

Engine Mechanical System

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General

SPECIFICATIONS

Items		Standard value	Limit	Remedy	
General					
Type	In line 4 cylinder 4cycle common rail				
Cylinder bore	103mm				
Cylinder stroke	118mm				
Displacement	3,933cc				
Compression pressure ratio	17 : 1				
Firing order	1-3-4-2				
Max. output	140ps/2,700rpm				
	150ps/2500rpm				
Max. torque	38kgf.m/1,000~2,400rpm				
	59kgf.m/1200~1800rpm				
Compression pressure (at 200rpm)	26kg/cm ² or more(Within 4kg/cm ² each cylinder)		20kg/cm ²	Adjust	
Valve timing					
Intake valve	Open	ATDC 4° (at 1mm Lift)			
	Close	ABDC 5° (at 1mm Lift)			
Exhaust valve	Open	BBDC 30° (at 1mm Lift)			
	Close	BTDC 2° (at 1mm Lift)			
Valve					
Intake valve length	147mm				
Exhaust valve length	147mm				
Intake valve stem outer diameter	6.965~6.980mm				6.85mm
Exhaust valve stem outer diameter	6.935~6.950mm				6.85mm
Intake valve face angle	24.35°				
Exhaust valve face angle	34.35°				
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					

Items	Standard value	Limit	Remedy
Intake	63.2~63.5mm		
Exhaust	63.2~63.5mm		
Valve recess			
Intake	0.3~0.7mm	1.5mm	Replace valve seat and valve.
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		
Squareness	1.5° MAX	3°	
Cylinder block			
Cylinder bore	102.985~103.015mm		
Flatness of upper face of crankcase	Below 0.07mm		
Flatness of gasket surface	0.07mm		
Squareness of gasket surface	0.05mm		
Clearance between piston ring and piston ring groove			
No. 1 piston ring	0.121~0.161mm	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	
Protrusion amount of piston			
Protrusion of piston	-0.309~0.259mm		Replace
Piston			
Piston outer diameter	102.863~102.881mm		Correct or replace with oversize
Clearance between cylinder bore grade A 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		
Piston pin			
Piston pin outer diameter	43.994~44.000mm		

Items	Standard value	Limit	Remedy
Clearance between piston pin and piston pin hole	0.007~0.021mm	0.05mm	Replace
Clearance between piston pin and connecting rod smaller end bush	0.030~0.046mm	0.1mm	Replace
Cylinder sleeve			
Inner diameter	102.985~103.015mm		Repair or replace with oversize
Squareness	0.05		
Cylindricity	0.012mm		
Cylinder head			
Flatness of lower face of cylinder head	Below 0.05mm (Total) 0.02mm (150×150mm) 0.01mm (50×50mm)		Repair or replace
Height from top to bottom of cylinder head	136.7~136.9mm		
Connecting rod			
Connecting rod bending (Measured length 50mm)	0.025mm	-	Replace
Connecting rod twist (measured length 50mm)	0.05mm	-	
Connecting rod end play	0.15~0.40mm	0.6mm	
Connecting rod bearing			
Free length	80.0~81.0mm	-	Replace
Bearing crush(measured load 6kN)	39.8395~39.8795mm	-	
Oil clearance	0.032~0.091mm	0.15mm	
Cam shaft			
Long diameter of intake cam	46.4883mm		
Short diameter of intake cam	40.6mm		
Lift of intake cam	5.8833mm		
Long diameter of exhaust cam	46.8164mm		
Short diameter of exhaust cam	40.6mm		
Lift of exhaust cam	6.2164mm		
Cam shaft end play	0.08~0.255mm	0.35mm	Replace thrust plate
Clearance between camshaft journal and bushing	0.024~0.077mm	0.15mm	Replace
Crankshaft			
Out of circularity of pin and journal	0.005mm		
No.2, No.4 journal runout (measured at No.1, No.5 journal)	0.07mm		

Items	Standard value	Limit	Remedy
No.3 journal runout (measured at No.1, No.5 journal)	0.11mm		
Crankshaft end play	0.100~0.292mm	0.4mm	Replace thrust bearing
Crankshaft bearing			
Oil clearance	0.048~0.110mm	0.15mm	Replace
Free length	92.0~93.0mm	-	
Bearing crush(measured load 7.5kN)	45.821~45.861	-	
Timing gear backlash			
Crank gear~idler AB	0.036~0.196mm		Correct or replace
Idler AB~supply pump gear	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		
Supply pump gear ~vacuum pump gear	0.036~0.196mm		
Idler E ~ power steering pump gear	0.036~0.196mm		
Idler gear end play	0.05~0.15mm	0.25mm	Replace thrust plate
Clearance between idler bushing and idler shaft	0.03~0.071mm	0.1mm	Replace bushing
Flywheel			
Friction surface runout	0.1mm	0.2mm	Replace
Height of friction surface	67mm	66mm	

Specification of intake and exhaust

Item	Specification	
Air cleaner type	Dry	
Element type	Paper	
Turbocharger	Type	TD04HL-11KX3SRC
	Length	214mm
	Width	196mm
	Height	180mm
	Max. revolution allowable	181,000 rpm
	Max. pressure ratio	3
	Max. exhaust gas temperature	760°C

Cooling system

Item		Specification		
		Reference value (():Basic dia.)	Limit	Corrective action
Fan revolution (Automatic cooling fan coupling)		-	2~3 turns or more	
Thermostat	Valve open temperature	80~84°C		Replace
	Valve lift / temperature	Above 10 / 95°C		Replace
Radiator	Open pressure of radiator cap	Normal	0.7±0.15kg/cm ²	
		Negative pressure	Max. 0.1kg/cm ²	
	Radiator check pressure		1.5kg/cm ²	

Tightening torque

Item	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)
Vacuum pump mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
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 mounting bolt	2(19.6, 14.5) + 90°
Injector clamp bolt	3(29.4, 21.7)
Rocker arm shaft mounting 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	10~11(98.1~107.9, 72.3~79.6)
Oil pump gear mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil outlet pipe mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)

Item	Tightening torque kgf.m(N.m, lb-ft)
Oil filter housing assembly mounting bolt	2.2~3.3(21.6~32.4, 15.9~23.9)
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	1.0~1.4(9.8~13.7, 7.2~10.1)
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)

DESCRIPTION

CYLINDER BLOCK

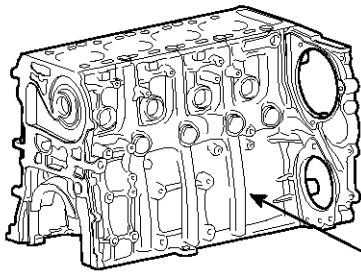
1. Outline/Structure/Operation

- High rigidity CGI material application
- Truss structure application

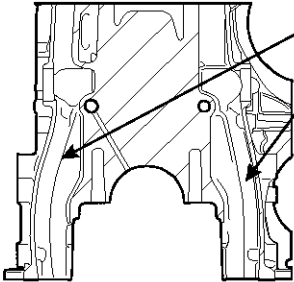
2. Main features

- Durability enhancement and light weight with high rigidity CGI material applied
- Block stiffness enhancement due to truss structure by using oil return passage
- Reliability improvement in leak by integrating rear plate to block

[CGI Cylinder block]



Truss structure



SDFEM9001L

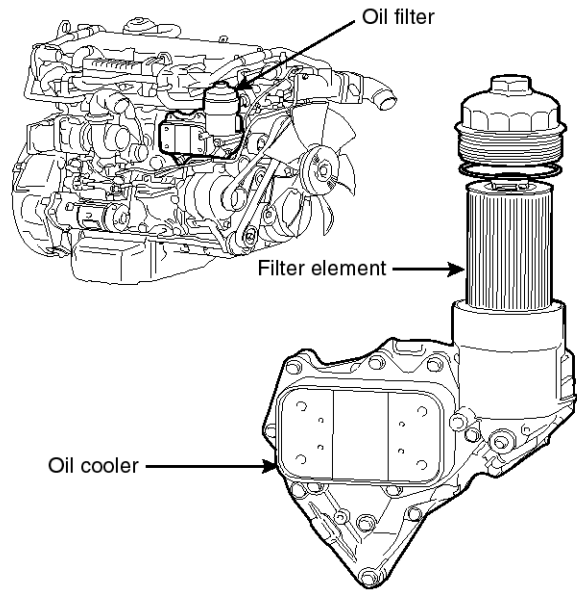
OIL FILTER AND OIL COOLER

1. Outline/Structure/Operation

- Replaceable oil filter paper type and the engine layout installed in the upper
- Built-out aluminum oil cooler adoption

2. Main features

- Cost reduction and serviceability with the application of replaceable oil filter paper type
- Heat exchange efficiency improvement with the application of aluminum material
- Oil cooler size reduction and light weight



SDFEM9002L

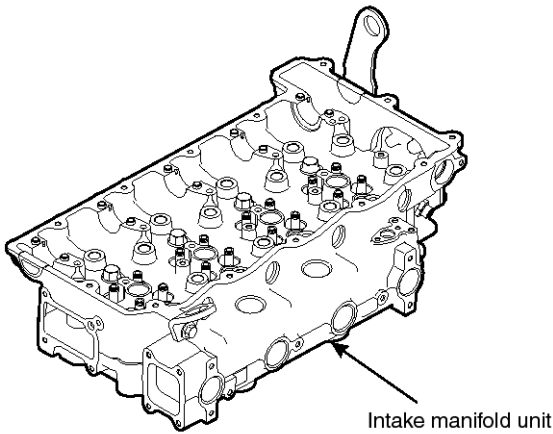
CYLINDER HEAD

1. Outline/Structure/Operation

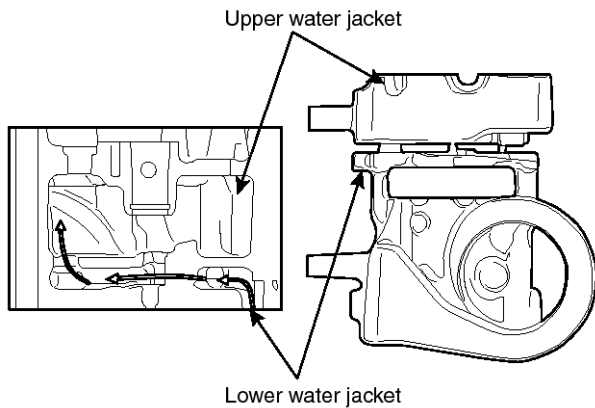
- Intake/exhaust port connecting intake/exhaust manifold and combustion chamber has been installed to exchange intake/exhaust gas.

2. Main features

- Intake manifold in one unit
- Upper/lower water jacket separation type
- Cooling performance maximization by minimizing temperature deviation among cylinders



SDFEM9003L



SDFEM9004L

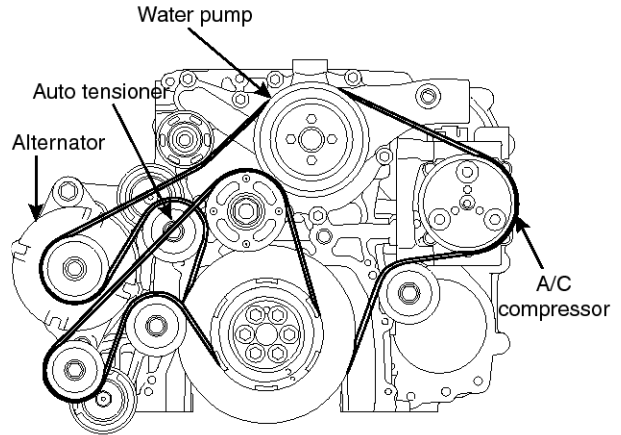
BELT SYSTEM

1. Outline/Structure/Operation

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

2. Main features

- V-ribbed belt : Belt durability improvement
- Improved fuel economy and belt durability with the independent operation of cooling fan
- Asymmetric damping auto tensioner adoption : Belt noise reduction/ improved durability
- Automatic control of belt tension



SDFEM9005L

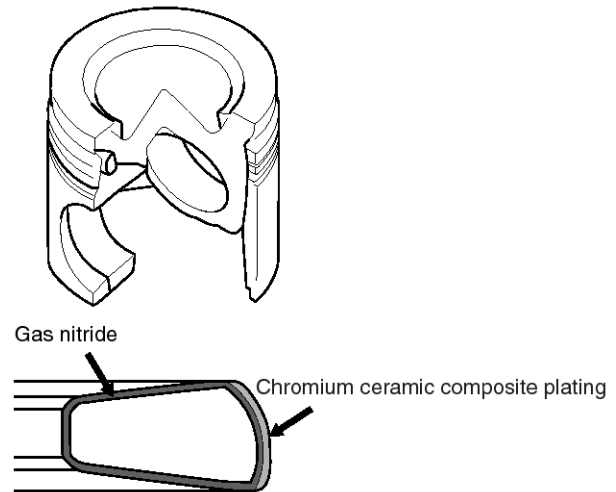
MOVING SYSTEM

1. Outline/Structure/Operation

- This is the system to delivery power to transmission after converting reciprocating motion to rotating motion with combustion.

2. Main features

- Improved piston durability with application of high rigidity aluminum material
- Improved piston ring durability and wear resistance



SDFEM9006L

VALVE TRAIN

1. Outline/Structure/Operation

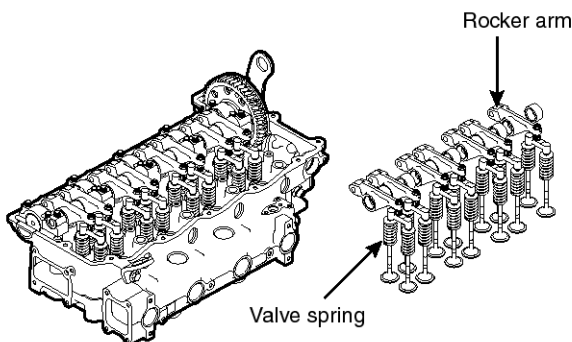
- This is the system to make the intake/exhaust valve open or close to the proper timing after converting the rotating motion of cam shaft to the linear motion of valve.

2. Main features

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

3. Main improvement

- Valve train stiffness
- Durable reliability



SDFEM9007L

TIMING GEAR TRAIN

1. Outline/Structure/Operation

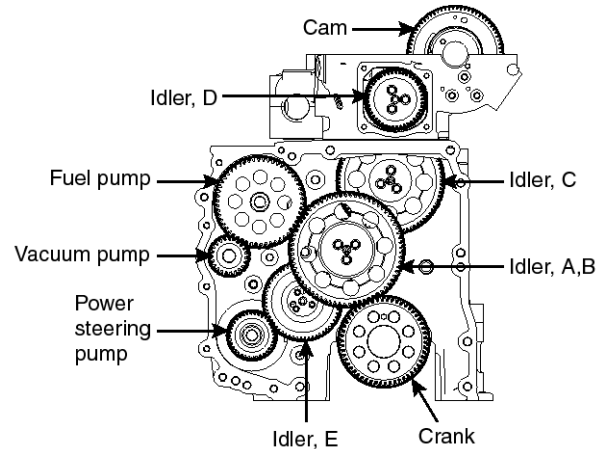
- Gear train is the system to deliver power to each accessory and camshaft.

2. Main features

- Rear gear train
- Small modulization to reduce noise
- Addition of cementation to alloy steel

3. Main improvement

- NVH(noise, vibration, harshness) reduction
- Durable reliability



SDFEM9008L

SCISSORS GEAR

1. Outline/Structure/Operation

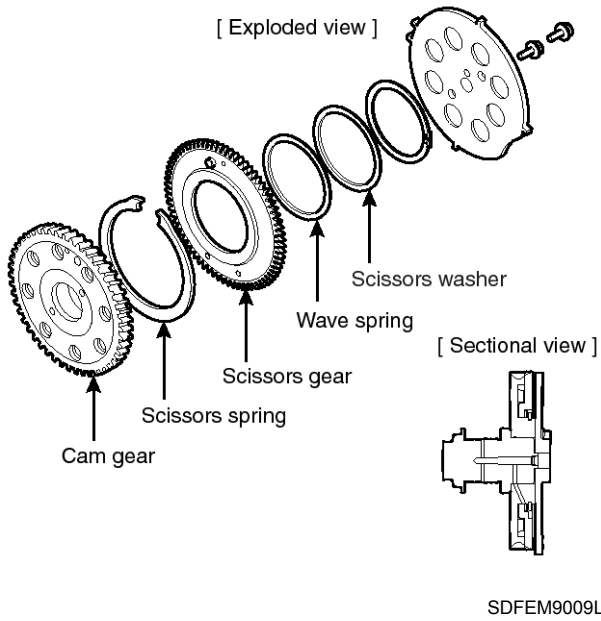
- This is the system to reduce the gear noise from engine.
- It is to prevent noise during operating by eliminating backlash between idler gear(drive gear) and camshaft gear(driven gear).

2. Main features

- Cam gear has become in one unit with application of scissors gear.
- Axial counterpart motion has been fixed due to the spring force with application of wave spring.
- The scissors washer has been adopted to increase the engaged area to secure with axial direction.

3. Main improvement

- Improved idle noise reduction and improve tone color
- It is not necessary to adjust gear backlash due to the improved gear assembly function.



ROCKER COVER

1. Outline/Structure/Operation

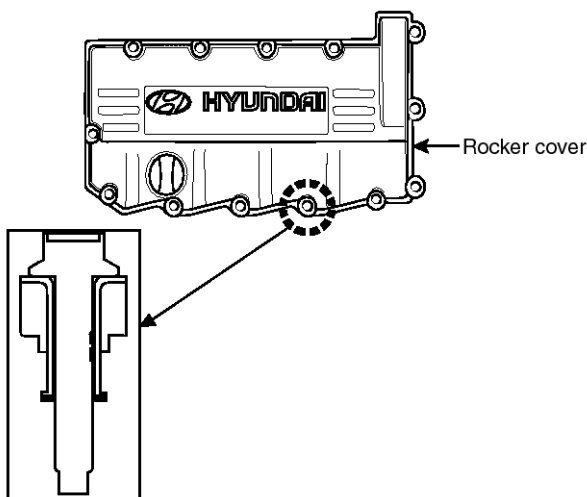
- This is the component to isolate outside parts so that moving parts such as camshaft, valve and rocker arm ect. placed on cylinder head can work smoothly.

2. Main features

- Material : Plastic
- Full Floating and side bolt type

3. Main improvement

- Light weight
- NVH reduction
- Non-leak reliability



[Tightening torque]

SDFEM9010L

VACUUM PUMP

1. Outline/Structure/Operation

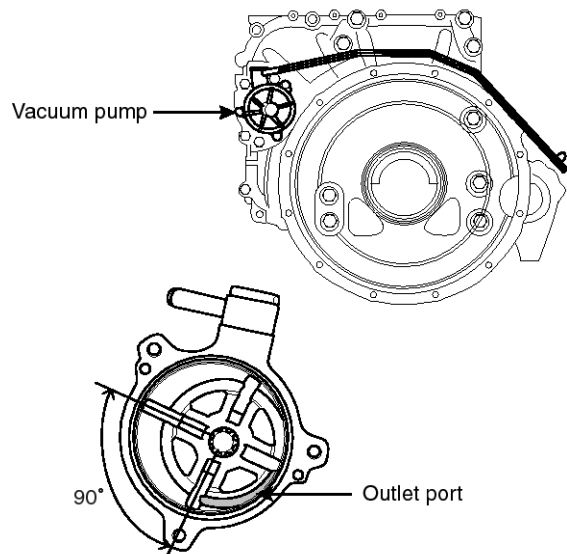
- This is the system to make the brake force necessary for the vehicle and vacuum in the vacuum tank.

2. Main features

- 4 vane structure type
- Improved vane material
- Optimized inlet, outlet port

3. Main improvement

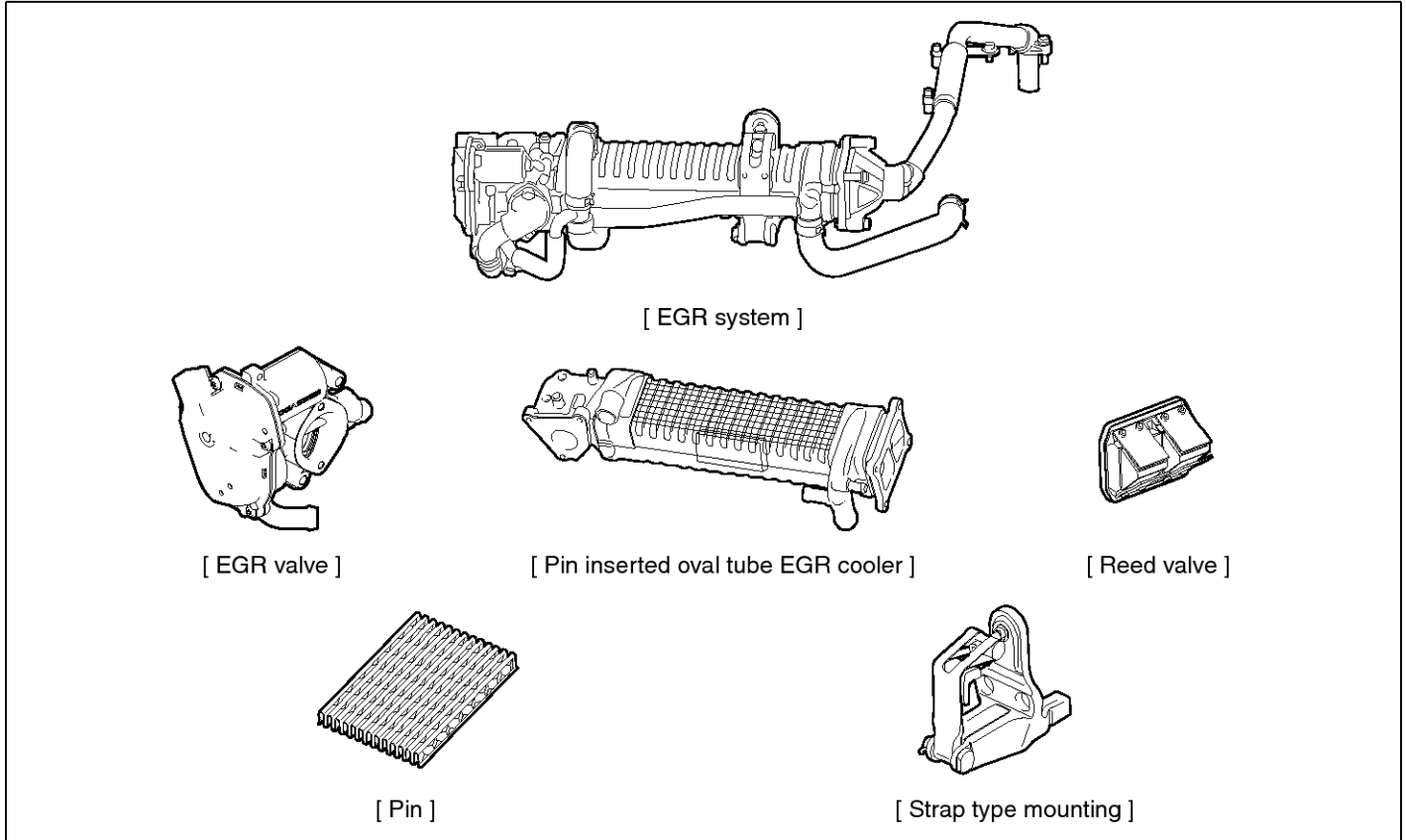
- Durable reliability
- Outlet performance



SDFEM9011L

EGR(Exhaust gas recirculation) SYSTEM

1. This is the system to reduce NOx generation by recirculating part of exhaust gases from the exhaust manifold to the combustion chamber.



SDFEM9012L

2. Main features and structure

- Electronic EGR valve type
- EGR cooler efficiency increase due to the application of pin inserted gas tube
- Reed valve(1-way) for securing EGR high rate at low speed
- Strap type mounting for absorbing heat change and preventing vibration
- Durable reliability(Maintenance free)
- Nox emission reduction

PARTICULATE MATTER CATALYST(PMC)

1. Outline

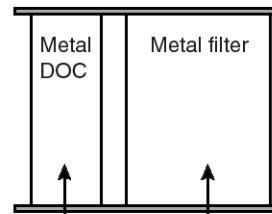
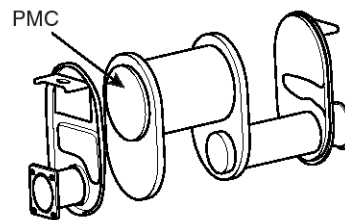
- This is the system to reduce SOF ingredient of HC, CO, PM among emission gases by DOC equipped with the inside of muffler and to collect and generate PM ingredient from filter by using NO2 generated by DOC.

2. Main features

- Mechanical durability is superior to ceramic

carrier with application of metal carrier.

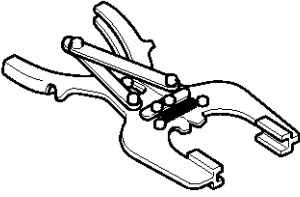
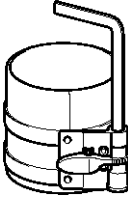
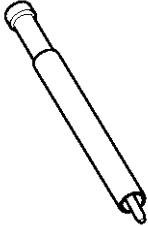
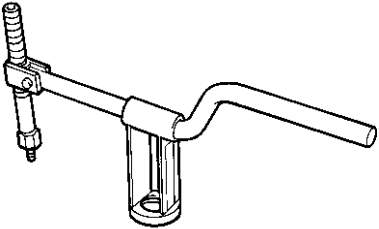
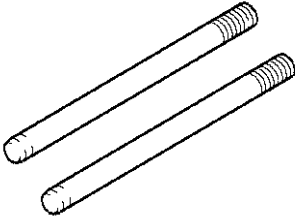
- Back pressure is lower than that of DPF as a PM reduction system.(Open flow type)
- Purification of emission gas(HC, CO, PM)



- Catalytic coating part
- PM collecting and combustion
- Open flow type

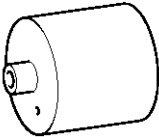
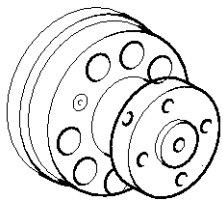
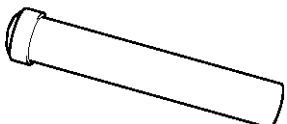
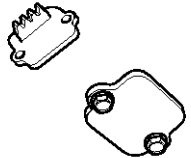
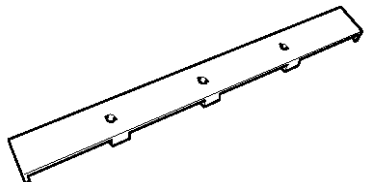
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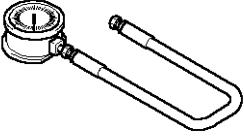
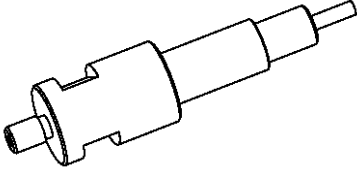
SPECIAL TOOLS

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)
09231-48300 Flywheel stopper	 <small>SDGEM7582D</small>	Flywheel fixture when installing or removing adapter pulley, flywheel
09245-48000 Installer or remover of rocker arm shaft	 <small>SDFEM7529D</small>	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)	 SDFEM7644D	Measurement of nozzle pressure

TROUBLESHOOTING

Symptom	Possible cause	Maintenance
Too low compression pressure	Cylinder head gasket burned or damaged Piston ring worn or damaged Piston or cylinder worn Valve seat worn or damaged	Replace gasket.(Check the upper surface of cylinder head, cylinder block) Replace ring. Repair or replace piston or cylinder block. Repair or replace valve or seat ring.
Too low oil pressure	Engine oil shortage Oil pressure switch defect Oil filter clogged Oil pump gear or case worn Low engine oil viscosity Oil relief valve stuck(open) Bearing clearance excess	Add engine oil. Replace with oil pressure switch. Replace with new one. Replace gear or case. Replace engine oil. Repair relief valve. Replace bearing.
Too high oil pressure	Oil relief valve stuck(Closed side)	Repair relief valve.
Noise of connecting rod or main bearing	Improper oil supply Low oil pressure Low engine oil viscosity Excessive bearing clearance	Check engine oil level. Refer to 'Too low oil pressure'. Replace engine oil. Replace bearing.
Excessive engine vibration	Loose engine mounting bolt Loose transmission mounting bolt Loose cross member bolt Cracked engine mounting rubber Cracked transmission mounting rubber	Retighten. Retighten. Retighten. Replace. Replace.
Low coolant level	Coolant leakage Radiator core joint damaged Radiator or heater hose corrosive or cracked Radiator cap valve or spring poor setting Thermostat malfunction Water pump malfunction EGR cooler defective EGR or hose poor connection	Replace. Replace. Replace. Retighten.
Radiator clogged	Foreign material inflow in coolant	Replace.
Coolant temperature abnormally high	Thermostat malfunction Radiator cap malfunction Poor flow in coolant system Drive belt loose Water pump malfunction Temperature wiring defective Radiator fan malfunction Coolant shortage	Replace. Replace. Replace. Check or replace auto tensioner. Replace. Repair or replace. Repair or replace. Add coolant.
Coolant temperature abnormally low	Thermostat malfunction Temperature wiring defective	Replace. Repair or replace.
Leakage in oil cooler system	O-ring or the left surface of seal ring damaged Hose or pipe cracked or damaged	Replace. Replace.
Radiator fan inoperative	Damaged	Repair or replace.

Symptom	Possible cause	Maintenance
Exhaust gas leaked	Connection part loose Pipe or muffler cracked	Retighten. Repair or replace.
Abnormal noise	Baffle plate fallen in muffler Rubber hanger cracked Interference between pipe or muffler and body Pipe or muffler cracked Out of valve clearance	Replace. Replace. Repair. Repair or replace. Retighten.

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.

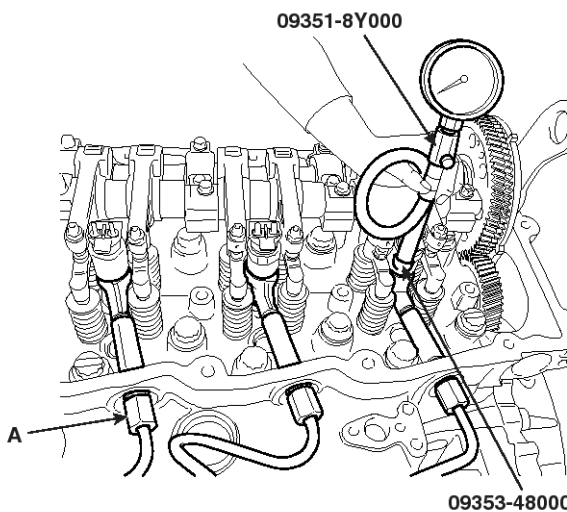
CAUTION

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

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

NOTICE

- If insufficient power, excessive engine oil consumption or poor fuel economy is found, measure compression pressure.
- When the injector is removed while measuring compression pressure, replace with new gasket and tighten it to the specified torque.



SDFEM7004D

7. Crank the engine and measure compression pressure.

CAUTION

1. Be careful that fuel does not scatter.
2. Measure the compression pressure of all cylinders since the wear amount for each cylinder is different.

NOTICE

Use the fully charged battery to rotate the engine to 200 rpm or more.

8. Measure the compression pressure for each cylinder and check the difference of the compression pressure among all cylinders is within limit value.

NOTICE

This measurement should be done as short a time as possible.

Item		Reference value	Limit value	Remedy
Compression pressure (at 200rpm)	Each cylinder	26kg/cm ²	20kg/cm ²	Check
	Difference each cylinder	-	4kg/cm ²	Check

9. If one of cylinders in compression pressure difference is in excess of the limit value, insert a little engine oil into the injector hole of the corresponding cylinder and measure the compression pressure again.

1) If the compression pressure increases, check that the piston, the piston ring or the cylinder wall is worn or damaged.

2) If the compression pressure does not increase, check for the valve stuck, the poor valve connection and the leaks through the cylinder head gasket.

3) In spite of inserting the engine oil into each piston since the compression pressure between adjacent two cylinders is low, if the pressure does not increase, check for the gasket of the cylinder head.

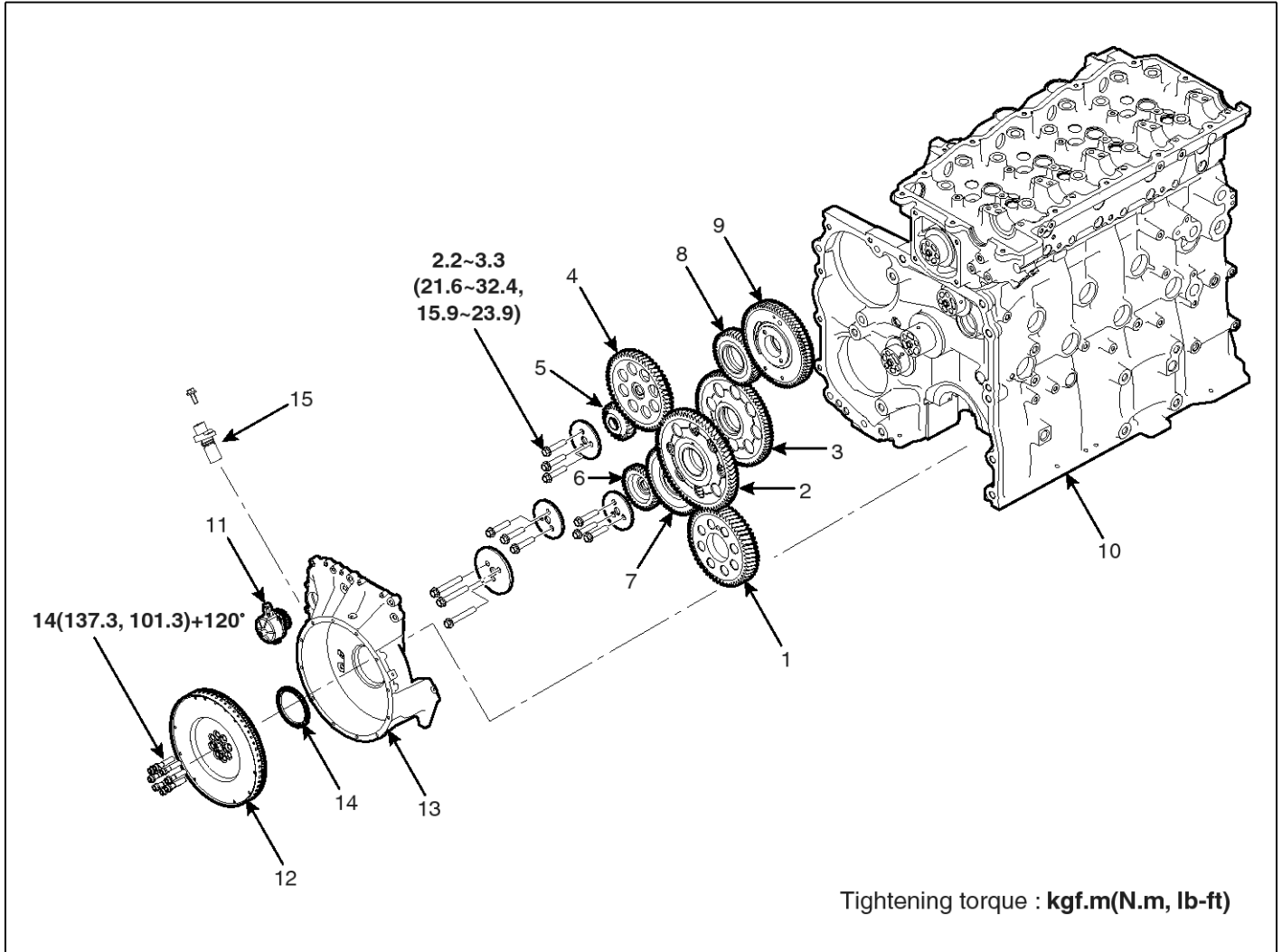
Or check for the oil of cylinder inside or the coolant.

