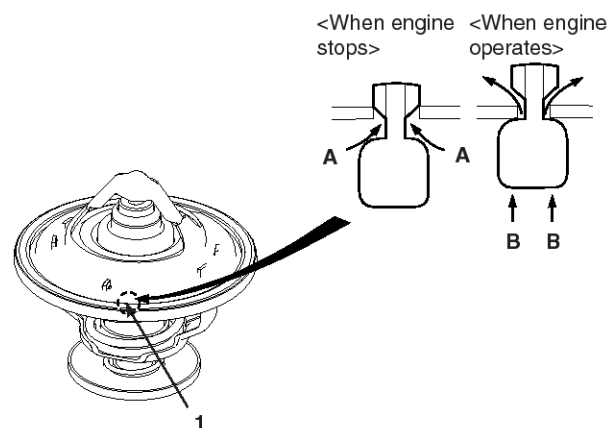
- A : From cylinder head
- B : To radiator
- C : To water pump
- D : From EGR cooler

3. A jiggle valve (1) is installed in the air plug hole of thermostat, which heats up the coolant temperature rapidly to reach the engine to the normal temperature.

When engine stops, the jiggle valve falls down by its weight. When coolant flows, air in the system is force-fed to radiator through the clearance between the jiggle valve and the air plug hole.

When engine starts, coolant flows into the radiator and jiggle valve is pushed up by the water pressure.

As a result, valve closes the air plug hole to prevent the coolant from leaking through the hole.



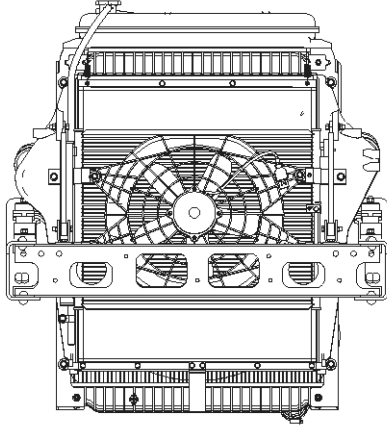
SDGEM9031L

- A : Air
- B : Water pressure

RADIATOR

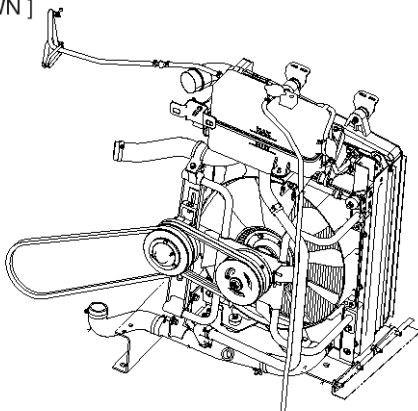
The radiator, which consists of tube and corrugated-fin type core, not only cools the engine coolant but also separates vapor from water and regulates pressure in the cooling system.

[HD120]



SDGEM9032L

[AEROTOWN]



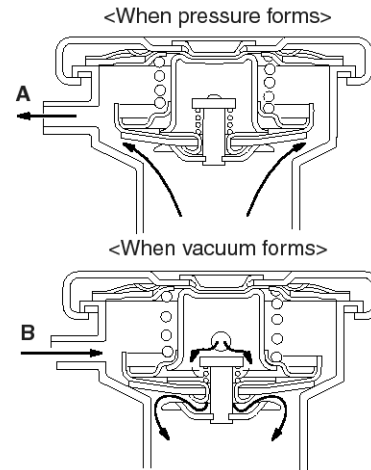
SDGEM9033L

RADIATOR CAP

Radiator cap regulates the pressure in the cooling system.

When the pressure exceeds the predetermined level, the pressure valve compresses the pressure spring to release the excessive pressure to the air.

When a vacuum in the radiator starts to form due to the coolant temperature drop, the vent valve opens to allow air into the radiator, thus preventing the radiator from being deformed by the vacuum.



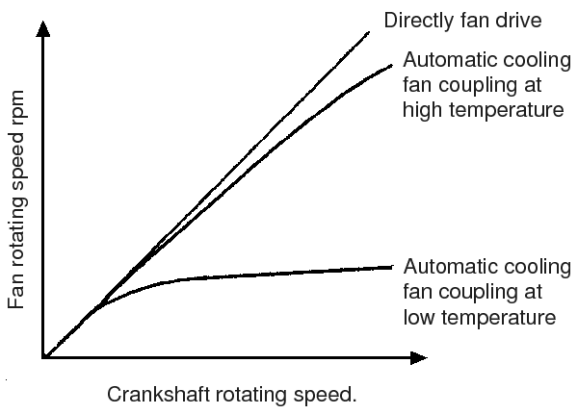
SDGEM9034L

A : To reservoir tank

B : From reservoir tank

COOLING FAN

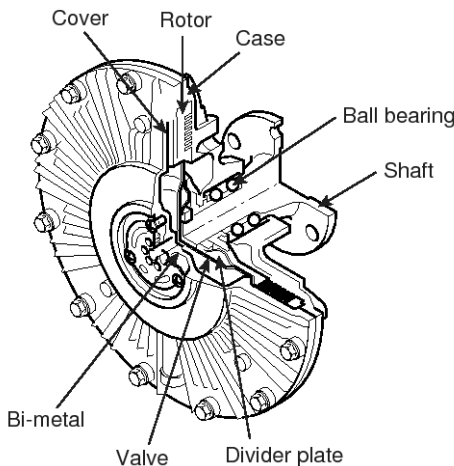
The viscous fan driver automatically adjusts the fan rotating speed based on the air temperature by passing through the radiator. The system contains the rotor that is driven by the engine crankshaft, the case that rotates around the rotor and supported by the shaft bearing, the divider plate separates the cover case inside into storage and operation chamber, and the bi-metal and valve that respond to the air temperature passed through the radiator. The fan is mounted on the case.



ECBEM5166A

The torque transfers from the shaft to the fan by viscous shearing stress of the silicone oil filled in the operation chamber.

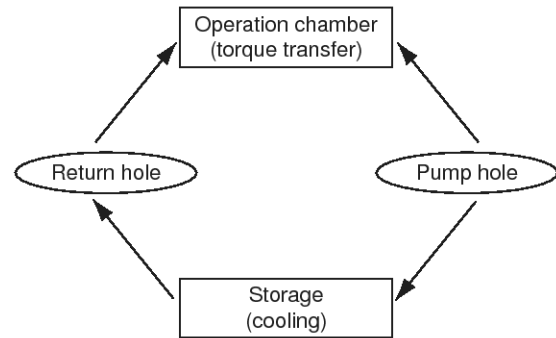
There is a small clearance between the rotor and the case in the operation chamber. Silicon oil transfers the rotation of the cover and the locker. The torque transfer varies depending on the transferred area structure, the silicone oil quantity and viscosity.



ECBEM5167A

Generally, useful viscosity of silicone oil is 100-20000cst(centistroke: viscosity).

The silicone oil circulates as shown in the illustration below. The clearance between the rotor and the cover makes the pump chamber.



ECBEM5168A

The silicone oil rotates with the rotor.

The oil driven into the pump chamber by centrifugal force collides with the protrusion at the cover and returns to the storage through the pump hole.

The silicone oil cooled in the storage moves through the return hole to the operation chamber by centrifugal force. The valve that opens or closes the return hole, which is located at the driver plate, regulates the silicone oil quantity related to the operation.

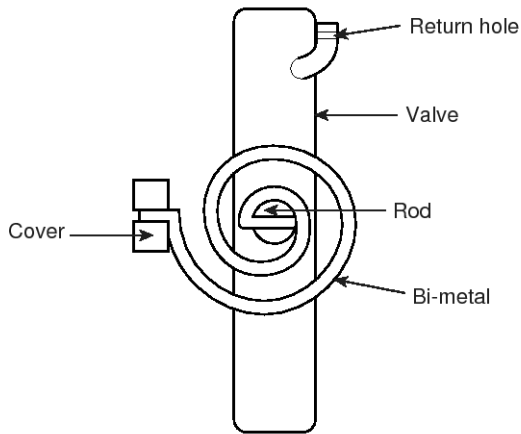
When the air temperature passing through the radiator is low, the return hole is kept close by the valve. Then the oil passed through the pump hole does not go to the operation chamber, but stays in the storage.

Therefore, silicone oil in the operation chamber decreases, and the cover and rotor slip to decrease the fan speed.

When the temperature goes up, the bi-metal operates to open the return hole.

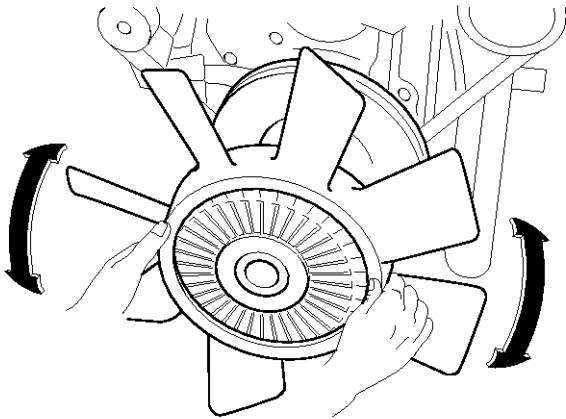
Then it increases the silicone oil in the operation chamber and reduces slip between the cover and the rotor to raise the fan speed.

The bimetal responds to the air temperature flowing through the radiator and is a spiral type. It moves sensitively in rotating direction by the temperature variation opening or closing the return hole.



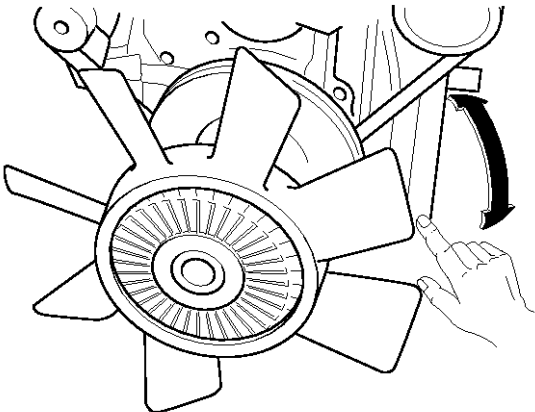
ECBEM5169A

- a. When the engine is cold, hold the fan mounting area and move it axially. If excessive run-out or play is found at the fan blade, it means that the ball bearing is damaged. Replace the auto cooling fan coupling.



ECBEM5170A

- b. Rotate the fan blade tip with fingers. If fan idling is out of service limit, replace the auto cooling fan coupling.

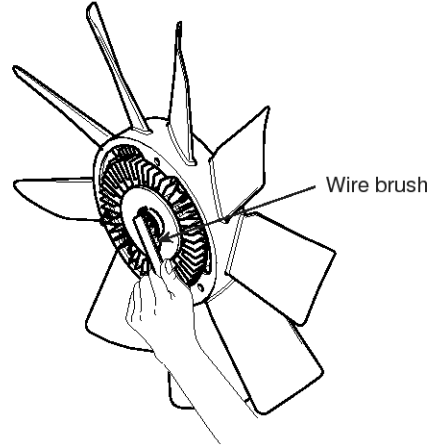


ECBEM5171A

- c. If the bi-metal is contaminated with dust or dirt, clean it completely using a wire brush.

NOTICE

Removing dust or dirt, be careful not to apply abnormal force on the bi-metal.



ECBEM5172A

SPECIFICATIONS

Items		Specification
Cooling method		Water cooling forced circulation
Coolant quantity		20ℓ
Water pump	Type	Volute
	Drive	V-ribbed belt
V-belt	Number of belts	One V-ribbed belt (HD120) Two V-ribbed belts(Aerotown)
Thermostat	Type	Wax pellet, Bottom bypass(Jiggle valve)
	Valve opening temp.	82°C
Fan	Type	Nylon + GF30%, Suction
Auto cooling fan coupling	Type	Fluid coupling(Viscosity)
	Hydraulic oil	Silicone oil
Radiator	Type	Corrugated fin, pressure
	Cap type	Pressure

SERVICE STANDARD

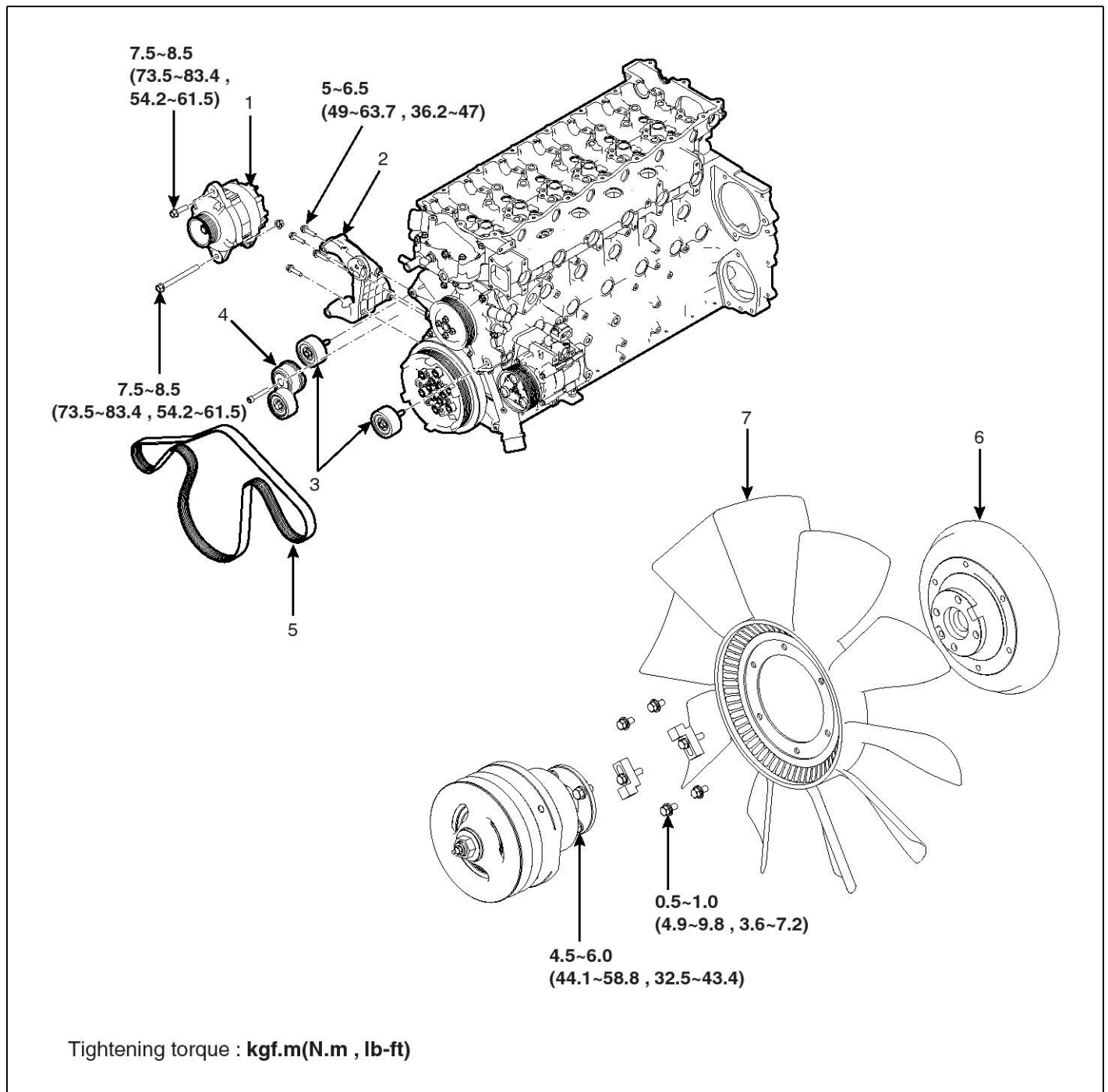
Items			Specification		
			Normal value([] indicates base diameter)	Limit	Remedy
Fan rotation (Auto cooling fan coupling)			-		
Water pump	Mounting dimension between impeller and pump case		2.7~3.3mm		Replace
Thermostat	Valve opening temp.		80~84℃		Replace
	Valve lift / temp.		Above 10mm / 100℃		Replace
Radiator	Opening pressure of radiator cap	Normal	0.7 bar		Replace
		Negative pressure	0.1 bar		Repalce
	Radiator inspection pressure		1.5 bar		Replace
Reservoir tank inner pressure			0.5 kg/mm²		Replace

TROUBLESHOOTING

Symptom	Possible cause	Remedy	Remarks	
Overheat	Defective V-belt Poor tension	Adjust tension. Replace if necessary.		
	Broken belt	Replace.		
	Clogged cooling system	Clean.		
	Defective thermostat	Replace.		
	Defective water pump Looseness between water pump shaft and flange	Replace.		
	Looseness between water pump shaft and impeller			
	Damaged impeller			
	Poor clearance between impeller and case			
	Clogged radiator fins	Clean.		
	Defective auto cooling fan coupling	Replace.		
	Defective auto cooling fan coupling proper			
	Clogged bi-metal	Clean.		
	Defective cooling fan	Replace.		
	Insufficient coolant	Refill.		
Overcool	Defective thermostat	Replace.		
Quick loss of coolant	Defective radiator hose Loose hose connection	Retighten.		
	Damaged or cracked hose	Replace.		
	Defective radiator Radiator proper not tight	Replace.		
	Pressure cap not tight			
	Defective water pump Defective unit seal	Replace.		
	Defective oil seal			
	Pump mounted improperly(Defective gasket)			
	Defective oil cooler	Replace.		Lubrication
	Thermostat case mounted improperly(Defectivegasket)	Replace gasket.		
	Defective heater hose Loose hose connection	Retighten.		
	Cracked or damaged hose	Replace.		
	Defective cylinder head gasket	Replace.		Engine
	Defective EGR system Defective EGR cooler	Replace.		
	Loose EGR connection or hose connection	Retighten.		

