Engine Mechanical System

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/cm² or more(Within 4kg/cm² each cylinder)	20kg/cm²	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				

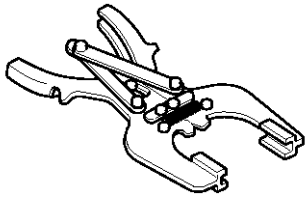
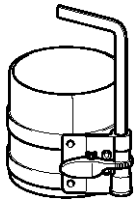
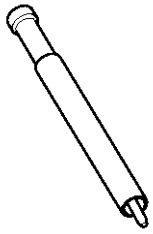
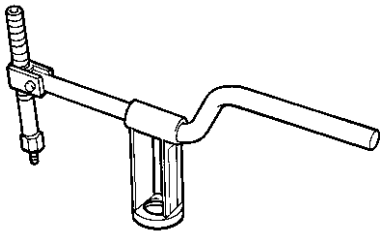
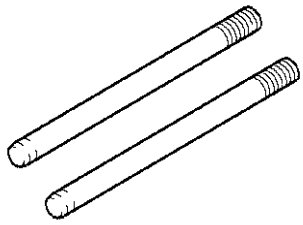
Cooling system

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/cm²		
		Negative pressure	Max. 0.1kg/cm²		
	Radiator check pressure		1.5kg/cm²		

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)