10. Install the injector.

Timing System

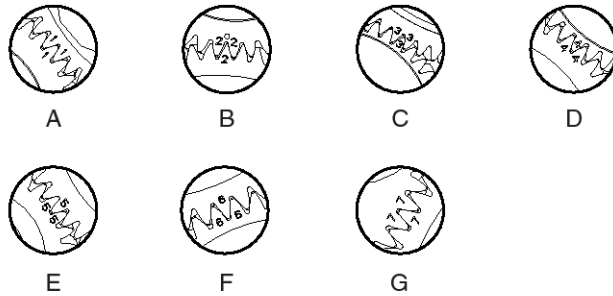
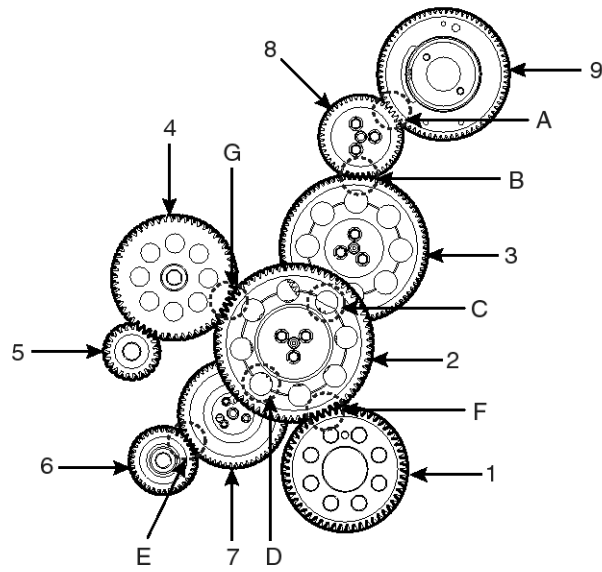
Timing Gear Assembly

COMPONENTS



SDFEM9014L

- | | | |
|----------------------------|-----------------------------|-------------------------|
| 1. Crank gear | 6. Power steering pump gear | 11. Vacuum pump |
| 2. Idler gear assembly A,B | 7. Idler gear E | 12. Flywheel |
| 3. Idler gear C | 8. Idler gear D | 13. Flywheel housing |
| 4. Fuel supply pump gear | 9. Cam gear | 14. Rear oil seal |
| 5. Vacuum pump gear | 10. Cylinder block | 15. Engine speed sensor |



SDFEM9015L

- 1. Crank gear
- 2. Idler gear assembly A,B
- 3. Idler gear C
- 4. Fuel supply pump gear
- 5. Vacuum pump gear

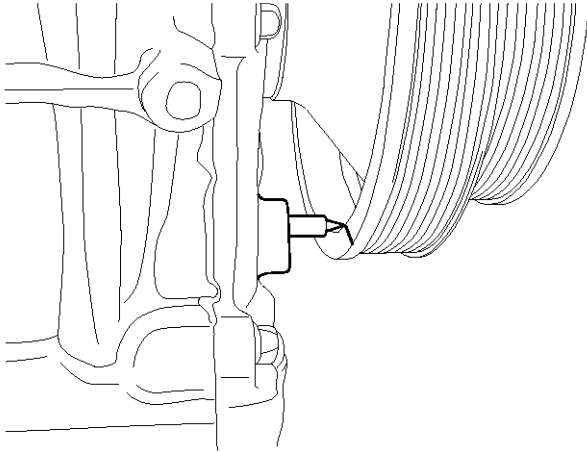
- 6. Power steering pump gear
- 7. Idler gear E
- 8. Idler gear D
- 9. Cam gear

REMOVAL

1. Align the engine cylinder #1 TDC.

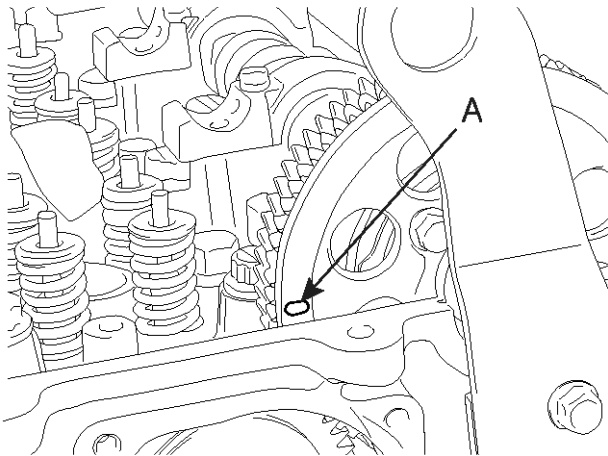
NOTICE

1. Align the mark(or painting) of circumferential surface on the engine crankshaft with the mark on the block surface.



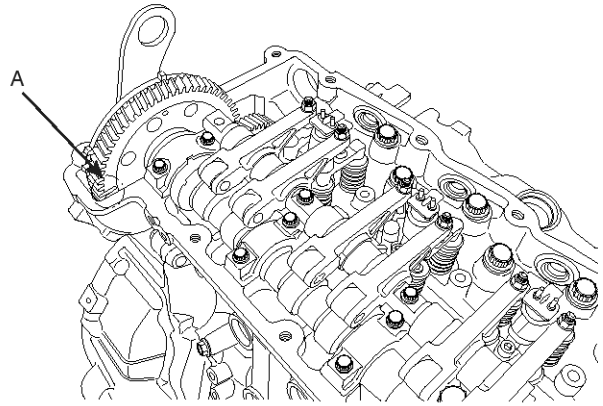
SDFEM7076D

2. Align the inscribed mark(A) of sensor plate in the front of the camshaft gear from the engine rear side with the machined surface on the cylinder head upper surface.



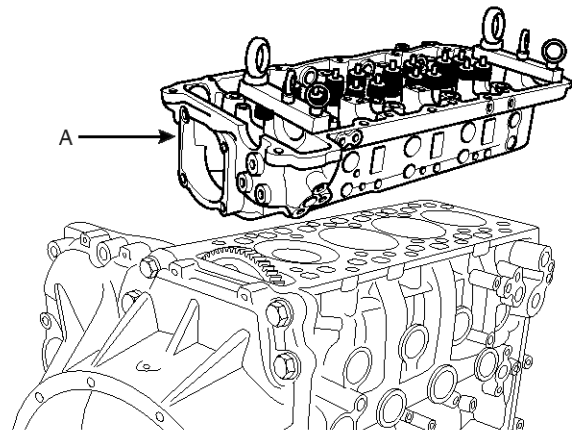
SDFEM7077D

3. Align the inscribed mark(A) on the camshaft gear from the engine front with the machined surface on the cylinder head upper surface.



SDFEM7630D

2. Remove the idler gear D and then remove cylinder head(A).

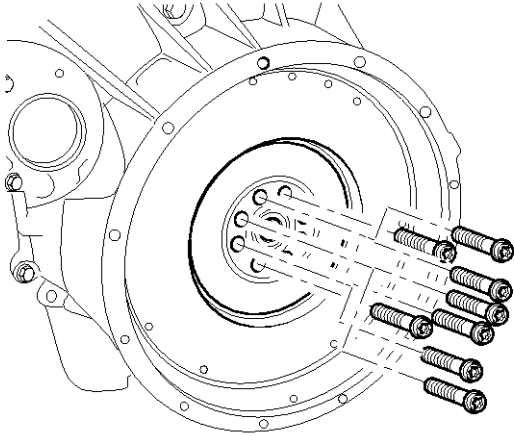


SDFEM7038D

- Remove the flywheel.

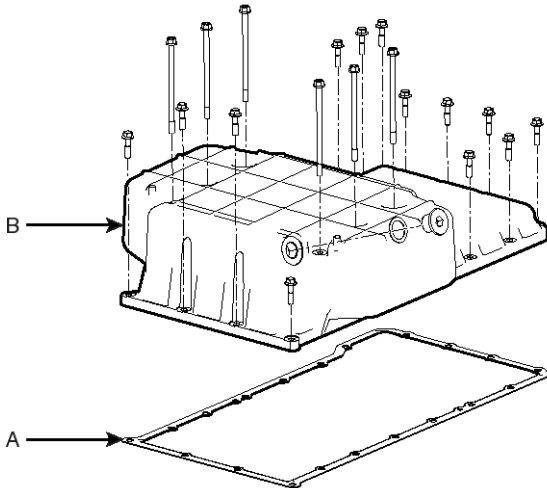
NOTICE

Regarding to flywheel-removal, refer to No. 1~6 of section 'Flywheel-removal'.



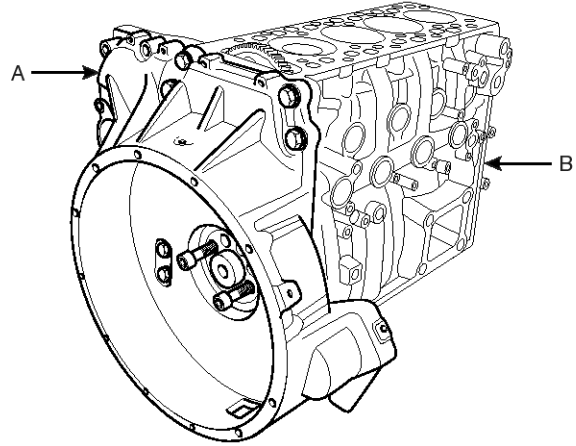
SDFEM7088D

- Remove the oil pan gasket(A) and the oil pan(B).



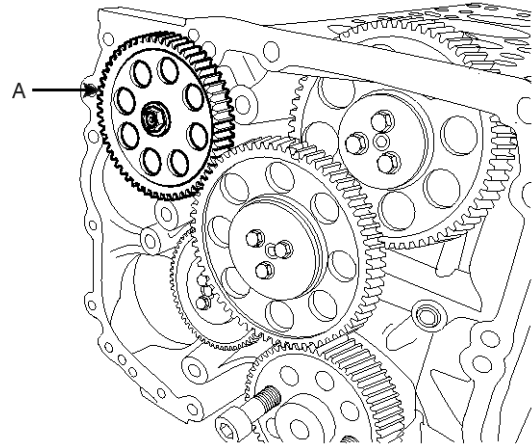
SDFEM9058L

- Remove the flywheel housing(A) from the cylinder block(B).



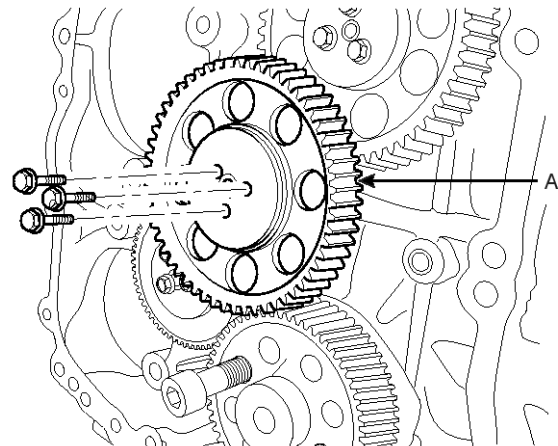
SDFEM7042D

- Remove the nut and the fuel supply pump gear(A) from the timing gear.



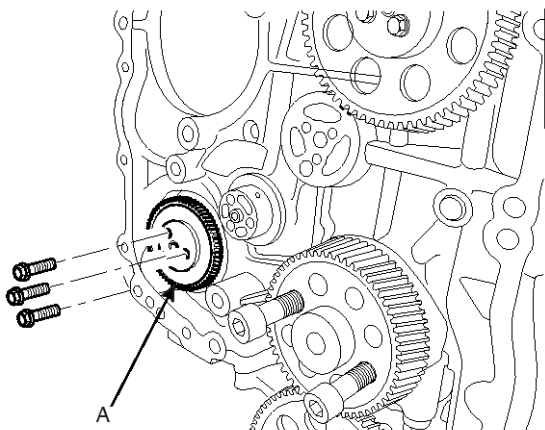
SDFEM7043D

- Detach the mounting bolt and remove the thrust wash and the idler gear assembly A,B(A).



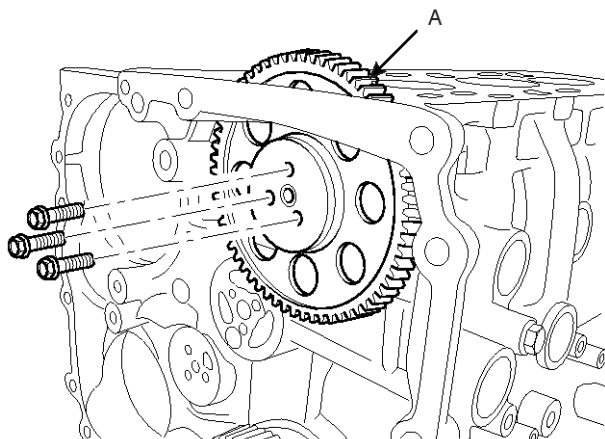
SDFEM7044D

8. Detach the idler shaft, the washer thrust and the bolt and remove the idler gear E(A).



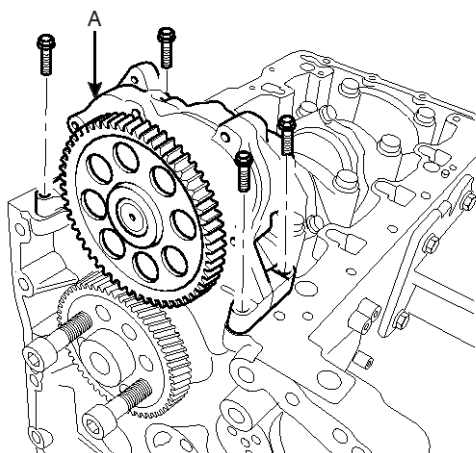
SDFEM7045D

9. Detach the idler shaft, the washer thrust and the bolt and remove the idler gear C(A).



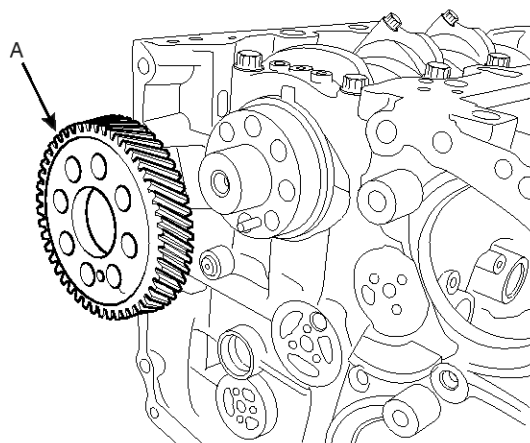
SDFEM7046D

10. Remove the oil pump assembly(A).



SDFEM7047D

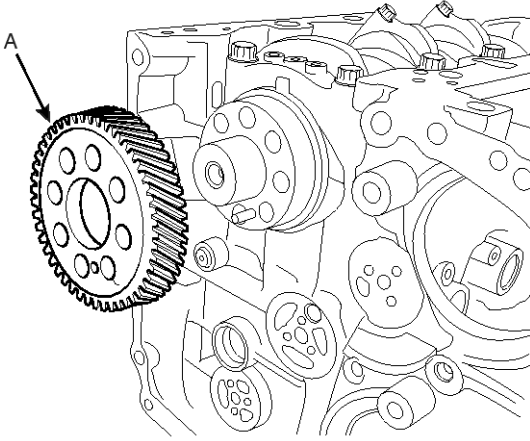
11. Remove the crankshaft gear(A).



SDFEM7048D

INSTALLATION

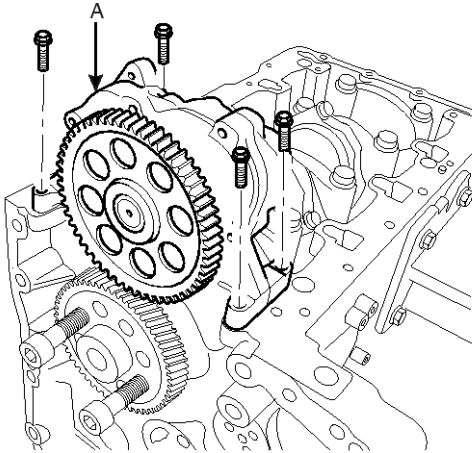
1. Install the crankshaft gear(A). Position the crankshaft gear so that the piston of cylinder No.1 is at the TDC of compression stroke.



SDFEM7007D

2. After installing the two O-rings, install the oil pump assembly(A).

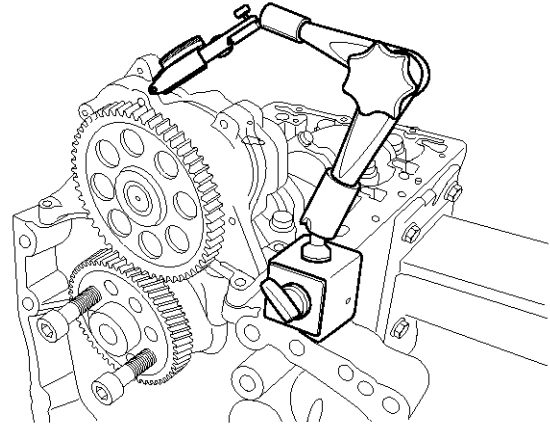
Oil pump assembly mounting bolt : 2.2~3.3 kgf.m (21.6~32.4 N.m, 15.9~23.9 lb.ft)



SDFEM7008D

3. Measure the backlash between the oil pump gear and the crankshaft gear.

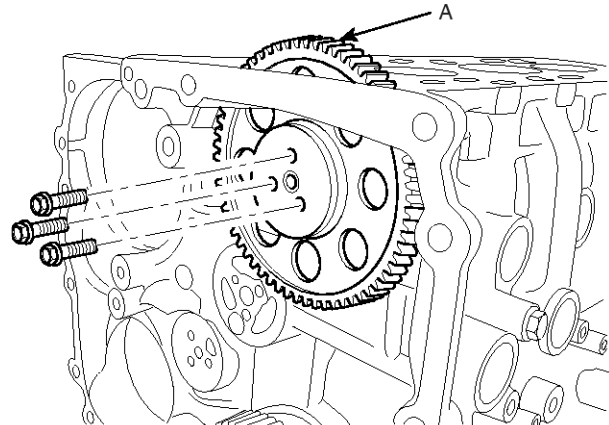
Reference value : 0.105~0.218mm



SDFEM7009D

4. Attach the idler shaft, the washer thrust and the bolt and install the idler gear C(A).

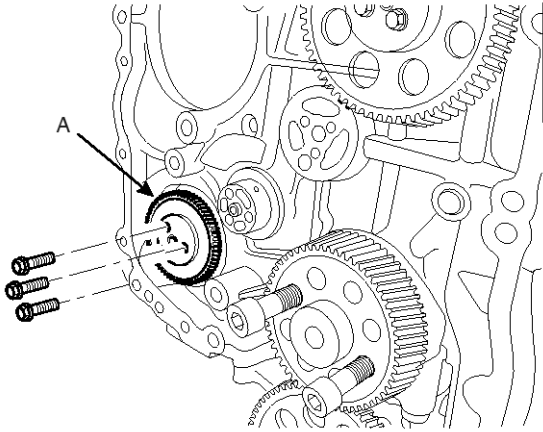
Idler gear C mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)



SDFEM7010D

5. Attach the idler shaft, the washer and the bolt and install the idler gear E(A).

Idler gear E mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)

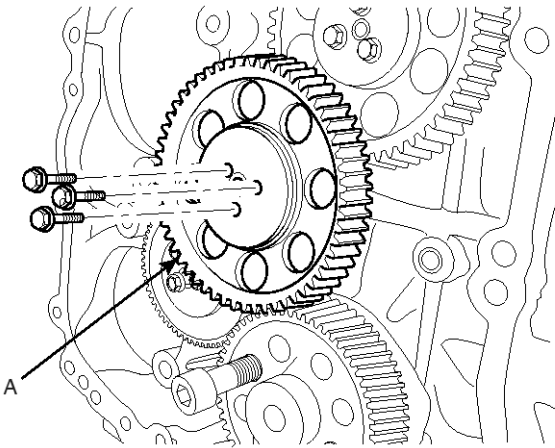


SDFEM7011D

6. Attach the idler shaft, the washer thrust and the bolt and install the idler gear assembly A, B(A).

When installing the idler gear assembly A,B, align the inscribed mark of the idler gear C with that of the idler gear and install them.

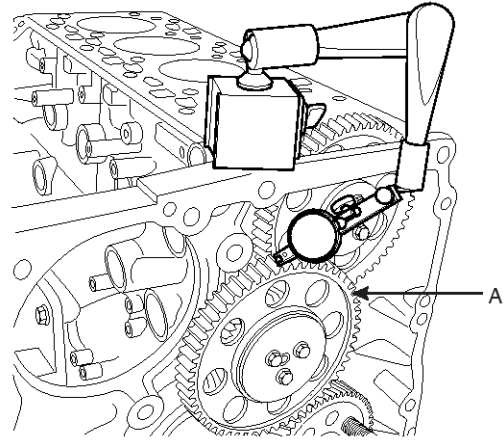
Idler gear A/B mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)



SDFEM7012D

7. Measure the backlash between the idler gear assembly A, B(A).

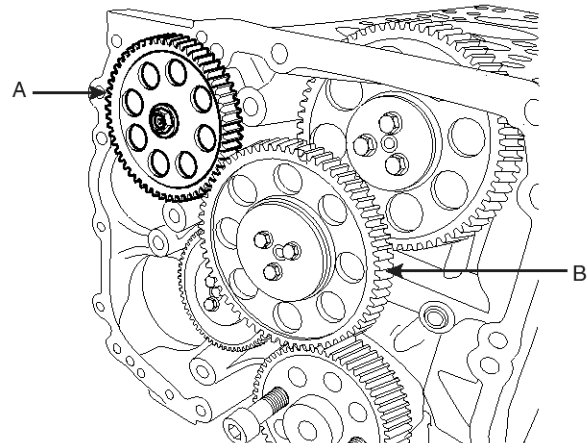
Reference value : 0.036~0.196mm



SDFEM7013D

8. Align the fuel supply pump gear(A) with the inscribed mark and install the idler gear assembly A, B(B).

Fuel supply pump gear mounting bolt : 6~7 kgf.m(58~69 Nm, 43.4~50.6 lb.ft)



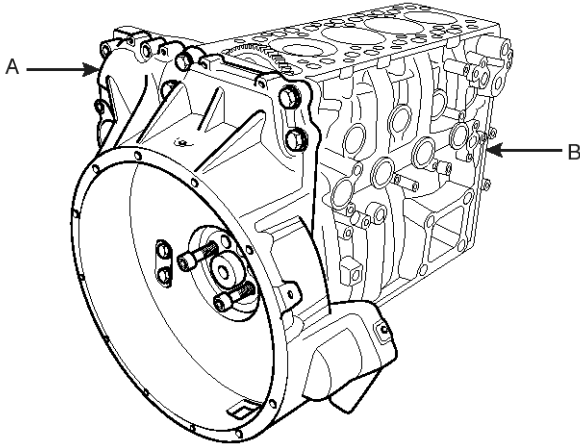
SDFEM7014D

EM-26

Engine Mechanical System

9. Apply the sealant and install the flywheel housing(A) to the cylinder block(B).

Flywheel housing mounting bolt : 13~18 kgf.m(127.5~176.5 Nm, 94~130.2 lb.ft)

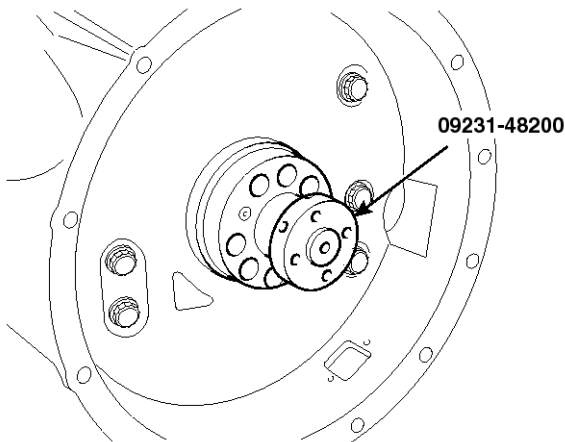


SDFEM7015D

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

CAUTION

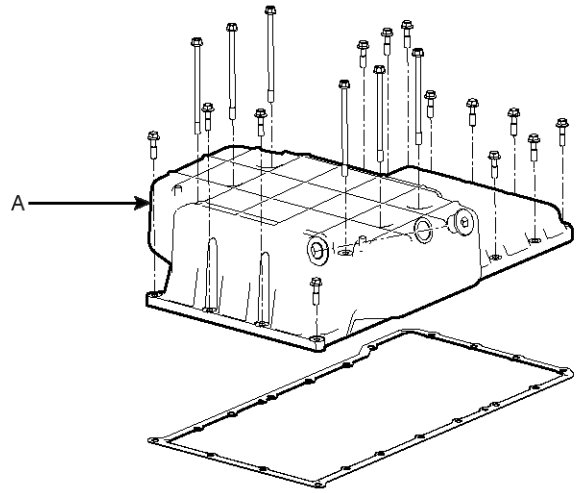
Check that the oil seal lip and the oil seal are good or not.



SDFEM7016D

11. Apply the sealant to the 4 T-joint places of the oil pan gasket and install the oil pan(A).

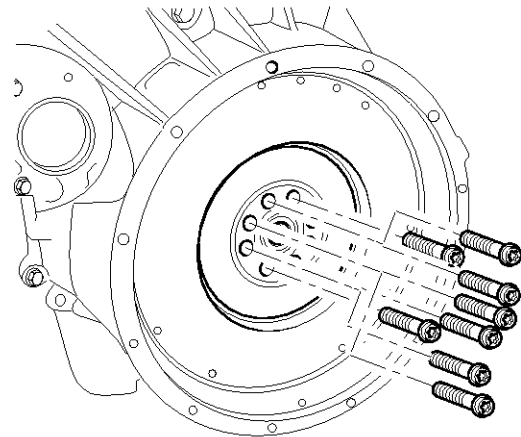
Oil pan mounting bolt : 2.2 ~ 3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb.ft)



SDFEM9059L

12. Install the flywheel.

Flywheel mounting bolt : 14 kgf.m(137 N.m, 101 lb-ft) + 120°



SDFEM7018D

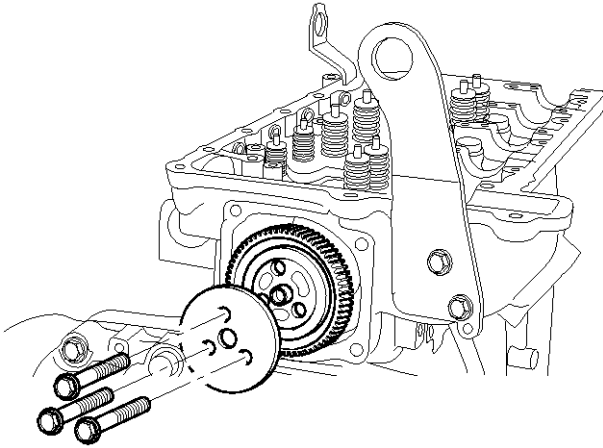
NOTICE

Regarding the flywheel installation, refer to No. 2~7 of section 'Flywheel-installation'.

CAUTION

Never reuse flywheel bolt.

13. Temporarily tighten the idler gear D so that the idler gear C meets the mark "2".

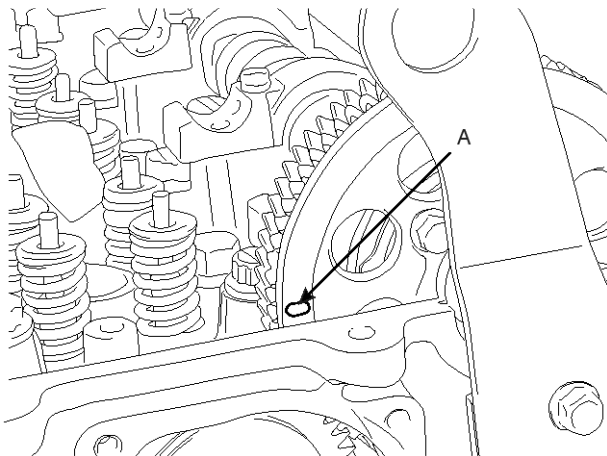


SDFEM7023D

14. Assemble the camshaft assembly.

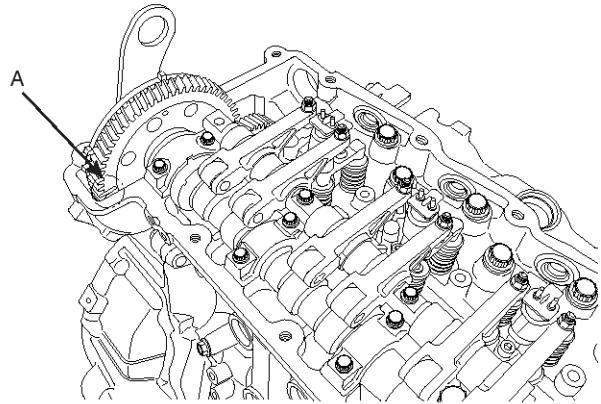
NOTICE

1. Align the machined surface of the cylinder head upper surface with the inscribed mark(A) of the sensor plate in front of the gear from the engine rear side.



SDFEM7071D

2. Align the machined surface of the cylinder head upper surface with the inscribed mark(A) of the cam gear from the engine front.

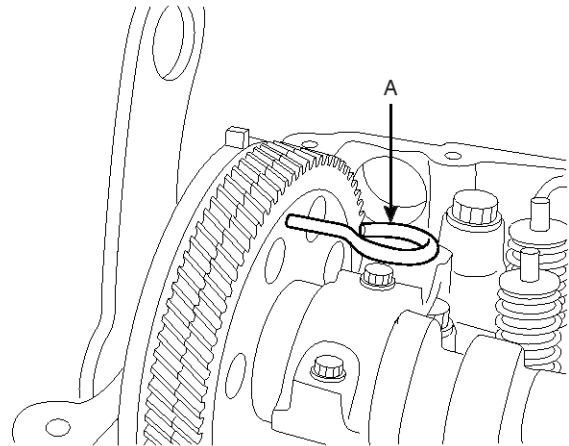


SDFEM7630D

15. Assemble the idler gear D.

Idler gear D mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9 ~23.9 lb.ft)

16. Remove the pin(A) assembled at the camshaft gear.

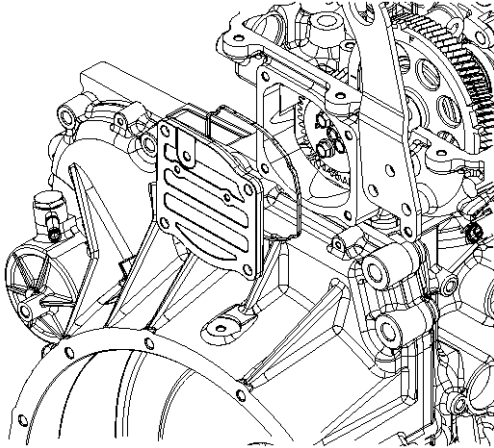


SDFEM7072D

17. Assemble the rear cover.

CAUTION

After checking that the O-ring is installed at the rear cover correctly, install it.



SDFEM7646D

18. Install the vacuum pump(A).

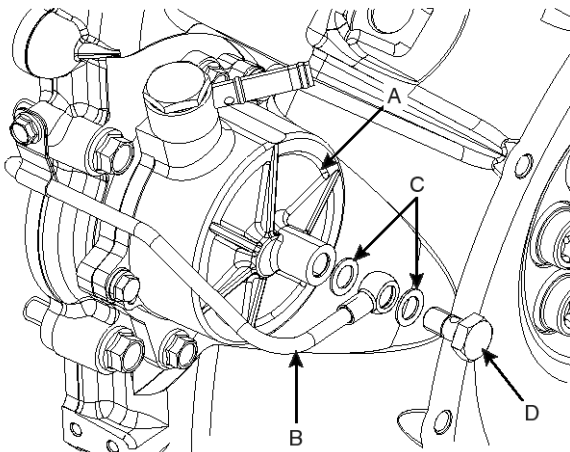
After installing the gasket(C) to the oil feed pipe(B) tighten the eye joint bolt(D).

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

Eye joint bolt : 2.5~3.0 kgf.m(24.5~29.4 Nm, 18.1~21.7 lb.ft)

CAUTION

1. Do not reuse the eye joint bolt(D).
2. Do not reuse the gasket(C).



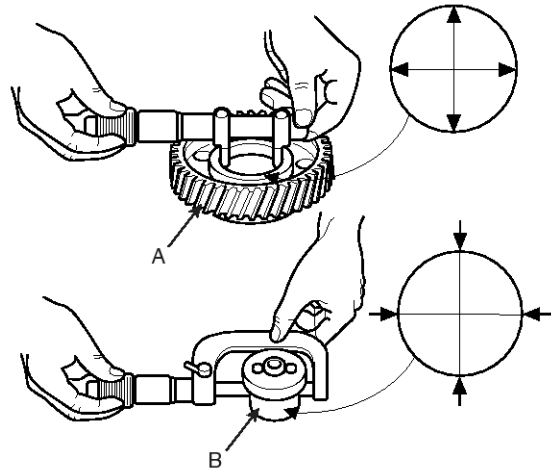
SDFEM7629D

INSPECTION

1. Measure the idler gear(A) I.D. and the idler shaft(B) O.D. and replace the idler gear bush if the gap exceeds limit value.

Gap between the idler bush and the idler shaft : 0.03~0.071mm

Limit value : 0.1mm



SDFEM7049D

2. Measure the long and short diameters of cam and replace the camshaft assembly if it exceeds limit value.

NOTICE

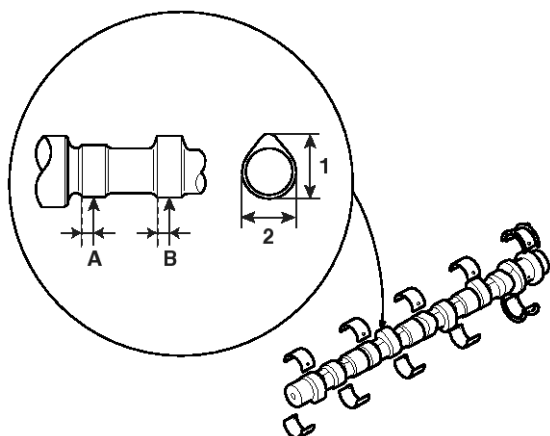
The difference between long and short diameter of cam becomes the cam lift.

Item	Short diameter of cam(2), mm	Long diameter of cam(1), mm	Cam lift, mm
Intake cam	40.6	46.4883	5.8843
Exhaust cam	40.6	46.8164	6.2164

CAUTION

Measure it at the position shown in the illustration since the taper cam is used.

Measuring position	A	B
	6.5mm	6.5mm



SDFEM7050D

3. Measure the gap between the camshaft journal and the bushing and correct the camshaft bushing with an oversize if the gap exceeds limit value.

(Gap between the camshaft journal and the bushing)

Reference value : 0.024~0.077mm

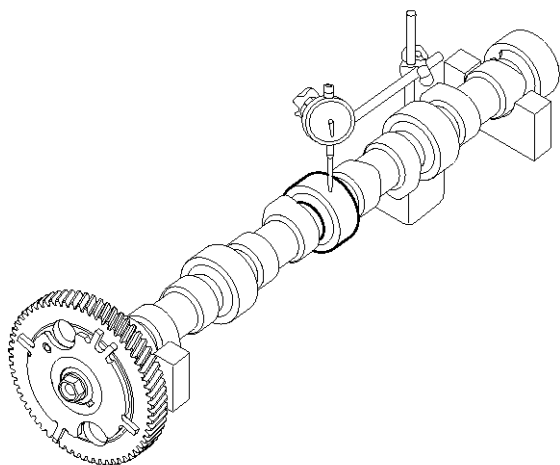
Limit value : 0.15mm

4. Measure the bend of the camshaft and repair or replace it with a press if it is in excess of limit value.

Bending of camshaft : 0.02mm

NOTICE

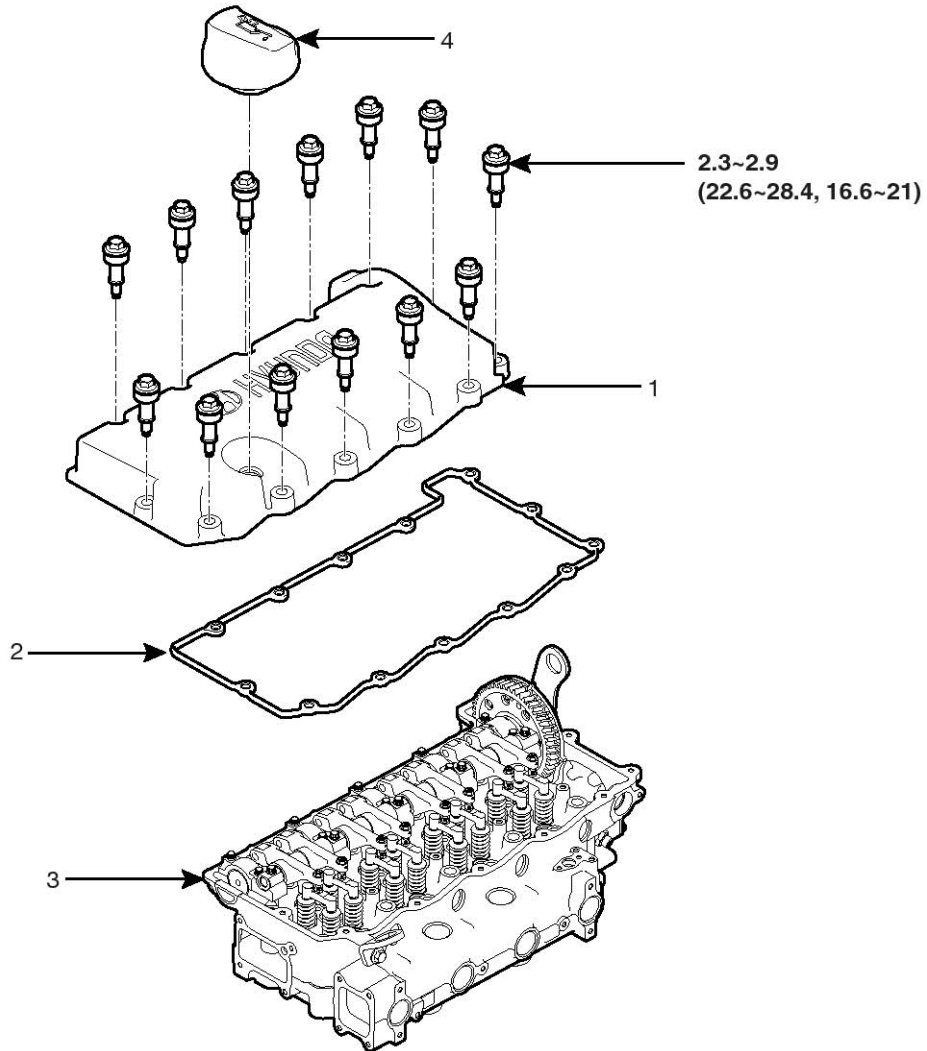
Place the camshaft on the block and rotate the camshaft one turn. At this moment, measure the value by a dial indicator. The one half of the measured value is the bend value of the camshaft.