Cooling fan

COMPONENTS



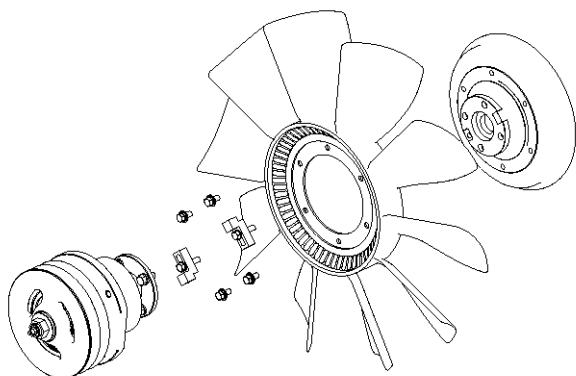
SDGEM9074L

1. Alternator
2. Alternator bracket
3. Idler pulley
4. Auto tensioner

5. V-ribbed belt
6. Fan clutch assembly
7. Cooling fan

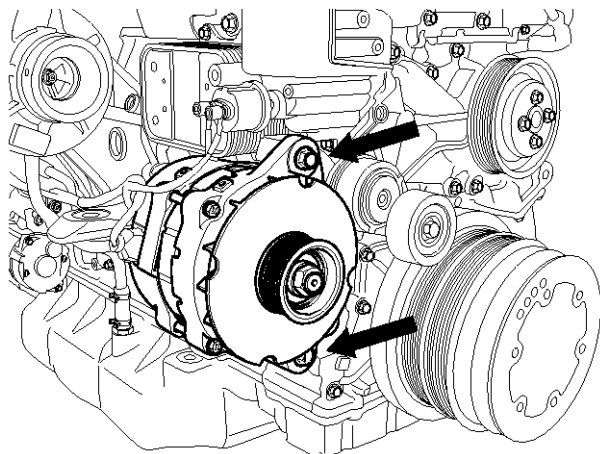
REMOVAL

1. Remove the cooling fan and the cooling clutch



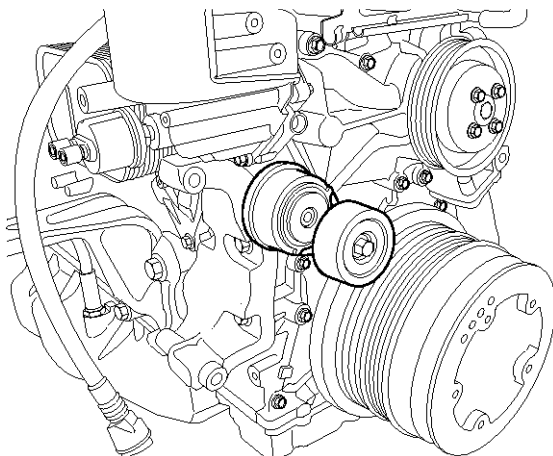
SDGEM9075L

2. Remove alternator.



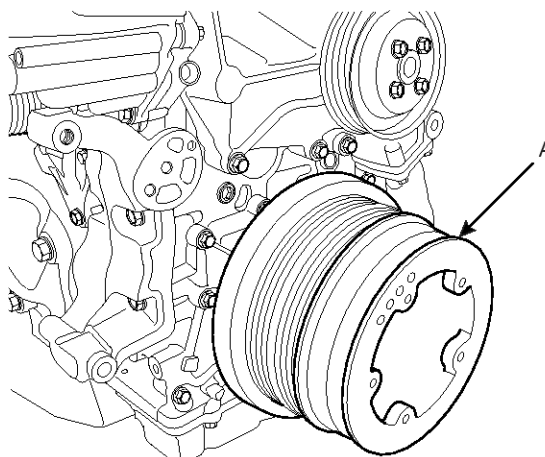
SDGEM7113D

3. Remove idler and auto tensioner.



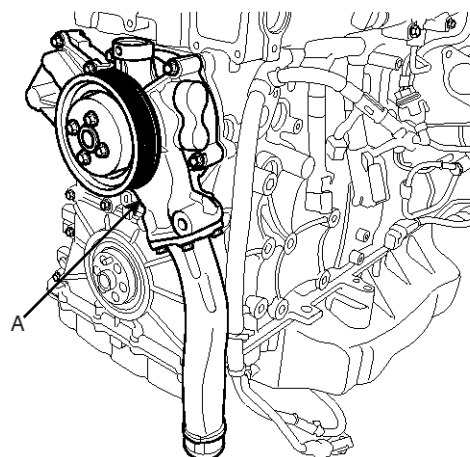
SDGEM7555D

4. Remove crankshaft pulley assembly (A).



SDGEM7554D

5. Remove water pump assembly (A).

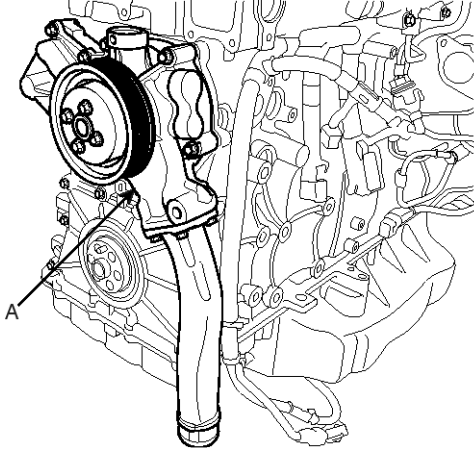


SDGEM7115D

INSTALLATION

1. Install water pump assembly (A).

Water pump assembly mounting bolt : 2.2~3.3 kgf.m
(21.6~32.4 N.m, 15.9~23.9 lb-ft)



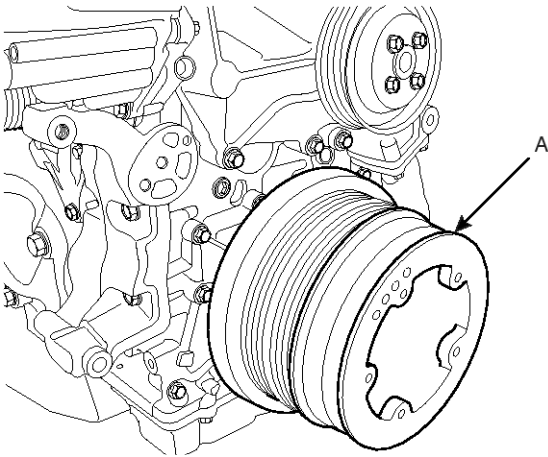
SDGEM7116D

2. Install crankshaft pulley assembly (A).

Crankshaft pulley bolt : 10 kgf.m(98.1 N.m, 72.3 lb-ft) + 80°

CAUTION

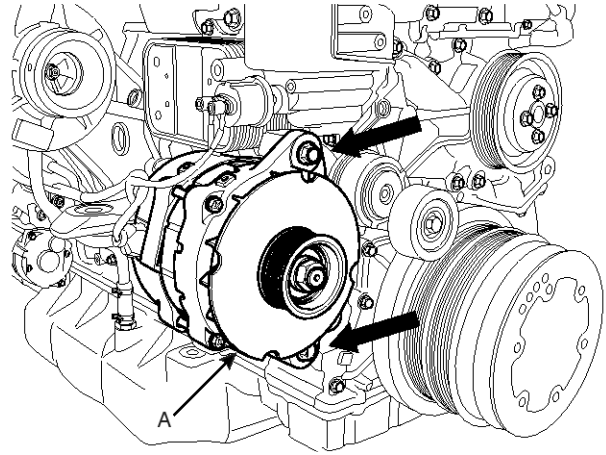
Never reuse crankshaft pulley.



SDGEM7554D

3. Install alternator (A).

Alternator mounting bolt(upper, lower) : 7.5~8.5 kgf.m(73.5~83.4 Nm, 54.2~ 61.5 lb.ft)

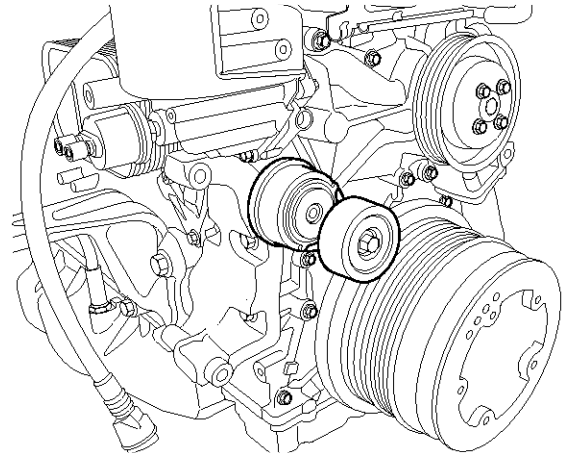


SDGEM7118D

4. Install idler and auto tensioner.

Auto tensioner mounting bolt : 5~6 kgf.m(49~58.8 Nm, 36.2~43.4 lb.ft)

Idler pulley mounting bolt : 4~5 kgf.m(39.2~49 Nm, 28.9~36.2 lb.ft)



SDGEM7555D

5. Install belt and adjust tension of belt by tightening auto tensioner.

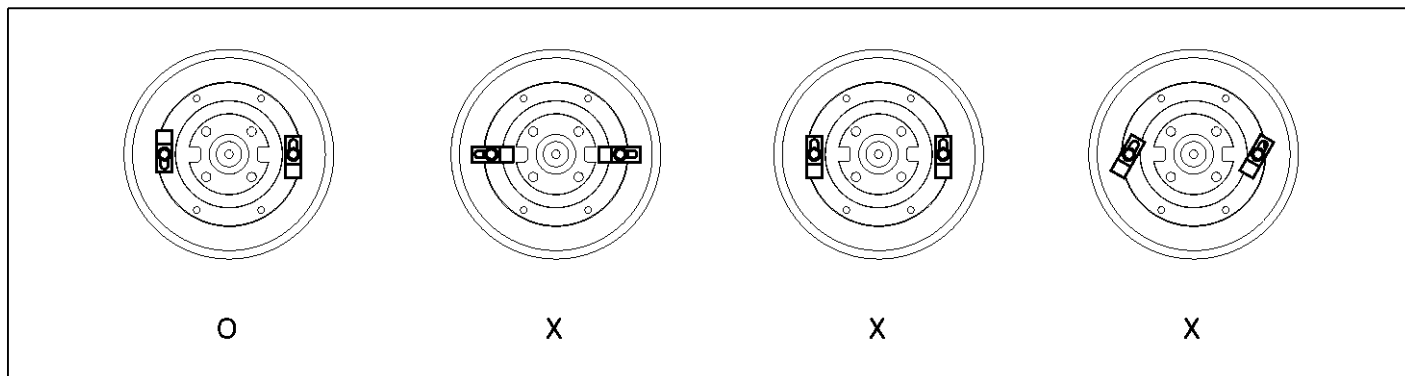
- a. Install belt in the sequence of alternator, idler pulley, water pump and crankshaft pulley.
- b. Install socket wrench to tensioner pulley bolt. And turn it clockwise and install belt to tensioner.

CAUTION

1. After installing the belt, check if the groove of the each pulley contacts with that of the belt except tensioner and idler pulley.
2. Check if the flat surface of tensioner and idler pulley contacts with that of belt.

Inspection

1. Fix the bolt as below picture for releasing lock function when assembling the lock key.



SDGEM7800D

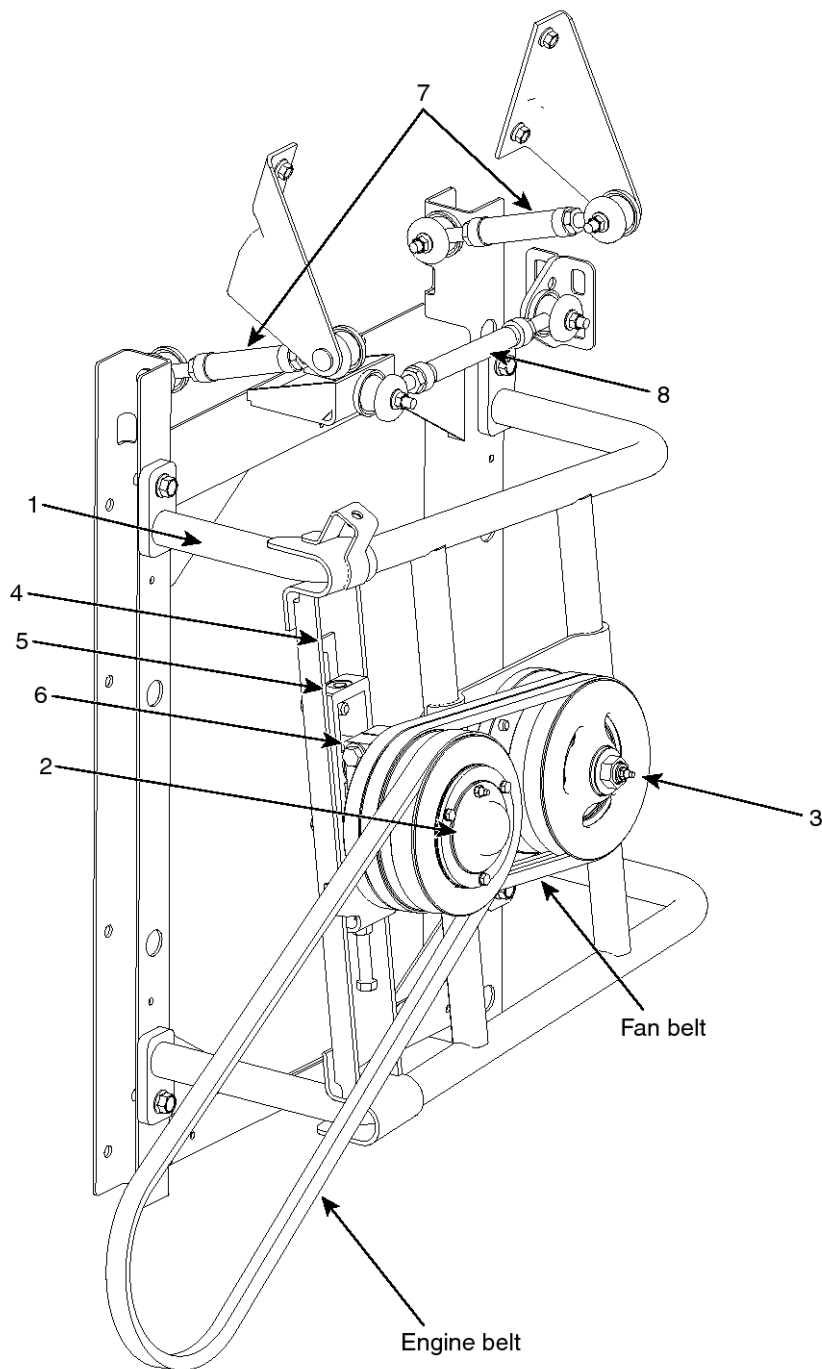
CAUTION

Assembling method allows for balance weight.

If you don't assemble it like as above procedure, when releasing the lock function, the lock key should be interference with the fan or pulley shaft.