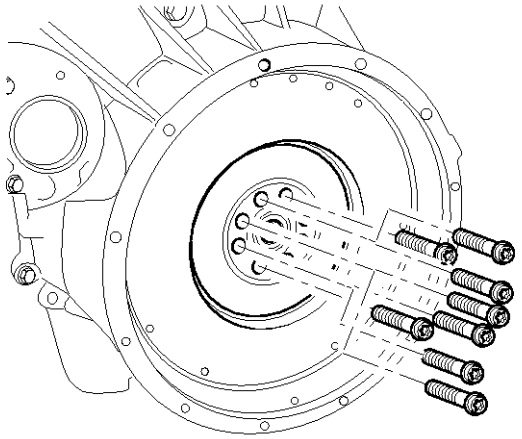
SPECIAL TOOLS

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

3. Remove the flywheel.

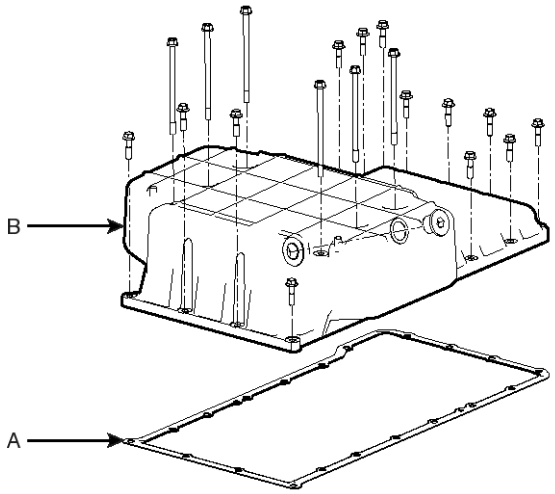
NOTICE

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



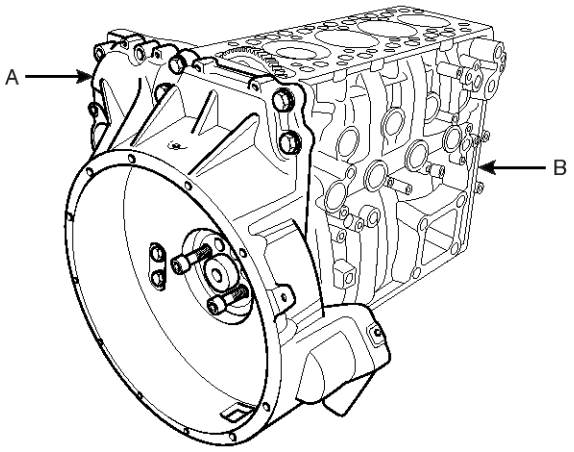
SDFEM7088D

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



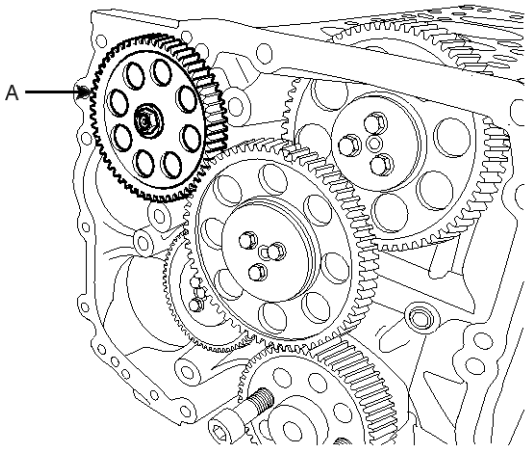
SDFEM9058L

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



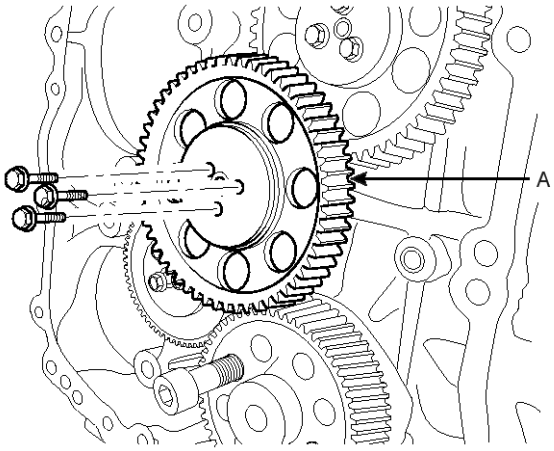
SDFEM7042D

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



SDFEM7043D

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

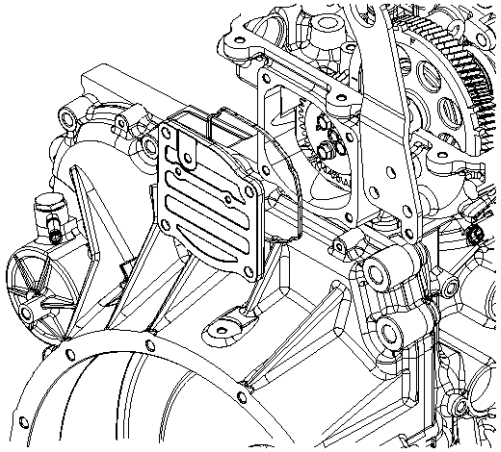


SDFEM7044D

17. Assemble the rear cover.

⚠CAUTION

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



SDFEM7646D

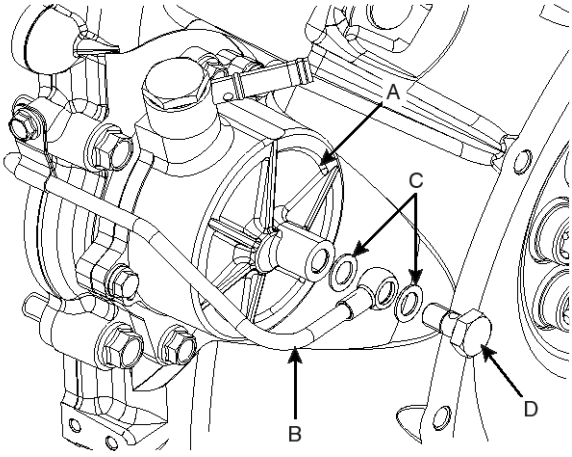
18. Install the vacuum pump(A).