SDFEM7051D

Cylinder Head Assembly

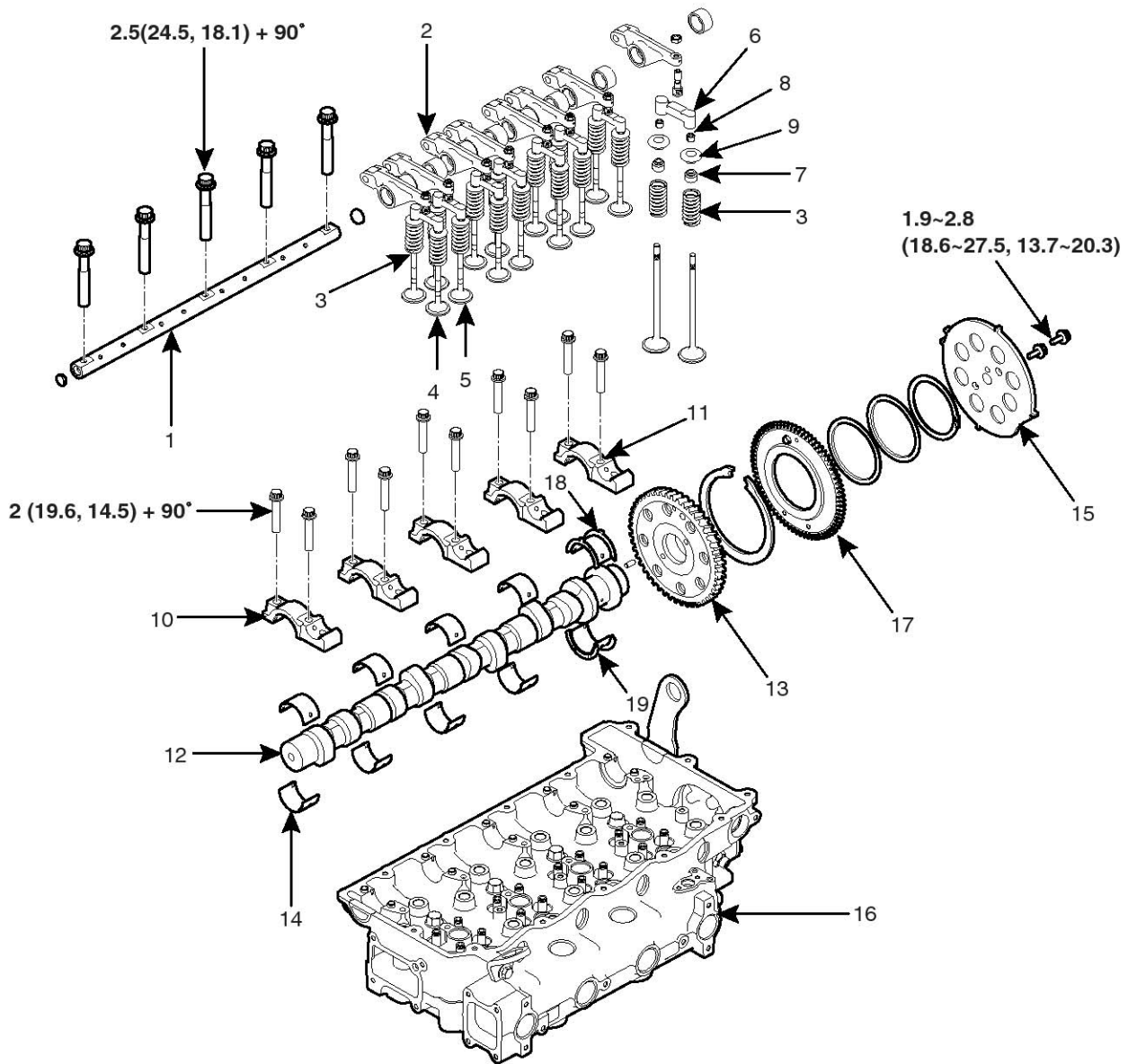
COMPONENTS



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

SDFEM9016L

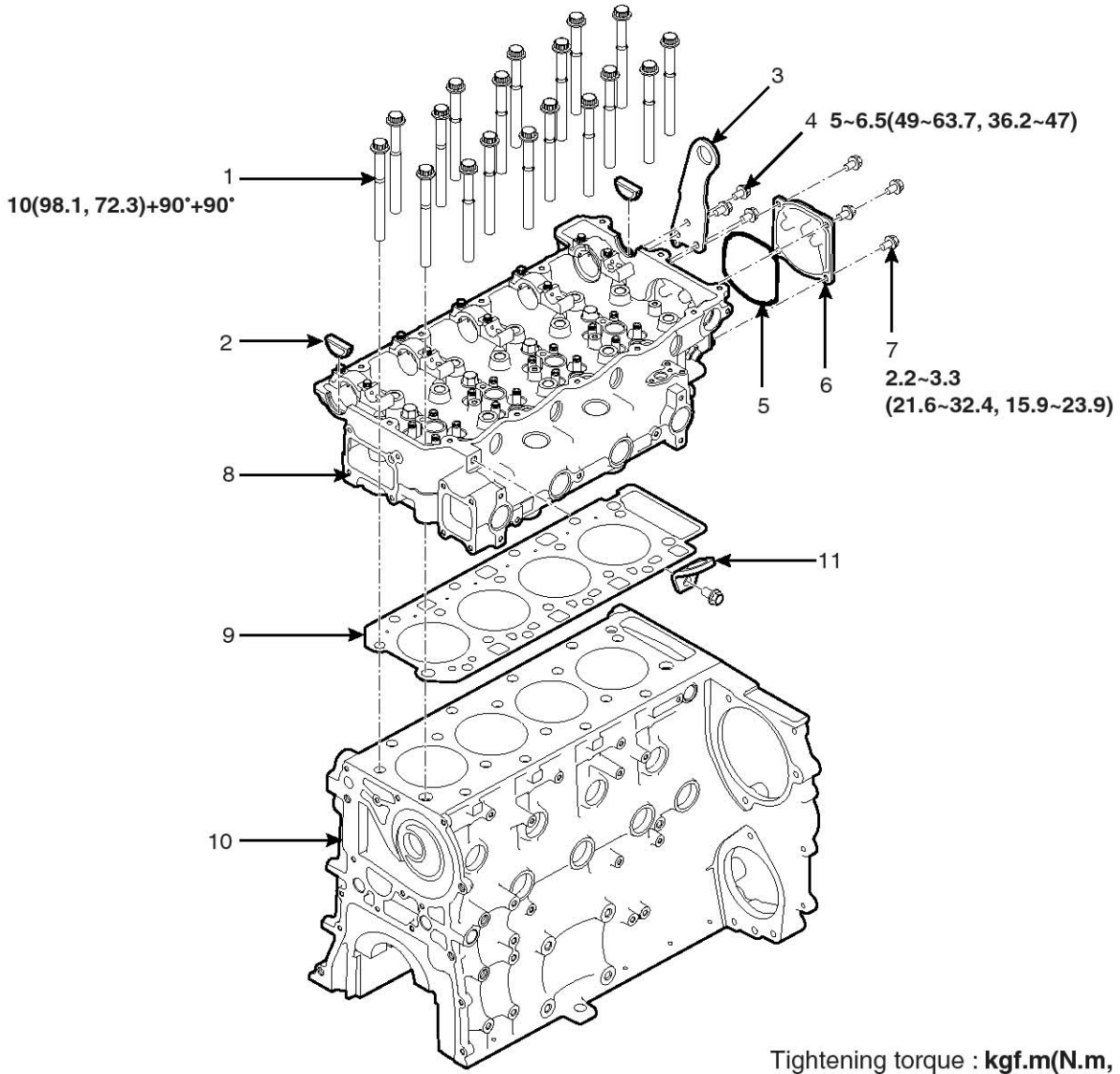
1. Rocker cover assembly
2. Gasket
3. Cylinder head assembly
4. Oil filler cap



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

SDFEM9017L

- | | | | |
|------------------|--------------------|-----------------------|---------------------------------|
| 1. Rocker shaft | 6. Valve bridge | 11. Camshaft rear cap | 16. Cylinder head |
| 2. Rocker arm | 7. Valve stem seal | 12. Camshaft | 17. Scissors gear |
| 3. Valve spring | 8. Valve cotter | 13. Camshaft gear | 18. Upper camshaft thrust plate |
| 4. Intake valve | 9. Retainer upper | 14. Camshaft bearing | 19. Lower camshaft thrust plate |
| 5. Exhaust valve | 10. Camshaft cap | 15. Cam sensor plate | |

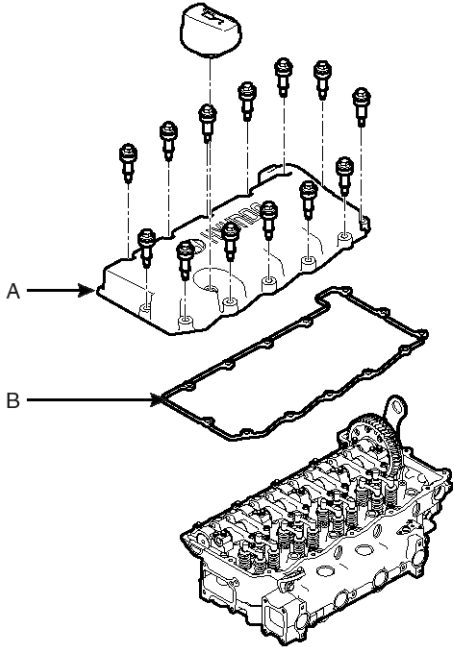


SDFEM9018L

- | | |
|--------------------------|---------------------------|
| 1. Cylinder head bolt | 7. Flange bolt |
| 2. Semi circular packing | 8. Cylinder head assembly |
| 3. Rear hanger | 9. Gasket |
| 4. Spring washer bolt | 10. Cylinder block |
| 5. Rear cover gasket | 11. Front hanger |
| 6. Rear cover | |

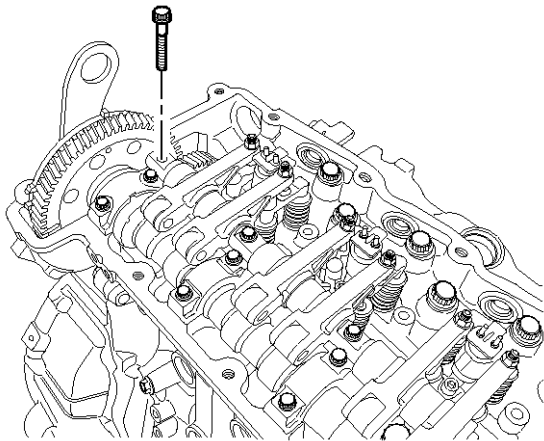
REMOVAL

1. Remove the EGR assembly.
2. Remove the thermostat and the water pipe.
3. Remove the rocker cover(A) and the gasket(B).



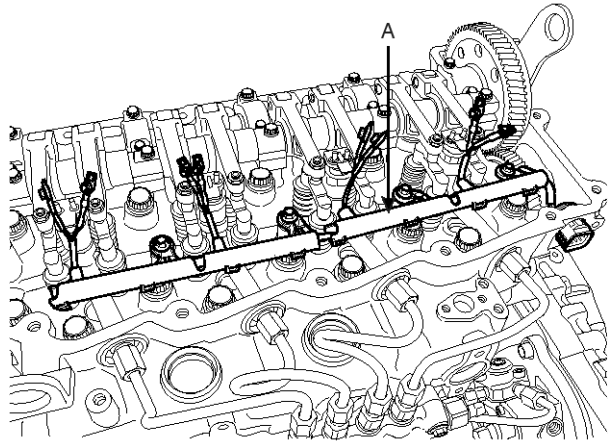
SDFEM7052D

4. Remove the rocker arm assembly.



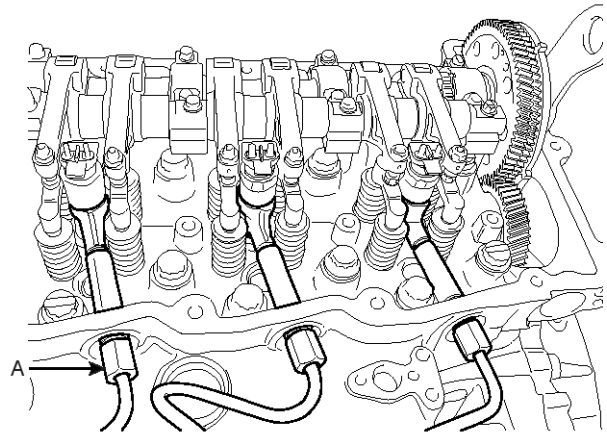
SDFEM7075D

5. After removing the ground of the injector, remove the injector wiring(A).



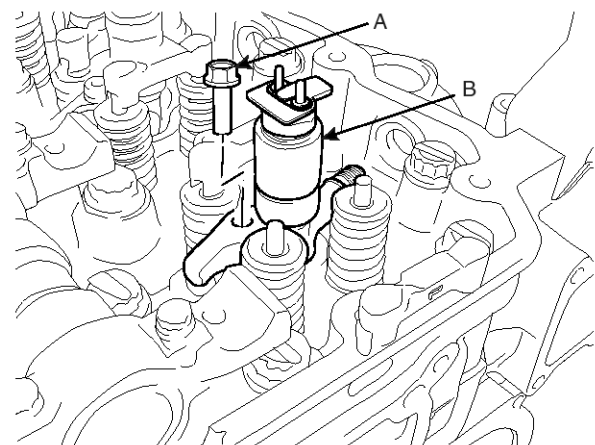
SDFEM7053D

6. Remove the high pressure pipe(A).



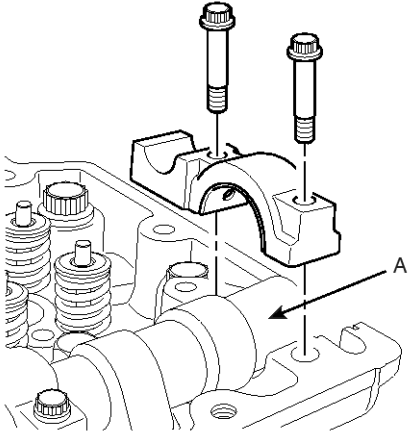
SDFEM7054D

7. Loosen the injector clamp bolt(A) and remove the injector.



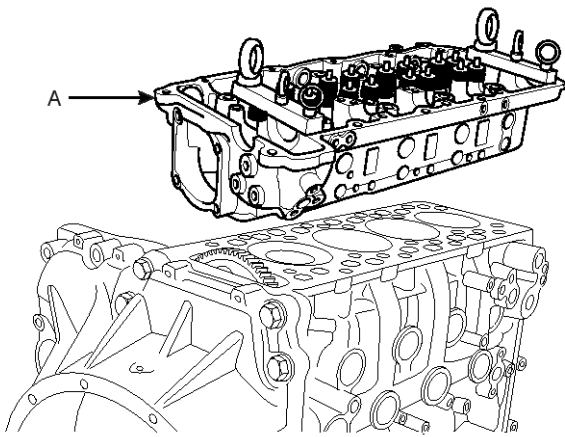
SDFEM7056D

8. After removing the idler gear D, remove the camshaft gear assembly(A) from the cylinder head.



SDFEM7057D

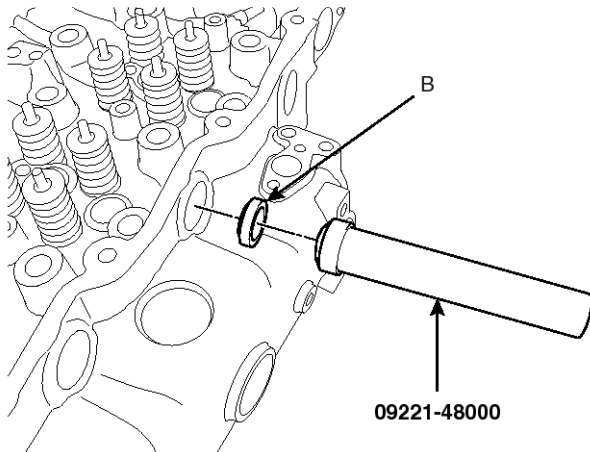
9. Remove the cylinder head assembly(A) with the gasket from the cylinder block.



SDFEM7058D

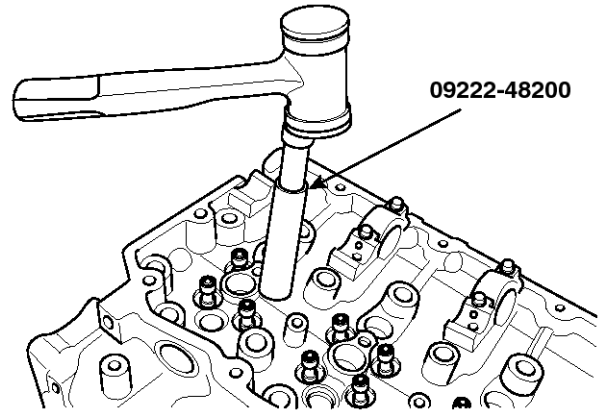
INSTALLATION

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



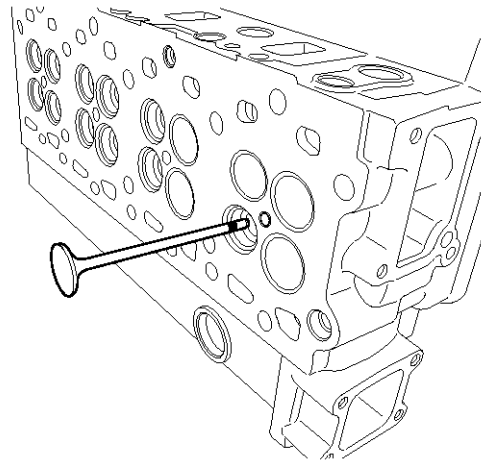
SDFEM7645D

2. Assemble the 16 stem seals by using SST (09222-48200).



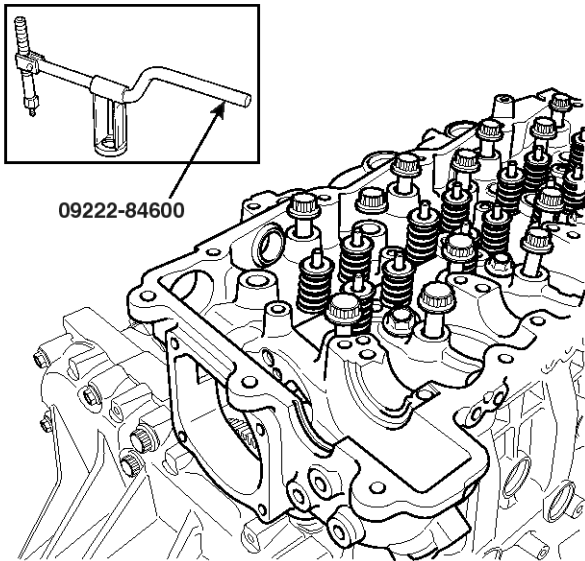
SDFEM7061D

3. Assemble the valves (8 intake valves, 8 exhaust valves) after checking the mark (IN or EX) on the bottom side of valve.



SDFEM7065D

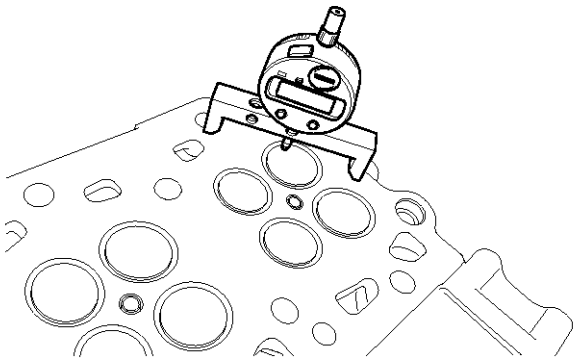
4. Assemble the valve spring, the upper retainer, and the valve cotter by using SST (09222-84600). Assemble those in the order of from intake to exhaust.



SDFEM7064D

5. Check the flatness of the cylinder head valve surface by using a dial gauge after assembling those.

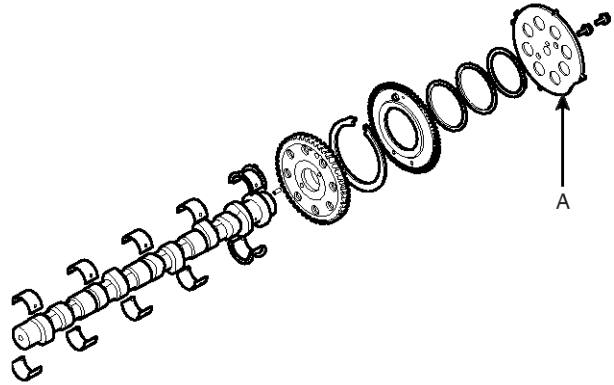
Valve flatness: 0.3~0.7 mm (On the basis of 4 points)



SDFEM7066D

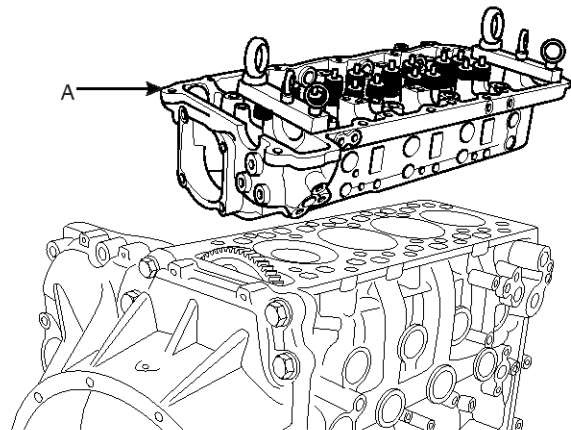
6. Assemble the cam sensor plate (A) to the camshaft gear.

Cam sensor plate mounting bolt: 1.9~2.8 kgf.m



SDFEM7067D

7. Install the cylinder head assembly (A) to the cylinder block with the gasket.



SDFEM7068D

EM-36

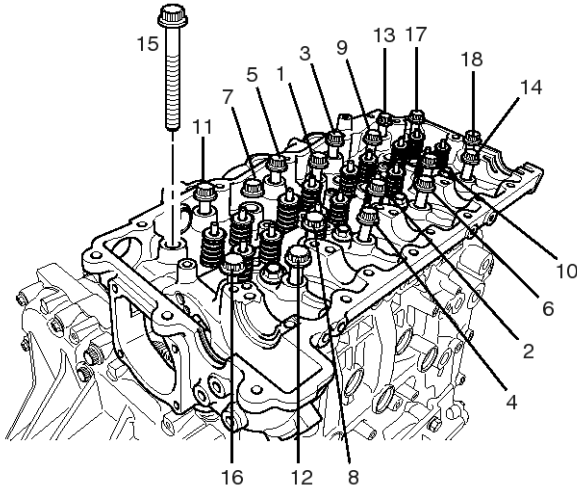
Engine Mechanical System

8. Follow the below order when installing the cylinder head bolts.

Cylinder head mounting bolt : 10 kgf.m(98.1 N.m, 72.3 lb-ft) + 90° + 90° (18EA)

CAUTION

Do not reuse the plasticity bolt.



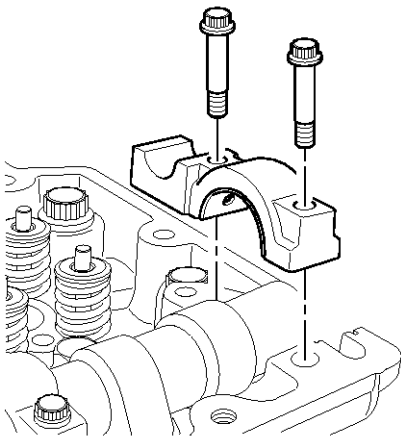
SDFEM7069D

9. Apply the engine oil to the lower and upper of bearings and assemble those with the thrust bearing. Assemble the camshaft gear assembly to the cylinder head.

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

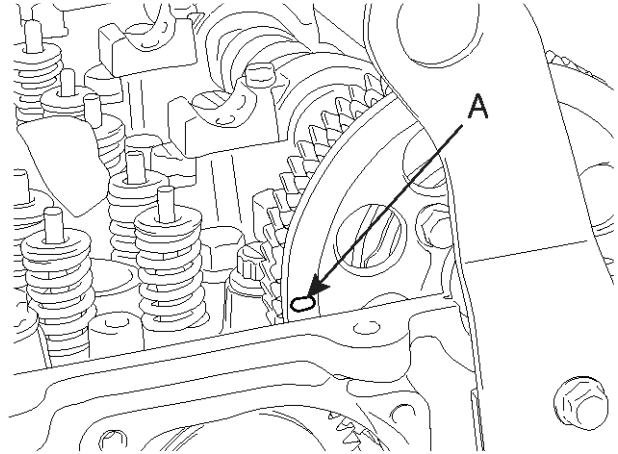
CAUTION

Do not reuse the plasticity bolt.



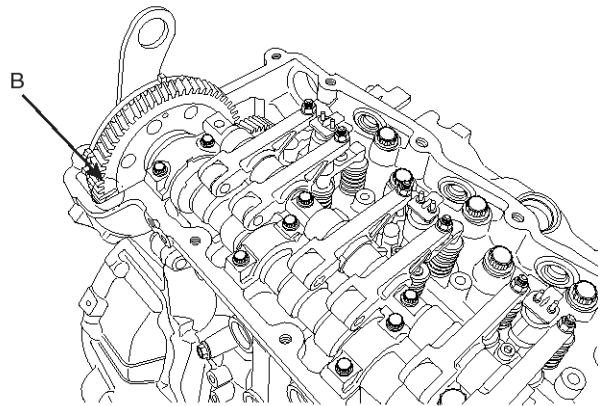
SDFEM7070D

10. When installing the camshaft from the engine rear side, align the inscribed mark (A) of sensor plate in the front of the camshaft gear with the machined surface on the cylinder head upper surface and install.



SDFEM7077D

When installing the camshaft from the engine front side, align the inscribed mark (B) of sensor plate in the front of the camshaft gear with the machined surface of the cylinder head upper surface and install.

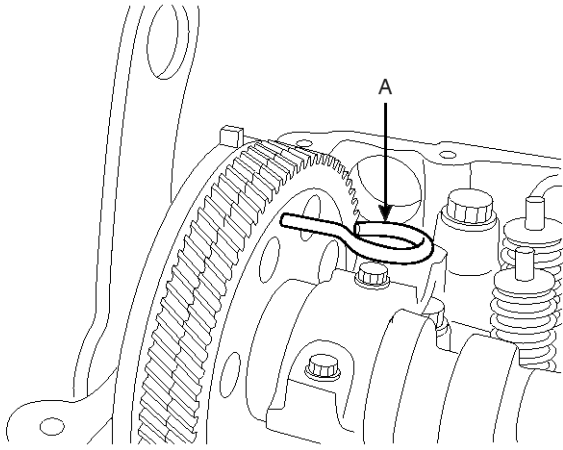


SDFEM9049L

11. Assemble the idler D gear.

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

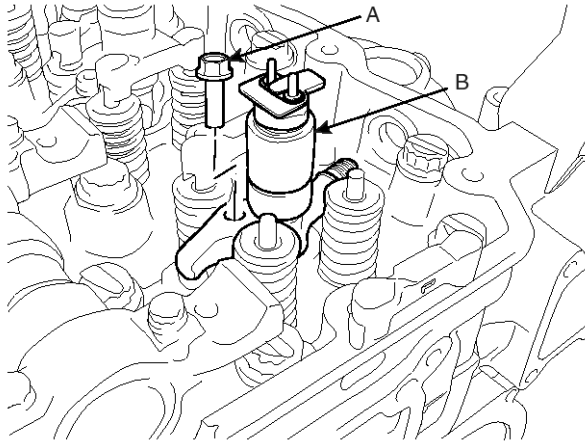
12. Remove the assembled pin (A) in the camshaft gear.



SDFEM7072D

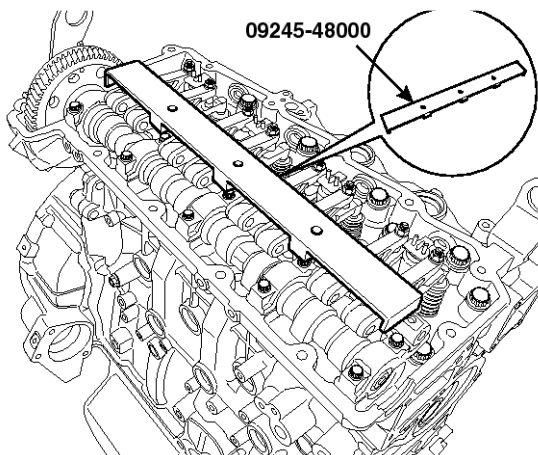
13. Install the injector (B) by tightening the injector clamp bolt.

Injector clamp bolt : 3 kgf.m(29.4 N.m, 21.7 lb-ft)



SDFEM7073D

14. Align the rocker arms from center to outside with the SST (09245-48000).



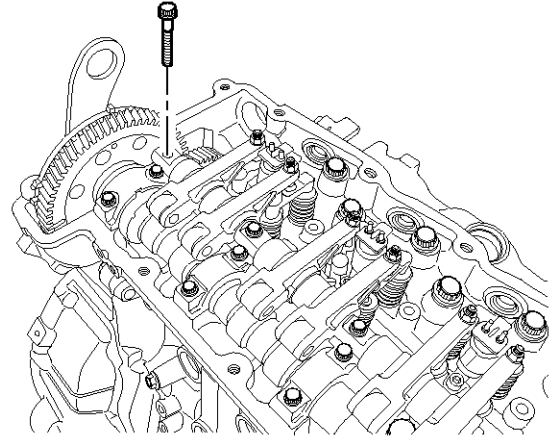
SDFEM7074D

15. Install the rocker arm assembly.

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

CAUTION

Do not reuse the plasticity bolt.



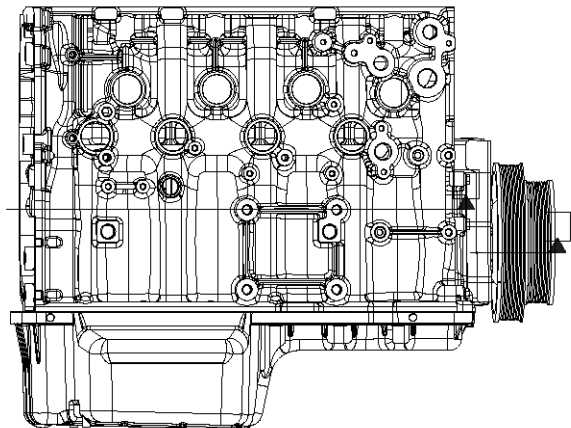
SDFEM7075D

16. Check and adjust the valve clearance by using a thickness gauge.

NOTICE

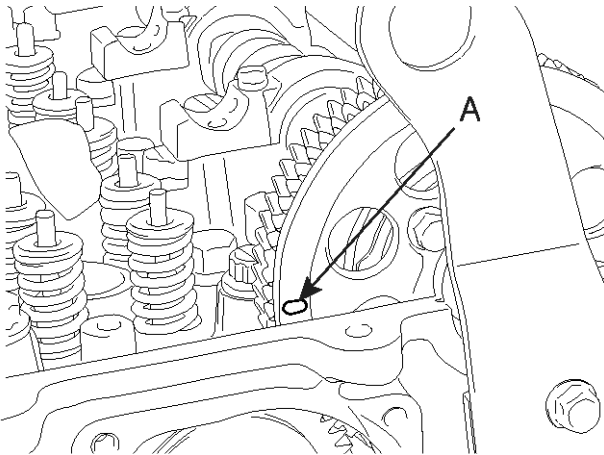
Check and adjust the valve clearance under cold condition.

- a. Align the cylinder #1 TDC.
- b. Align the mark (or painting) at damper pulley circumferential surface of crankshaft with the direction mark on block surface.



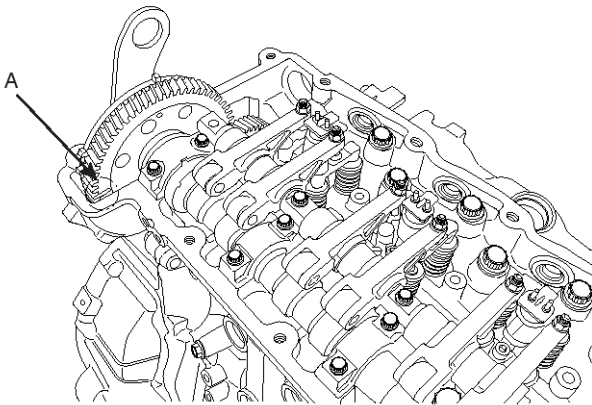
SDFEM7631D

- c. Open the rocker cover, in view from the rear of engine, align the mark (or painting) of cam sensor plate with the machined surface of the cylinder head from the left.



SDFEM7077D

- d. In view from the front of the engine, align the machined surface of the cylinder head with the inscribed mark of the cam gear.



SDFEM7630D

- e. When the above three conditions are satisfied, the condition is in the cylinder #1 TDC.
- f. Refer to the below table under the condition of the cylinder #1 TDC, check and adjust the valve clearance marked "O". Turn the crankshaft to 180° and check and adjust the valve clearance of the rest marked "X".

Cylinder No	1		2		3		4	
	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust	Intake	Exhaust
#1, #4 TDC	O	O	O			O		
#2, #3 TDC				X	X		X	X

- g. Check the clearance between the rocker arm screw and the valve cap by using the thickness gauge (A).

Valve clearance (At cold)

Intake valve: 0.2 mm

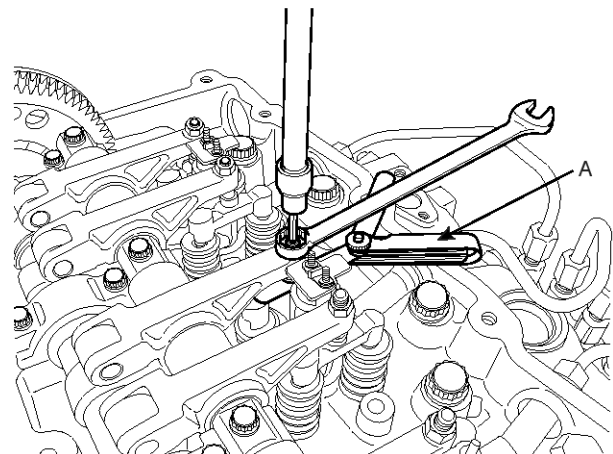
Exhaust valve: 0.6 mm

- h. If the valve clearance is out of specification, adjust the clearance with a thickness gauge by turning the adjusting screw after loosening the lock nut loosely.
- i. After adjusting the valve clearance, tighten the lock nut to the specified torque with the adjusting screw secured by using the screwdriver.

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

NOTICE

Make sure that the valve clearance is within specification after adjusting it.



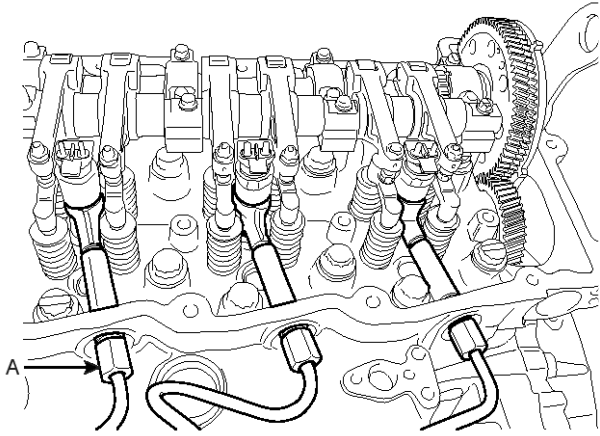
SDFEM7078D

Cylinder Head Assembly

EM-39

17. Install the high pressure fuel pipe (A).

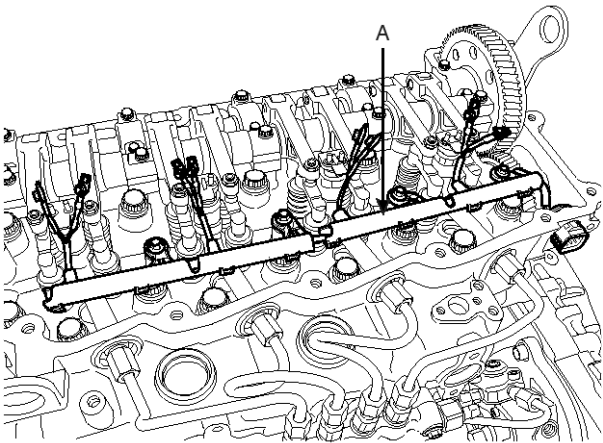
High pressure fuel pipe mounting bolt : 4~5 kgf.m
(39.2~49 N.m, 28.9~36.2 lb-ft)



SDFEM7079D

18. Install the injector wiring (A).

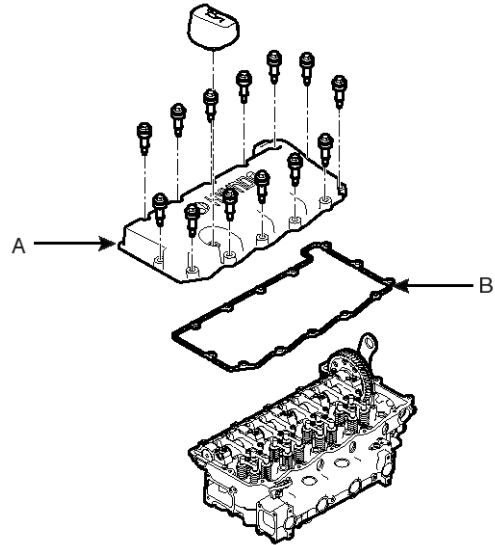
Injector nut tightening torque : 0.18~0.22 kgf.m(1.8~2.2 N.m, 1.3~1.6 lb-ft)



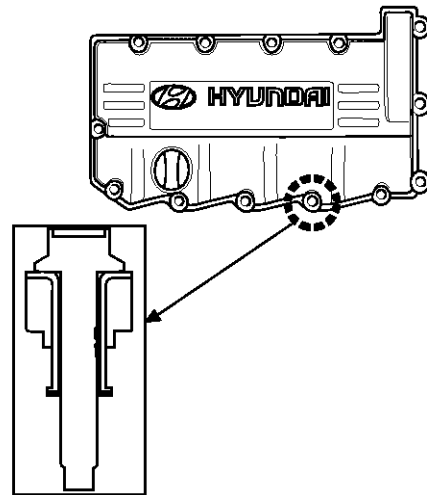
SDFEM7080D

19. Install the rocker cover (A) and the gasket (B).

Rocker cover mounting bolt : 2.3~2.9 kgf.m(22.6~28.4 N.m, 16.6~21 lb-ft)



SDFEM7081D



SDFEM7082D

DISASSEMBLY

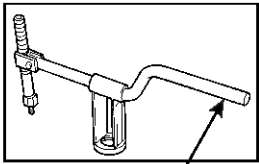
VALVE AND CYLINDER HEAD ASSEMBLY

1. Remove the cylinder head and the cylinder head gasket.

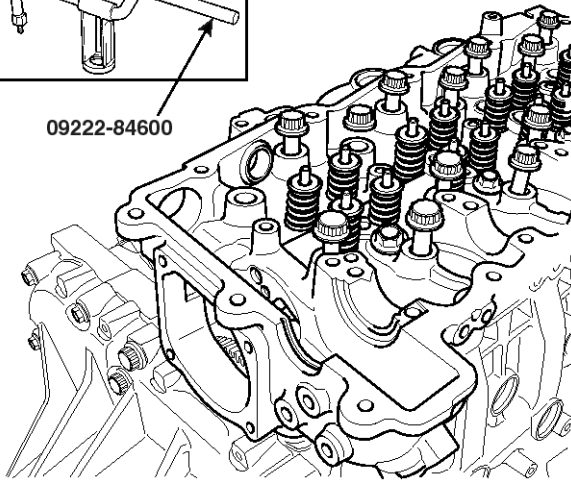
CAUTION

Check the cylinder head and the crankcase for damage when removing the cylinder head gasket.