Adjustment

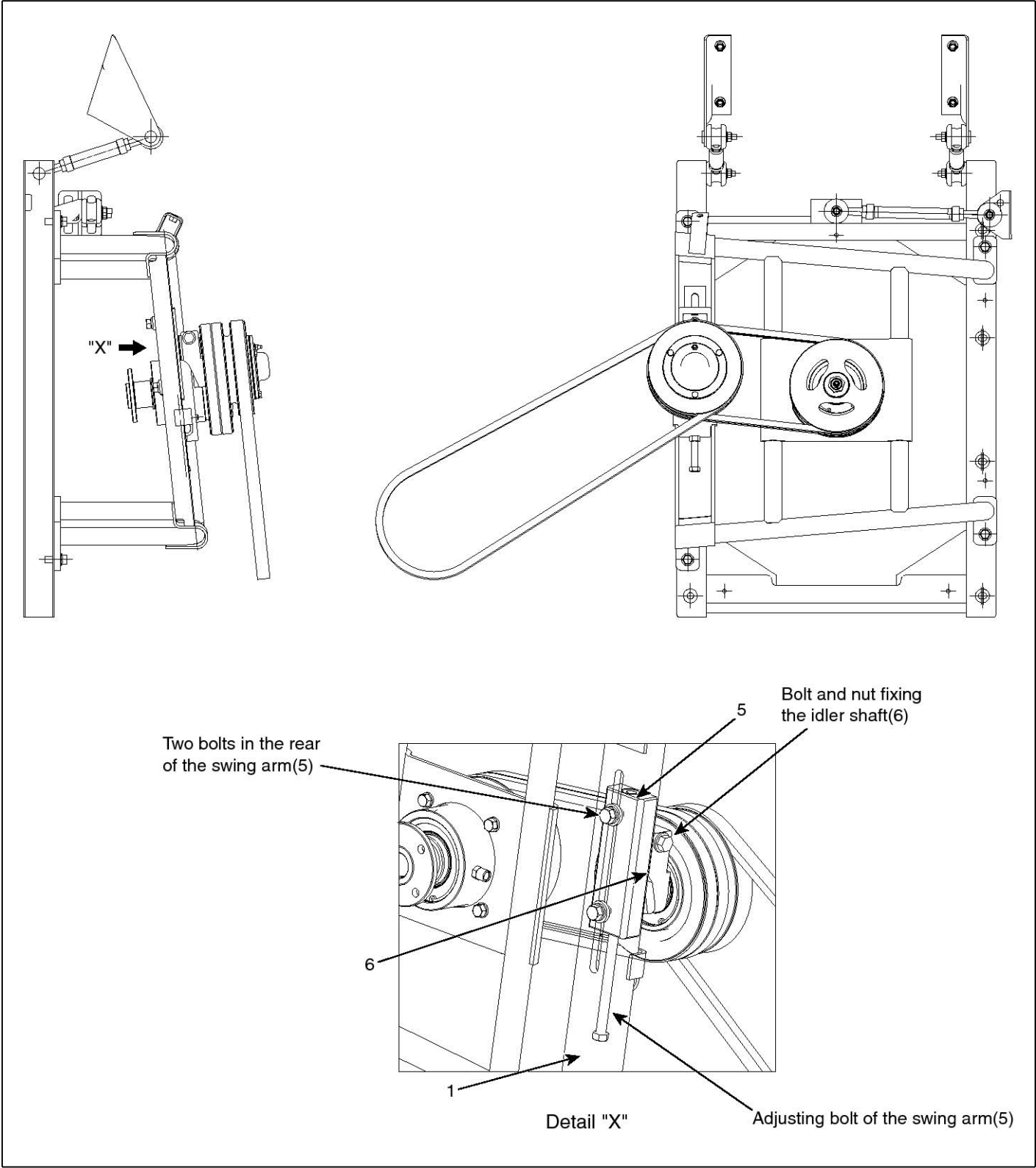
1. Component location



SDGEM9069L

- 1. Support fan drive
- 2. Idler pulley
- 3. Fan pulley
- 4. Holder

- 5. Swing arm
- 6. Idler shaft
- 7. Adjusting rod(2 EA)
- 8. Adjusting rod(Side)



2. How to adjust belt tension

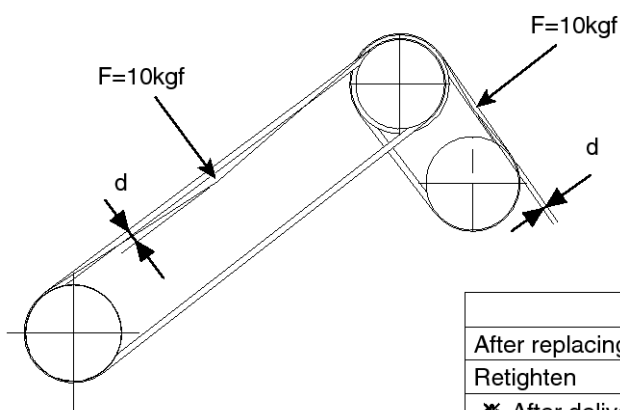
- 1) Loosen bolt and nut fixing the idler shaft(6).
- 2) Loosen two fixing bolts(installed in the support fan drive) in the rear of the swing arm (5).
- 3) Lower the idler pulley(2), the swing arm(5) and the idler shaft(6) as the assembly after loosening the upper two nuts of swing arm(5).
- 4) Install fan belt and engine drive belt.
- 5) Tighten two nuts in the upper of the swing arm(5).
(The idler pulley(2), the swing arm(5) and the idler shaft(6) will be raised as the assembly.)
- 6) Repeat the above procedure 5 until the specified tension is applied to the fan belt and the engine drive belt.
- 7) Tighten the two bolts in the rear of the swing arm(5) completely after confirming the specified tension.
- 8) Tighten the bolt and the nut of the idler shaft(6) completely.

⚠ CAUTION

1. If the above procedure 1 is skipped when replacing belt or re-adjusting tension, the tension is adjustable for the engine drive belt not for fan belt.
2. Be sure to check the above procedure 7 and 8 after replacing the belt.

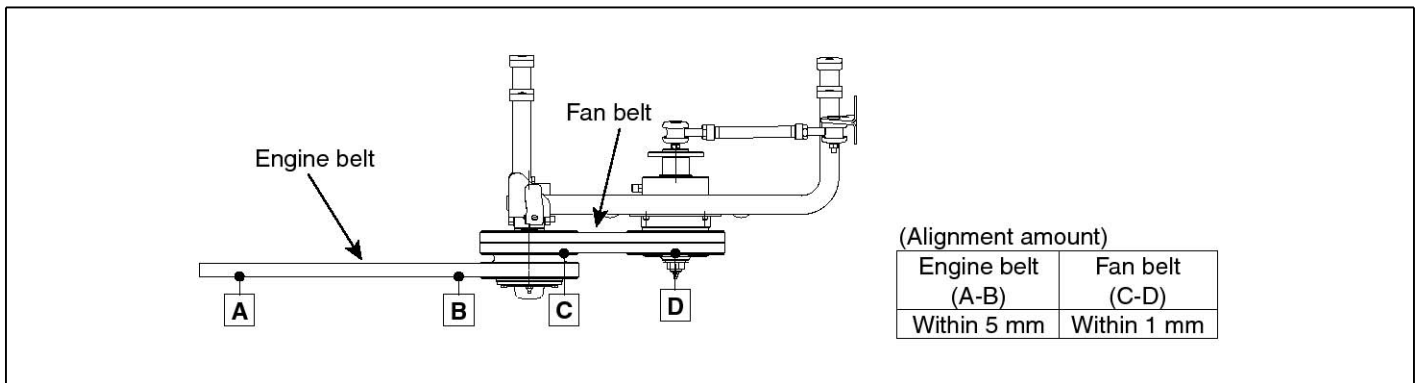
3. How to check the appropriate belt tension

The deflection of belt should be met within the specified amount when pressing the center part of belt with force of 10kgf.



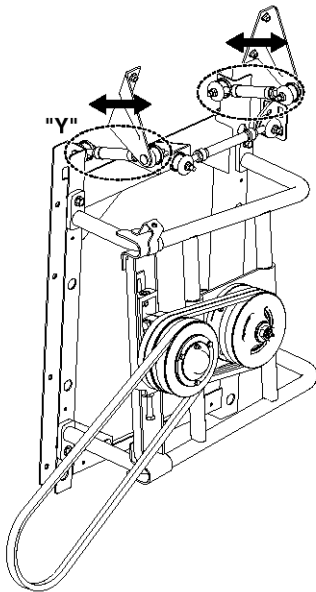
		Fan belt	Engine belt
After replacing the belt(First time)	Deflection(d)	8~12mm	15~25mm
Retighten	Deflection(d)	14~18mm	30~40mm
※ After delivering(or replacing the belt), adjust the belt since driving for 500 km.			

4. Alignment amount of belt



SDGEM9072L

5. How to adjust the alignment amount of belt



SDGEM7805D

Using the two adjusting rods(7) on "Y" part

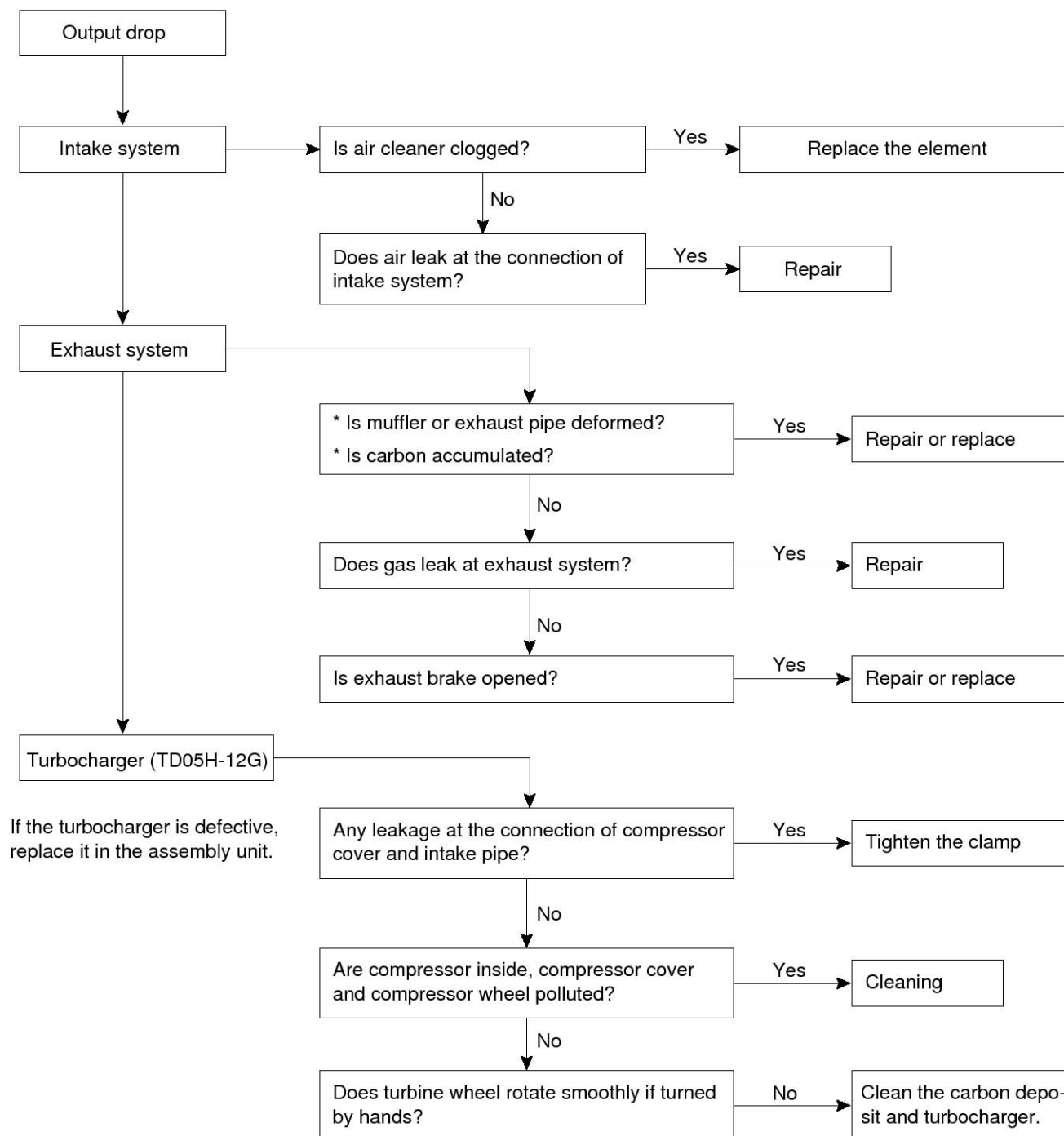
- 1) Extend or lessen the length of rod.
 If the length of rod is extended, the fan pulley moves forward of vehicle.
 If the length of rod is lessened, the fan pulley moves rearward of vehicle.
- 2) Adjust the alignment of engine belt basis on the engine pulley like as procedure "1)".

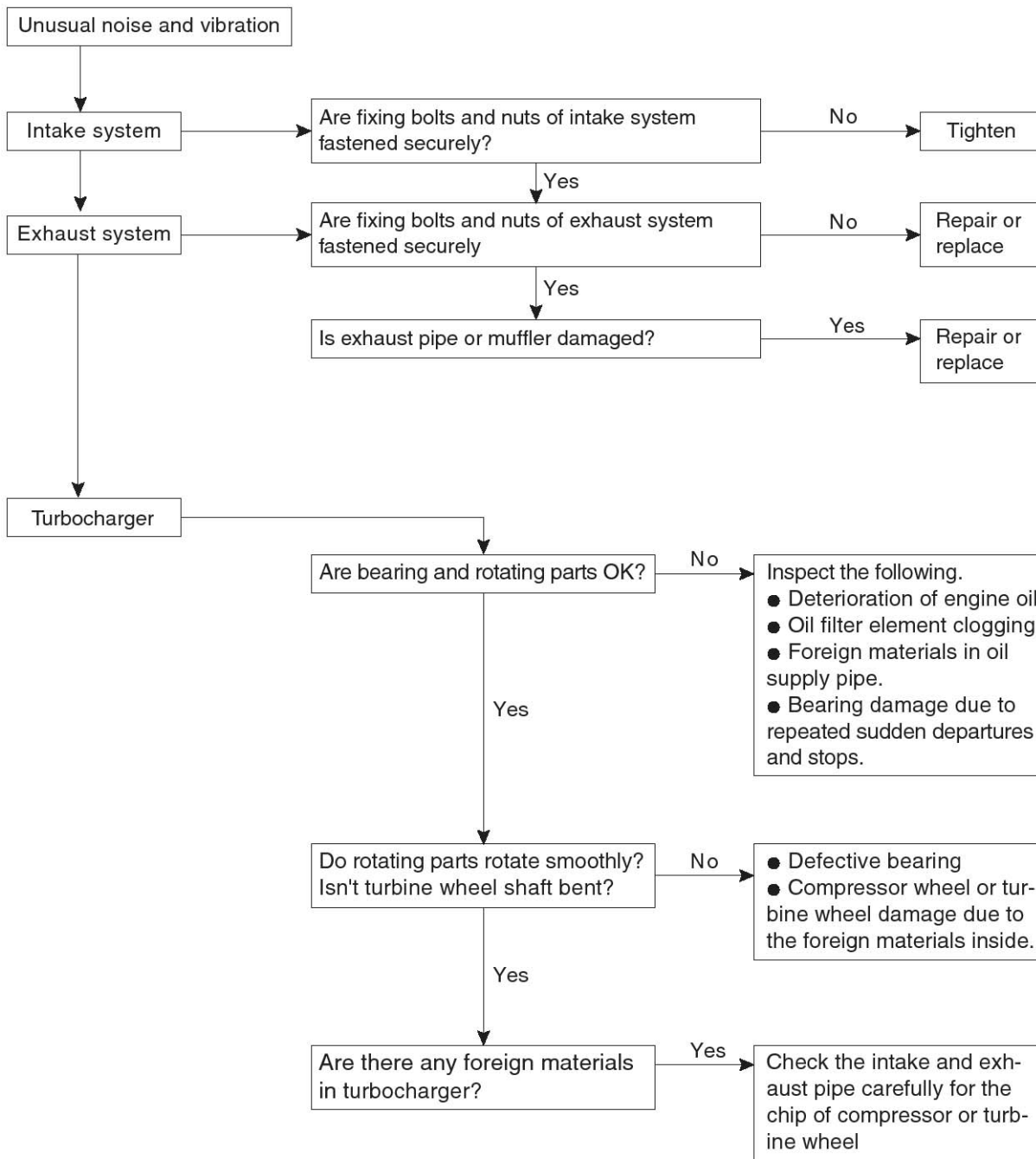
Intake And Exhaust System

SPECIFICATIONS

Type		Specification
Air cleaner type		Dry type
Element type		Paper type
Intercooler	Type	Turbocharger (TE06H-20KX3RC-5 ²)
	Length	274mm
	Width	254mm
	Height	245mm
	Max. rpm allowed	132,000rpm
	Max. pressure ratio	3.2
	Max. exhaust gas temp.	760°C