2. Using the SST(09222-84600) remove the valve cotter with the valve spring pressed.



09222-84600



SDFEM7059D

3. Remove the retainer, the valve spring, the valve stem seal, the intake valve and the exhaust valve from the cylinder head.

CAUTION

Always be sure to replace the valve stem seal with a new one.

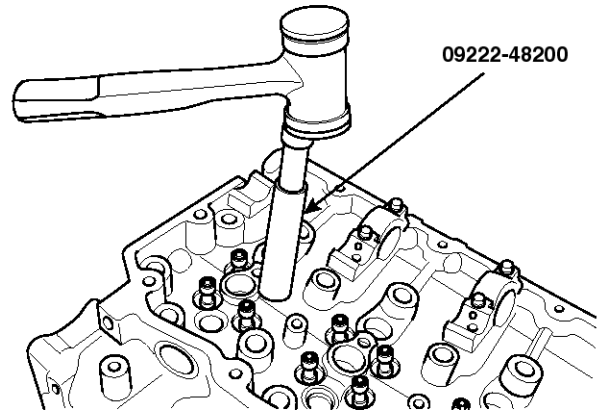
REASSEMBLY

NOTICE

1. Wash each parts cleanly before assembling.
2. Apply new engine oil to contacting part or rotating part prior to installing the parts.
3. Replace the oil seal with new one.

1. Install the valve.

- 1) Using the SST(09222-48200), install the valve stem seal with new one.

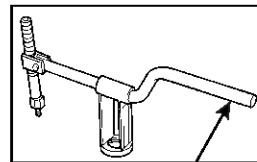


09222-48200

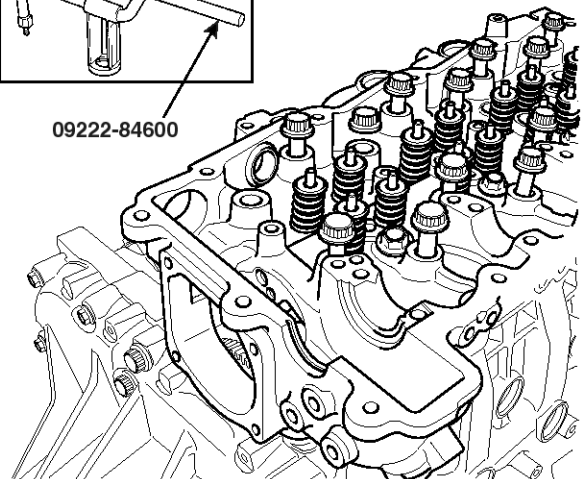
SDFEM7085D

NOTICE

1. Do not reuse the used valve stem oil seal.
 2. Be careful that the oil seal is installed correctly so that the oil may not leak through the valve guide.
 3. Before installing the valve stem seal, apply the engine oil to the valve guide contacting surface of the valve stem seal or the periphery surface of the valve guide.
- 2) Install the valve, the valve spring and the spring retainer.
 - 3) Using the SST(09222-84600), install the valve spring, the retainer upper and the valve cotter. The order of installation starts from the intake valve to the exhaust valve.



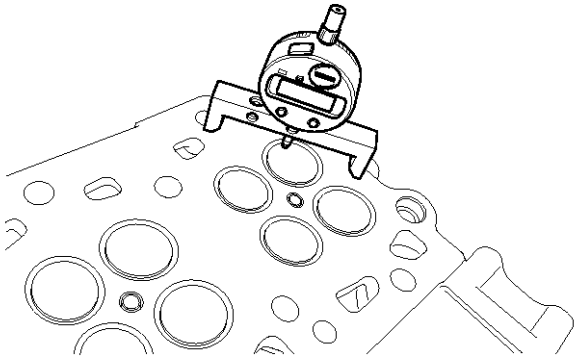
09222-84600



SDFEM7086D

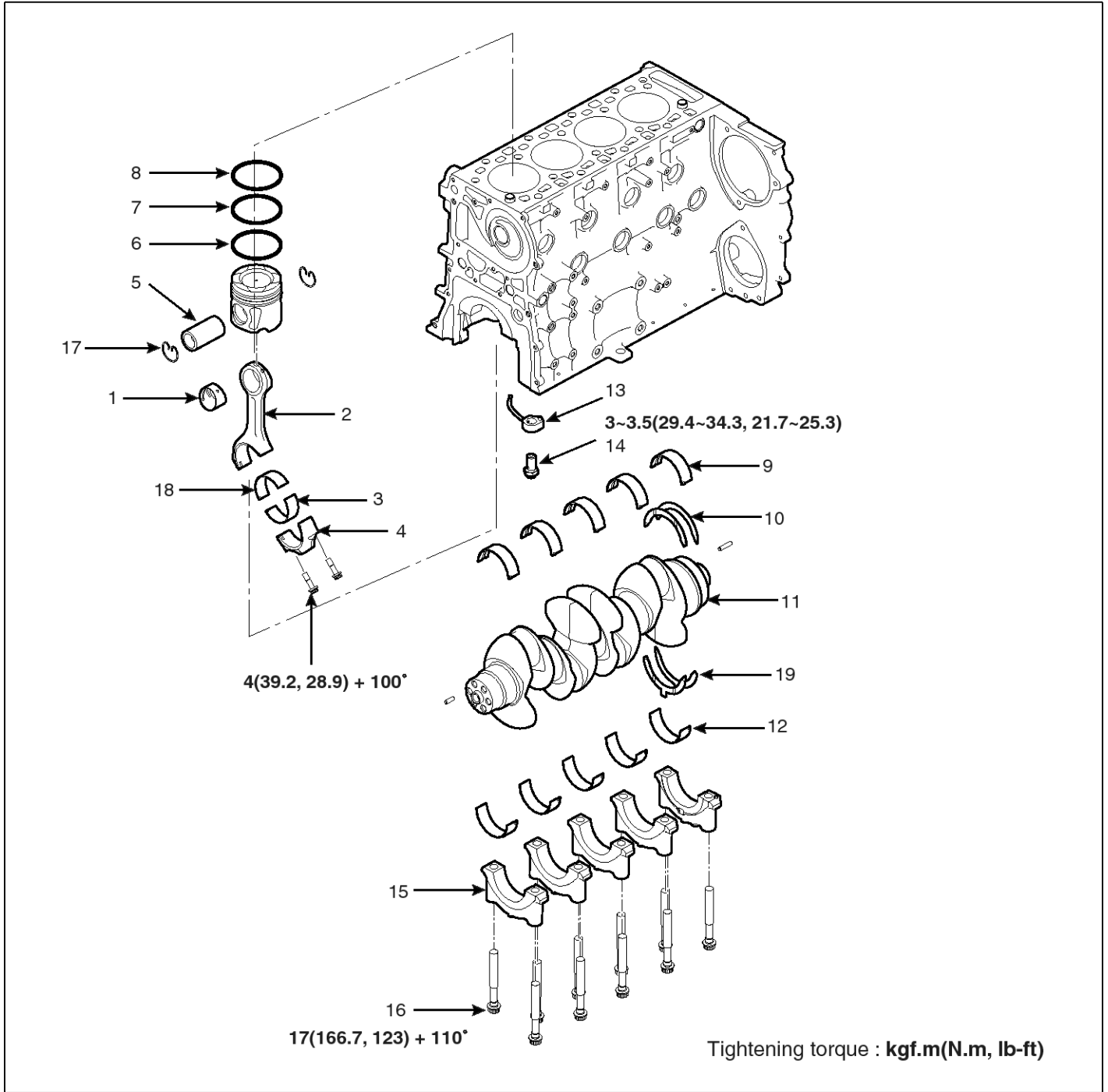
- 4) Measure the flatness of the cylinder head valve surface by using the dial gauge after installing.

Flatness of valve surface : 0.3~0.7 mm(Based on 4 points)



SDFEM7087D

Cylinder Block
COMPONENTS

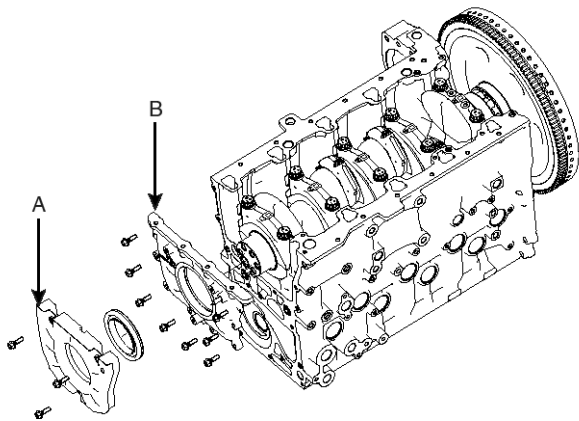


SDFEM9019L

- | | | | |
|---------------------------------|--------------------------|-------------------------|------------------------------------|
| 1. Connecting rod bushing | 6. Oil ring | 11. Crankshaft assembly | 16. Main bearing cap mounting bolt |
| 2. Connecting rod | 7. 2nd piston ring | 12. Lower main bearing | 17. Snap ring |
| 3. Lower connecting rod bearing | 8. 1st piston ring | 13. Oil jet | 18. Upper connecting rod bearing |
| 4. Connecting rod cap | 9. Upper main bearing | 14. Check valve | 19. Lower thrust bearing |
| 5. Piston pin | 10. Upper thrust bearing | 15. Main bearing cap | |

REMOVAL

1. Separate the transmission from the engine.
2. Remove the accessories from the engine.
3. Align the engine cylinder #1 with TDC.
4. Remove the cylinder head assembly.
5. Remove the oil pan assembly.
6. Remove the flywheel and the flywheel housing.
7. Remove the timing gear.
8. Remove the oil pump assembly.
9. Remove the crankshaft gear.
10. Remove the front shield(A) and the front cover(B).

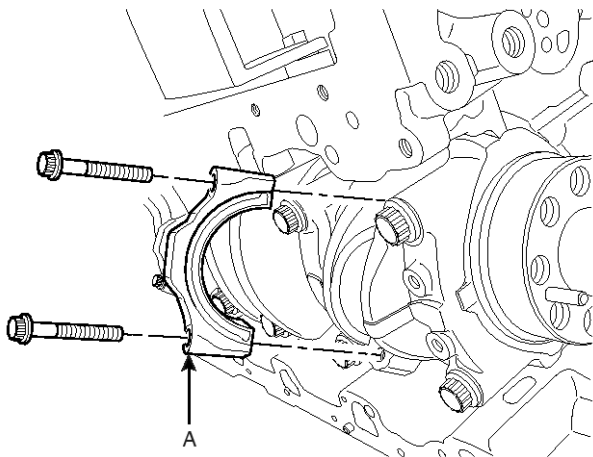


SDFEM7632D

11. Detach the connecting rod cap(A) and remove the piston.

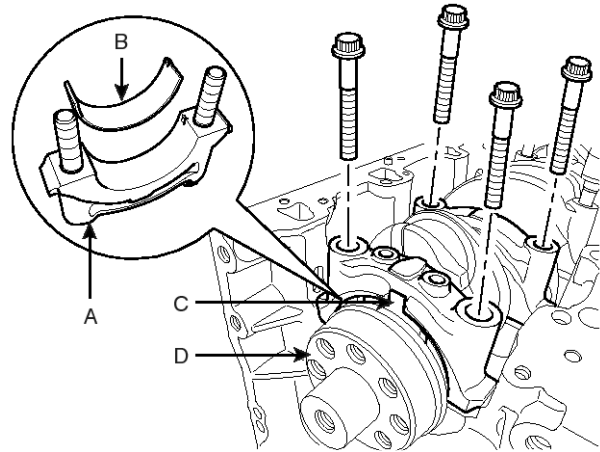
NOTICE

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



SDFEM7092D

12. Remove the piston and the connecting rod assembly from the cylinder block.
13. Remove the main bearing cap (A), the lower main bearing (B), and the lower thrust bearing (C) from the crankshaft (D).

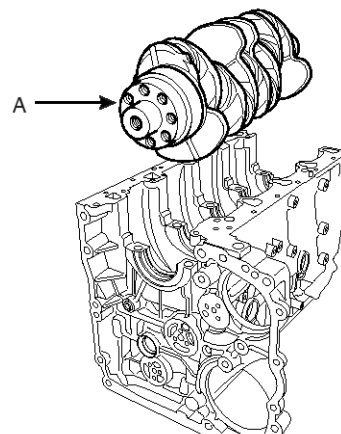


SDFEM7095D

14. Remove the crankshaft(A) from the cylinder block.

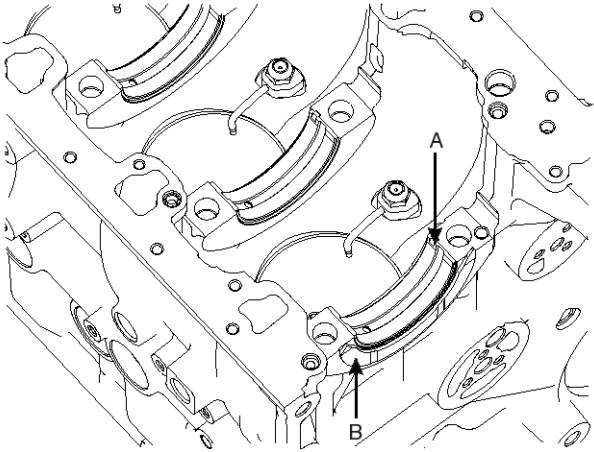
CAUTION

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



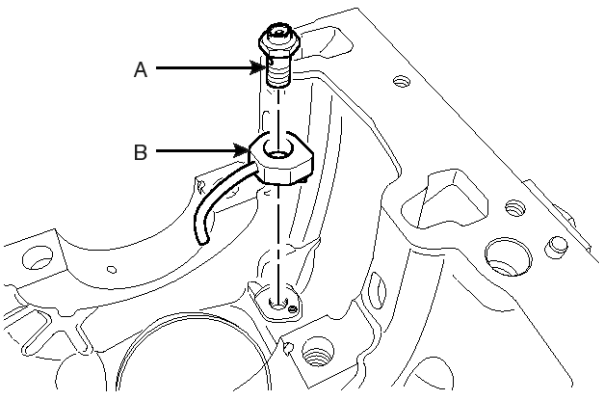
SDFEM7096D

15. Remove the upper main bearing (A) and the upper thrust bearing (B).



SDFEM7642D

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

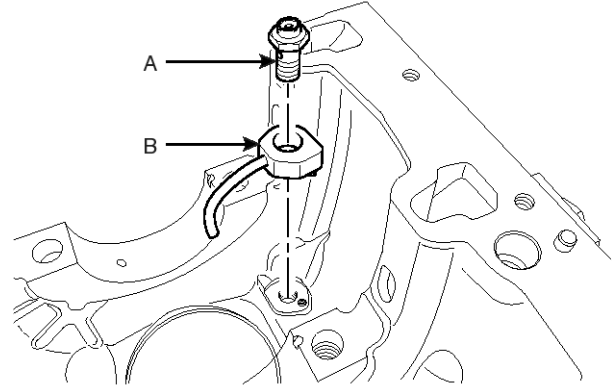


SDFEM7098D

INSTALLATION

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

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

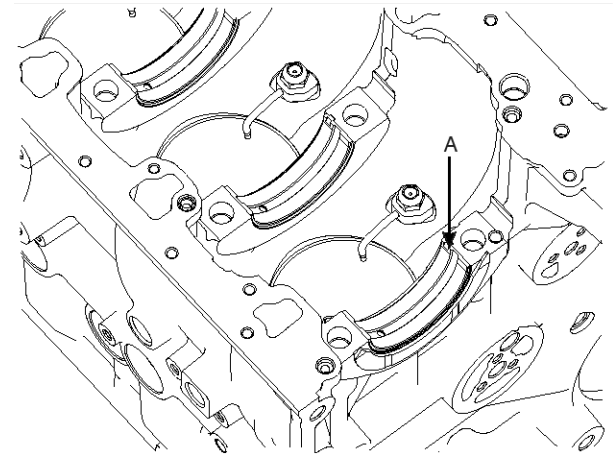


SDFEM7098D

2. Install the upper main bearing (A).

⚠ CAUTION

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

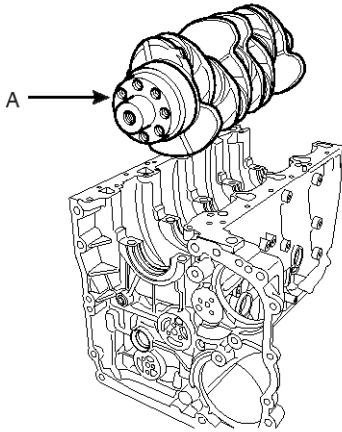


SDFEM7097D

3. Install the crankshaft(A) to the cylinder block.

CAUTION

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



SDFEM7096D

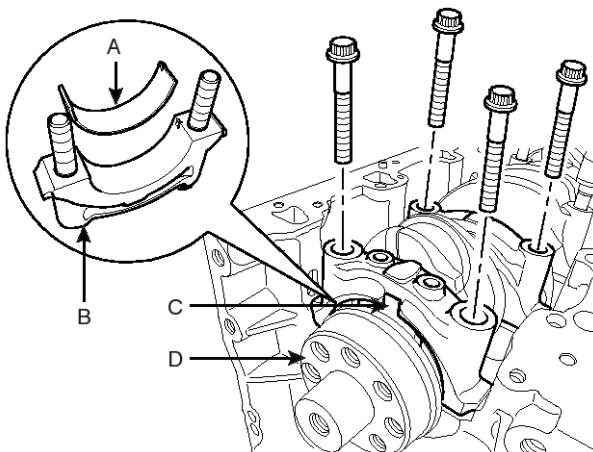
4. Assemble the upper thrust bearing to both sides of the journal of the crankshaft No.5.

CAUTION

Assemble the thrust bearing after facing its oil groove outside.

5. Install the lower main bearing (A) to the main bearing cap (B) and then install to the crankshaft (D). Install the bearing cap No.5 with the lower thrust bearing (C).

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



SDFEM7633D

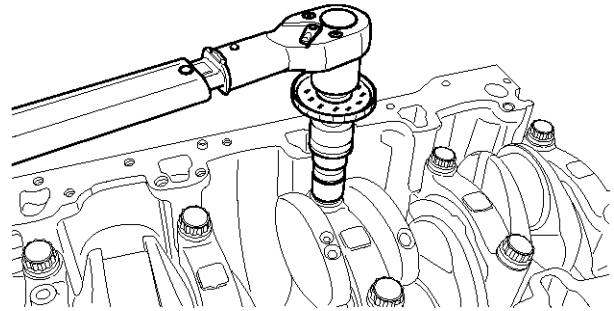
NOTICE

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

CAUTION

Never reuse the main bearing cap bolt.

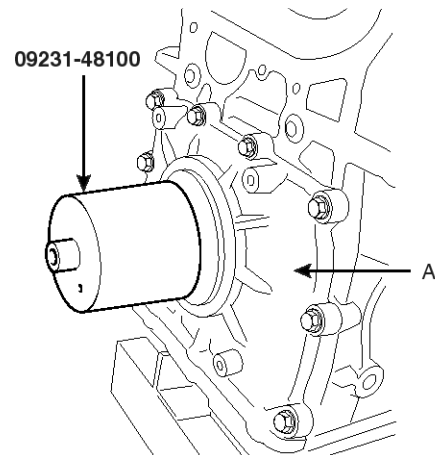
- b. Make sure that the crankshaft rotates smoothly.



SDFEM7099D

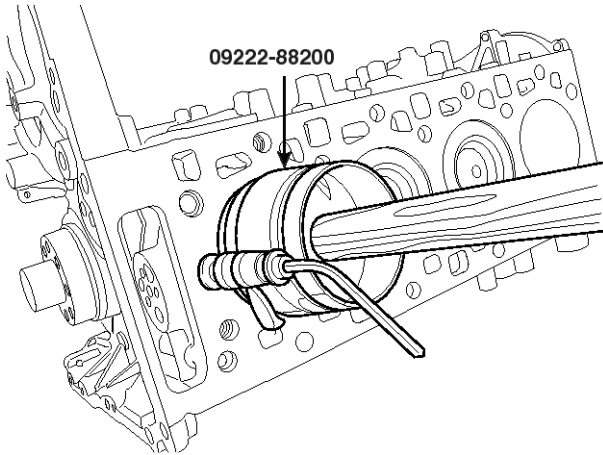
6. Install front cover (A) with sealant applied and using the special tool(09231-48100), install the front oil seal and the front shield.

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



SDFEM7634D

7. Using the SST(09222-88200), install the piston and the connecting rod assembly to the cylinder block.



SDFEM7100D

NOTICE

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

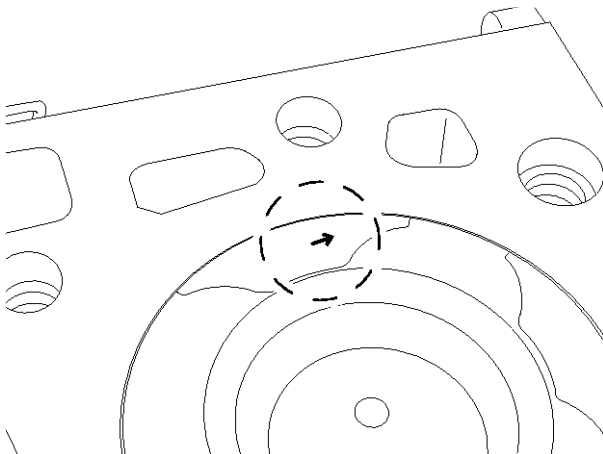
- b. Use the piston fit with the cylinder block bore diameter grade.

* Cylinder block A,B : Piston A

* Cylinder block B,C : Piston B

CAUTION

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



SDFEM7101D

8. Tighten the connecting rod bolt to the specified torque. After installing the pistons #2,#3, install the piston #1, #4 by turning the crankshaft.

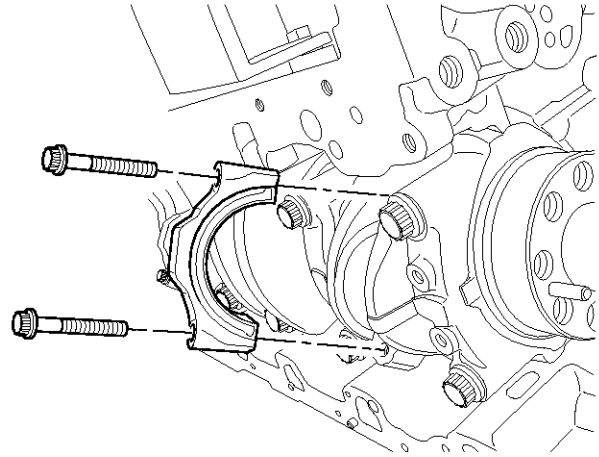
Connecting rod bolt : 4 kgf.m(39.2 N.m, 28.9 lb-ft)+100 °

NOTICE

- a. The connection rod cap surface might not be smooth for the durability of the connecting rod. Do not mistake it for the defective parts.

CAUTION

Do not reuse the connecting rod bolt.



SDFEM7102D

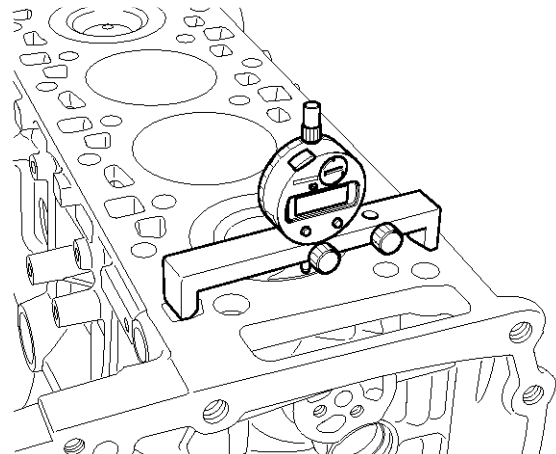
- b. Apply a small amount of oil to the moving surfaces of the connecting rod bearing and the crankshaft journal and install the connecting rod cap.

9. Measure the piston protrusion amount.

Protrusion amount : -0.309 ~ 0.259 mm

NOTICE

Measure at the same position as the crankshaft center line.



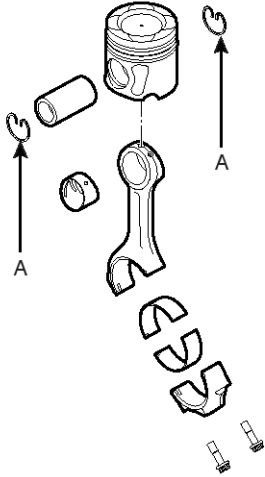
SDFEM7103D

10. Install the crankshaft gear.
 11. Install the oil pump assembly.
 12. Install the oil pan assembly.
 13. Install the timing gear.

14. Install the flywheel housing and the flywheel.
15. Install the cylinder head.
16. Install accessories into the engine.

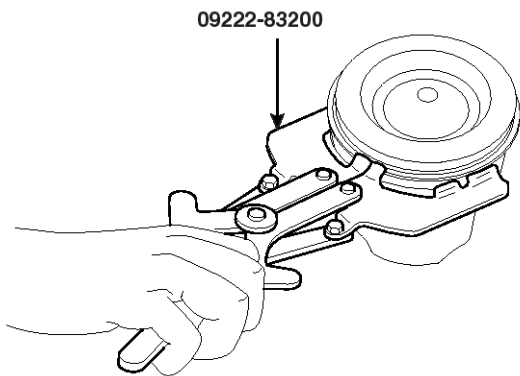
DISASSEMBLY

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



SDFEM7104D

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

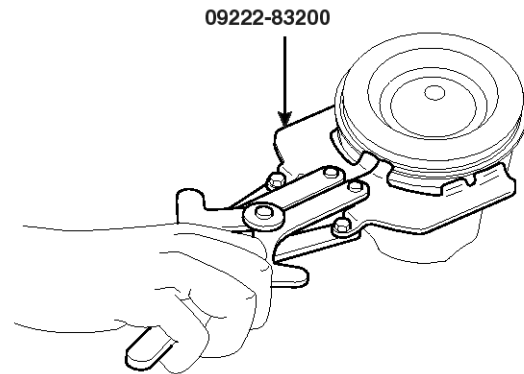


SDFEM7105D

REASSEMBLY

PISTON AND CONNECTING ROD ASSEMBLY

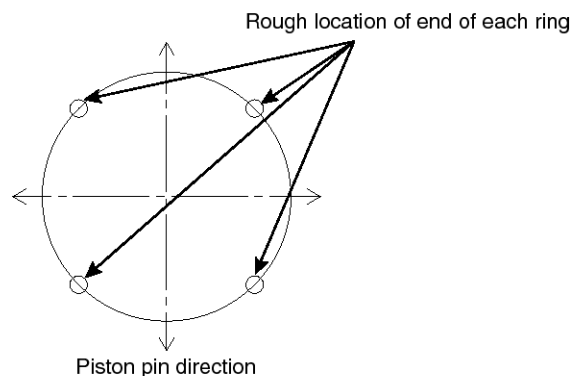
1. Using the SST(09222-83200), assemble the piston ring.



SDFEM7105D

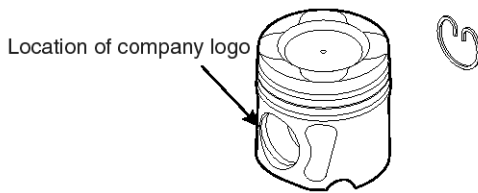
NOTICE

1. Piston ring No. 1, 2
 - a. Face the company mark of ring end upwards (cylinder head side) and assemble it.
 - b. Assemble 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
 - a. The open end of oil ring assembles to be in the 180 degree direction with the open end of coil spring and the open end of ring No.2 assembles to be in the 90 degree direction.
3. Make sure that the piston ring moves smoothly when turning it to right or left.
4. The position of open end of each ring is as follows:



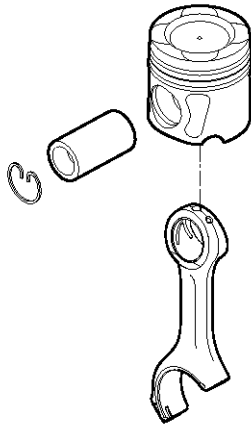
SDFEM9020L

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



SDFEM9021L

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



SDFEM7108D

4. Apply oil sufficiently to the periphery of the piston pin, the piston pin hole and the connecting rod smaller end.

Lubricants : Engine oil, lard oil or non water-soluble press oil

5. After assembling the piston pin, assemble the snap ring of the opposite side.

⚠ CAUTION

1. When assembling, be careful that the contacting surfaces of the connecting rod smaller end and the piston and the piston pin do not cause damage or scratch.
 2. Be sure to align and assemble the snap ring with the piston pin hole.
6. Assemble the 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 the 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.

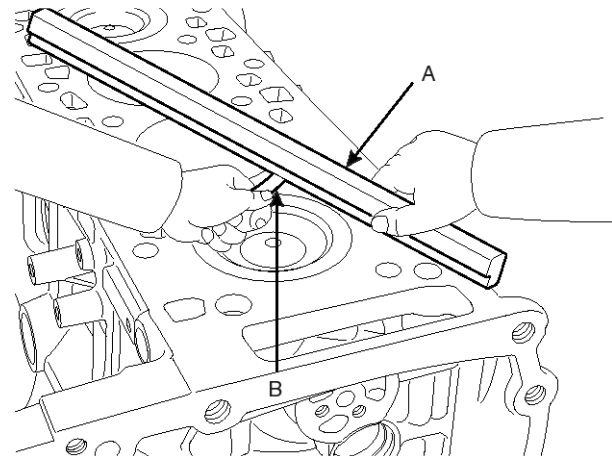
📌 NOTICE

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

⚠ CAUTION

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

Flatness figure of the cylinder block upper surface
Reference value : Below 0.07 mm



SDFEM7109D

3. Check the cylinder wall for 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.

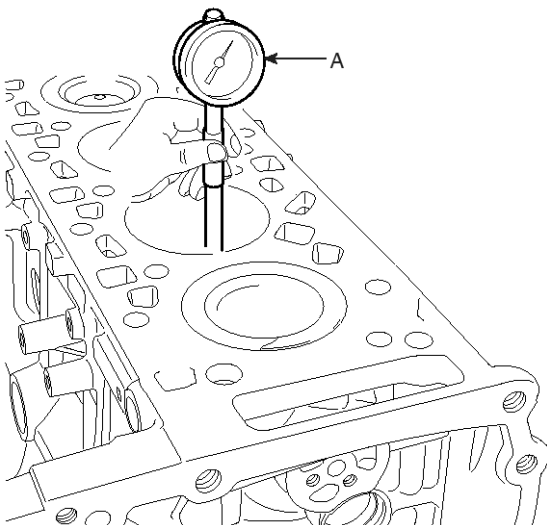
Item	I.D of cylinder block	Roughness (I.D of cylinder block)	O.D of sleeve
Repair size(mm)	Ø 106.938 ~ 106.96	Rz 12.5	Ø 107.15 ~ 107.18
Repair oversize(mm)	Ø 107.438 ~ 107.46	Rz 12.5	Ø 107.65 ~ 107.68

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

Clearance between piston and cylinder sleeve :
0.111 ~ 0.145 mm

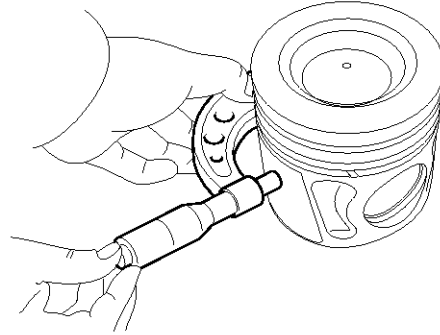
- a. Measure the inner diameter of the cylinder sleeve using the cylinder gauge (A).

The inner diameter of cylinder sleeve : 102.985 ~ 103.015 mm



- b. Measure the outer diameter of piston skirt at the position which is 84.2mm down from the upper of the piston.

Piston O.D. : 102.863 ~ 102.881 mm



SDFEM7110D

SDFEM7111D

CAUTION

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

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	

SDFEM9044L

*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 ± 5°

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 piston and the piston ring should be replaced with the same as oversize.

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

PISTON

1. Check each piston for damaged or not.
2. Check whether the piston pin is installed correctly in the piston hole.

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

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



SDFEM7112D

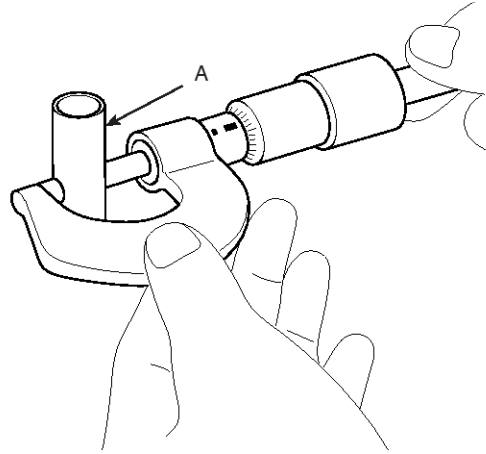
3. Measure the clearance between the piston pin(A) and the piston pin hole by measuring the outer diameter of the piston pin (A) and the inner diameter of piston pin hole.

Outer diameter of piston pin : 43.994~44mm

Inner diameter of piston pin hole : 44.007~44.015mm

Clearance reference value : 0.007~0.021mm

Clearance limit value : 0.05mm



SDFEM7113D

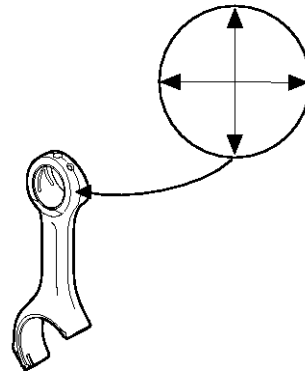
4. Measure the clearance between the piston pin and the connecting rod smaller end.

Inner diameter of connecting rod smaller end : 44.030~44.040mm

Outer diameter of piston pin : 43.994~44mm

Clearance reference value : 0.03~0.046mm

Clearance limit value : 0.1mm



SDFEM7114D

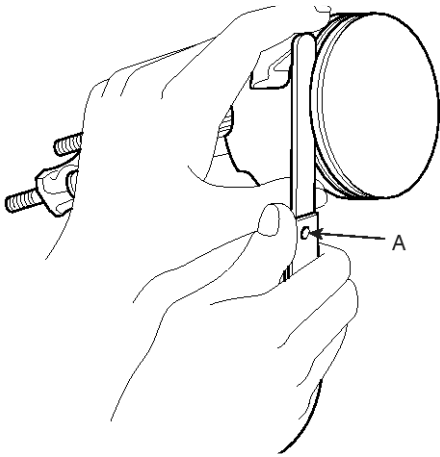
PISTON RING

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

NOTICE

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

Piston ring	Reference value(mm)	Limit value(mm)
Piston ring #1	0.121~0.161	0.2
Piston ring #2	0.09~0.13	0.17
Oil ring	0.03~0.07	0.15



SDFEM7115D

CRANKSHAFT

1. Measure the endplay of the crankshaft.

Crankshaft endplay

Reference value : 0.1 ~ 0.292 mm

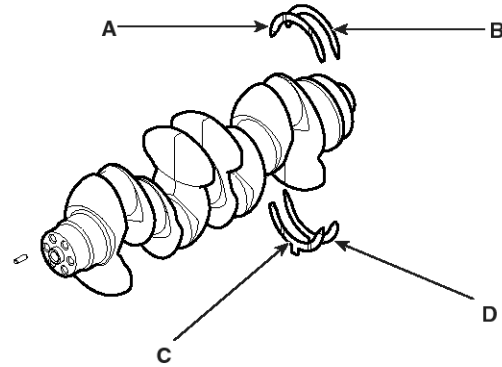
Limit value : 0.4 mm

- 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) is not necessarily same as that of B(D).

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



SDFEM9053L

2. Measure the oil gap of the crankshaft main bearing.
 - a. Separate the main bearing cap.
 - b. Measure the oil gap of the main bearing.
 - 1) Remove the oil or other foreign materials from the 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.

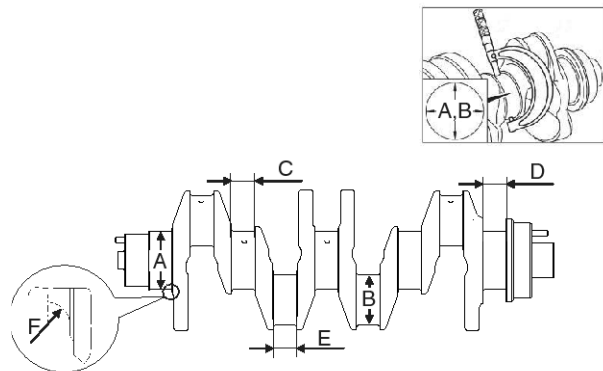
Tightening torque : 17 kgf.m(166.7 N.m, 123 lb-ft) + 110 °

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

Reference value : 0.048~0.11mm, Limit value : 0.15mm

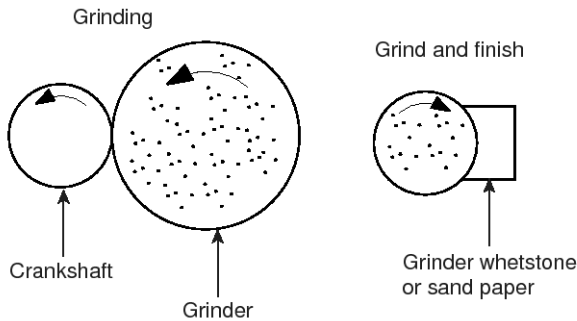
- 5) If the oil gap of the main bearing is excessively out of range, replace the main bearing.
3. Measure circularity and parallelism of the crankshaft journal and pin.

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



SDFEM9054L

- At grinding, the distance between a pin center and a journal center should not be changed.
- A width of journal and pin should not be changed.
- Lightly finish the fillet with specified radius R.
- Check grinding crack using a magnetic detector, and the surface hardness (HV 550), as well, if decreased.
- When grinding the crank shaft, the grinder and the crankshaft both rotate counterclockwise if seen from the front.
- Perform the finishing treatment of the crankshaft while rotating it to clockwise 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)	Circularity	Parallelism	
			#1~#4	#5				Journal/pin	Journal/pin
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	-	-	-	-			

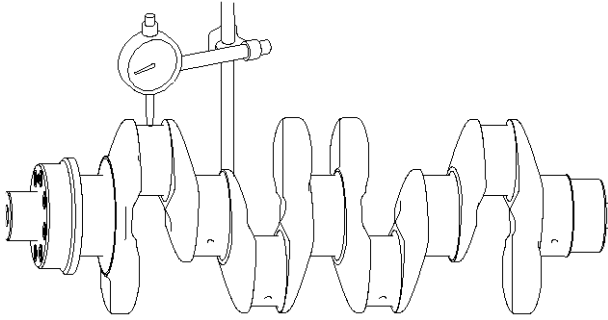
4. Check the crankshaft for bending.

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

Bending of crankshaft

Play of journal No.2,4 - measure it at journal No. 1, 5 : 0.07 mm

Play of journal No.3 - measure it at journal No. 1, 5 : 0.11 mm



SDFEM7116D

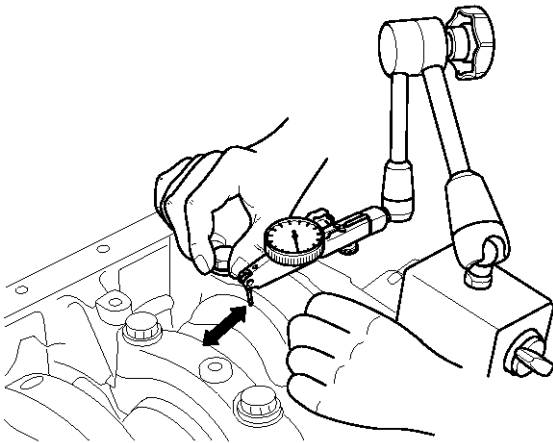
CONNECTING ROD BEARING

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

Endplay of connecting rod

Reference value : 0.15~0.40 mm

Limit value : 0.6 mm



SDFEM7117D

2. Measure the oil gap of the 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 the crankshaft pin and connecting rod bearing surface.

- b. Place the plastic gauge along with the shaft direction of the crankshaft pin.

- c. Install the connecting rod bearing cap and tighten the bolt.

Connecting rod cap mounting bolt : 4 kgf.m + 100 °

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

Connecting rod oil gap

Reference value : 0.032~0.091mm

Limit value : 0.15mm

- e. If the oil gap is excessively out of range, replace the connecting rod bearing.

3. Length of connecting rod bearing

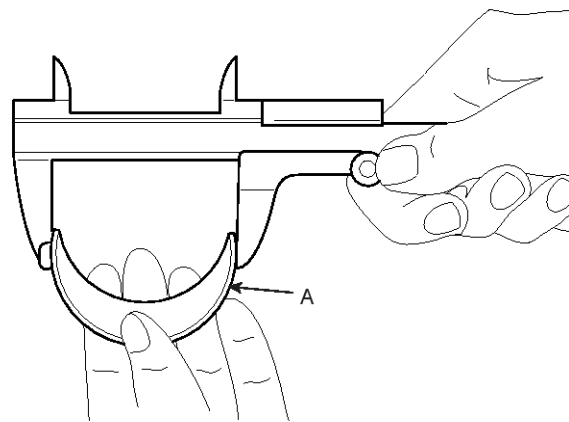
Measure the length of the connecting rod bearing (A) at the free state. If the measured value is out of the reference value, replace the upper and lower bearing.

Length of connecting rod bearing

Reference value : 80.0~81.0mm

⚠ CAUTION

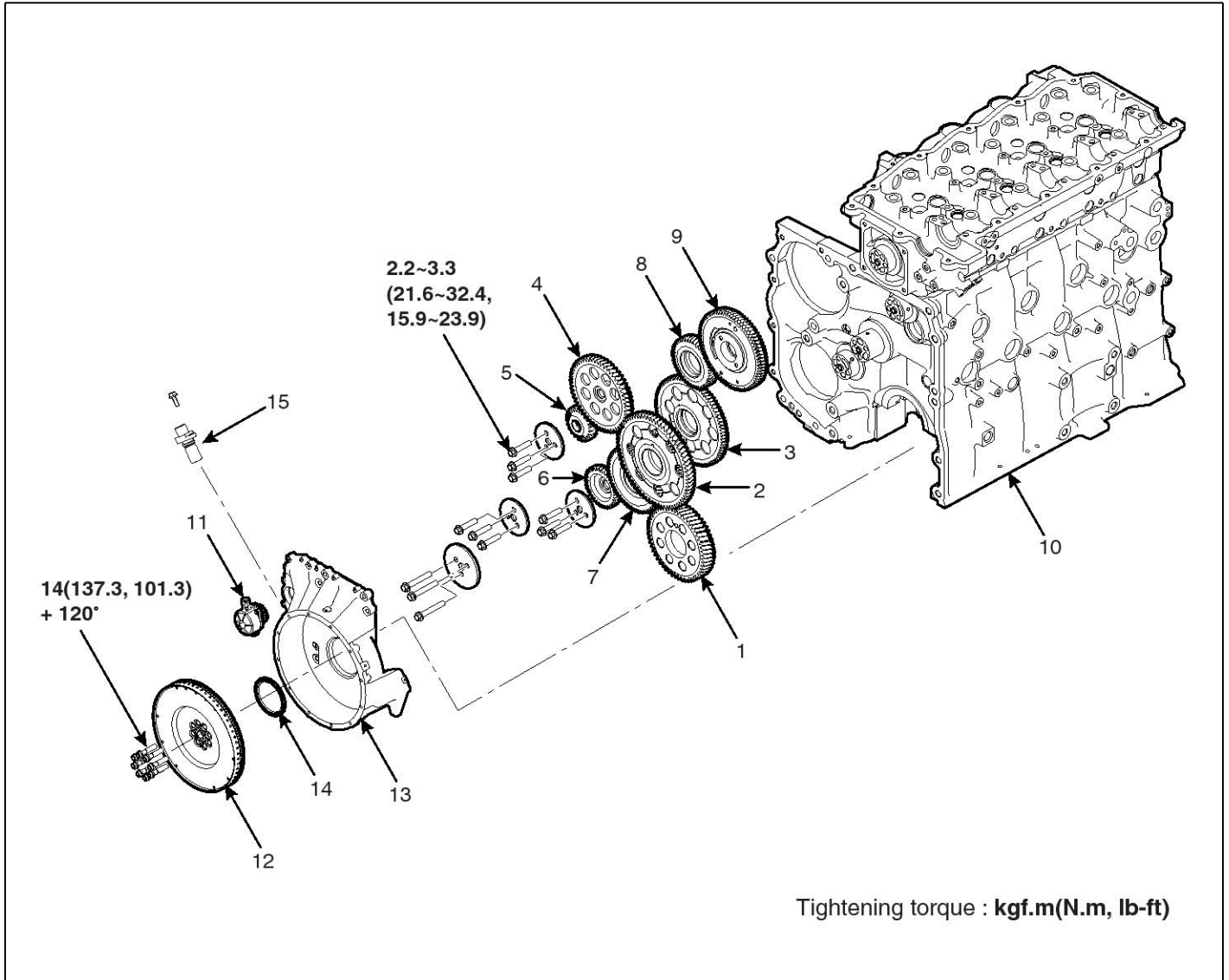
Bearing should not be artificially expanded to reuse.



SDFEM7118D

Flywheel

COMPONENTS



SDFEM9022L

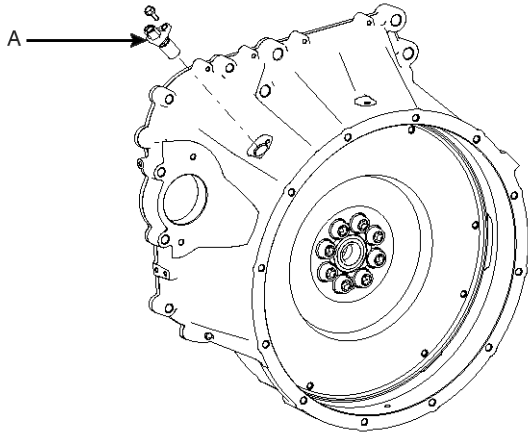
- 1. Crank gear
- 2. Idler gear assembly A,B
- 3. Idler gear C
- 4. Fuel supply pump gear
- 5. Vacuum pump gear

- 6. Power steering pump gear
- 7. Idler gear E
- 8. Idler gear D
- 9. Cam gear
- 10. Cylinder block

- 11. Vacuum pump
- 12. Flywheel
- 13. Flywheel housing
- 14. Rear oil seal
- 15. Engine speed sensor

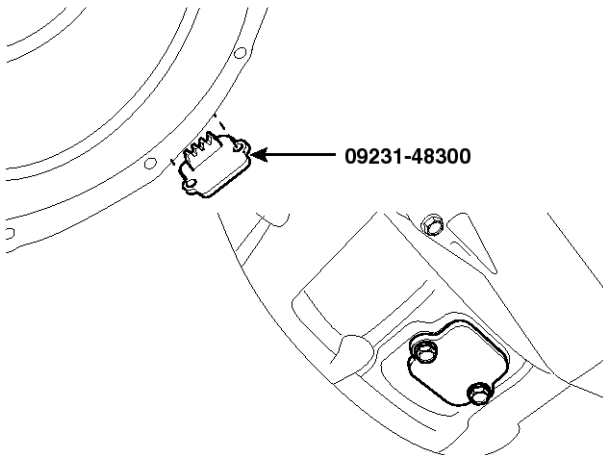
REMOVAL

1. Remove the engine speed sensor(A).



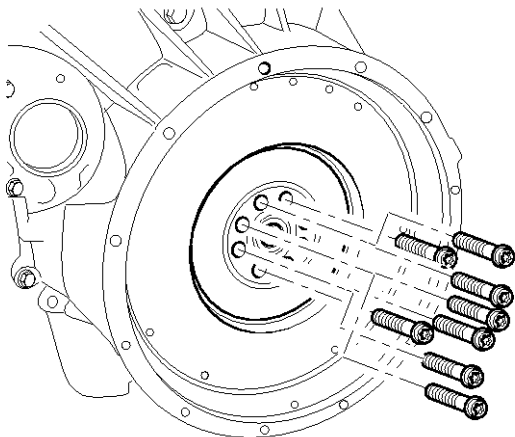
SDFEM7636D

2. Using the SST(09231-48300) to the service window in the flywheel housing, secure the flywheel.



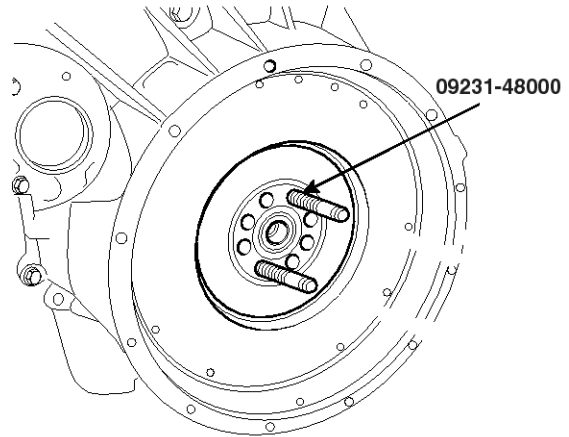
SDFEM9045L

3. Remove the flywheel mounting bolt.



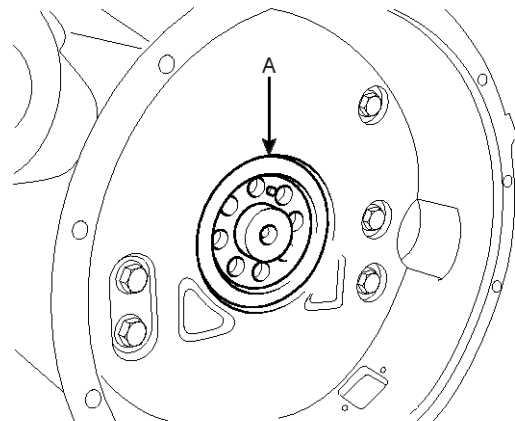
SDFEM7088D

4. Install the two or more SSTs(09231-48000) to the crankshaft.



SDFEM7637D

5. Remove the SST(09231-48300) from the flywheel housing.
6. Remove the flywheel and remove the SST(09231-48000).
7. Remove the crankshaft rear oil seal(A).

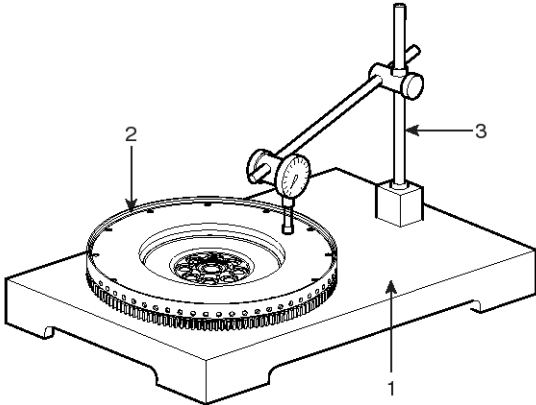


SDFEM7089D

INSPECTION

1. Twist of friction surface

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



SDFEM9055L

- 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.

Flatness of friction surface
 Basic value : Below 0.05 mm
 Limited value : 0.2 mm

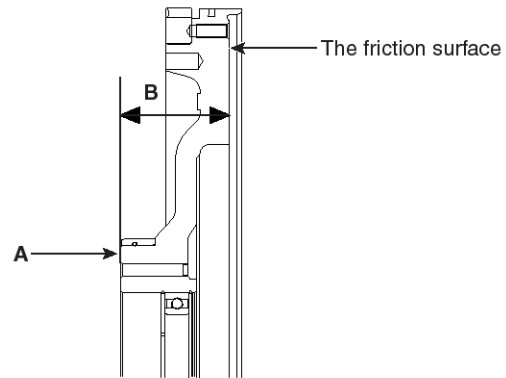
2. Repairing the friction surface of flywheel.

Repair the friction surface of flywheel using a grinder.
 Grind the friction surface of the flywheel by a grinder.

⚠ CAUTION

- a. After repairing the friction surface, the runout of the friction surface should be within 0.1 mm. (On the basis of surface "A")
- b. The height of the friction surface(dimension B) should not exceed the limit.

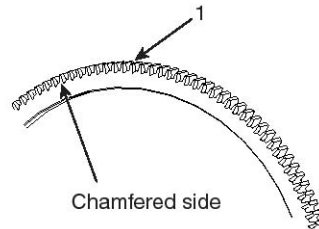
The height of the friction surface(B)
 Basic value : 67 mm
 Limited value : 66 mm



SDFEM9056L

3. Replacing the ring gear

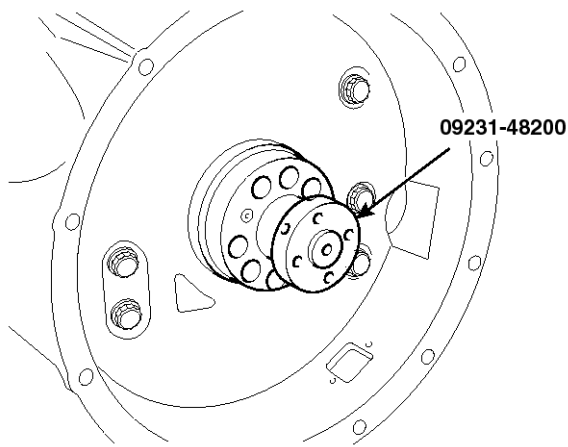
- a. Heat the ring gear(1) evenly using a torch. Holding it with a protective rod, evenly tap around the ring gear.
- b. Heat the ring gear using a heater(around 200 °C). Assemble the ring gear to the flywheel to direct the surface which is not chamfered toward the flywheel.



SDFEM9057L

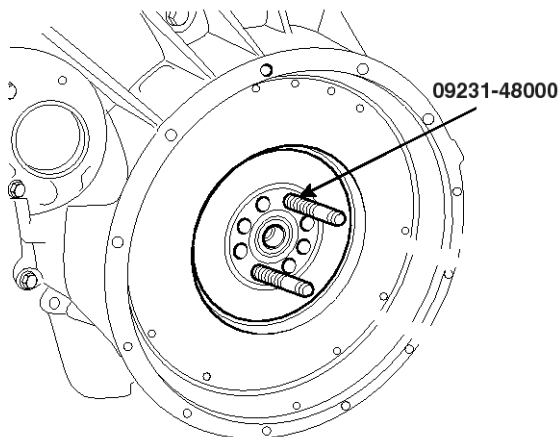
INSTALLATION

1. Using the SST(09231-48200), install the rear oil seal.



SDFEM7016D

2. Install the two or more SSTs(09231-48000) to the crankshaft.

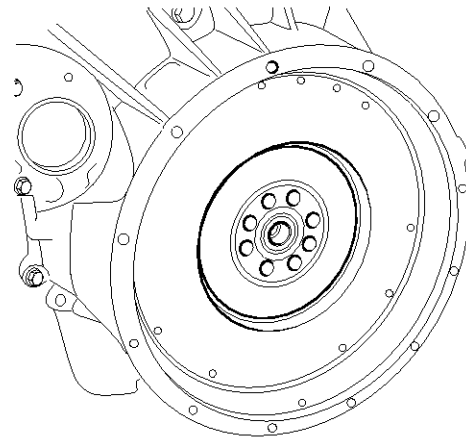


SDFEM7637D

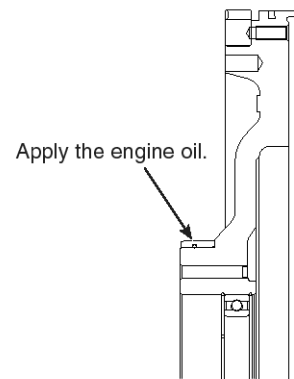
3. Install the flywheel and remove the SST(09231-48000).

⚠ CAUTION

- Pay a special attention while handling the flywheel since it is heavy.
- Assemble the flywheel after applying the small quantity of engine oil to the connected flywheel parts of oil seal.

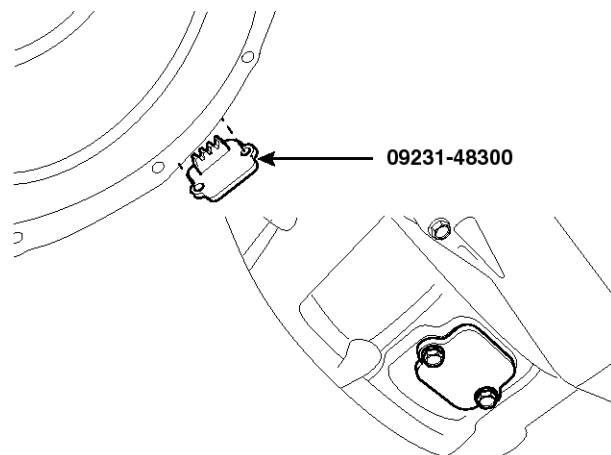


SDFEM9067L



SDFEM9066L

4. Install the SST(09231-48300) to the flywheel housing and secure the flywheel.



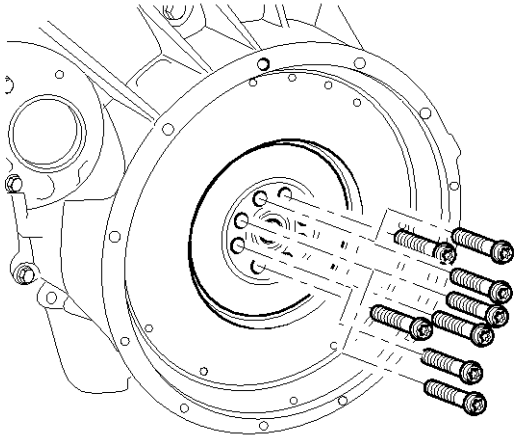
SDFEM7021D

5. Tighten the flywheel bolt.

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

CAUTION

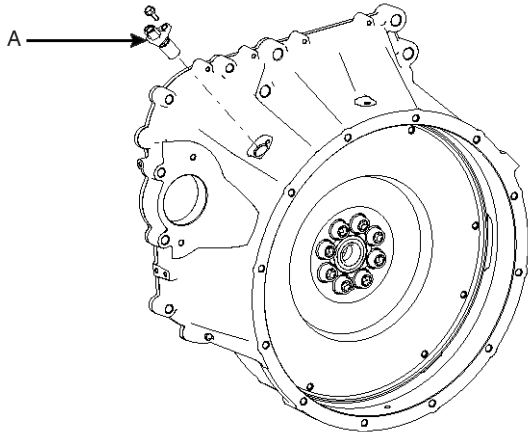
Never reuse the flywheel bolt.



SDFEM7088D

6. Remove the SST(09231-48300) from the flywheel housing.

7. Install the engine speed sensor.



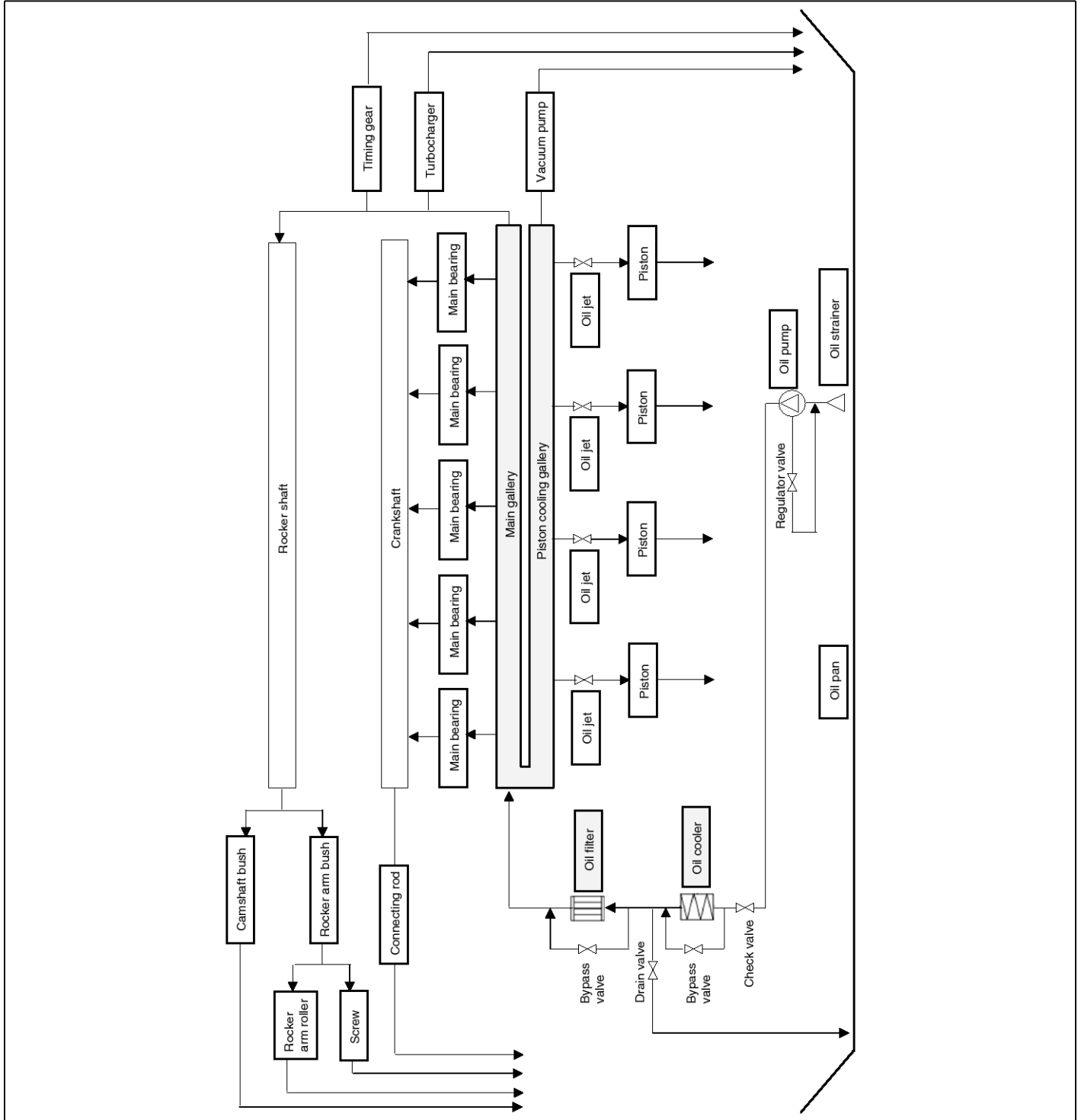
SDFEM7636D

Lubrication System

DESCRIPTION

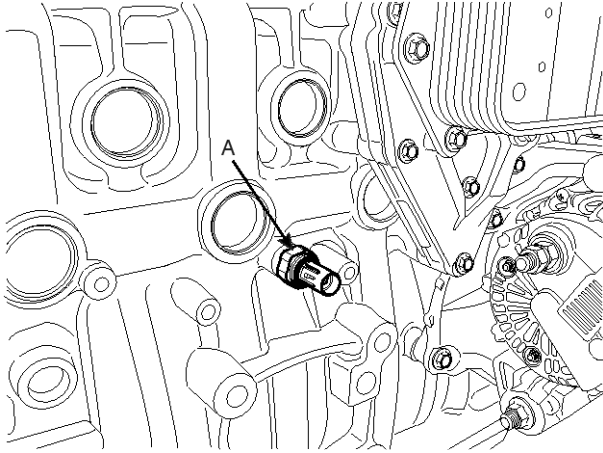
LUBRICATION SYSTEM CIRCUIT

The engine is lubricated by a gear-type oil pump. The engine oil lubricates each parts of engine after cooling and cleaning through the oil cooler and the oil filter.



OIL PRESSURE SWITCH

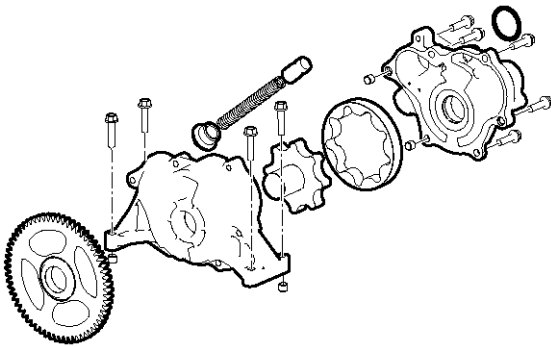
If the pressure of engine oil which is sent to the main oil gallery is below the specification, the built-in relay in the oil pressure switch (A) is closed, then the warning lamp in the instrument panel is on to inform the driver of abnormal pressure.



SDFEM7119D

OIL PUMP ASSEMBLY

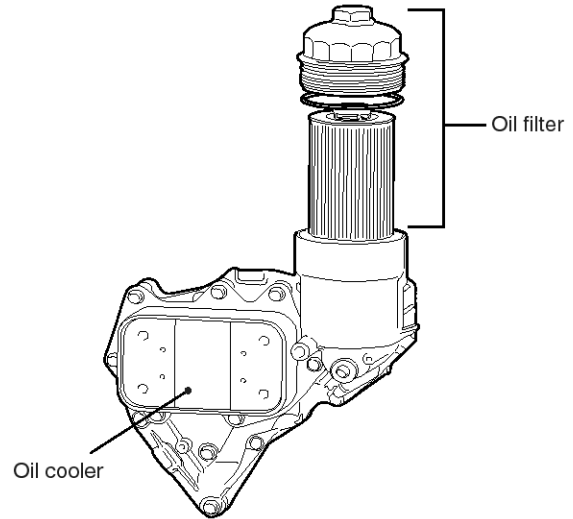
The oil pump, a gear type, is driven by the crankshaft rotating force engaged with the crankshaft gear and the oil pump gear. And the relief valve is installed to the oil pump so that it prevents the excessive pressure by bypassing the engine oil to the oil pan when the oil pressure exceeds the specification.



SDFEM7120D

OIL COOLER

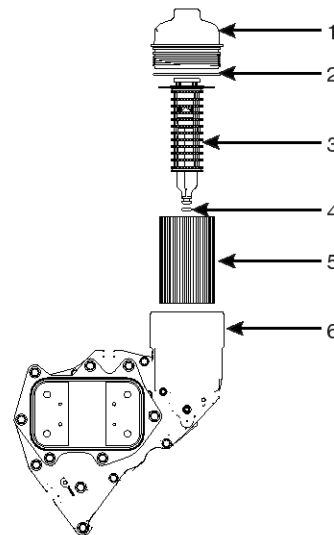
The oil cooler is installed to the oil filter and is the equipment to exchange heat between oil fed from the oil pump and coolant in the water jacket.



SDFEM9024L

OIL FILTER

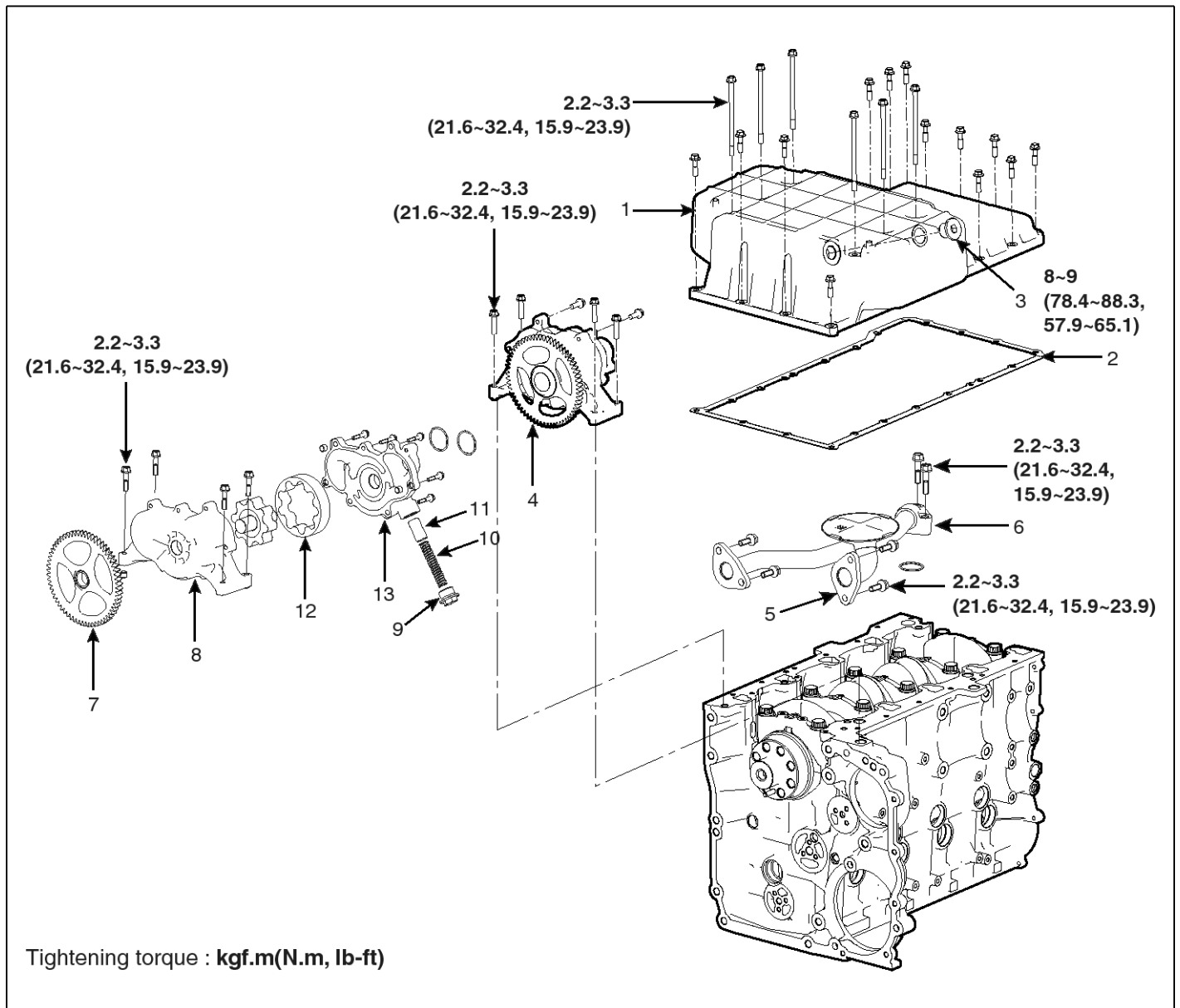
The oil filter is a replaceable paper element of a current type. There is the bypass valve under the filter. If the filter element is overloaded, the bypass valve will be opened to send oil to the oil main gallery directly without passing the filter element to prevent the engine load.