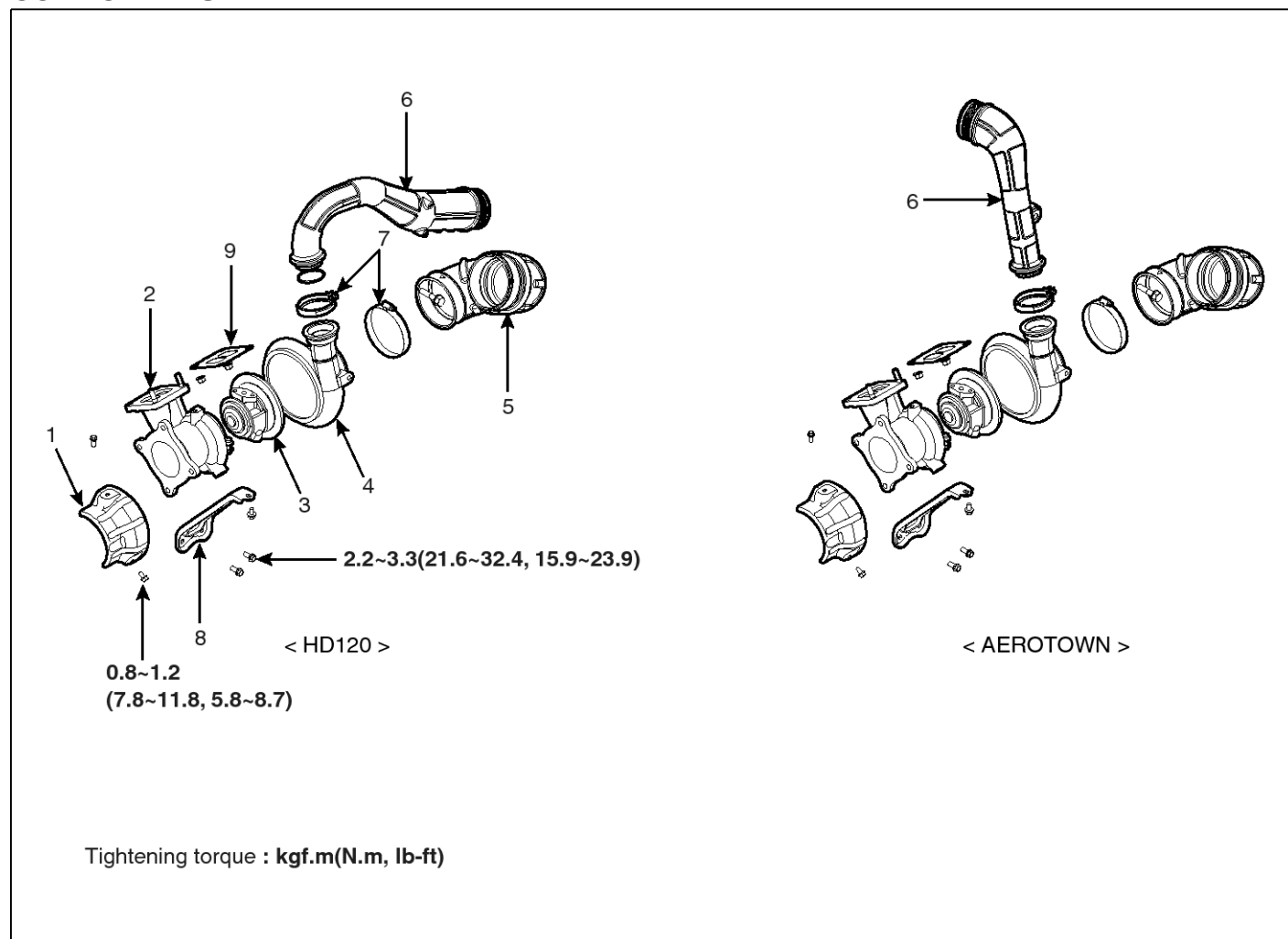
TROUBLESHOOTING





Turbo Charger

COMPONENTS



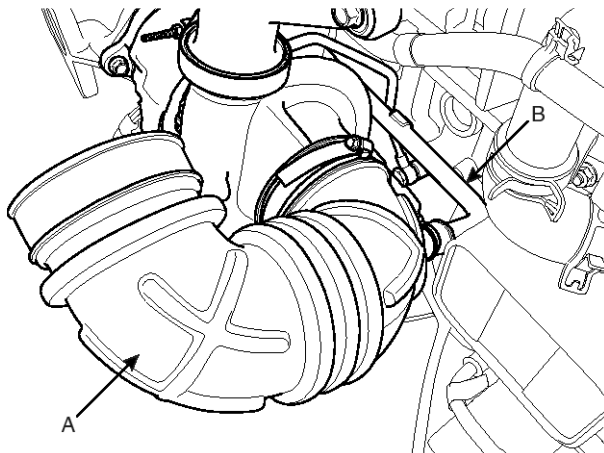
SDGEM9037L

1. Turbocharger insulator
2. Turbine housing
3. Cartridge
4. Compressor housing
5. Elbow hose

6. Compressor out coupler assembly
7. Clamp
8. Turbocharger support bracket
9. Turbocharger gasket

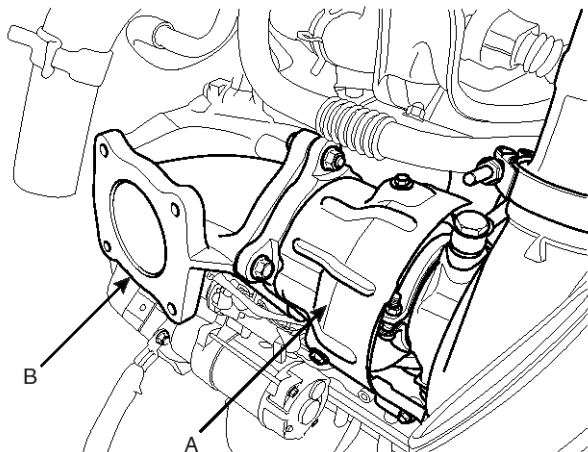
REMOVAL

1. Remove clamp and then remove turbocharger elbow hose (A).
2. Remove oil separator hose (B).



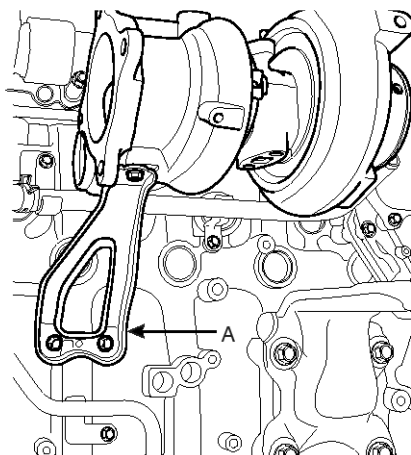
SDGEM7123D

3. Remove insulator (A) and then remove exhaust coupler (B).



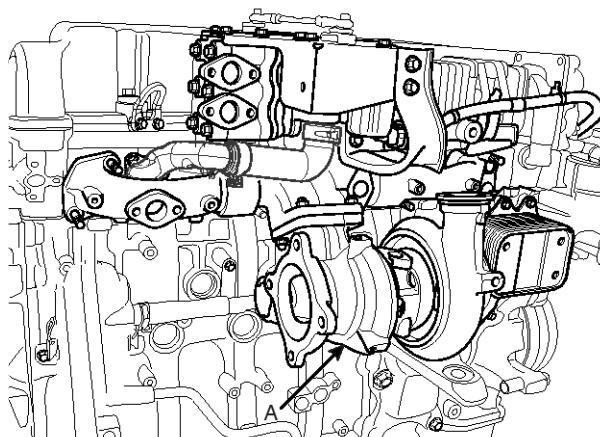
SDGEM7124D

4. Remove turbocharger support bracket (A).



SDGEM7125D

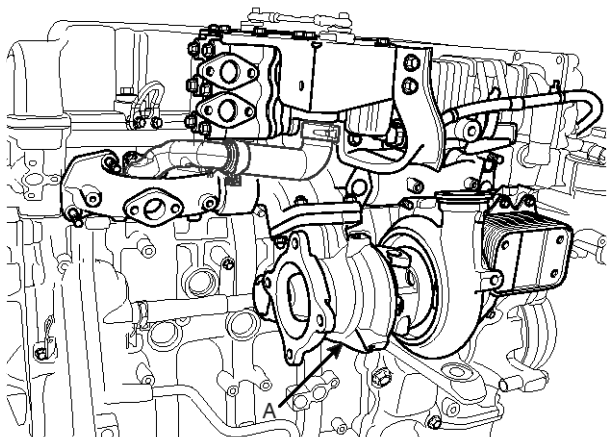
5. Remove turbocharger assembly (A).



SDGEM7126D

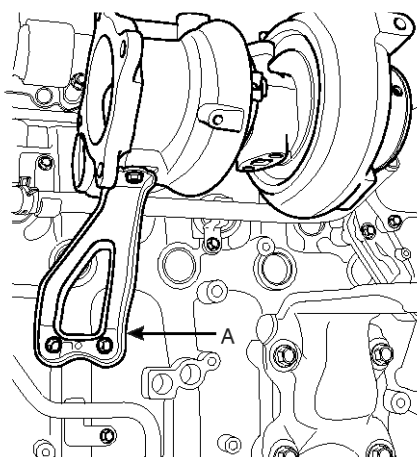
INSTALLATION

1. Install turbocharger assembly (A) to exhaust manifold.



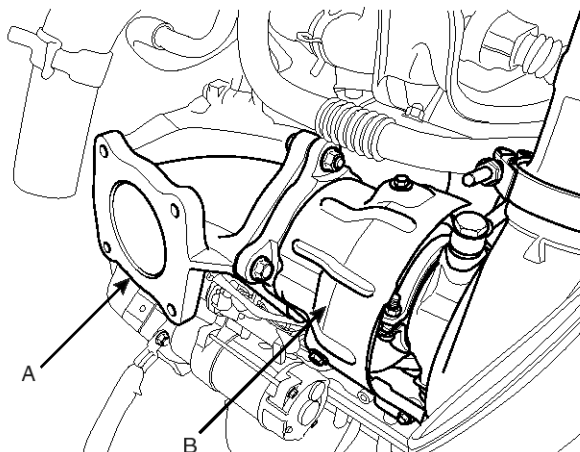
SDGEM7126D

2. Install turbocharger assembly support bracket (A).



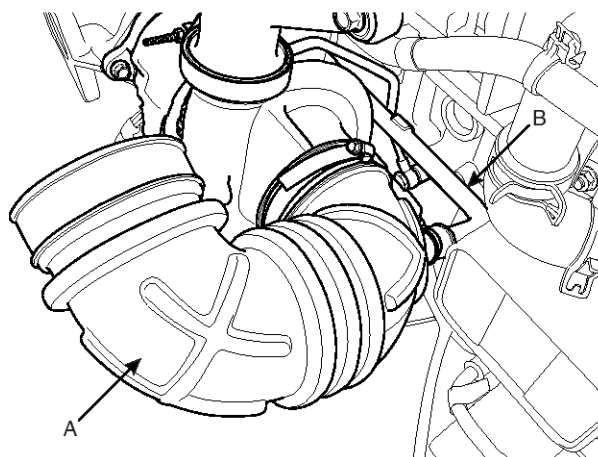
SDGEM7125D

3. Install exhaust coupler (A) and then install insulator (B).



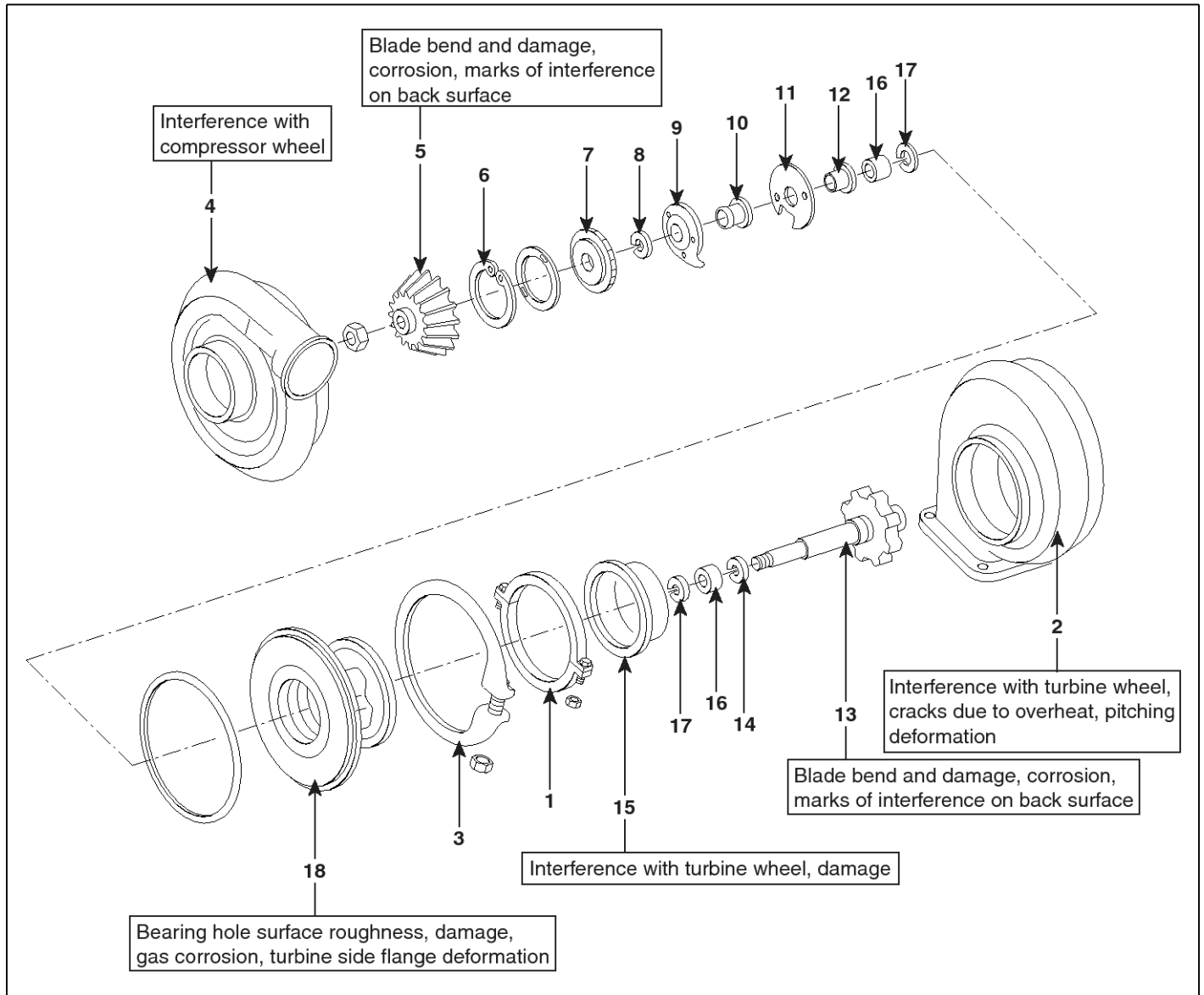
SDGEM7589D

4. Install elbow hose (A) and then tighten clamp.
5. Install oil separator hose (B).



SDGEM7123D

DISASSEMBLY



SDGEM9038L

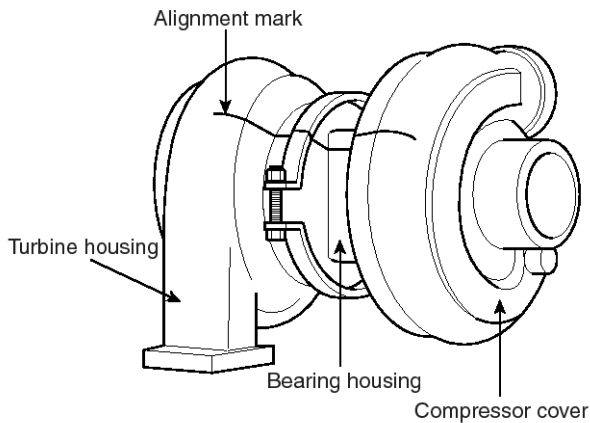
<Disassembly sequence>

- | | | |
|-----------------------|--------------------|-----------------------------|
| 1. Coupling assembly | 6. Snap ring | 12. Shaft and turbine wheel |
| 2. Turbine housing | 7. Insert | 13. Piston ring |
| 3. Snap ring assembly | 8. Piston ring | 14. Turbine back plate |
| 4. Compressor cover | 9. Oil deflector | 15. Bearing |
| 5. Compressor wheel | 10. Thrust bearing | 16. Snap ring |
| | 11. Thrust ring | 17. Bearing housing |

* For parts with No. 2, 4, 7, refer to disassembly sequence that follows

DISASSEMBLY PROCEDURE

1. Before disassembling turbocharger, make an aligning mark on compressor cover bearing housing and turbine housing. Use the marks when reassembling.