SDFEM9025L

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

COMPONENTS



SDFEM9026L

- | | | |
|-----------------|------------------|--------------------|
| 1. Oil pan | 6. Oil pipe | 11. R/V valve |
| 2. Gasket | 7. Gear head | 12. Drive gear |
| 3. Drain plug | 8. Oil pump case | 13. Oil pump cover |
| 4. Oil pump | 9. Plug | |
| 5. Oil strainer | 10. Spring | |

EM-62

Engine Mechanical System

SPECIFICATIONS

OIL COOLER

Items	Specifications
Bypass valve opening pressure(bar)	2.5±0.5
Pressure loss(bar)	Oil passage : Below 0.7, Water passage : Below 0.8
Heat discharge amount(kw)	12.0 (Condition: Oil flow 45 ℓ/min, Water flow 50 ℓ/min)

OIL PUMP

Items		Specifications
Head gear	Module	2.5
	Pressure angle	20°
	Teeth	63
	Torsion angle / direction	-15°/ left
	Backlash(mm)	0.105~0.218
Pump drive ratio (pump : engine)		1 : 0.857
Oil in use		SAE 10W~40W
Actual discharge pressure(bar)	1000 rpm (engine)	Above 3 (at oil temp. 110°C)
	2500 rpm (engine)	Above 5 (at oil temp. 110°C)
Actual discharge amount (ℓ/min)	1000 rpm (engine)	Above 38 (at oil temp. 110°C)
	2500 rpm (engine)	Above 100 (at oil temp. 110°C)
Theoretical discharge amount (cc/min)		51.7

OIL FILTER

Items	Specifications
Filtering area	3,000±90cm ²
Pressure loss (filter paper)	Below 0.5bar (Oil temp.: 80°C, Discharge amount: 86 ℓ/min)
Bypass valve opening pressure (bar)	2.5±0.5
Non return valve opening pressure (bar)	0.2±0.05

LUBRICANTS

Item	Type	Oil grade	Oil viscosity	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 : 13.5ℓ Including oil filter : 14ℓ

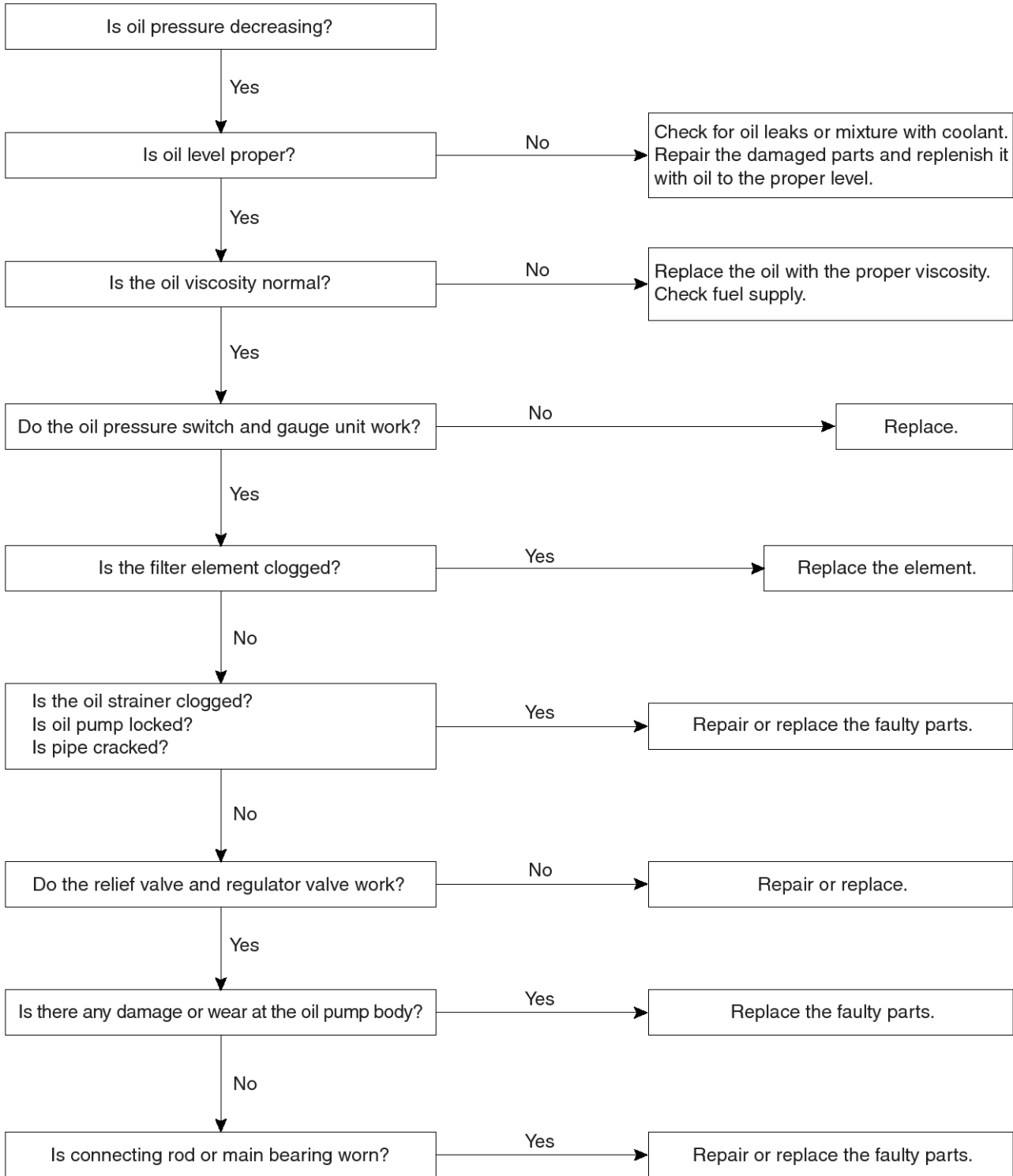
SERVICE STANDARDS

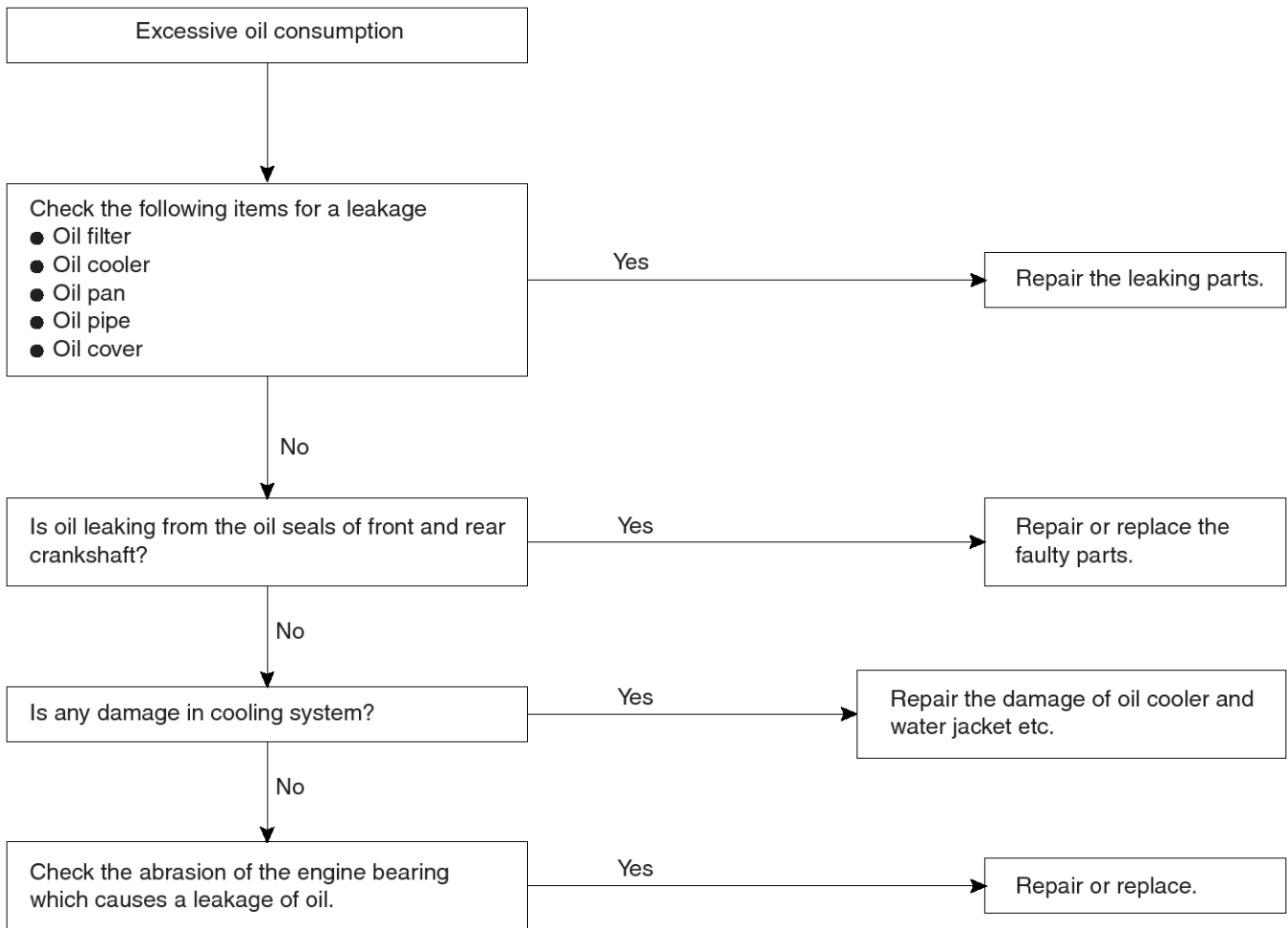
Items		Reference value ([]: Basic diameter)	Limit value	Remarks
Oil pressure (Oil temp. 70~90°C)	At idle	Above 1.5 bar	0.51 bar	Adjust
	At max. speed	Above 4.0 bar	2.0 bar	Adjust
Oil pump	Difference between oil pump case depth and gear height (sinkage)	0.05~0.1mm		Replace
	Gap between driven gear and driven shaft	[35]0.055~0.087mm		Replace
	Regulator valve opening pressure	5.3~6.4 bar		Replace
Oil cooler	Bypass valve pressure	3.4~4.4 bar		Replace

TIGHTENING TORQUE

Items (Diameter×Length)	O.D×pitch(mm)	Tightening kgf.m(N.m, lb-ft)
Oil strainer flange bolt (8×22)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil pipe flange bolt (8×35)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil pan mounting flange bolt (8×32, 8×140)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil level gauge mounting flange bolt (8×14)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil pan drain plug	M26×1.5	10~11(98.1~107.9, 72.3~79.6)
Oil filter cap	-	2.3~2.8(22.6~27.5, 16.6~20.3)
Oil filter mounting flange bolt (8×45)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil cooler mounting flange bolt (8×45)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Turbo oil feed pipe eye bolt	M12×1.25	2.7~3.3(26.5~32.4, 19.5~23.9)
Turbo oil return pipe flange bolt (8×16)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)
Oil pump mounting flange bolt (8×55)	M8×1.25	2.2~3.3(21.6~32.4, 15.9~23.9)

TROUBLESHOOTING





ADJUSTMENT**ENGINE OIL INSPECTION**

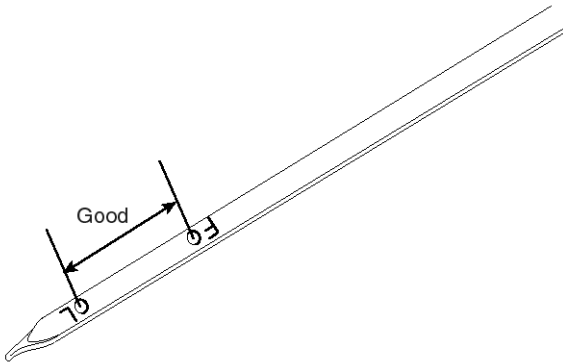
1. Park the vehicle on the flat surface.
2. Stop the engine.

NOTICE

1. Warm up the engine for several minutes if the vehicle has not been inspected for a long period of time.
 2. 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, engine oil should be the same type as the one in the oil pan.



SDFEM9046L

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 the oil pan to drain engine oil.
3. Tighten the drain plug to the specified torque.

Tightening torque : 10~11 kgf.m

CAUTION

If the 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 whenever changing engine oil.

4. Fill the new engine oil into the oil filler cap.

Oil capacity

Oil pan : 13.5 liter

With oil filter : 14 liter

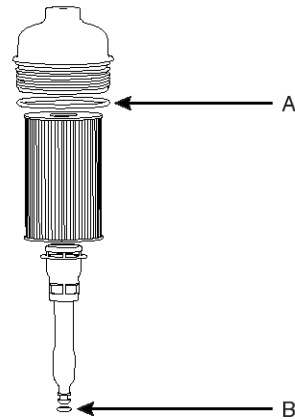
CAUTION

Overfilling may cause oil saturation or pressure drop.

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

OIL FILTER ELEMENT REPLACEMENT

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

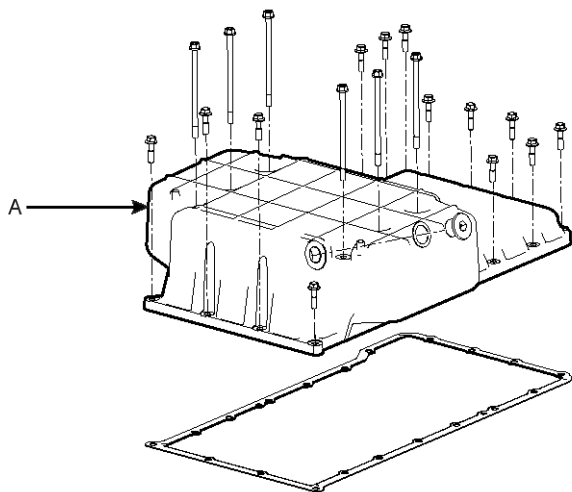


SDFEM7122D

4. Install the oil filter to the specified torque.
5. Start the engine and check the oil for leak.
6. Stop the engine and check oil level. Refill the engine oil as required.

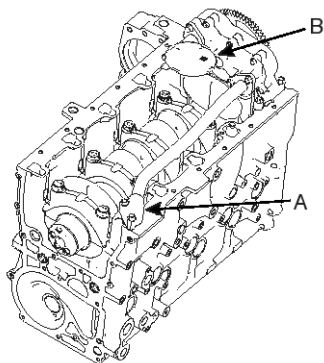
REMOVAL

1. Remove the oil pan(A) from the cylinder block.



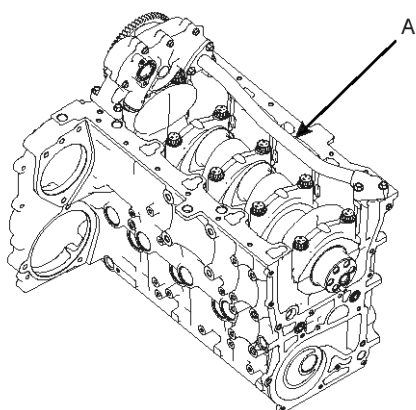
SDFEM9062L

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



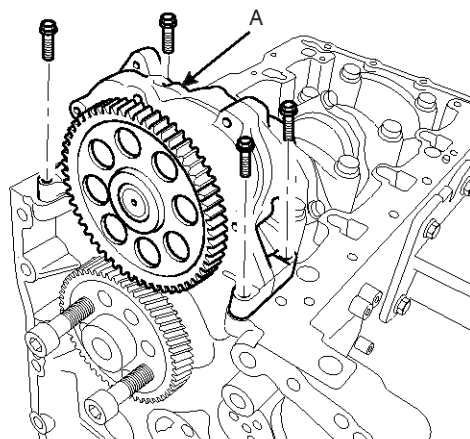
SDFEM9060L

3. Remove the pipe(A).



SDFEM9061L

4. Remove the oil pump assembly(A).

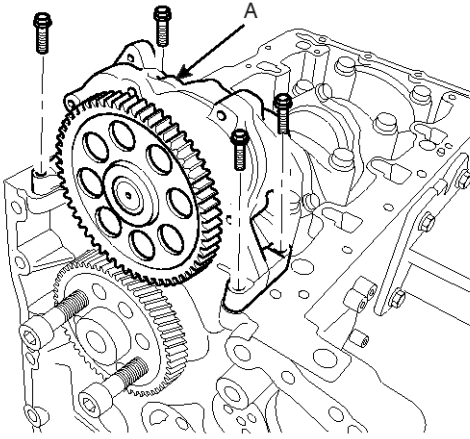


SDFEM7126D

INSTALLATION

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

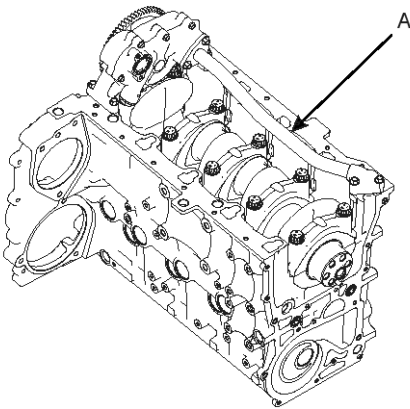
Oil pump assembly mounting bolt : 2.2~3.3 kgf.m (21.6~32.4 N.m, 15.9~23.9 lb-ft)



SDFEM7126D

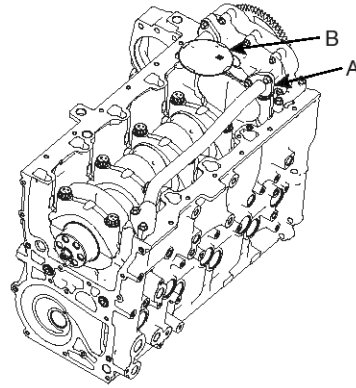
2. Install the pipe(A) with two O-rings.

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



SDFEM9061L

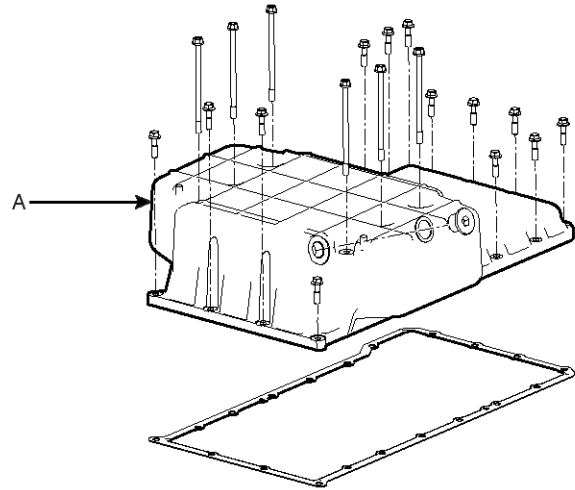
3. Install the oil outlet pipe(A) and the oil strainer(B).



SDFEM9063L

4. Install the oil pan (A) after the application of sealant to the 4 points T-joint parts of the oil pan gasket.

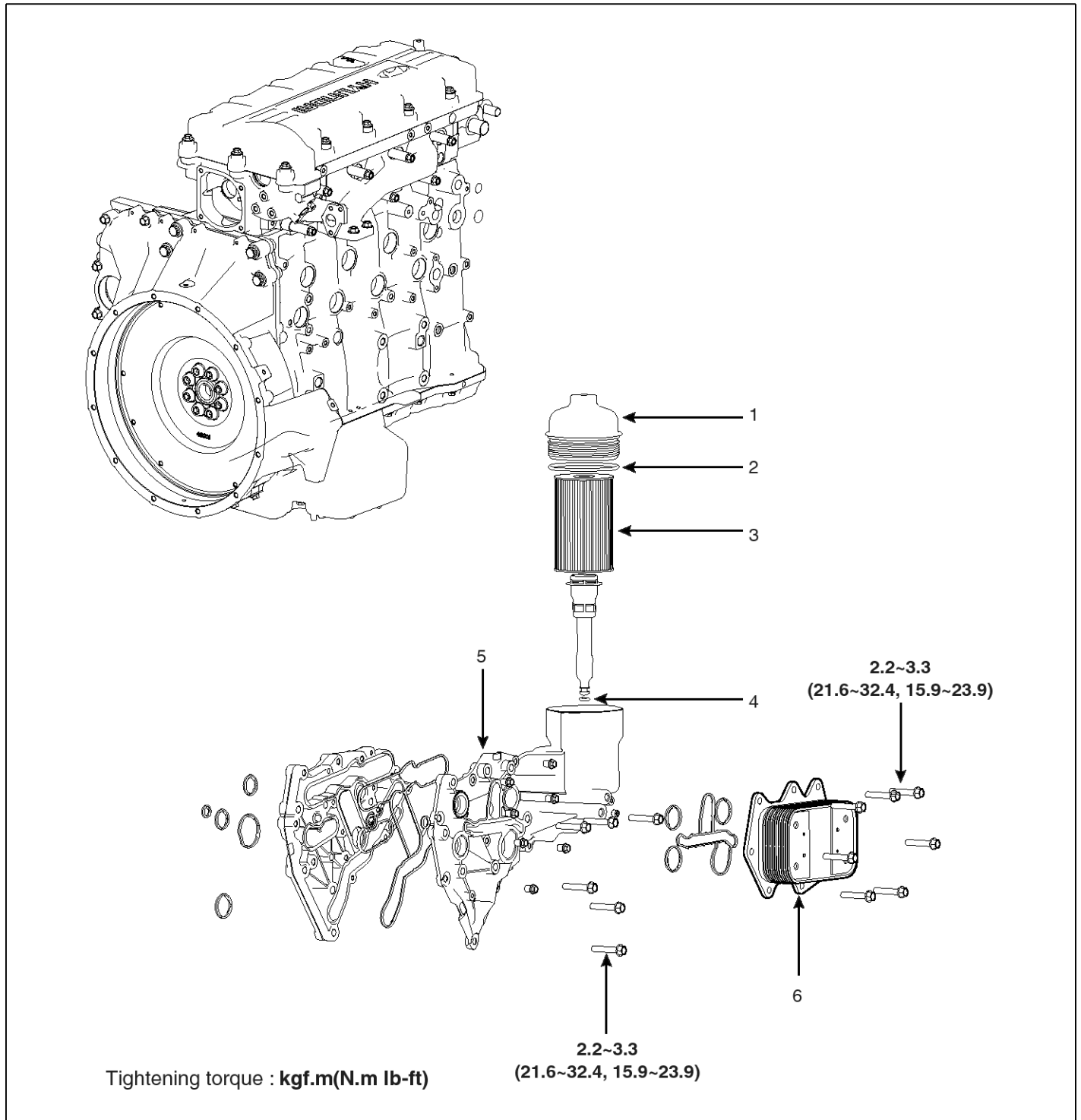
Oil pan mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb-ft)



SDFEM9065L

Oil Cooler

COMPONENTS



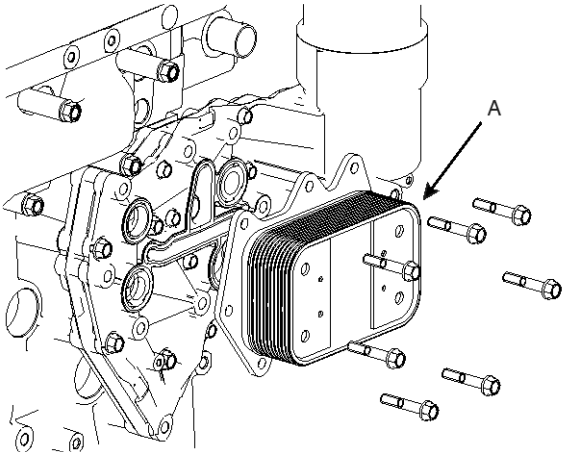
SDFEM9027L

1. Oil filter cap
2. Cap O-ring
3. Element

4. Center rod O-ring
5. Housing assembly
6. Oil cooler

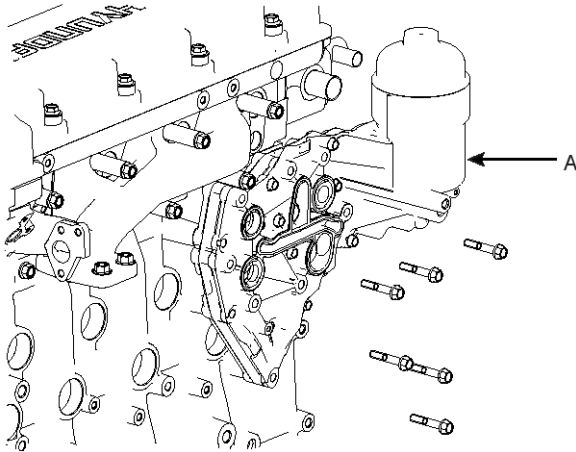
REPLACEMENT

1. Remove the oil cooler (A) from the oil filter assembly.



SDFEM7129D

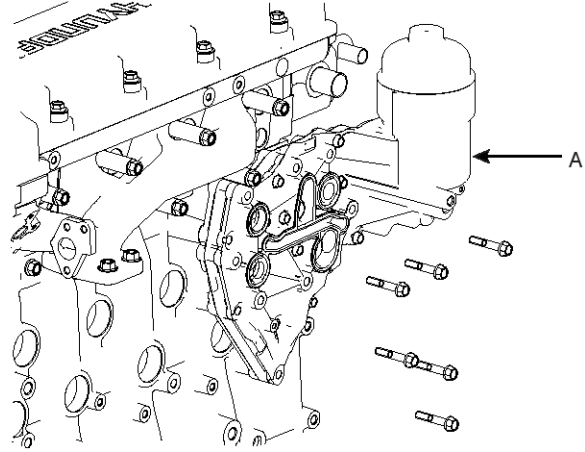
2. Remove the oil filter assembly (A) from the cylinder block.



SDFEM7130D

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

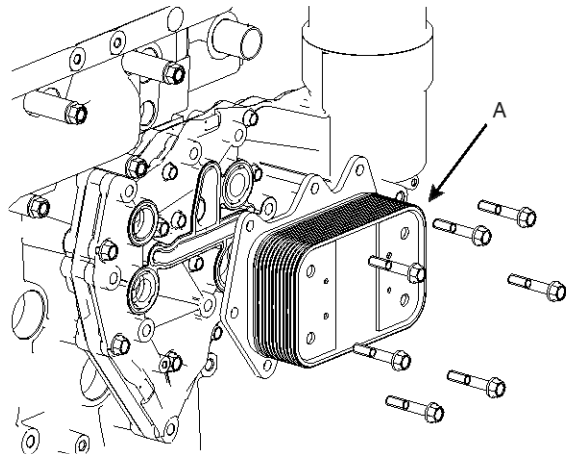
Oil filter housing assembly mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb-ft)



SDFEM7130D

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

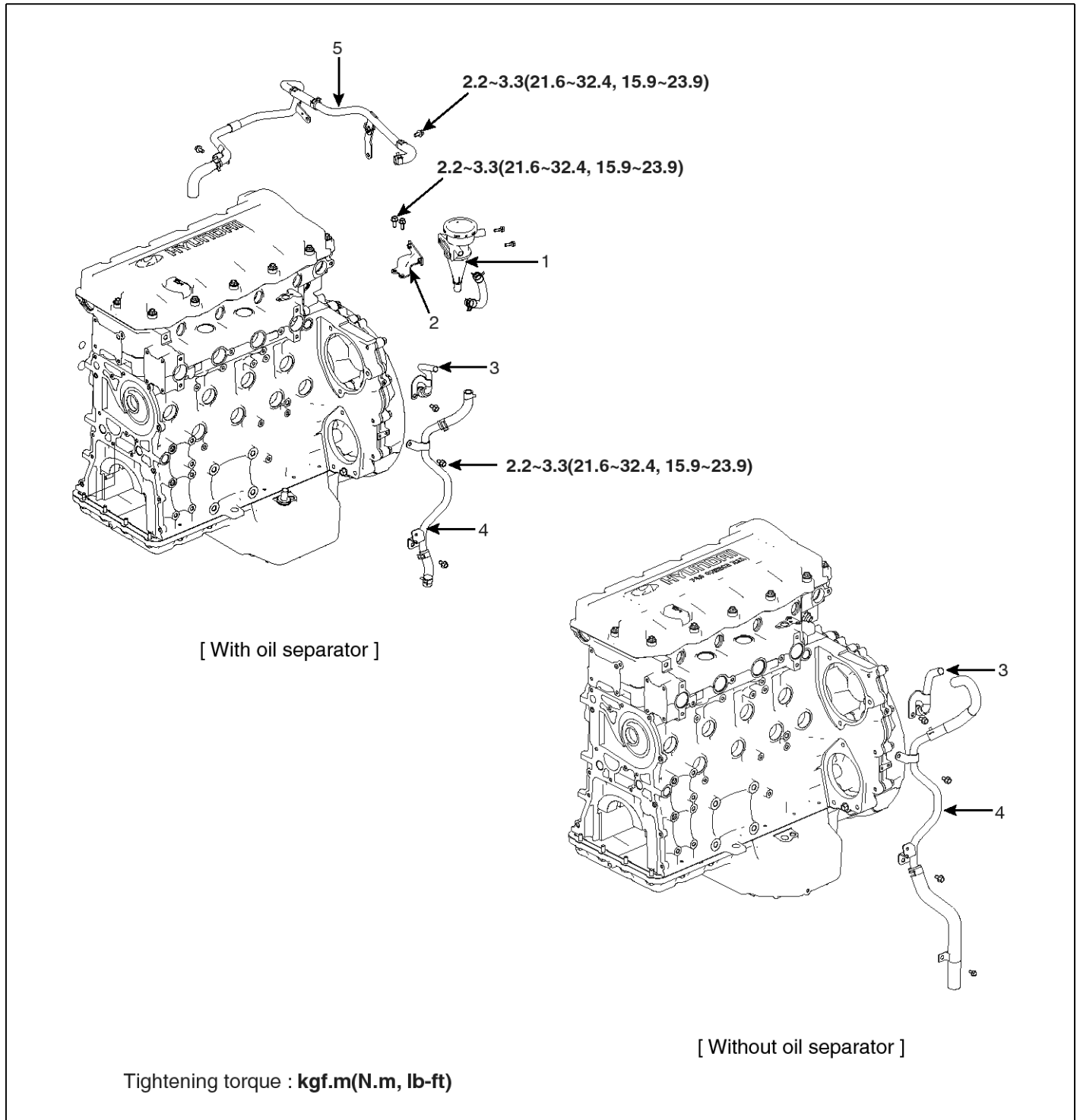
Oil cooler mounting bolt : 2.2~3.3 kgf.m(21.6~32.4 N.m, 15.9~23.9 lb-ft)



SDFEM7129D

Oil Separator

COMPONENTS



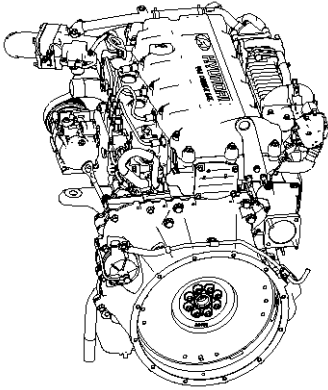
SDFEM9028L

- 1. Oil separator assembly
- 2. Bracket
- 3. Breather pipe

- 4. Oil drain pipe
- 5. Gas return pipe

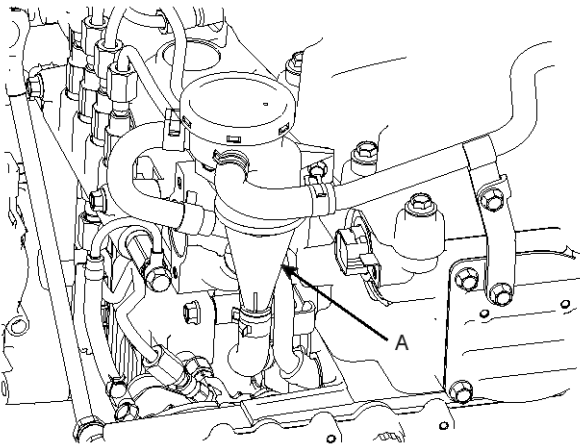
REPLACEMENT

1. Remove the breather pipe, oil drain pipe and the gas return pipe.



SDFEM9064L

(Without oil separator)



SDFEM7601D

(With oil separator)

2. Remove the bracket mounting bolt and then remove the oil separator(A).
3. Installation is in the reverse of removal.

Cooling System

DESCRIPTION

Cooling System

The water pump cools down the engine heat by circulating the coolant forcibly.

Water Pump

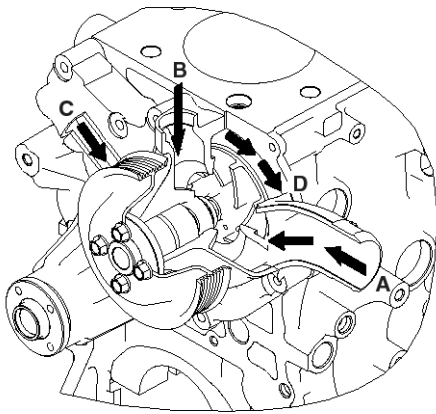
The water pump, a centrifugal type, is driven by the V-ribbed belt from the crankshaft pulley.

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

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

The water pump is mounted on the crankcase.

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



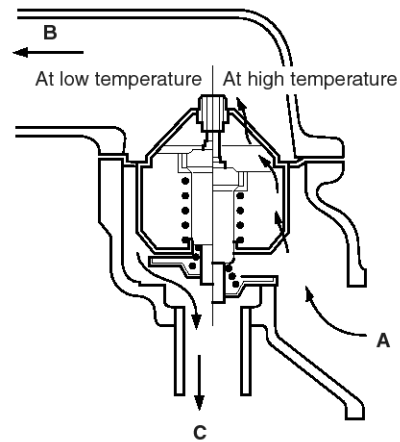
SDFEM9029L

- A : From radiator
- B : From thermostat
- C: From oil cooler
- D : To Crank case

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 when 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 the water pump(bypass side), thus controlling coolant temperature.



SDFEM9030L

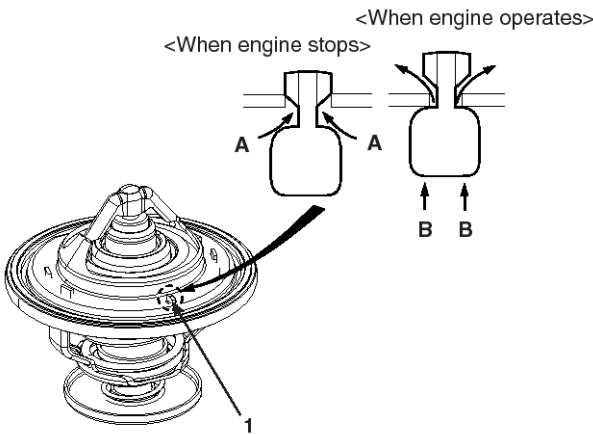
- A : From cylinder head
- B : To radiator
- C : To water pump

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

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

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

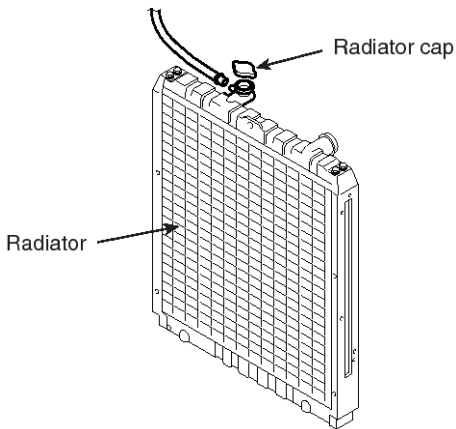


SDFEM9031L

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.



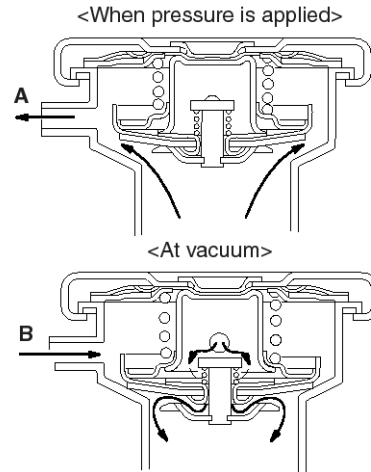
SDFEM9032L

Radiator Cap

The 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.



SDFEM9033L

A : To reservoir tank
B : From reservoir tank

Automatic Cooling Fan

The automatic cooling fan coupling controls fan speed according to the engine coolant temperature.

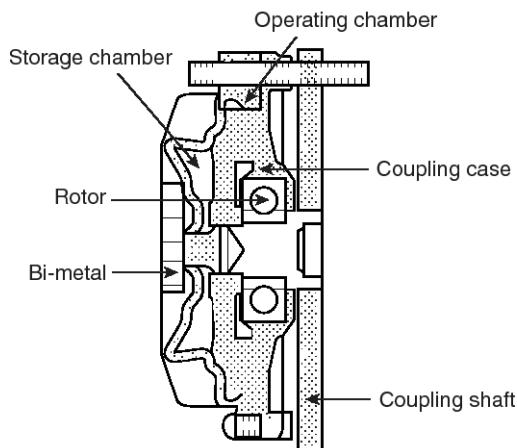
The control of fan speed is controlled by the bi-metal to change the fluid amount of the fluid coupling after sensing the temperature of air which flows through the radiator.

1. When the temperature of the air flowing through the radiator is high, the valve in the storage chamber is opened by the bi-metal.
2. At that time the silicon oil flows out of it. The viscosity between the coupling case and the rotor increases and the speed of the fan installed in the case becomes similar to that of the shaft.

The viscosity varies according to the amount of silicon oil.

3. When the temperature of air is low, the valve is closed by bi-metal and the silicon oil is returned to the storage chamber.

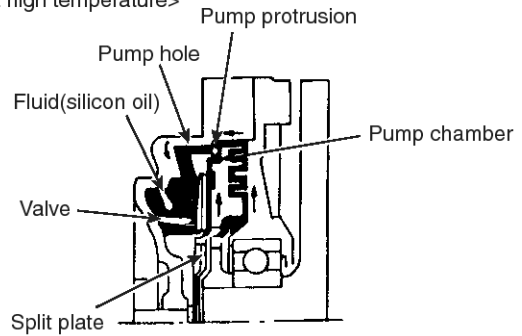
This causes the sliding between the coupling case and the rotor to reduce the speed of fan rapidly.



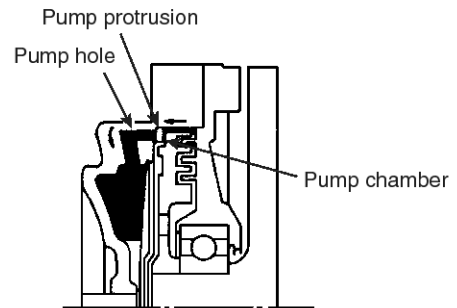
SDFEM9034L

Operation of Automatic Cooling Fan Coupling

<At high temperature>

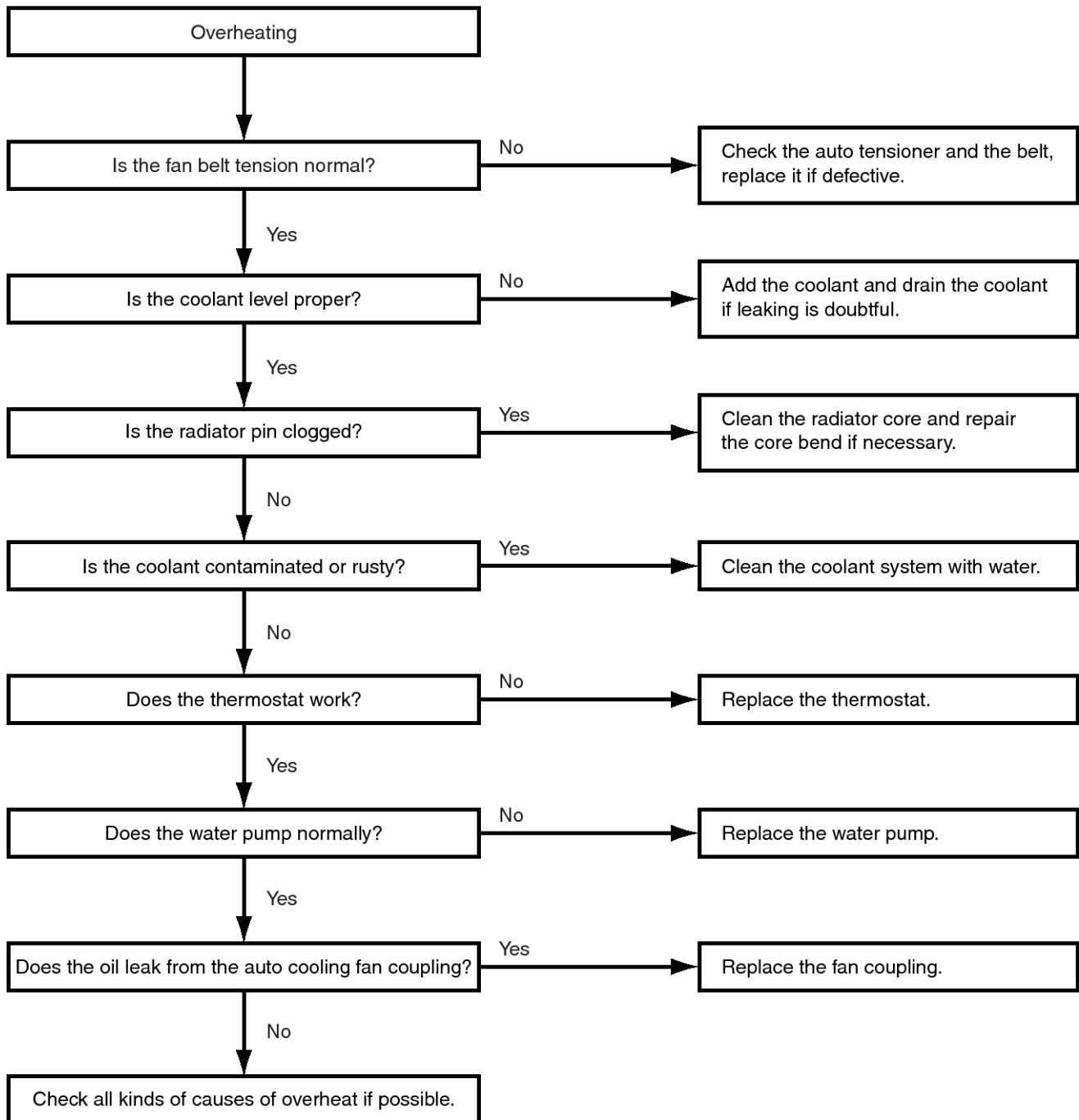


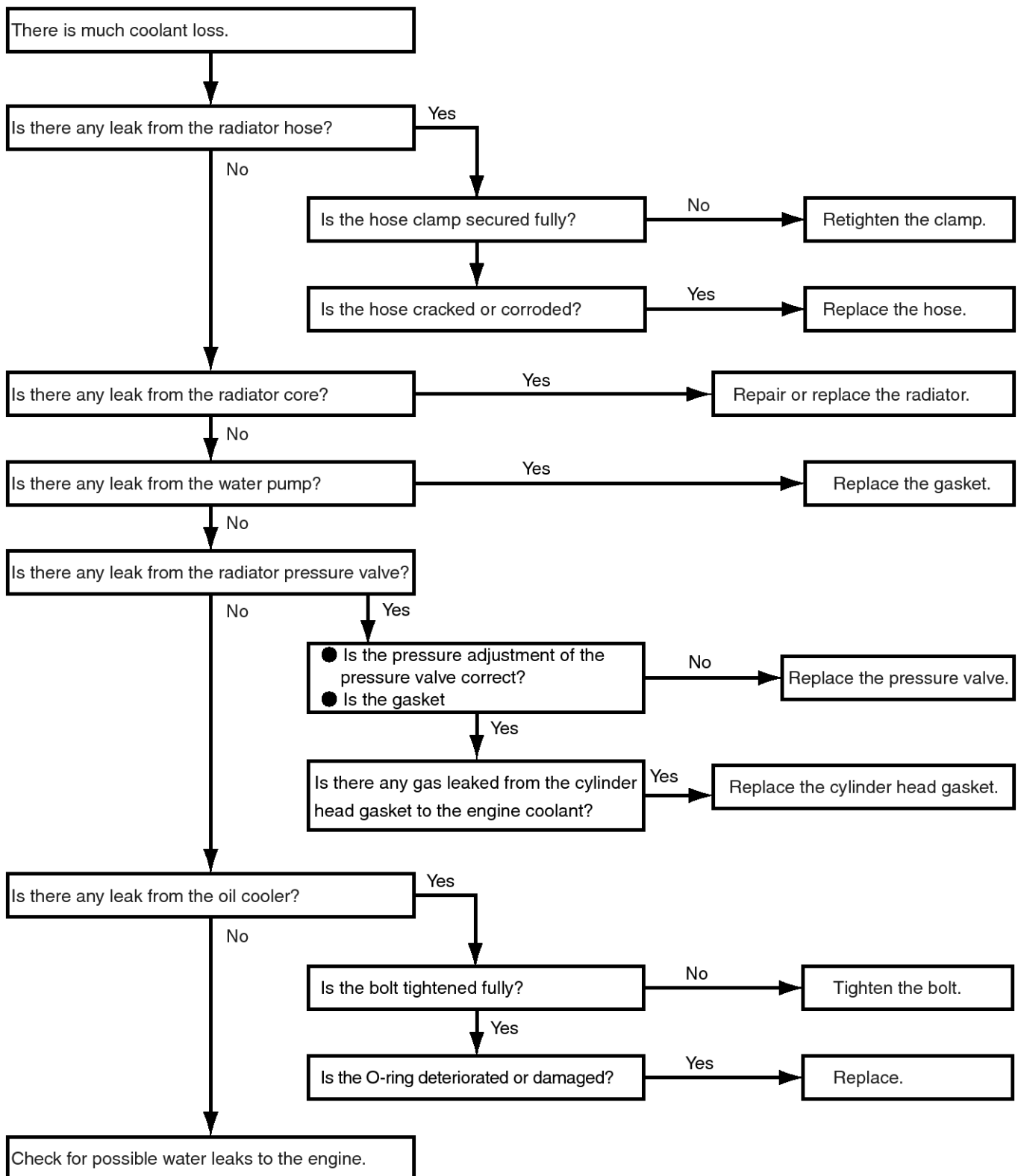
<At low temperature>



SDFEM9035L

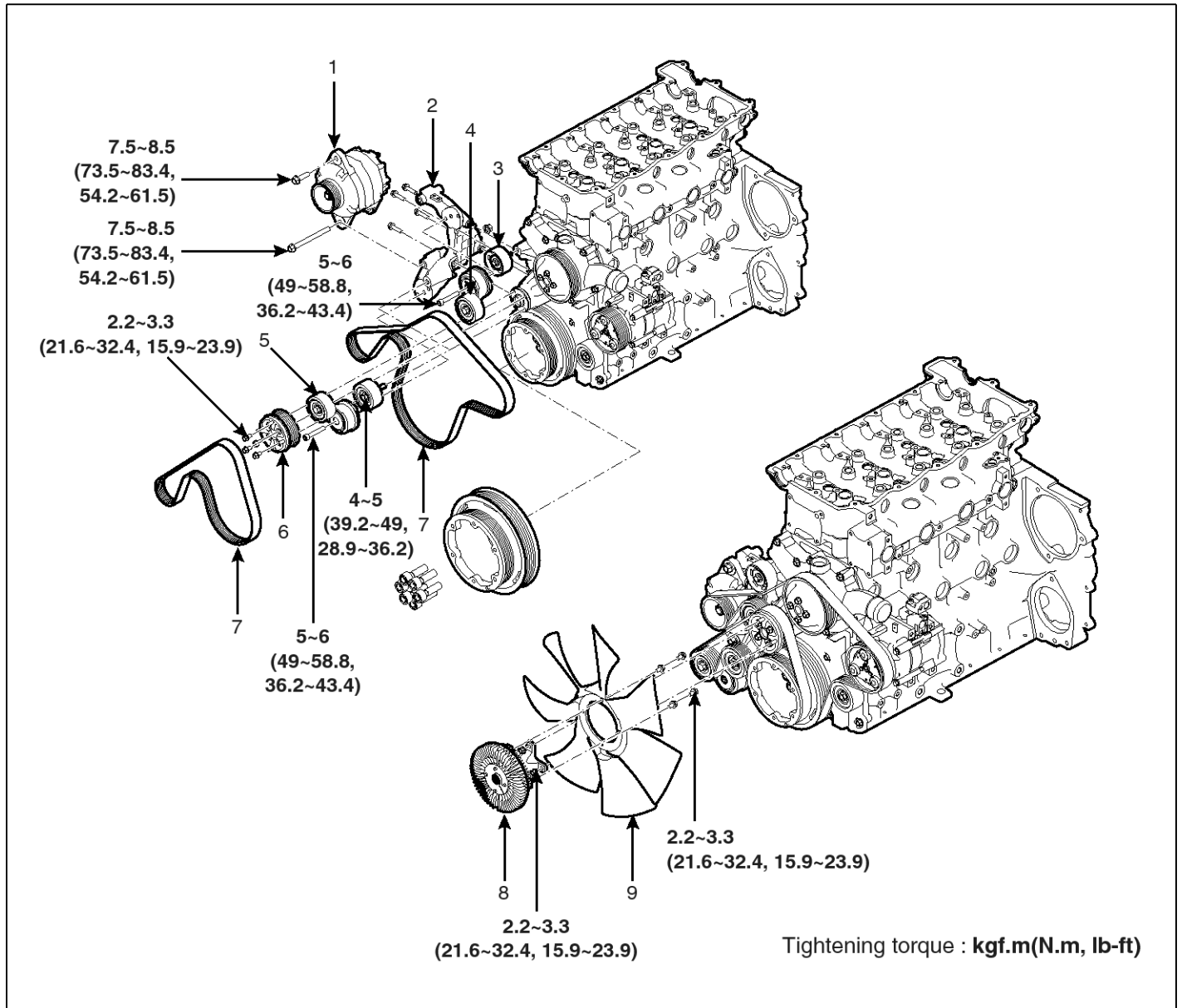
TROUBLESHOOTING





Cooling Fan

COMPONENTS



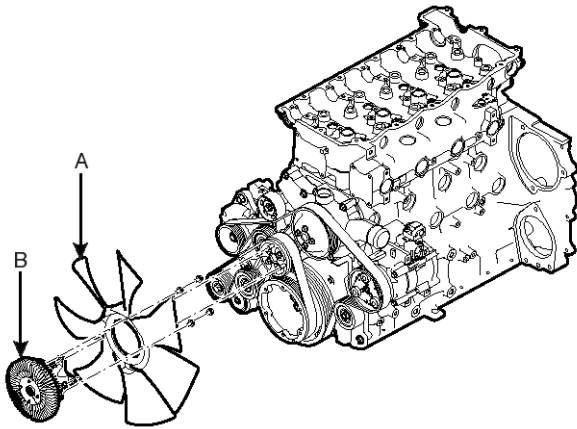
SDFEM9038L

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

6. Fan pulley assembly
7. V-ribbed belt
8. Fan clutch assembly
9. Cooling fan

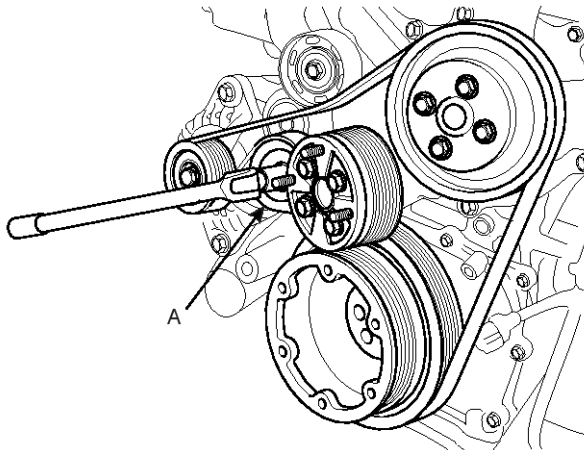
REMOVAL

1. After removing the cooling fan(A) and the cooling fan coupling(B), remove the auto tensioner and the 2nd belt.



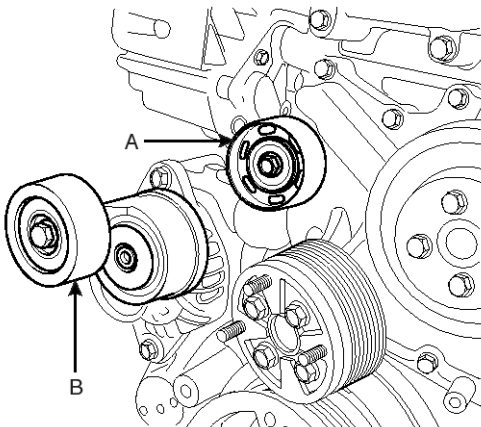
SDFEM7131D

2. Detach the auto tensioner(A) and remove the accessory belt.



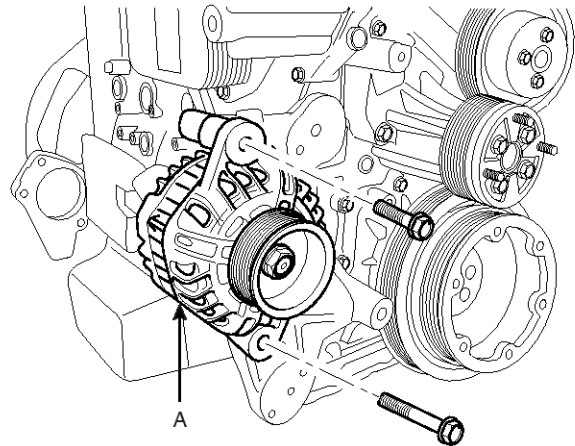
SDFEM7132D

3. Remove the idler(A) and the auto tensioner(B).



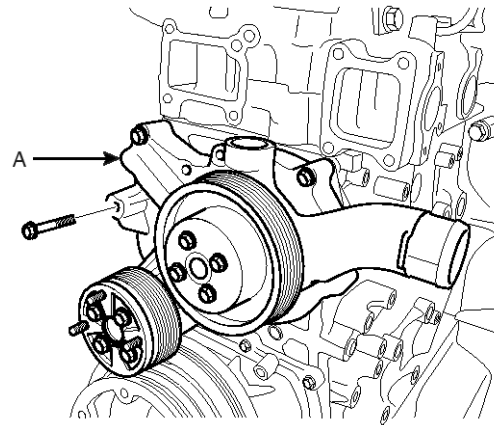
SDFEM7133D

4. Remove the alternator(A).



SDFEM7134D

5. Remove the water pump assembly(A).

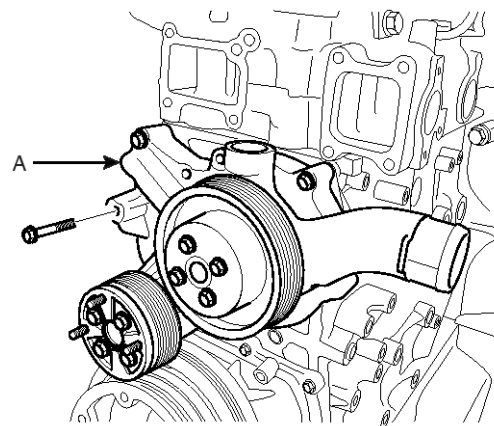


SDFEM7136D

INSTALLATION

1. Install the water pump assembly (A).

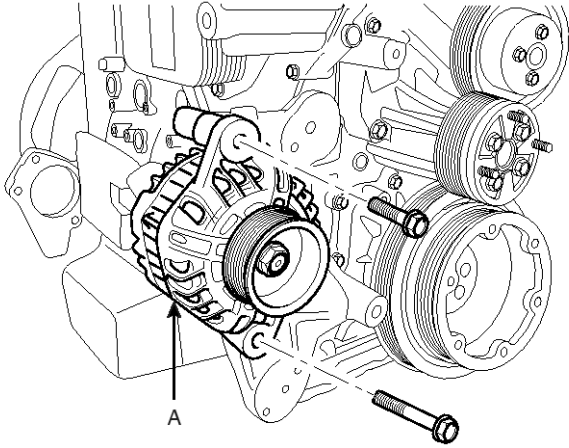
Water pump assembly mounting bolt : 2.2~3.3 kgf.m
(21.6~32.4 Nm, 15.9~23.9 lb-ft)



SDFEM7136D

2. Install the alternator (A).

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

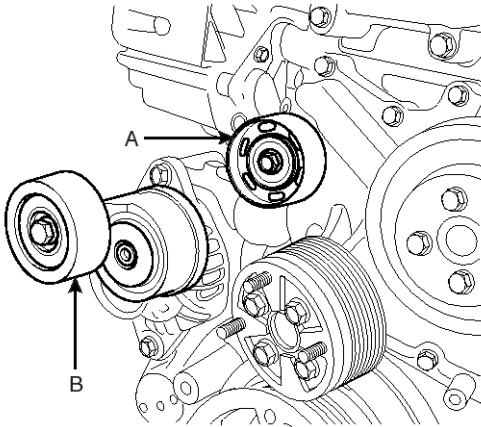


SDFEM7134D

3. Install the idler(A) and the auto tensioner(B).

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)



SDFEM7133D

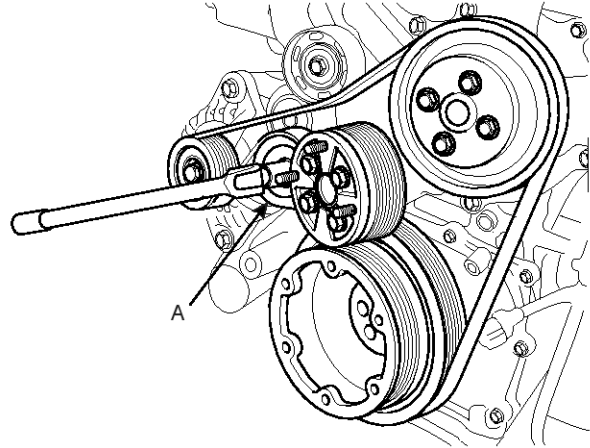
4. Install the belt and adjust the tension of belt by tightening the auto tensioner.

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

⚠ CAUTION

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

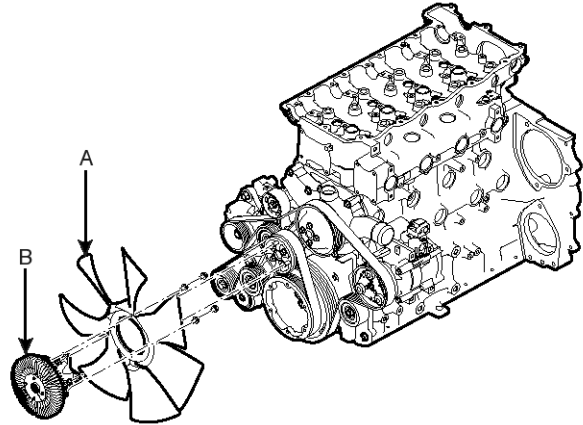
2. Check if the flat surface of tensioner and idler pulley contacts well with that of belt.



SDFEM7132D

5. After installing the 2nd belt, install the cooling fan(A) and the cooling fan coupling(B).

Cooling fan coupling mounting bolt : 2.2~3.3 kgf.m
(21.6~32.4 N.m, 15.9~23.9 lb-ft)



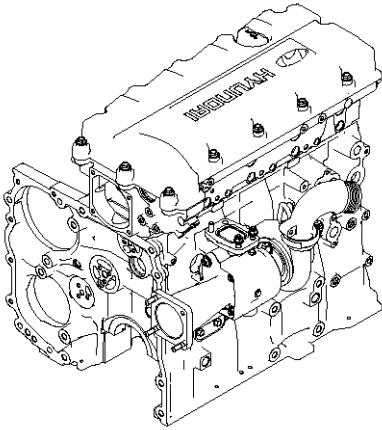
SDFEM7131D

Intake And Exhaust System

DESCRIPTION

TURBO CHARGER

The turbo charger is the mechanical actuator drive type. The operational principle is like this. If the turbine wheel is driven by the exhaust gas, the compressor wheel connected by shaft is rotated. This compresses the air entered through the turbo inlet. If the pressure of air is increased under condition that the volume of air is same, more fuel can be combustible since the mass per volume increases. This is the principle to enhance the power of vehicle



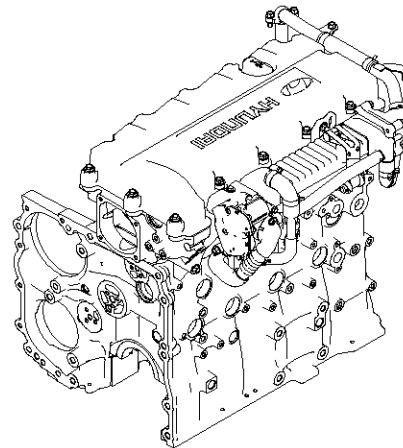
SDFEM7649D

EGR SYSTEM

The EGR system is installed to reduce the Nox of exhaust system. The system consists of the EGR cooler, the EGR valve & hose, the pipes and the mounting bracket.

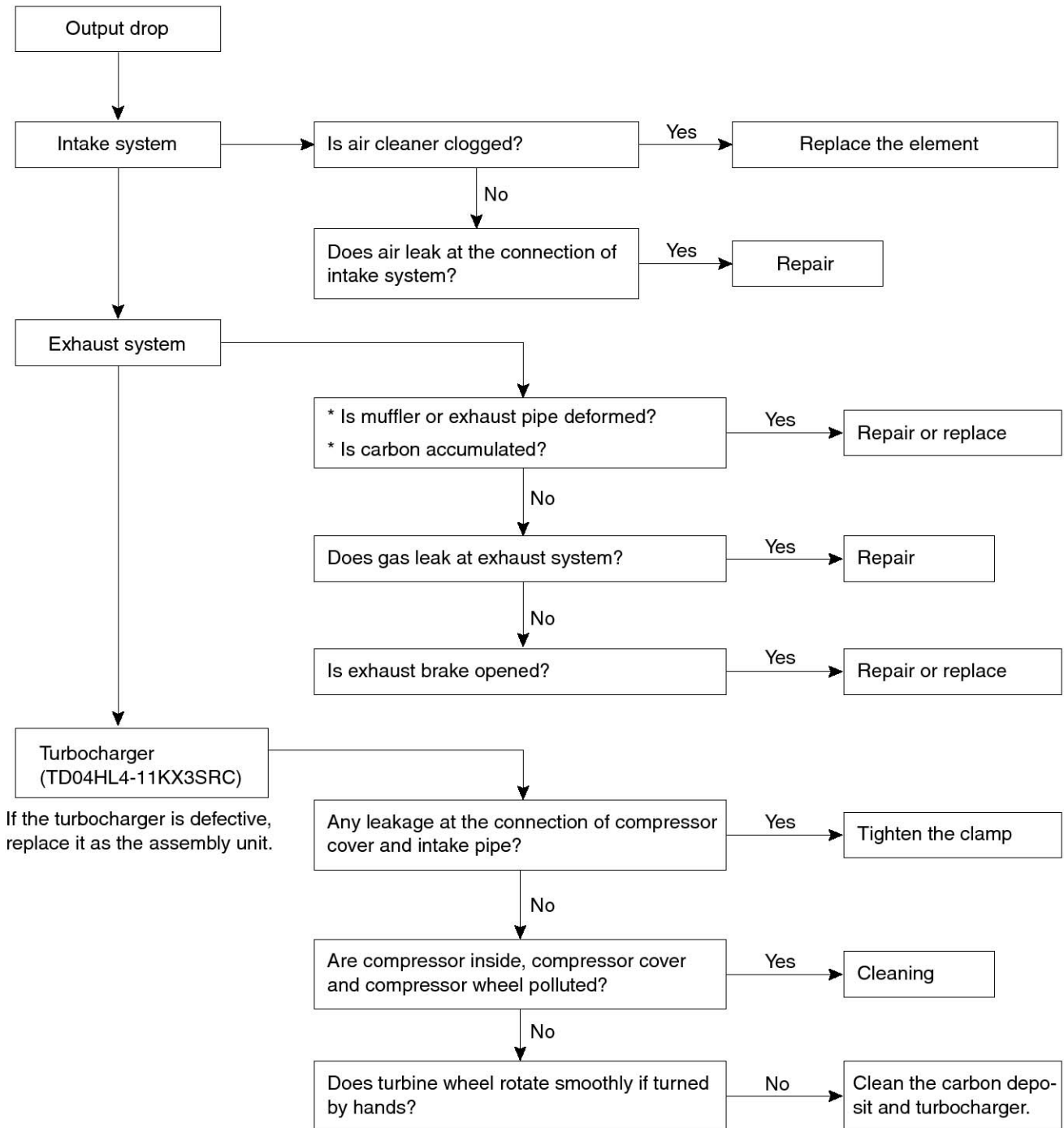
The principle of the EGR is the system to reduce the generation of Nox by recirculating some of exhaust gases as the intake gases. This results in reducing actual oxygen. And the inert gas of exhaust gases reduces the generation of Nox by restricting the temperature rise of combustible gas.

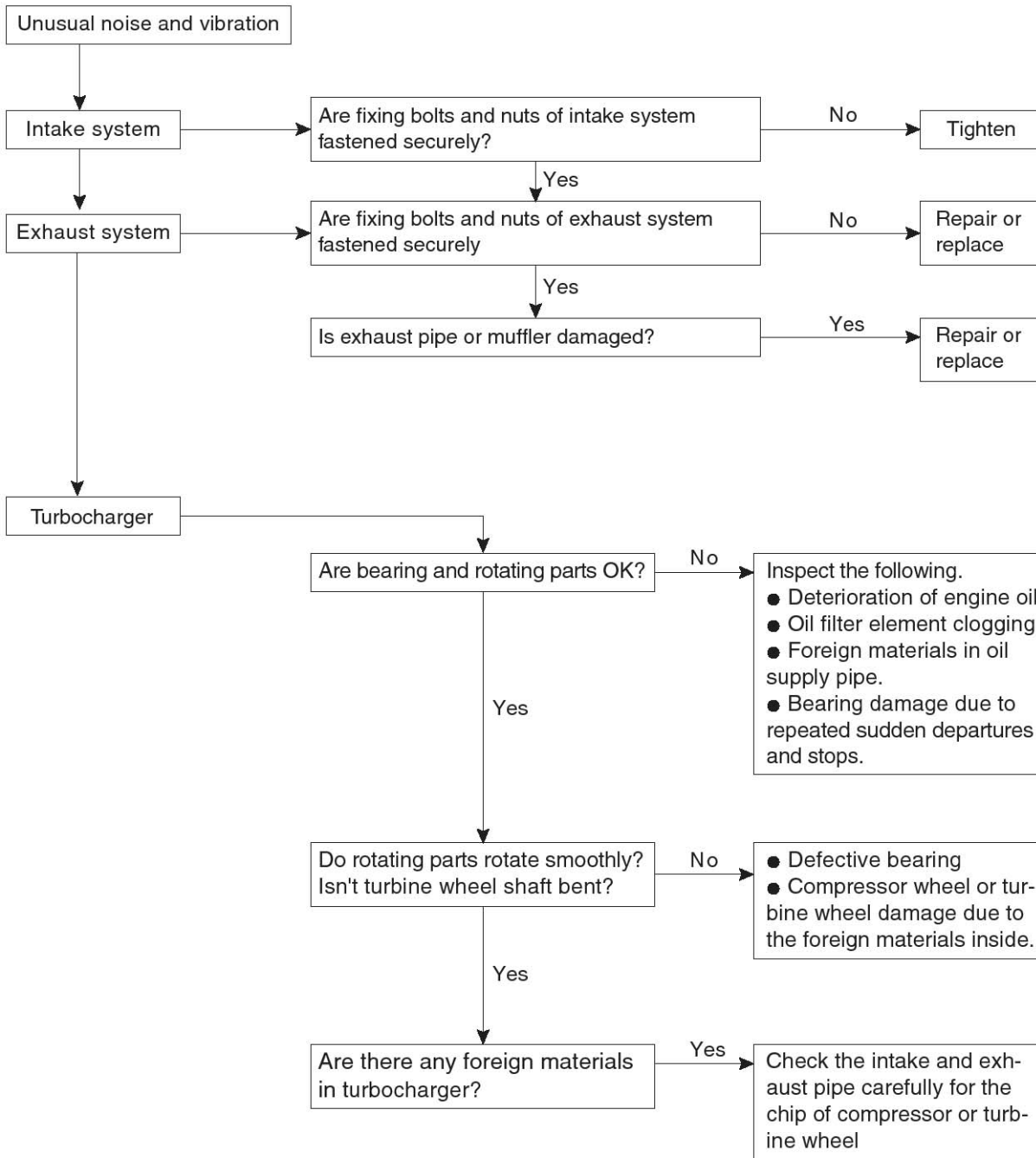
When the exhaust gas flows to the EGR cooler, heat exchange between exhaust gas and engine coolant occurs. This is the role to increase the charging efficiency of exhaust gas in high temperature. The electronic EGR valve type has been equipped to control the exhaust gas amount in proportion to the exact EGR rate depending on the engine condition.



SDFEM7650D

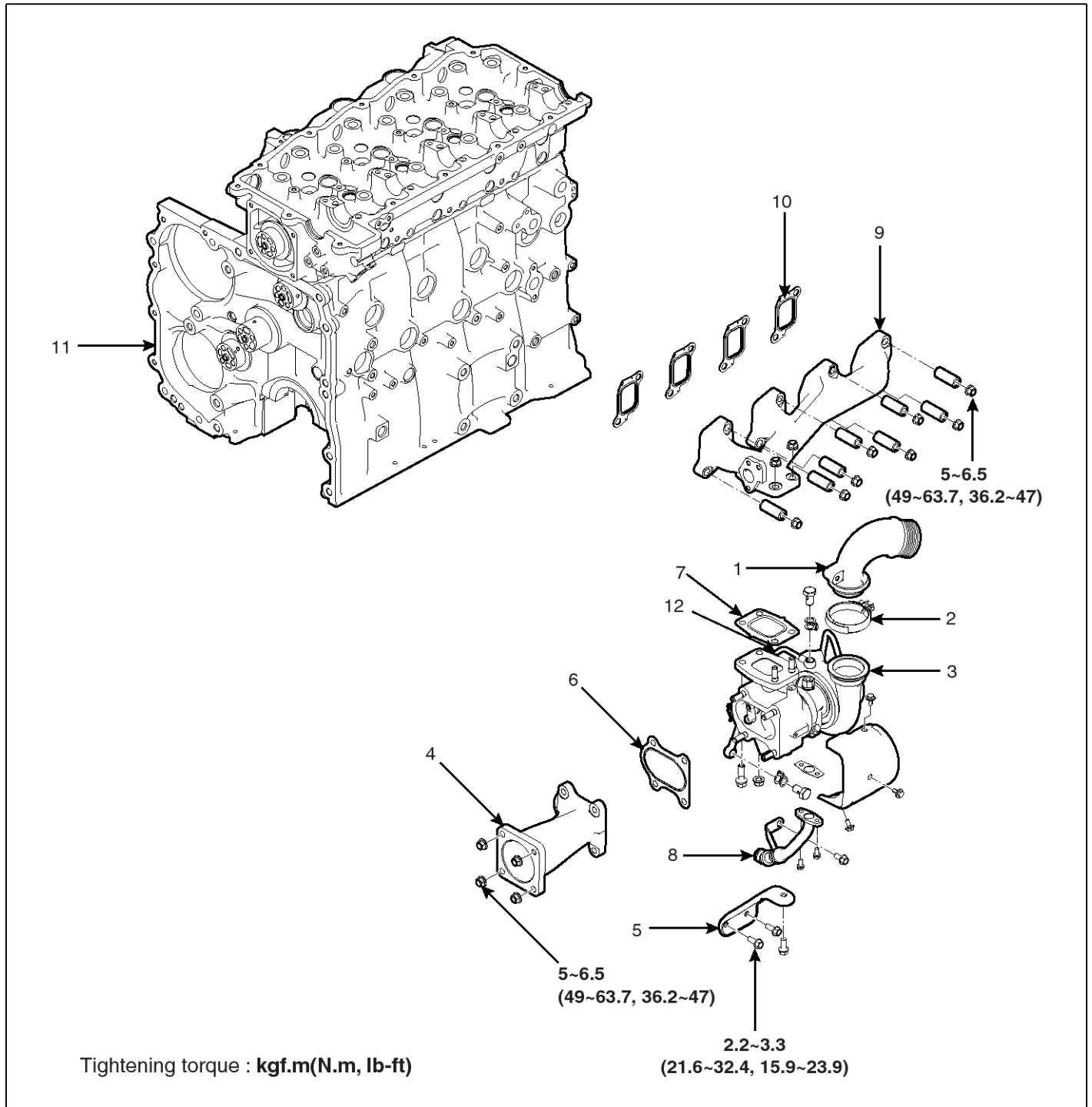
TROUBLESHOOTING





Turbo Charger

COMPONENTS



SDFEM9039L

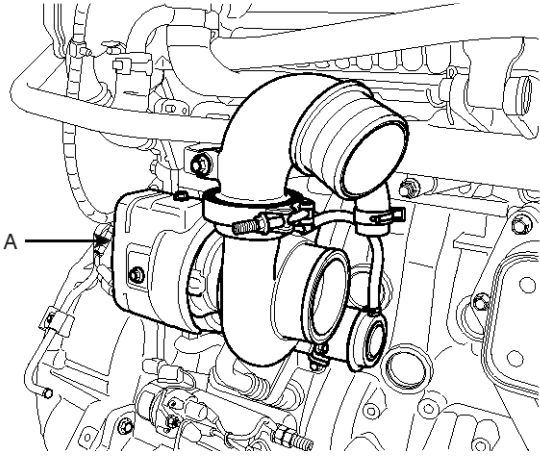
- 1. Compressor out coupler
- 2. V-clamp
- 3. Turbo charger assembly
- 4. Exhaust pipe

- 5. Turbo charger support bracket
- 6. Exhaust pipe gasket
- 7. Gasket
- 8. Turbo charger oil return pipe

- 9. Exhaust manifold
- 10. Exhaust manifold gasket
- 11. Cylinder block
- 12. Turbo charger oil feed pipe

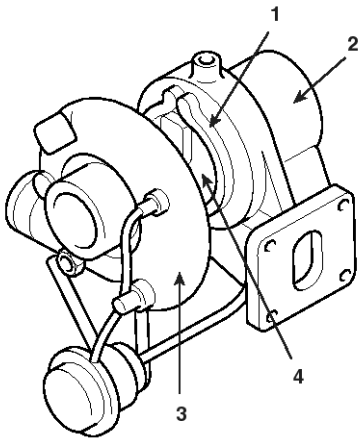
REMOVAL

1. Remove the turbo charger heater protector cover(A).



SDFEM7138D

2. Remove the turbo charger assembly.
3. Position the corresponding marks to the coupling(1), the turbine housing(2), the compressor cover(3) and the cartridge assembly(4).

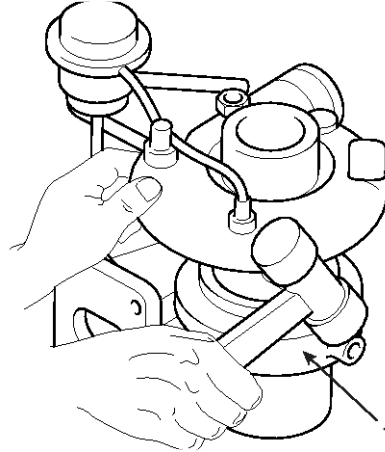


SDFEM7610D

4. Remove the turbine housing(1).

⚠CAUTION

1. Tap the circumference of housing lightly with a rubber hammer or the like not to cause damage to the turbine housing.
2. Be careful of removing the housing because the blade of turbine wheel is flexible.

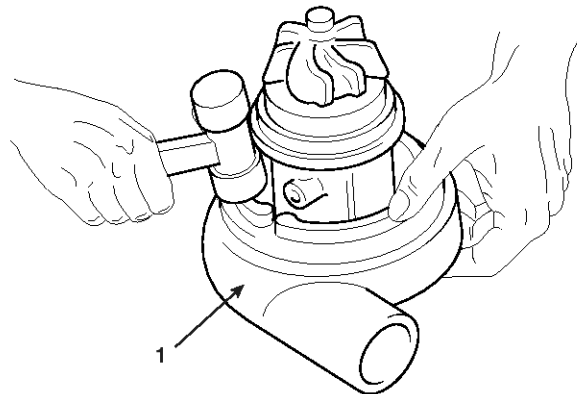


SDFEM7611D

5. Remove the compressor cover(1).

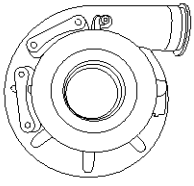
⚠CAUTION

1. Tap the periphery of cover lightly with a rubber hammer or the like not to cause damage to the compressor cover.
2. Be careful of removing the compressor cover because the blade of compressor wheel is flexible.

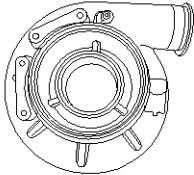


SDFEM7612D

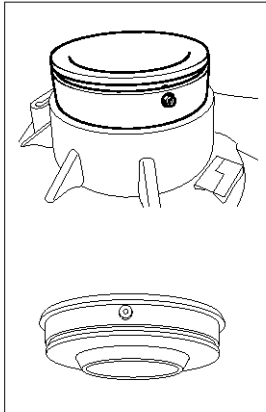
- Remove the RCC(recirculation cover) noise protector cover.



[Before removal]



[After removal]



[RCC noise protector cover]

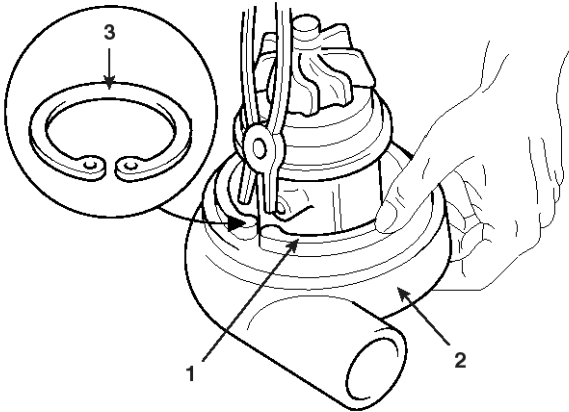
SDFEM9048L

INSTALLATION

- When assembling the snap ring(1) to the compressor cover(2), assemble with the taper side(3) of the snap ring face upward.