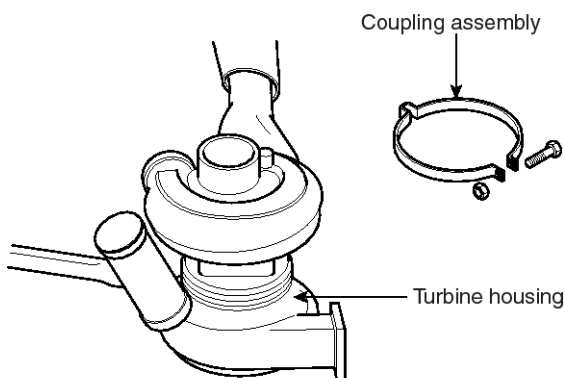
SDGEM9039L

2. Removal of turbine housing

Loosen coupling assembly and separate housing by lightly tapping housing with a plastic hammer or the like.

CAUTION

Since turbine wheel blade is easily bent, exercise care not to damage when removing housing.



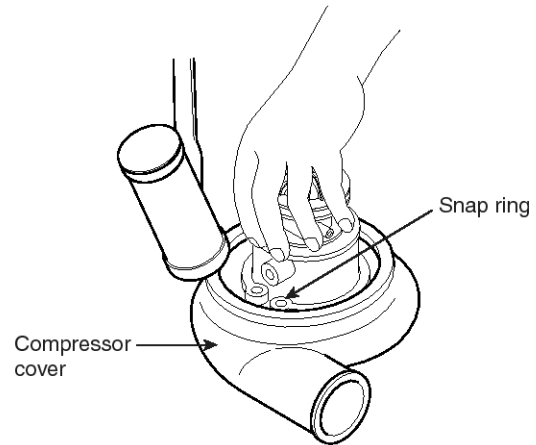
SDGEM9040L

3. Removal of compressor

Loosen snap ring and separate compressor cover by lightly tapping it with a plastic hammer or the like.

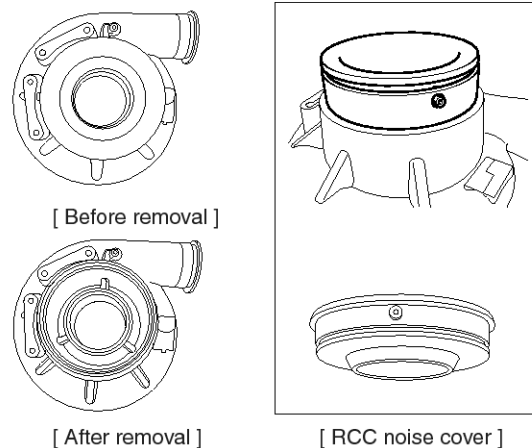
CAUTION

Since turbine wheel blade is easily bent, exercise care not to damage when removing compressor cover.



SDGEM9041L

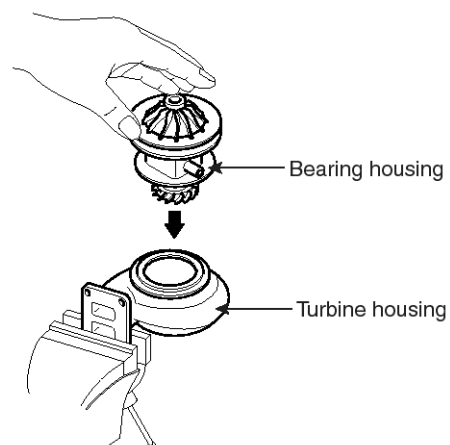
4. Remove RCC(recirculation cover) noise protector cover.



SDGEM9042L

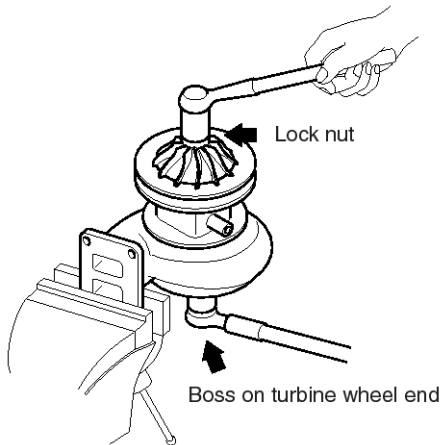
5. Removal of compressor wheel

- 1) Place turbine housing in a vise and insert bearing housing into housing.



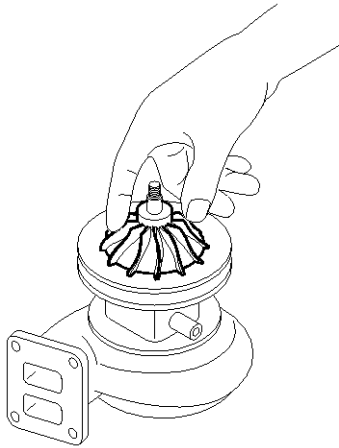
SDGEM9043L

- 2) Secure shaft and turbine wheel boss and loosen lock nut securing compressor wheel.



SDGEM9044L

- 3) Disconnect compressor wheel.



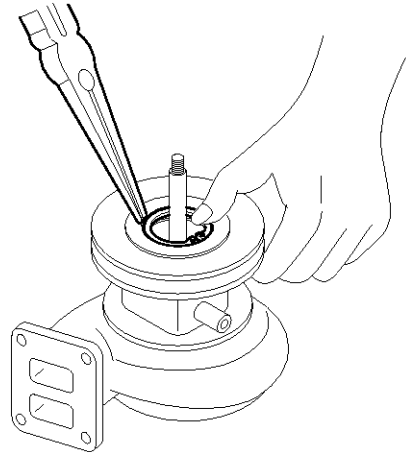
K5TEM4198A

6. Removal of insert

- 1) Disconnect snap ring.

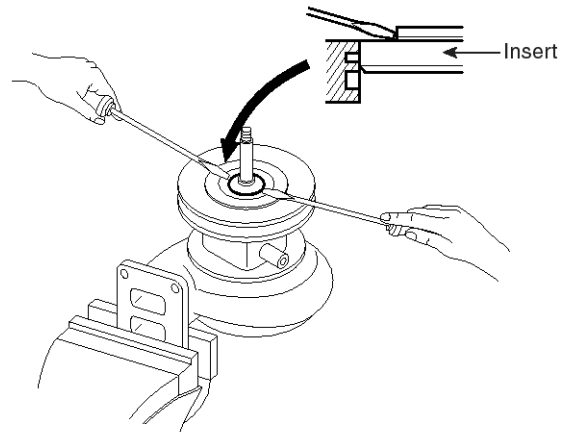
CAUTION

Be careful not to pop snap ring out from a plier.



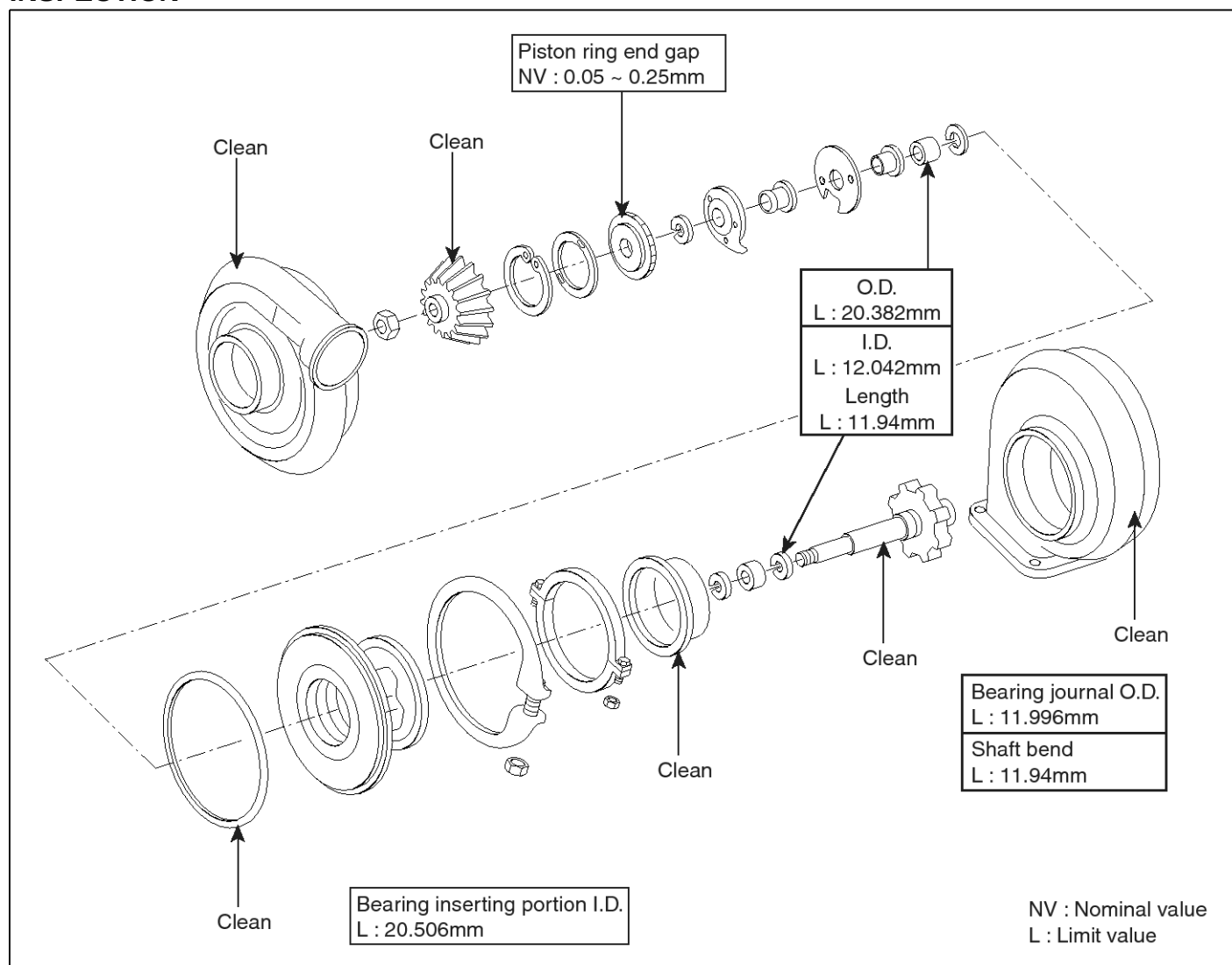
K5TEM4199A

- 2) Separate insert from bearing housing by inserting the end of a screwdriver into the groove of insert.



SDGEM9045L

INSPECTION

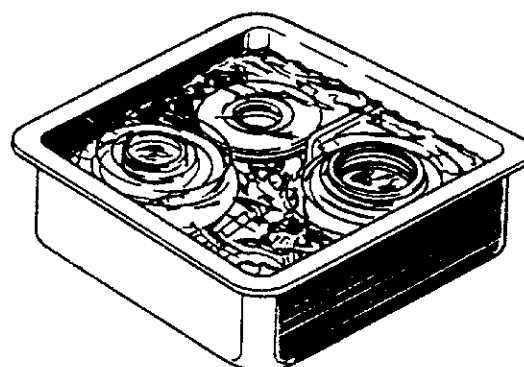


SDGEM9046L

CLEANING

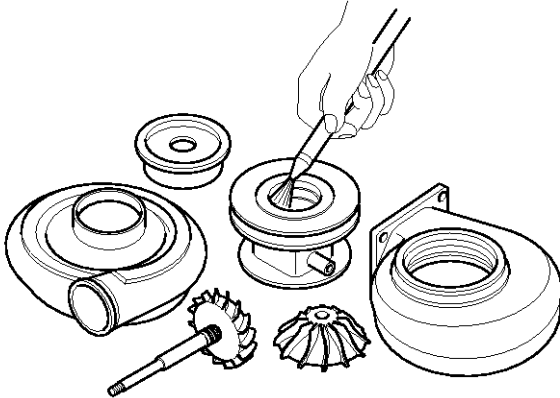
When cleaning parts by using detergents, wash cleanly so that any parts are not contaminated.

1. After cleaning, as it is difficult to check whether each part is defected or not, check each part for wear, crack or other defects prior to washing.
2. Fill the container for cleaning with inflammable solvent (Daido Kagaku Kogyo's Dai Cleaner T-30) and soak the parts completely.



K5TEM4202A

- Clean the inside and outside of the surface by using compressed air.

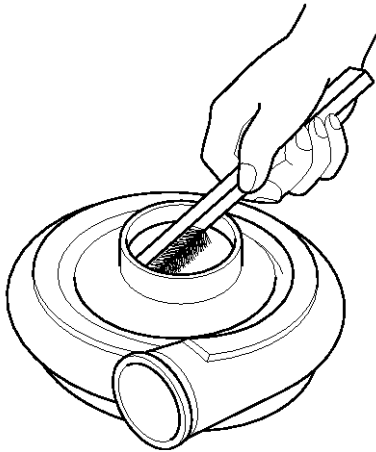


K5TEM4203A

- Wipe out dirt, using plastic scraper or hard brush.

CAUTION

Be careful not to damage any parts.

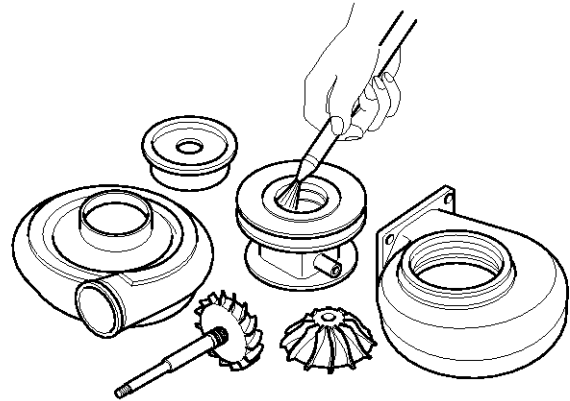


K5TEM4204A

- Clean the inside and outside of the surface by using compressed air.

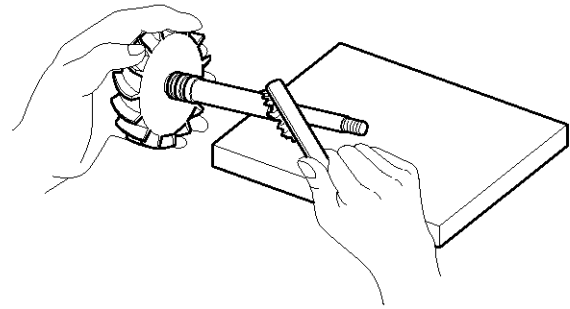
CAUTION

After finishing No. 4, soak the bearing housing and turbine wheel shaft into inflammable detergents. Remove the dirt, then blow the compressed air out.



K5TEM4203A

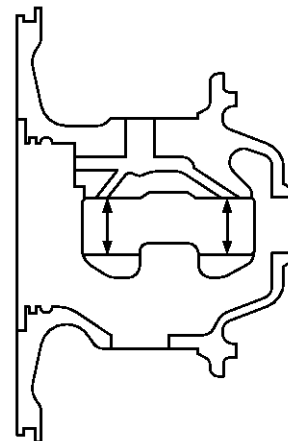
- Apply the engine oil to the back plate shaft of the inside and outside of the bearing housing, and the turbine wheel to prevent corrosion.



K5TEM4205A

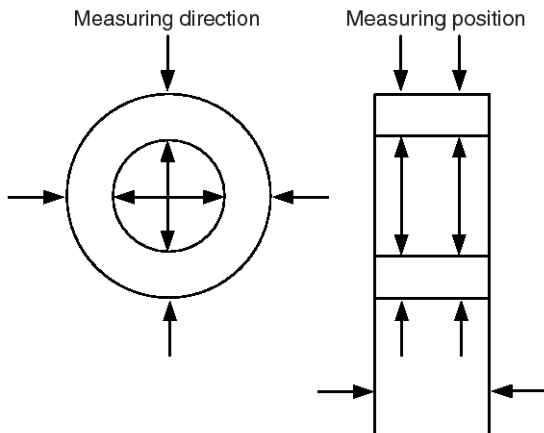
INSPECTION

- When the diameter of bearing hole is out of limits, replace the bearing housing.



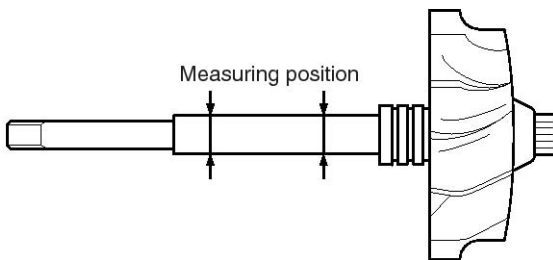
K5TEM4206A

2. Measure the I.D., O.D. and length of the bearing, and if they exceed service limits, replace the bearing.



SDGEM9047L

3. Measure the diameter of shaft and turbine wheel journal, and if they exceed service limits, replace shaft and turbine wheel.