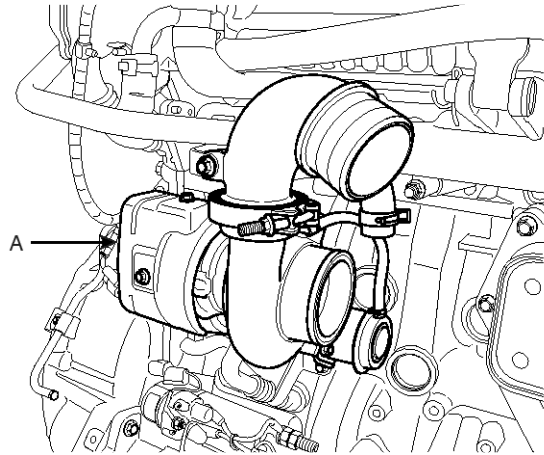
CAUTION

Install the snap ring to the compressor cover by holding the snap ring securely by a hand so that it would not bounce from a snap ring plier.



SDFEM7614D

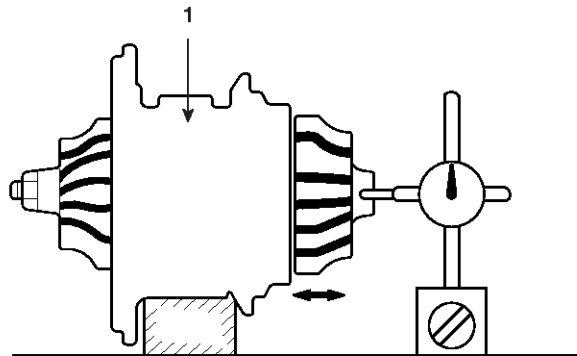
- Install the turbo charger assembly.
- Install the turbo charger pipe.
- Install the turbo charger heater protector cover(A).



SDFEM7615D

INSPECTION

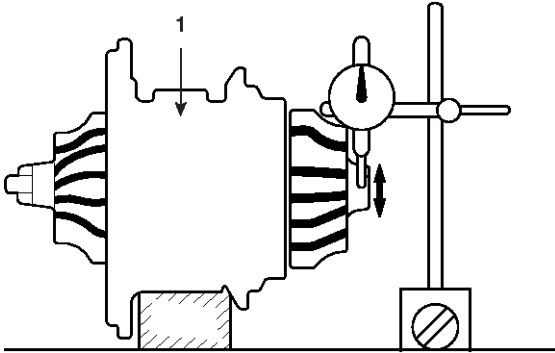
- Measure the end play of the axial direction of the shaft and turbine wheel assembly and replace the cartridge assembly(1) if the measured value is out of the specification.



SDFEM7616D

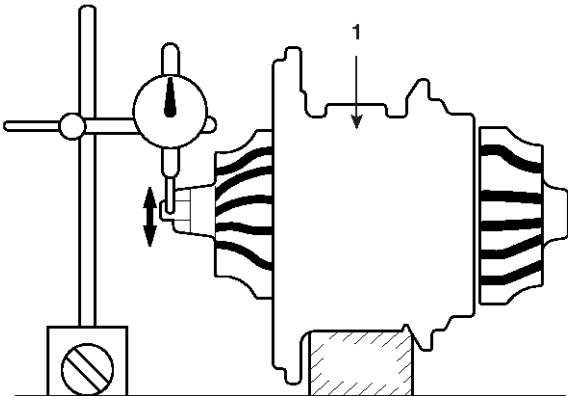
2. Check the shaft and turbine wheel assembly for the end play of the axial direction.

- 1) Measure the end play of the turbine wheel and replace the cartridge assembly(1) if the measured value is out of the specification.



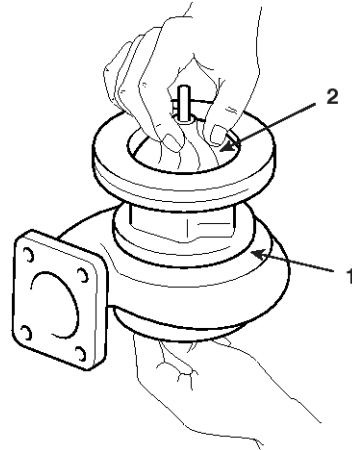
SDFEM7617D

- 2) Measure the end play of the compressor wheel and replace the cartridge assembly(1) if the measured value is out of the specification.



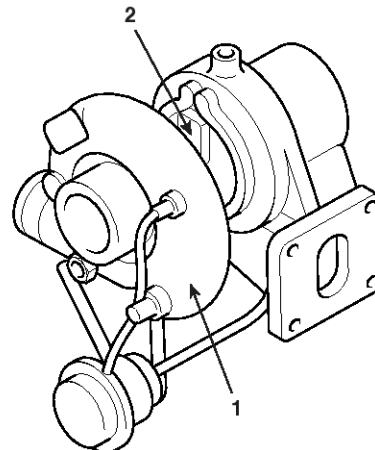
SDFEM7618D

3. Assemble the turbo charger assembly(1) and check each wheel(2) for smooth rotation.



SDFEM7619D

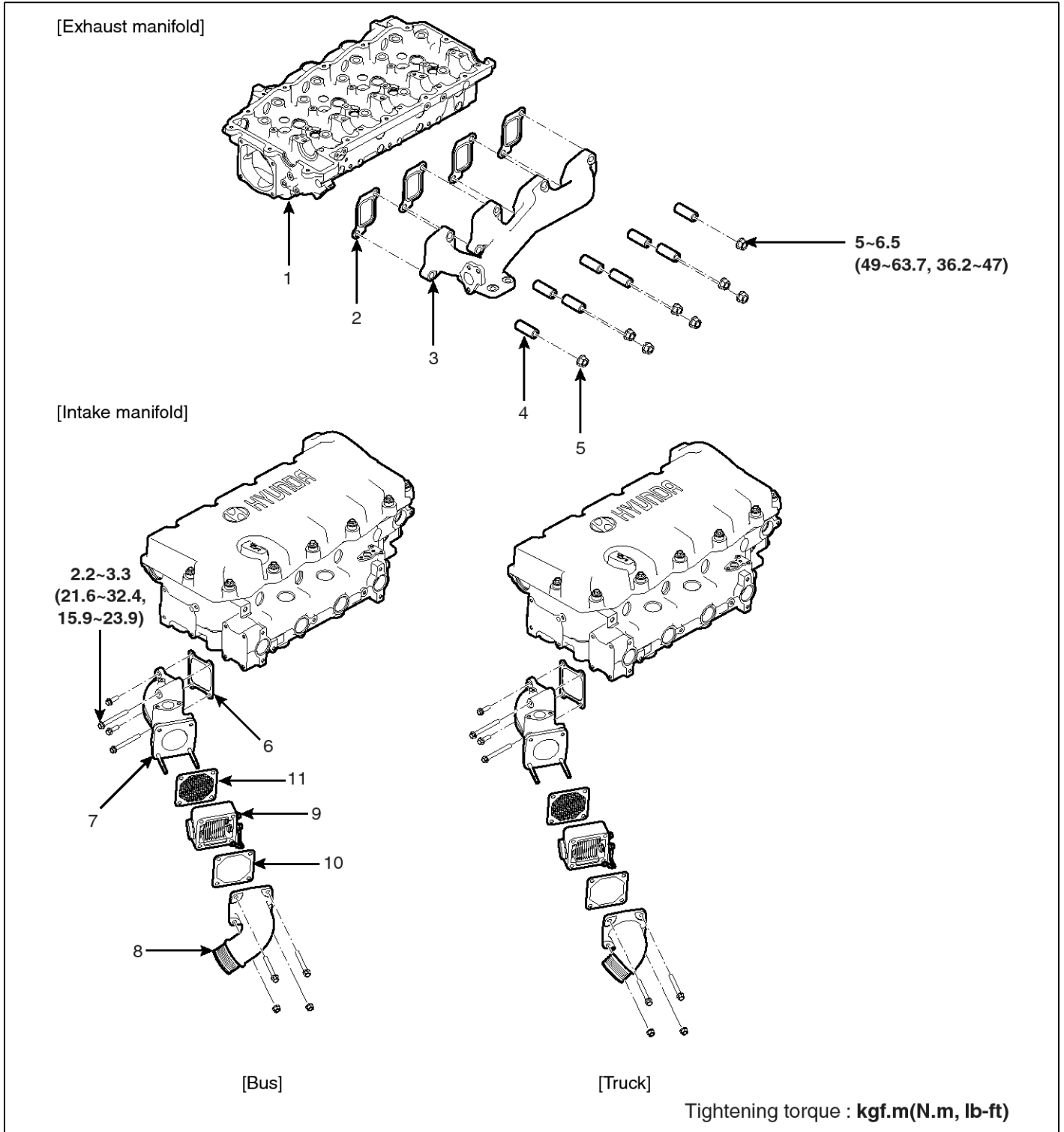
4. Pour the engine oil to the oil hole(2) to move each parts smoothly when assembling the turbo charger assembly(1).



SDFEM7620D

Exhaust Manifold

COMPONENTS

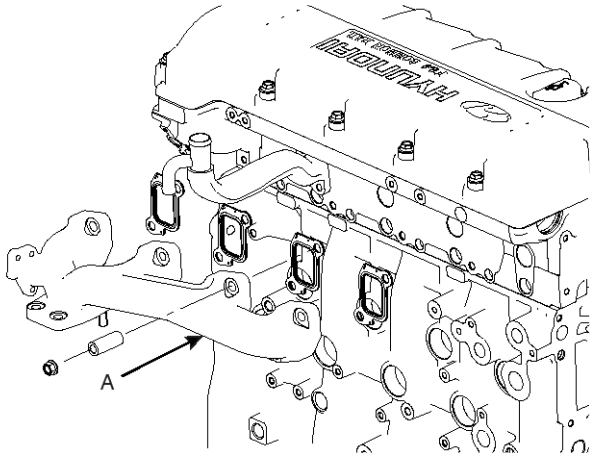


SDFEM9040L

- | | | | |
|----------------------------|--------------------------|------------------------|-------------------------|
| 1. Cylinder head | 4. Stud | 7. Intake coupler | 10. Heater gasket |
| 2. Exhaust manifold gasket | 5. Nut | 8. Pipe air heater | 11. Heater gasket(MESH) |
| 3. Exhaust manifold | 6. Intake coupler gasket | 9. Air heater assembly | |

REMOVAL

1. Remove the turbo charger assembly.
2. Remove the EGR assembly.
3. Remove the exhaust manifold(A) with the gasket from the cylinder block and then remove the water pump pipe.

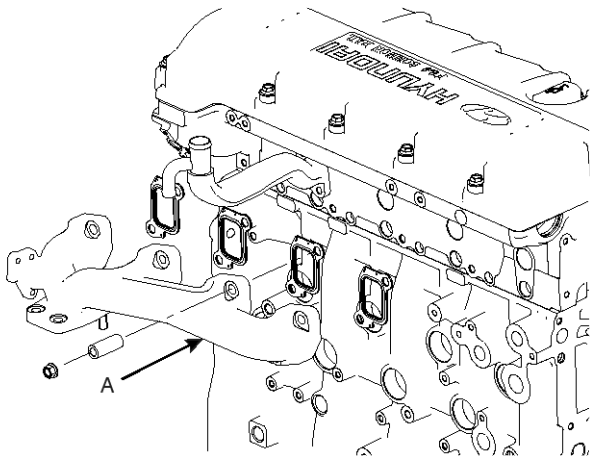


SDFEM7139D

INSTALLATION

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

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

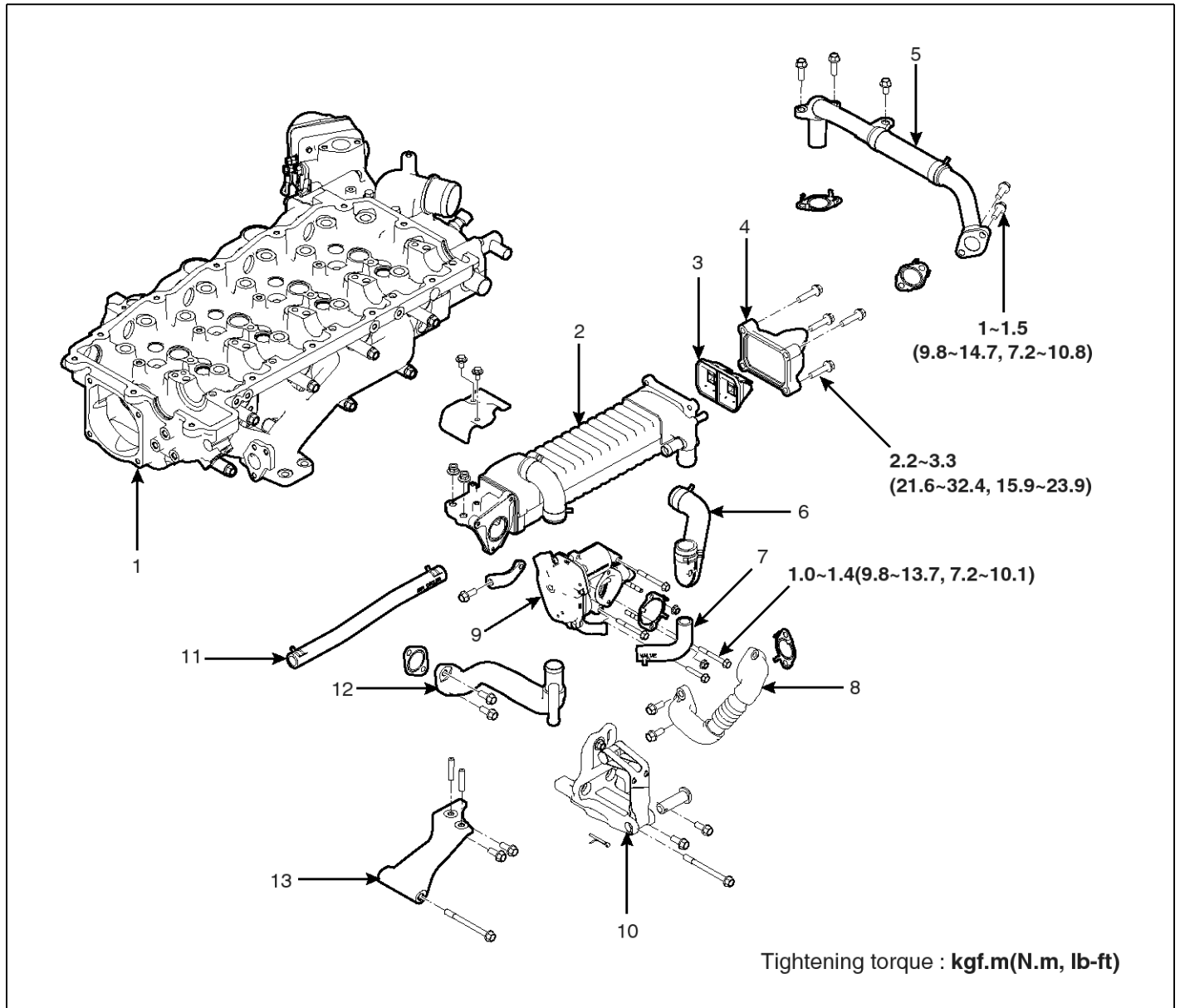


SDFEM7139D

2. Install the EGR assembly.
3. Install the turbo charger assembly.
4. Install the turbo charger heater protector cover.

EGR Assembly

COMPONENTS



- 1. Cylinder head
- 2. EGR cooler assembly
- 3. Reed valve
- 4. Reed valve housing
- 5. EGR gas outlet pipe

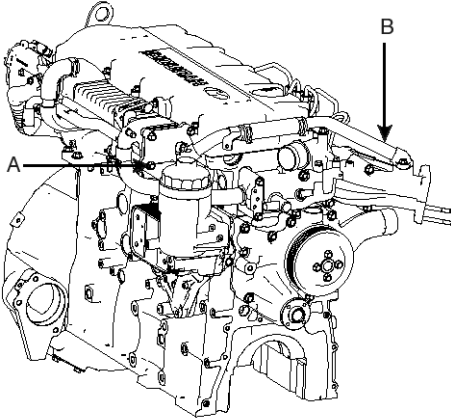
- 6. EGR water out hose
- 7. EGR valve water inlet hose
- 8. EGR gas inlet pipe
- 9. EGR valve
- 10. EGR cooler front bracket

- 11. EGR valve water outlet hose
- 12. EGR water inlet hose
- 13. EGR cooler rear bracket

SDFEM9041L

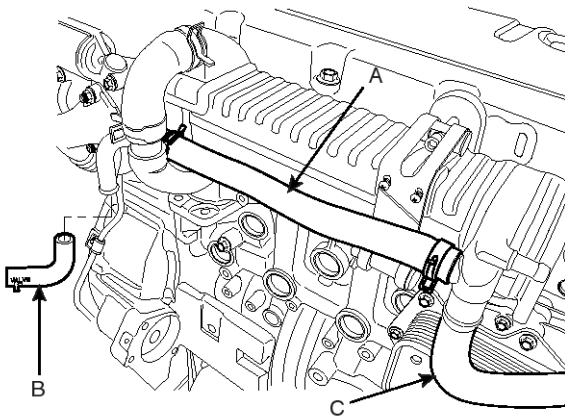
REMOVAL

1. Remove the EGR water out hose and then remove the reed valve housing(A) and the EGR outlet pipe(B).



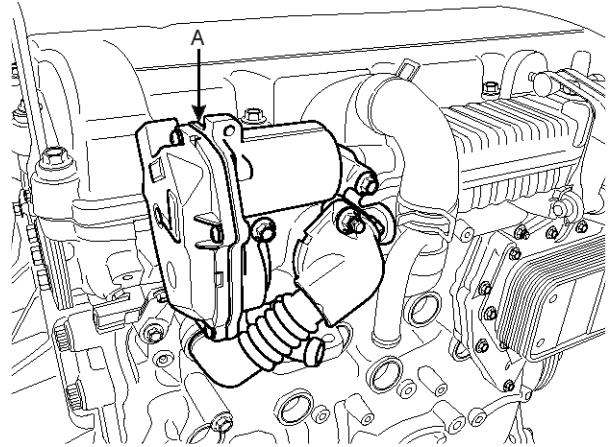
SDFEM7140D

2. Remove the EGR valve water inlet hose(B) and then the EGR valve water outlet hose(A) and the EGR water outlet hose(C).



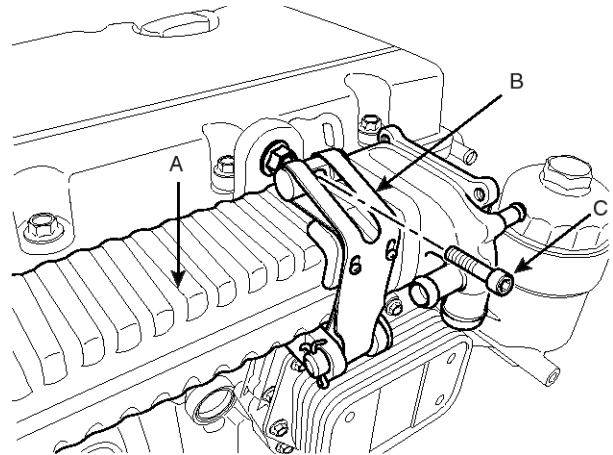
SDFEM7141D

3. Remove the EGR valve bracket and the EGR gas inlet pipe and then the EGR valve(A).



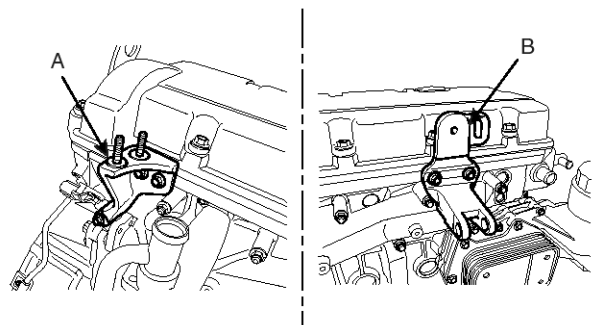
SDFEM7142D

4. After removing the bolt(C), pull the strap back and remove the EGR cooler(A) from the bracket(B).



SDFEM7143D

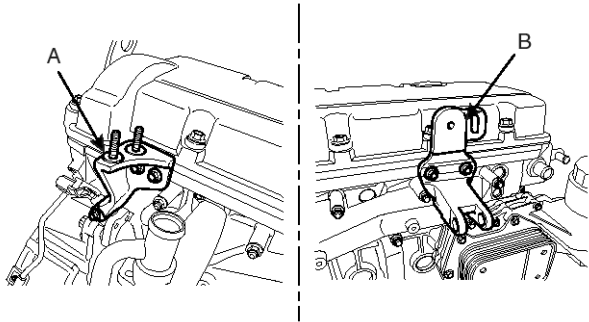
5. Remove the EGR assembly bracket(A, B).



SDFEM7144D

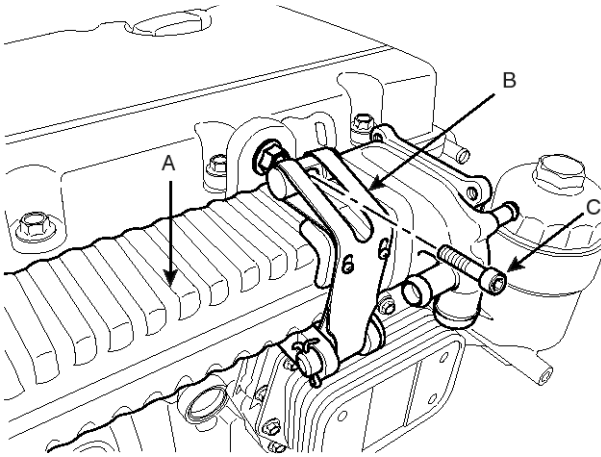
INSTALLATION

1. Install the EGR assembly bracket(A, B).



SDFEM7144D

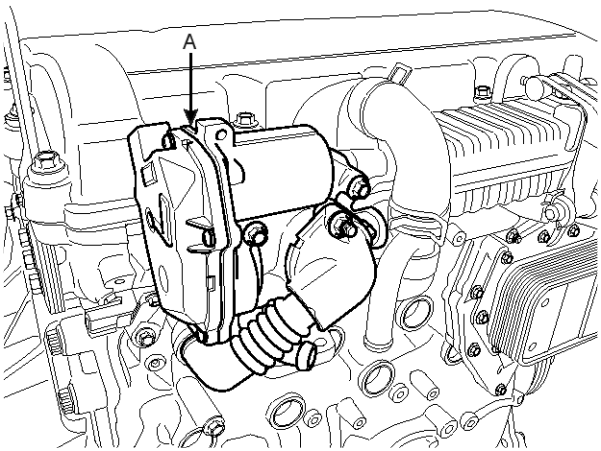
2. Install the EGR cooler(A) to the bracket(B).



SDFEM7143D

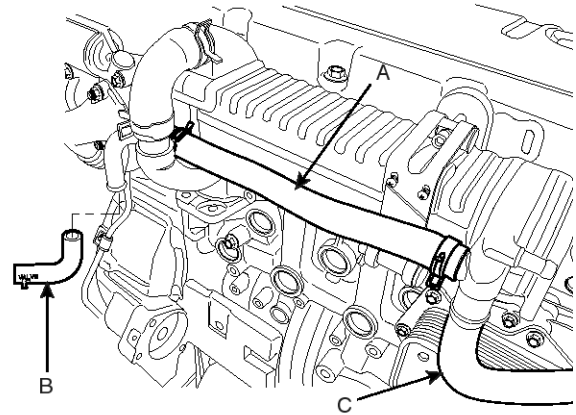
3. Install the EGR valve(A) and then install the EGR valve bracket and the EGR gas inlet pipe.

EGR valve mounting bolt : 1.0~1.4 kgf.m(9.8~13.7 Nm, 7.2~10.1 lb.ft)



SDFEM7142D

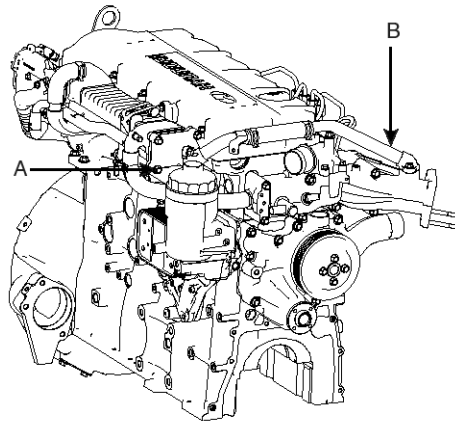
4. Install the EGR valve water inlet hose(B), the EGR valve water outlet hose(A) and the EGR water outlet hose(C).



SDFEM7141D

5. Install the reed valve housing(A), the EGR gas outlet pipe(B) and the EGR water outlet hose.

Reed valve housing mounting bolt : 2.2~3.3 kgf.m
(21.6~32.4 N.m, 15.9~23.9 lb-ft)

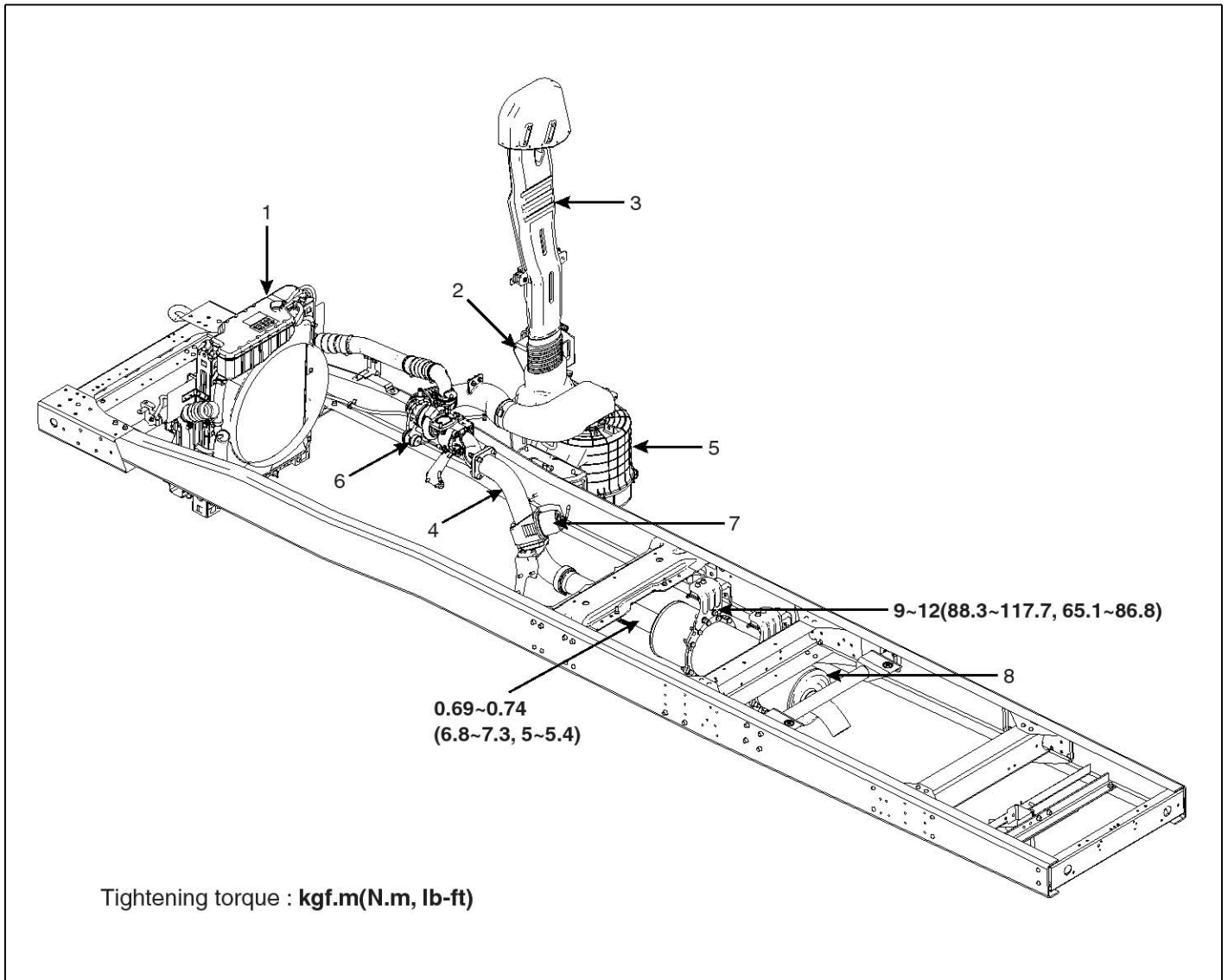


SDFEM7140D

Air Cleaner And Muffler

COMPONENTS

Truck

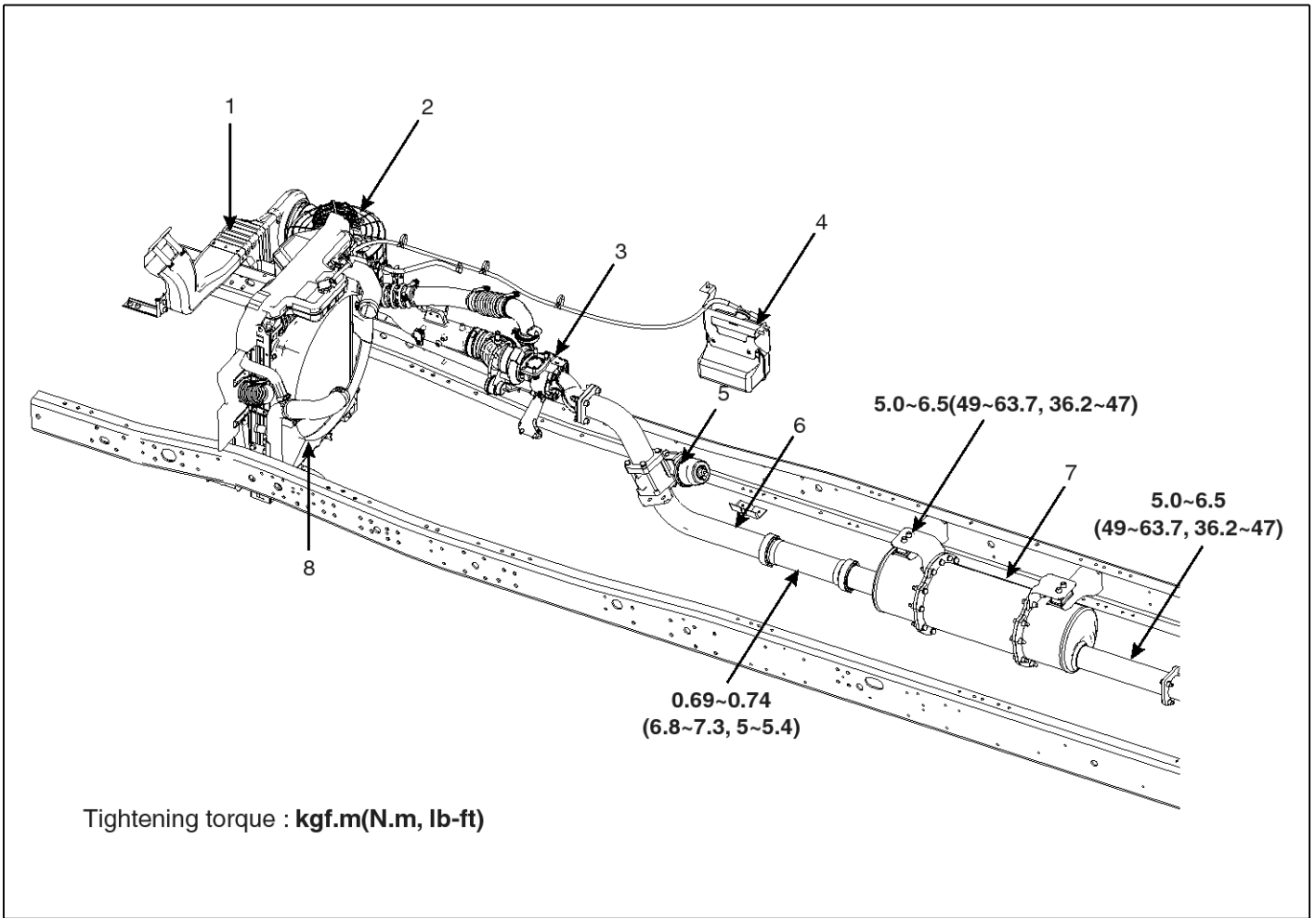


SDFEM9042L

1. Radiator and surge tank
2. Radiator reservoir
3. Air inlet duct
4. Intercooler outlet pipe

5. Air cleaner
6. Turbo charger
7. Exhaust brake
8. Muffler

Bus



SDFEM9043L

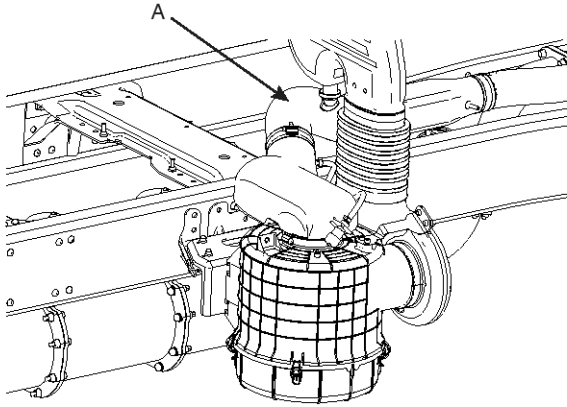
1. Inlet duct
2. Air cleaner
3. Turbo charger
4. Radiator reservoir

5. Exhaust brake
6. Exhaust pipe assembly(front)
7. Muffler
8. Radiator and surge tank

REPLACEMENT

AIR CLEANER (Truck)

1. Tilt the cap.
2. Disconnect the intercooler outlet pipe (A) from the air cleaner.



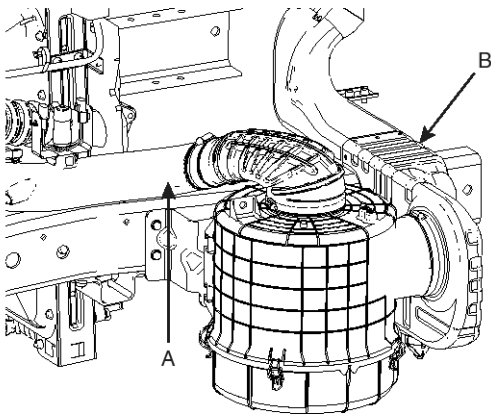
SDFEM7623D

3. Disconnect the mounting bolt mounted to the frame and remove the air cleaner assembly.
4. Installation is in the reverse of removal.

Air cleaner assembly mounting bolt : 2.1~3.1 kgf.m
(20.6~30.4 N.m, 15.2~22.4 lb.ft)

AIR CLEANER (Bus)

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



SDFEM7624D

3. Detach the mounting bolt mounted to the frame and remove the air cleaner assembly.
4. Installation is in the reverse of removal.

Air cleaner assembly mounting bolt : 2.1~3.1 kgf.m
(20.6~30.4 N.m, 15.2~22.4 lb.ft)

AIR CLEANER FILTER REPLACEMENT(Truck, Bus)

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

CAUTION

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

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

NOTICE

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

CAUTION

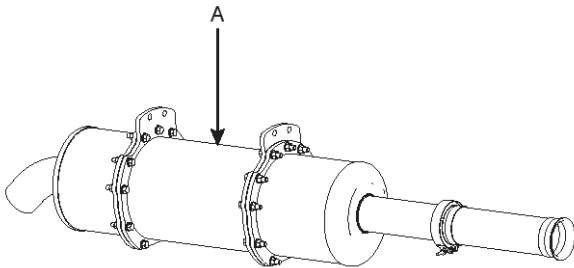
Use a genuine part when replacing the air cleaner element and driving without the air cleaner may cause premature damage to the engine.

EXHAUST MUFFLER(Truck)

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

NOTICE

The particulate matter catalyst(PMC) is built-in in the center muffler (A).



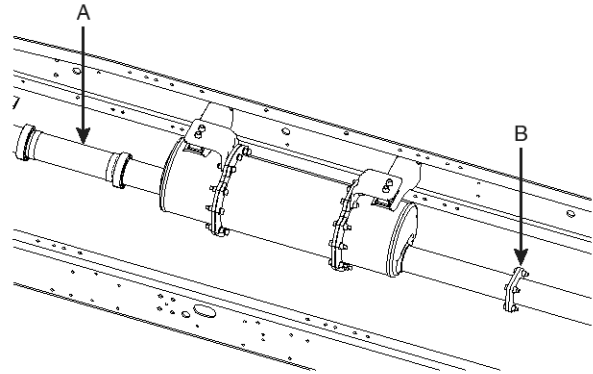
SDFEM7625D

4. Installation is in the reverse of removal.

EXHAUST MUFFLER(Bus)

1. Loosen the clamp and detach the flexible pipe(A) from the muffler assembly.

Remove the bolt(B) connected to the rear pipe assembly.

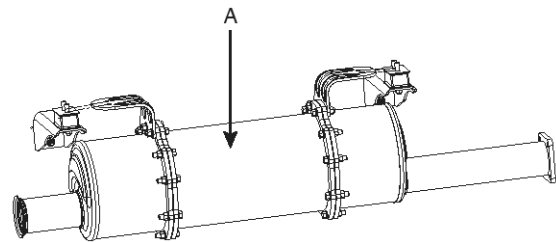


SDFEM7626D

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

NOTICE

The particulate matter catalyst(PMC) is built-in in the center muffler (A).



SDFEM7627D

4. Installation is in the reverse of removal.