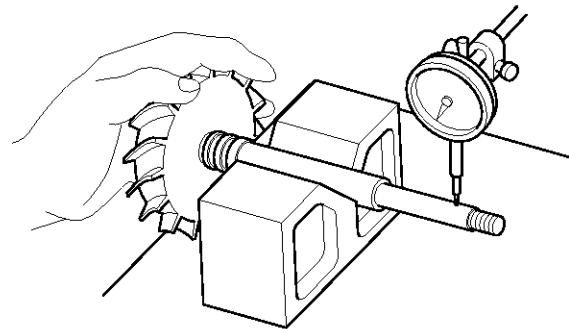


SDGEM9048L

4. Set the dial gauge to shaft screw, and measure the bending, and if the value exceeds service limit, replace shaft and turbine wheel.

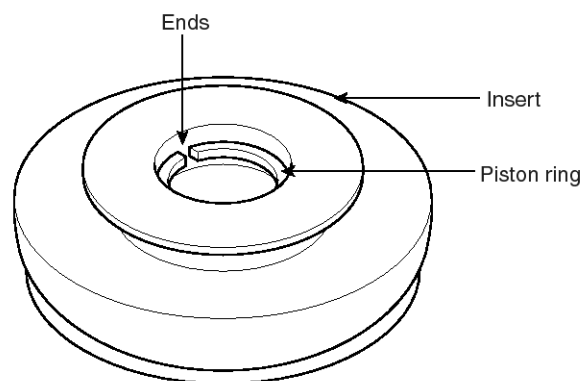
CAUTION

- Do not correct the deformed shaft but replace it.
- If the shaft journal is rough, place the smaller diameter part in the lathe chuck, and grind by applying oil to #400 sandpaper, with the spindle speed at 300~600rpm.



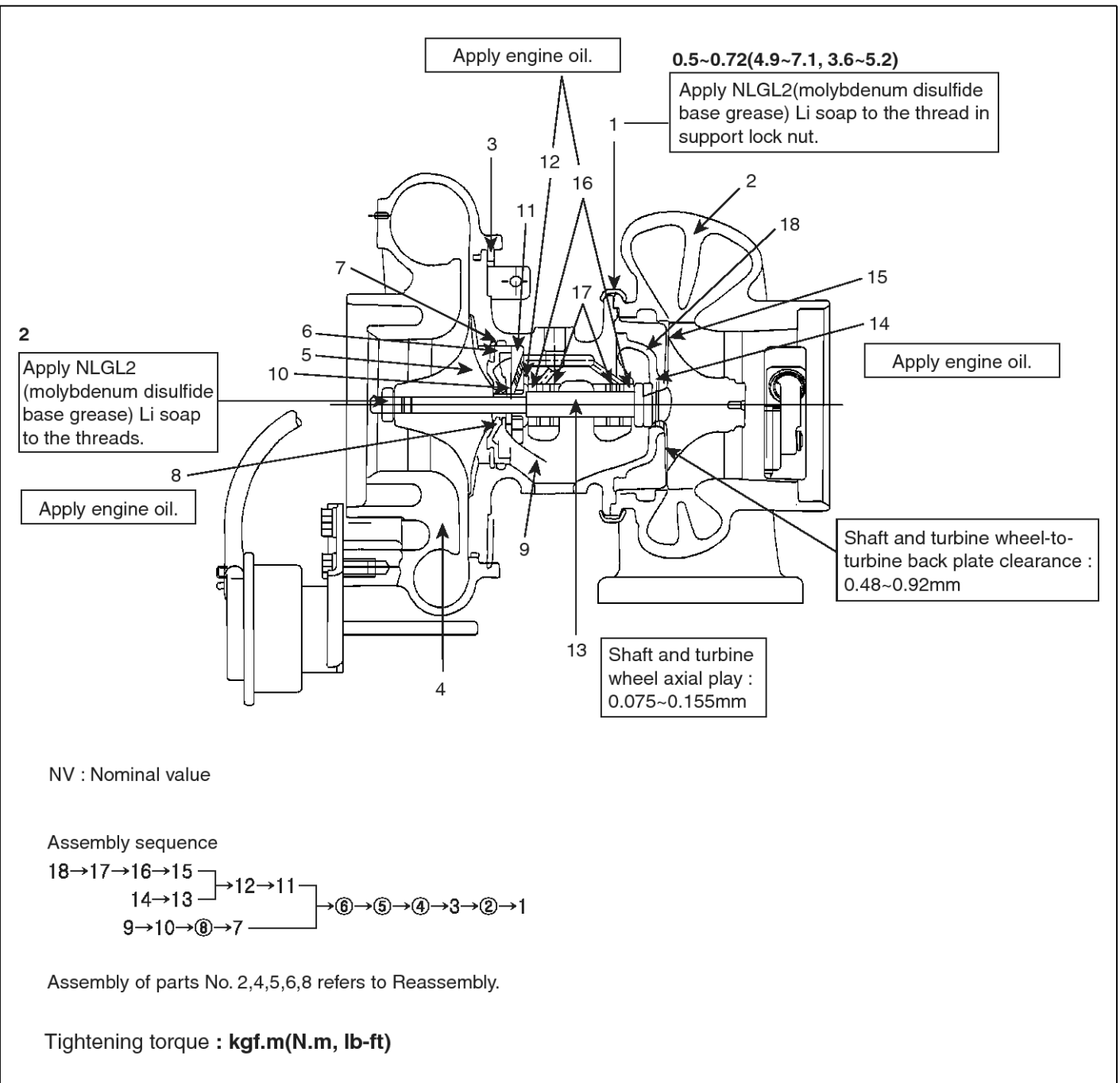
K5TEM4209A

5. Insert the new piston ring to the groove of insert, and measure the end clearance of piston ring. If the value exceeds the normal value, replace the insert.



SDGEM9049L

REASSEMBLY

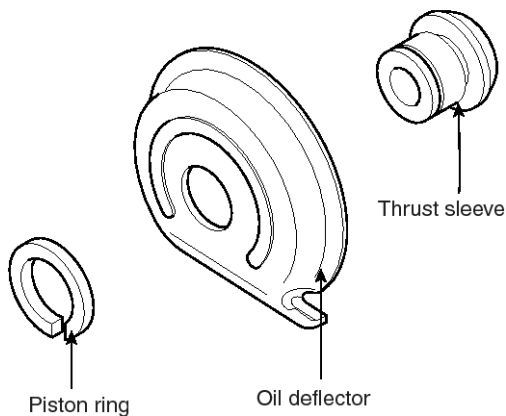


1. Assembly of piston ring

Insert the thrust sleeve into the oil deflector and assemble the piston ring.

⚠ CAUTION

- When assembling the piston ring, be sure that the ring should not bounce or the ring's end should not be distorted.
- When replacing piston ring with new one, thrust sleeve, shaft and turbine wheel must also be replaced with new ones.



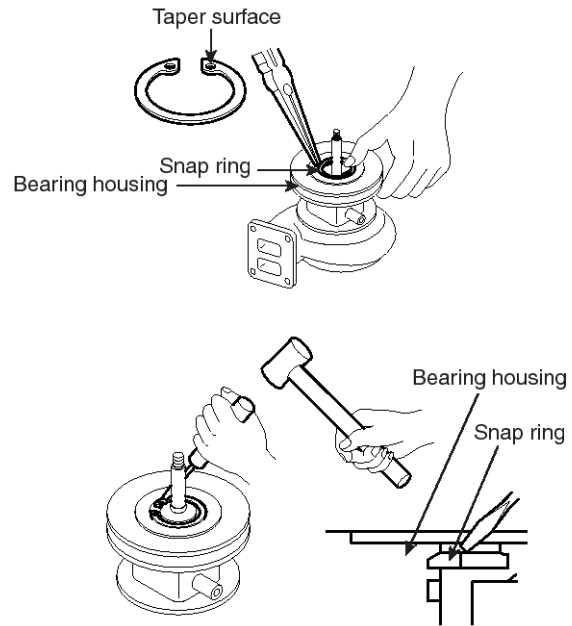
SDGEM9051L

2. Assembling snap ring

After assembling to bearing housing with the taper part of snap ring placed upward, insert the snap ring into the bearing housing hole by tapping with a screwdriver.

⚠ CAUTION

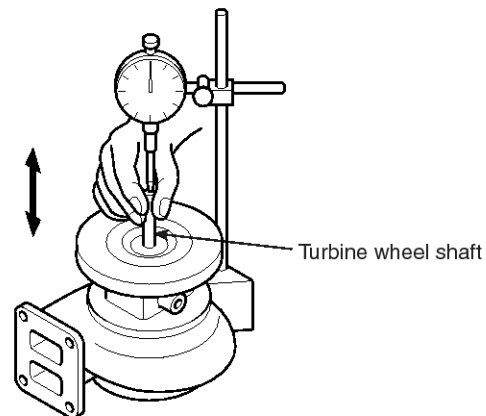
- Hold the snap ring securely by hand so that it would not bounce from a snap ring plier.
- When inserting the snap ring into the bearing housing with a screwdriver, be careful not to damage.



SDGEM9052L

3. Measure the clearance between shaft and wheel turbine housing.

Set the dial gauge to the shaft and the end of turbine wheel, and move shaft and turbine wheel into the axial direction to measure the clearance between turbine wheel and turbine housing. If the clearance exceeds the normal value, disassemble to find out the possible cause.



SDGEM9053L

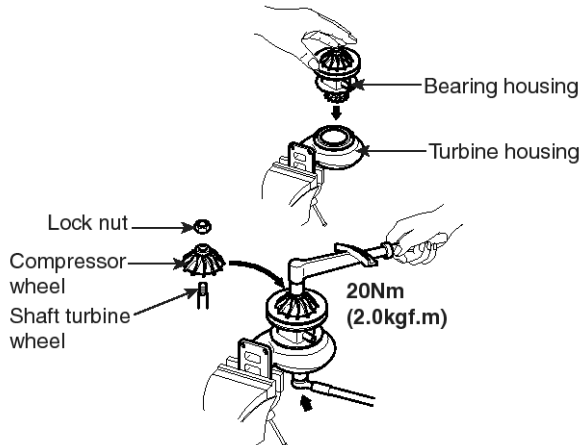
- Secure the adjusting turbine housing of the compressor wheel to the vise, and set the turbine wheel side into the turbine housing.

Apply grease(NLGI No.2) to shaft and turbine wheel screws, and install the compressor wheel on the shaft.

Hold securely the boss in the turbine wheel, and tighten the compressor wheel lock nut to the specified torque.

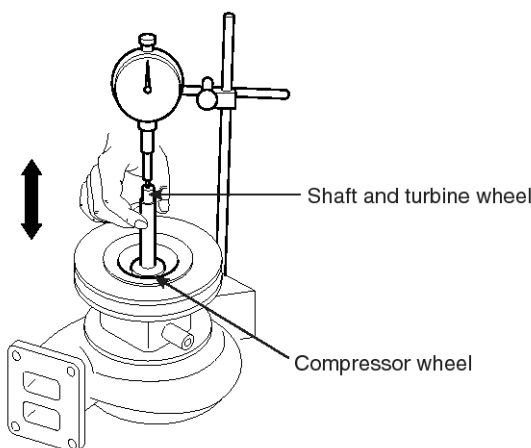
⚠CAUTION

When setting the bearing housing, be careful not to cause damage to the turbine wheel.



SDGEM9054L

- Set the dial gauge on the shaft and turbine wheel, and move the compressor wheel to the axial direction, and measure the end play. If the value exceeds the nominal value, disassemble to find out the possible cause.



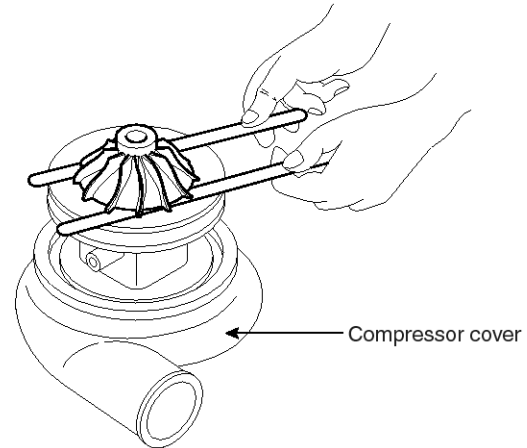
SDGEM9055L

- After removing bearing housing and compressor cover, measure as follows.

Measure the clearance between turbine back plate and rear surface of turbine wheel by using two clearance gauges. If it exceeds the nominal value, disassemble to find out the possible cause.

⚠CAUTION

Measure near blade tip by using two clearance gauges.



SDGEM9056L

- Clearance between shaft & turbine wheel and compressor cover should be checked as follows:

- 1) Measure the run out (R) by moving the compressor wheel up and down.

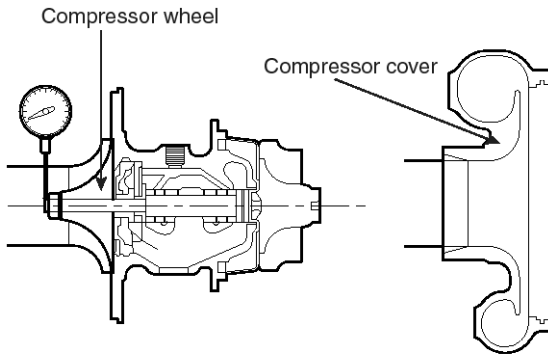
⚠CAUTION

While measuring R, do not run compressor wheel.

- 2) Measure the compressor cover I.D. (D) and compressor wheel O.D. (d) as shown in the illustration.

- 3) Calculate the clearance as given, and if it exceeds the nominal value, disassemble to inspect again.

$$\text{Clearance} = 1/2(D-d-R)$$

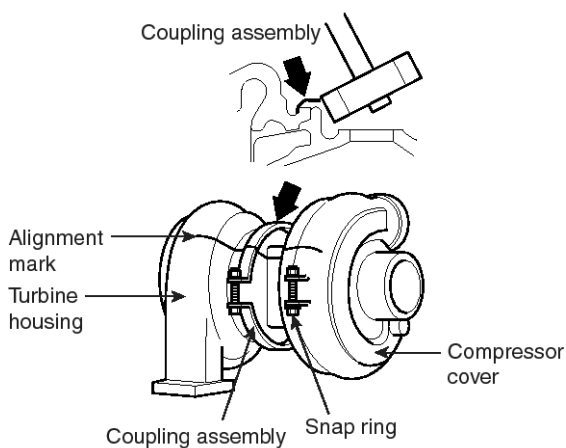


SDGEM9057L

8. Align the marks of turbine housing and compressor cover, and then fix the parts correctly with coupling assembly and snap ring.

Coupling assembly should be assembled as follows:

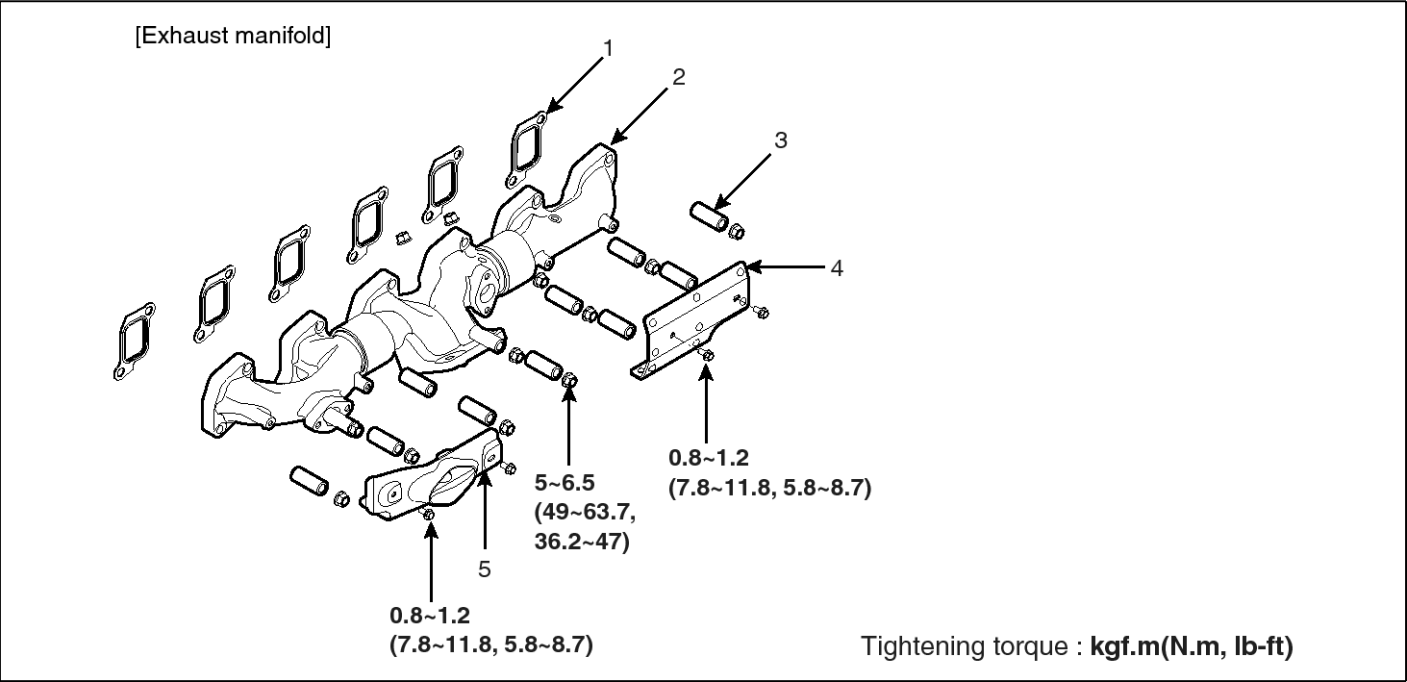
- 1) Tighten the coupling assembly to the specified torque.
- 2) Tap all around the coupling.
- 3) Retighten coupling to the specified torque.
9. After assembling, check by hand that turbine wheel and compressor wheel rotate smoothly. If the wheel rotates uneasily, or if it is bent, disassemble it again to find out the possible cause.



SDGEM9058L

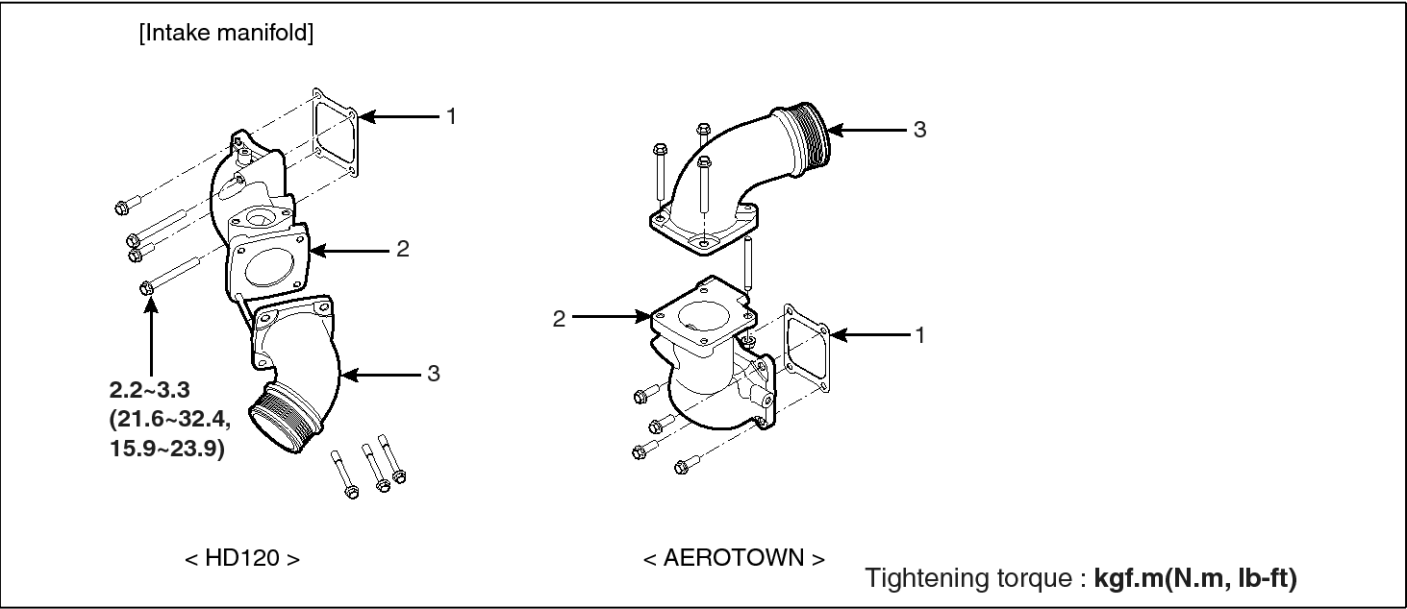
Exhaust Manifold

COMPONENTS



SDGEM9059L

- 1. Exhaust manifold gasket
- 2. Exhaust manifold assembly
- 3. Bushing
- 4. Heater insulator
- 5. Rear heater insulator

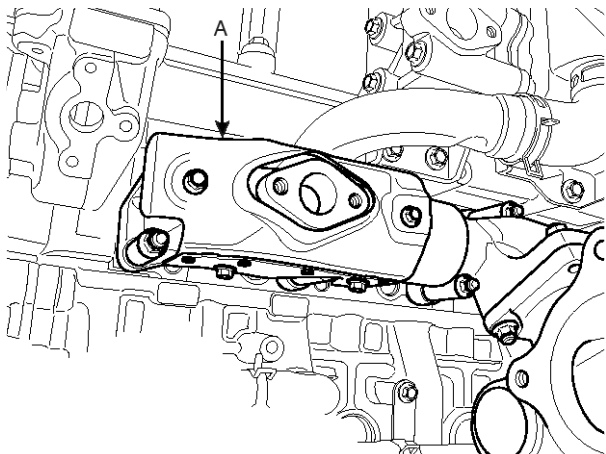


SDGEM9068L

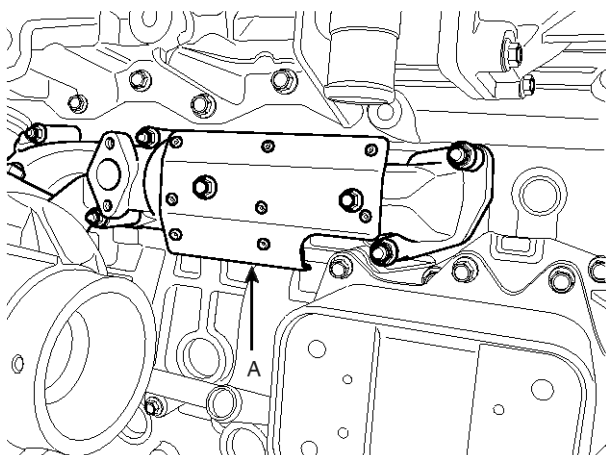
- 1. Coupler intake gasket
- 2. Intake coupler assembly
- 3. Air heater pipe

REMOVAL

1. Remove turbocharger assembly.
2. Remove EGR assembly.
3. Remove insulator (A).

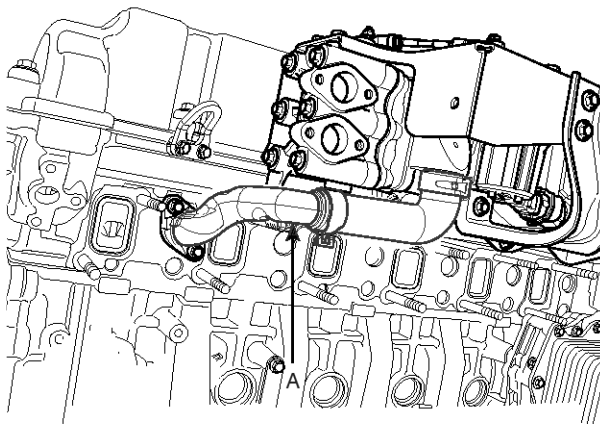


SDGEM7128D

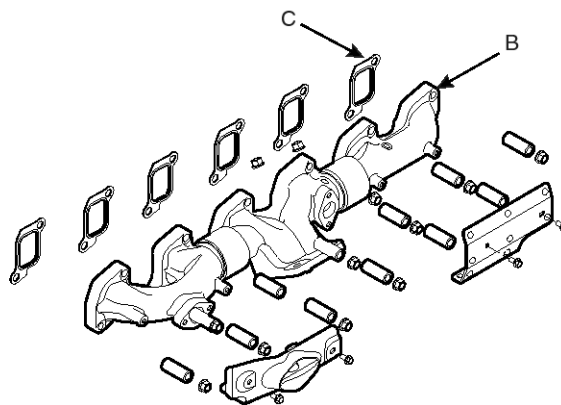


SDGEM7129D

4. Remove exhaust manifold (B) with gasket (C) from cylinder block and then remove water inlet pipe (A).



SDGEM7130D



SDGEM7131D

INSTALLATION

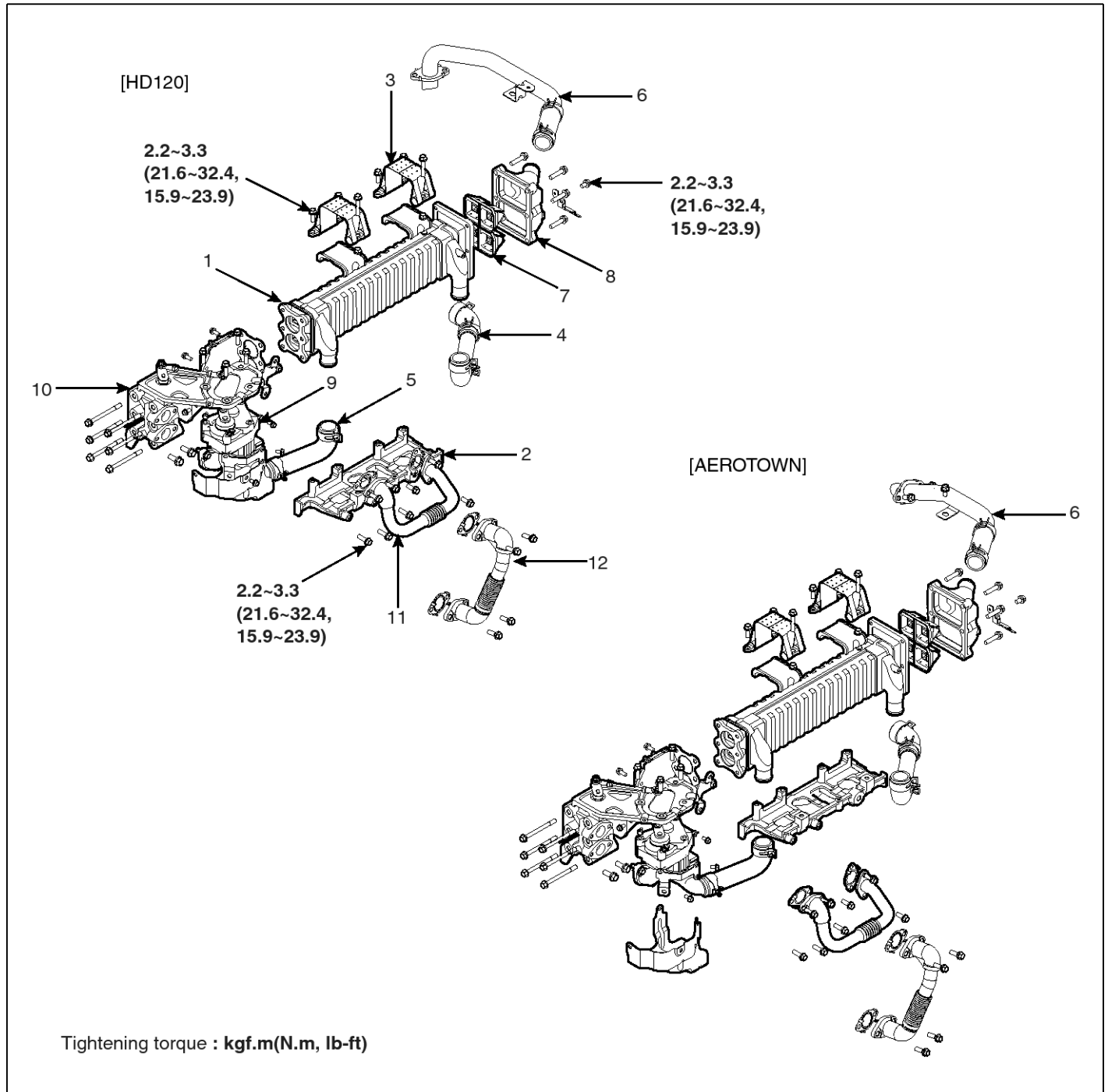
1. Install water inlet pipe. After installing insulator to exhaust manifold (A), install it to cylinder block with the gasket.

Exhaust manifold mounting nut : 5~6.5 kgf.m(49~63.7 N.m, 36.2~47 lb-ft)

2. Install EGR assembly.
3. Install turbocharger assembly.

EGR Assembly

COMPONENTS

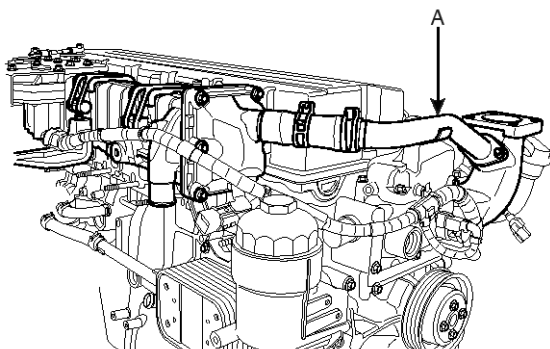


SDGEM9060L

- | | | |
|-------------------------|-----------------------|-------------------------|
| 1. EGR cooler | 5. EGR water in pipe | 9. EGR actuator |
| 2. EGR cooler bracket | 6. EGR out pipe | 10. Flap valve assembly |
| 3. Total strap assembly | 7. Reed valve | 11. EGR inlet No.1 pipe |
| 4. Water outlet pipe | 8. Reed valve housing | 12. EGR inlet No.2 pipe |

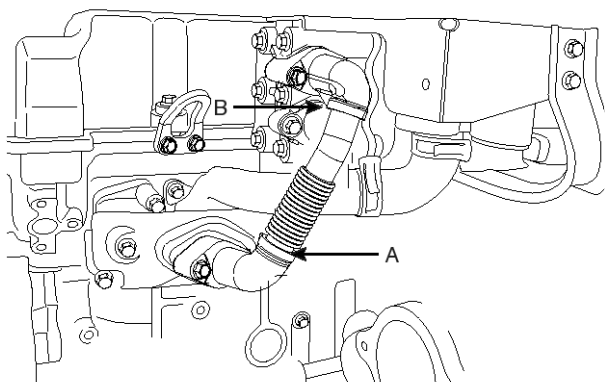
REMOVAL

1. Remove EGR outlet pipe (A).



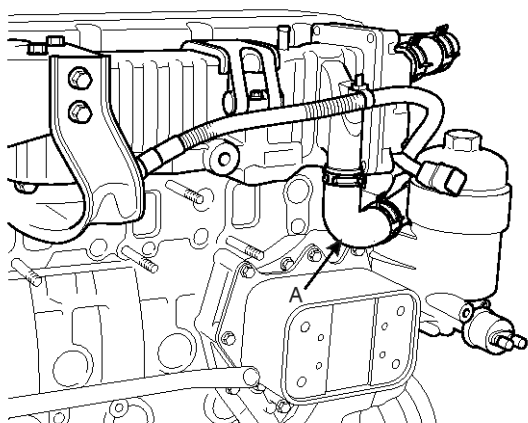
SDGEM7133D

2. Remove EGR inlet pipe No.1(B) , No.2(A).

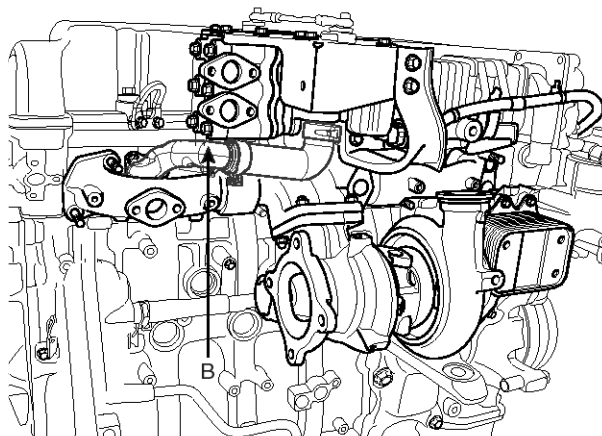


SDGEM7134D

3. Remove water inlet pipe (B) and water outlet pipe (A).

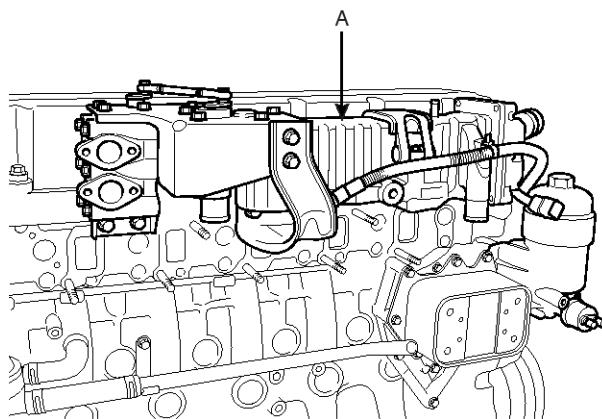


SDGEM7135D



SDGEM7136D

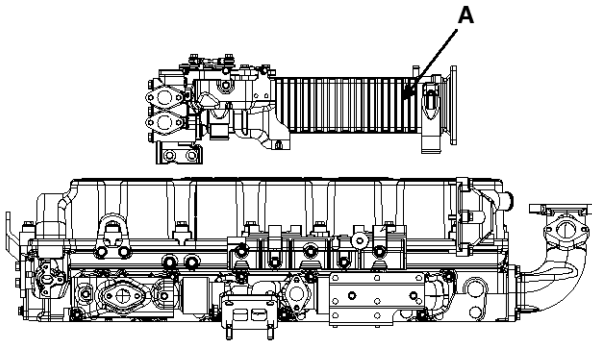
4. Remove EGR assembly (A).



SDGEM7137D

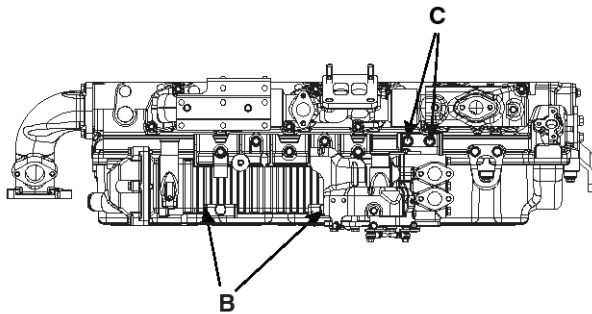
INSTALLATION

1. Put EGR cooler (A) on the bracket.



SDGEM7591D

2. Tighten bolt M10 (B) temporarily to confirm the position of EGR cooler.(Do not tighten it to the specified torque.)
3. Put compression pad (C) on the EGR cooler.



SDGEM7592D

4. Install strap assembly (D).
5. Install strap back bolts M8 (E).

Tightening torque : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)

6. Tighten M8 bolt (F).

Tightening torque: 1.0~1.5 kgf.m(9.8~14.7 N.m, 7.2~10.8 lb.ft)

⚠ CAUTION

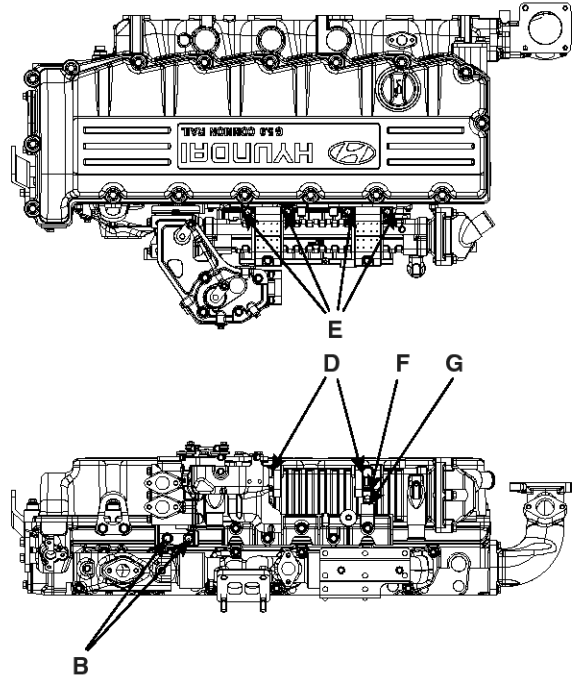
If any bolt is not tightened naturally, do work again from procedure No.1. The bolt might be damaged.

7. Tighten bolt with nut (G).

Tightening torque: 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)

8. Tighten M10 bolt (B) to the specified torque.

Tightening torque : 5.0~6.5 kgf.m(49~63.7 N.m, 36.2~47.0 lb.ft)

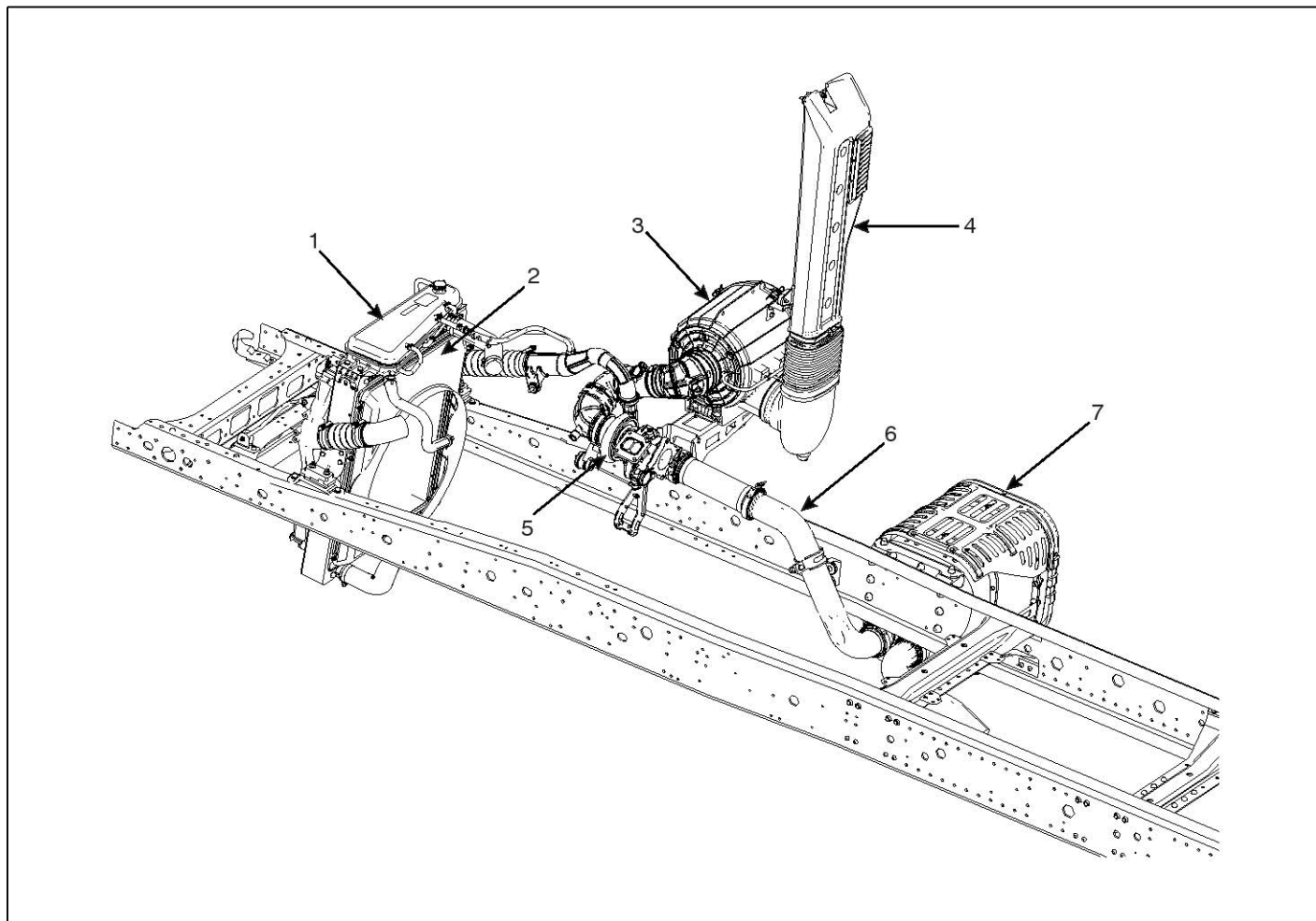


SDGEM7593D

Air Cleaner And Muffler

COMPONENTS

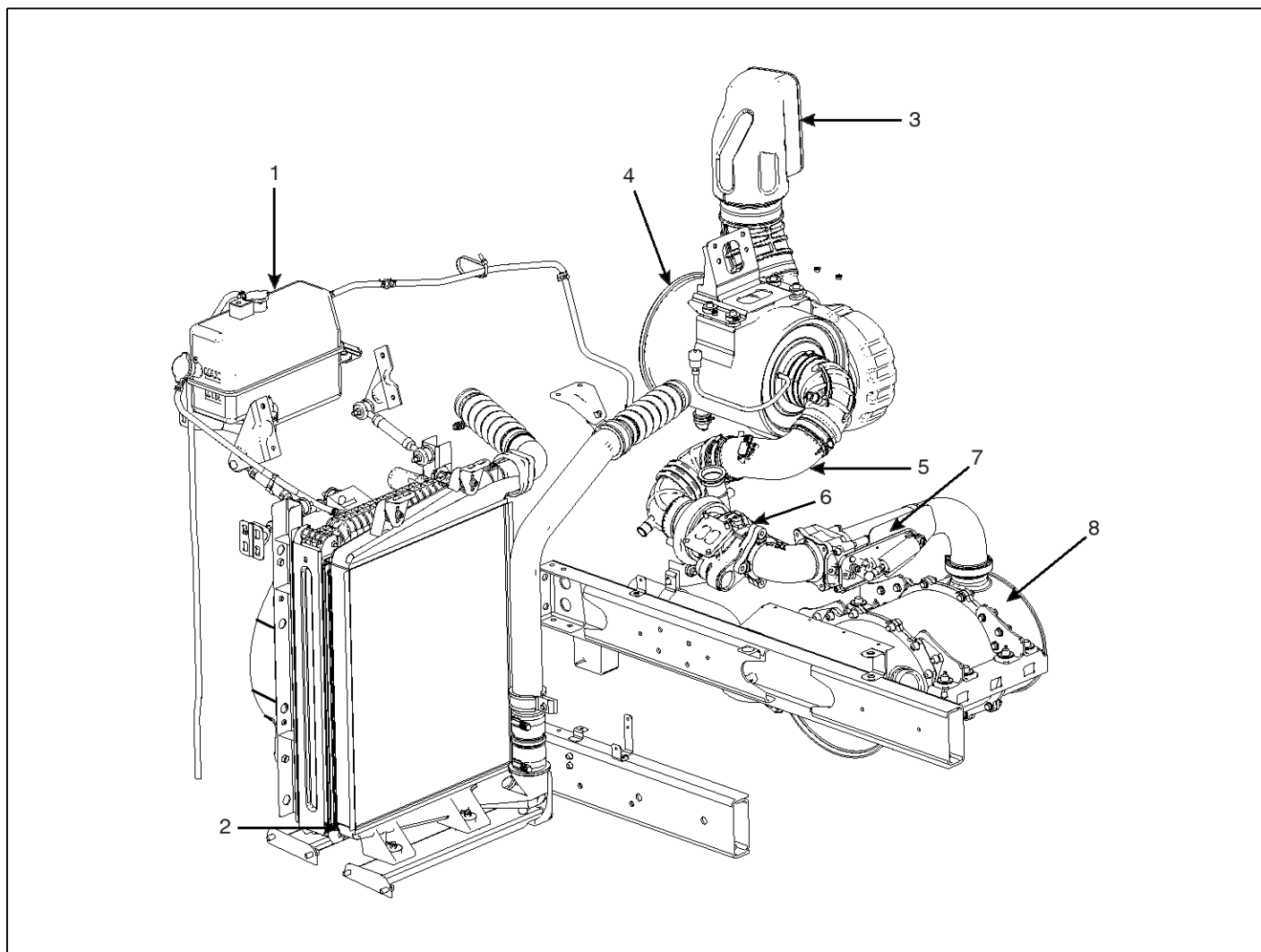
HD120



SDGEM9061L

1. Radiator surge tank
2. Radiator
3. Air cleaner
4. Inlet duct
5. Turbocharger
6. Exhaust pipe
7. Muffler

AEROTOWN



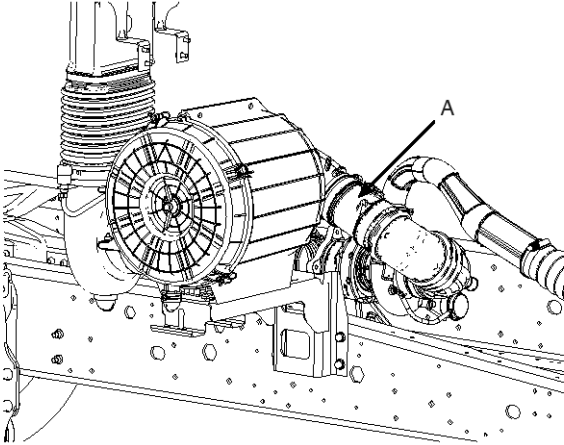
SDGEM9062L

1. Radiator surge tank
2. Radiator
3. Air intake duct
4. Air cleaner
5. Outlet pipe
6. Turbocharger
7. Exhaust pipe
8. Muffler

REPLACEMENT

AIR CLEANER (HD120)

1. Tilt cap.
2. Disconnect intercooler outlet pipe (A) from air cleaner.
3. Disconnect mounting bolt mounted to frame and remove air cleaner assembly.

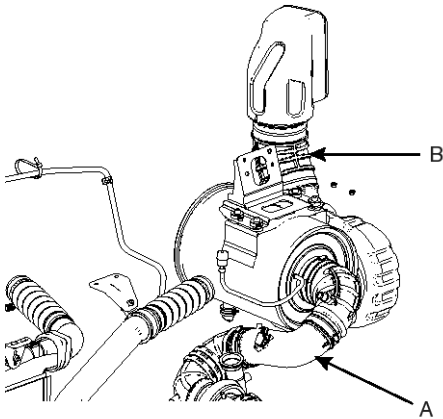


SDGEM7576D

4. Installation is the reverse order of removal.

AIR CLEANER (AEROTOWN)

1. Disconnect intercooler outlet pipe (A) from air cleaner.
2. Remove inlet duct (B).



SDGEM7577D

3. Disconnect mounting bolt mounted to vehicle body and remove air cleaner assembly.
4. Installation is the reverse order of removal.

AIR CLEANER FILTER REPLACEMENT

1. Remove the cap of air cleaner proper.
2. Loosen element wing nut.
3. Remove element.
4. Replace the element of air cleaner with new one.

⚠ CAUTION

When replacing element, be careful that dust or foreign material will not enter the inside of air cleaner.

5. Tighten element wing nut.
6. Secure lower cap after checking if the packing of air cleaner proper connecting part is installed correctly.

📖 NOTICE

If dust indicator is installed, clear red color by pressing reset button down.

⚠ CAUTION

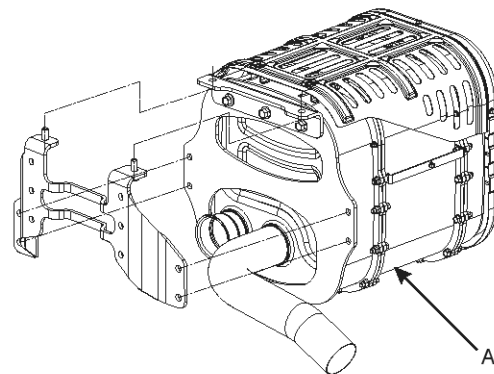
Use genuine part when replacing air cleaner element and driving without air cleaner may cause premature damage to engine.

EXHAUST MUFFLER (HD120)

1. Loosen clamp and disconnect flexible pipe from muffler assembly.
2. Remove bracket mounting bolt and then remove muffler assembly.
3. Remove bolt and gasket and then remove muffler(front, center and rear).

📖 NOTICE

Particulate matter catalyst(PMC) is built-in in center muffler (A).



SDGEM7579D

4. Installation is the reverse order of removal.

EXHAUST MUFFLER (AEROTOWN)

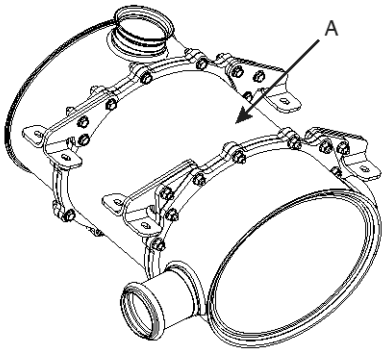
1. Loosen clamp and disconnect exhaust pipe assembly from muffler assembly.

Loosen clamp and remove tail pipe assembly.

2. Remove bracket mounting bolt and then remove muffler assembly.
3. Remove bolt and gasket and then remove muffler(front, center and rear).

NOTICE

Particulate matter catalyst(PMC) is built-in in center muffler (A).



SDGEM7580D

4. Installation is the reverse order of removal.