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).**

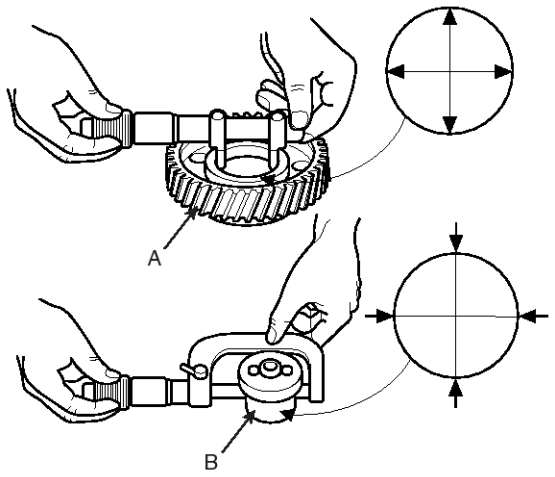


SDFEM7629D

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

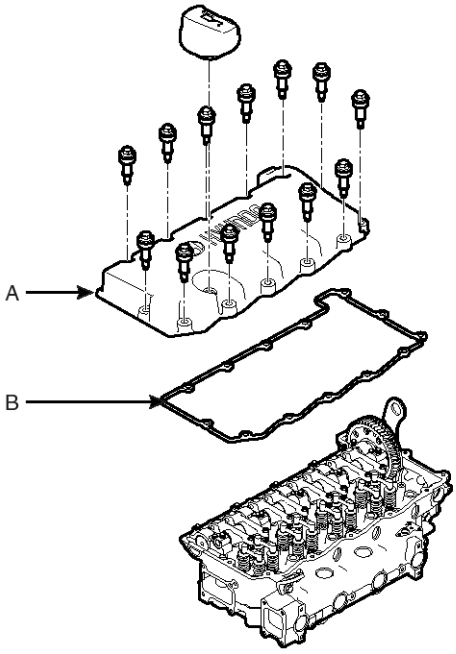
⚠CAUTION

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

Measuring position	A	B
	6.5mm	6.5mm

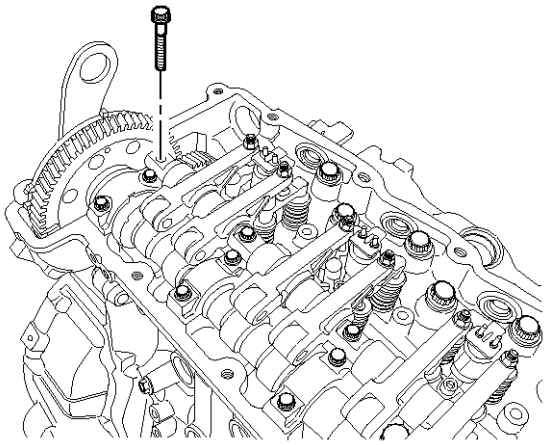
REMOVAL

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



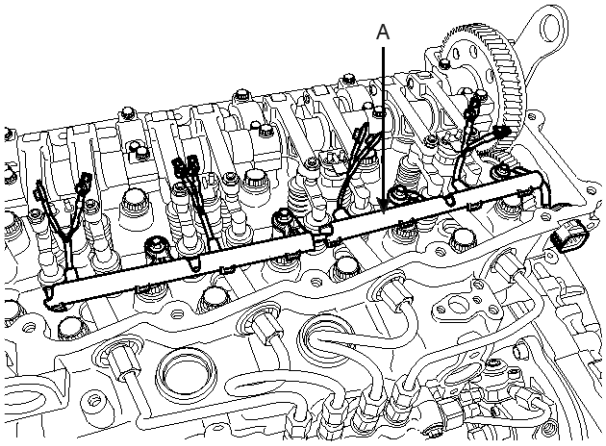
SDFEM7052D

4. Remove the rocker arm assembly.



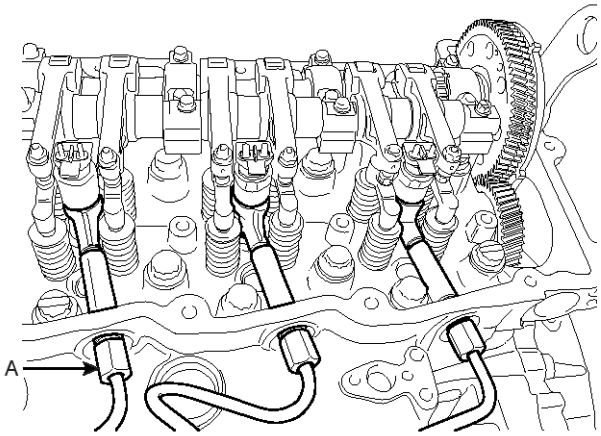
SDFEM7075D

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



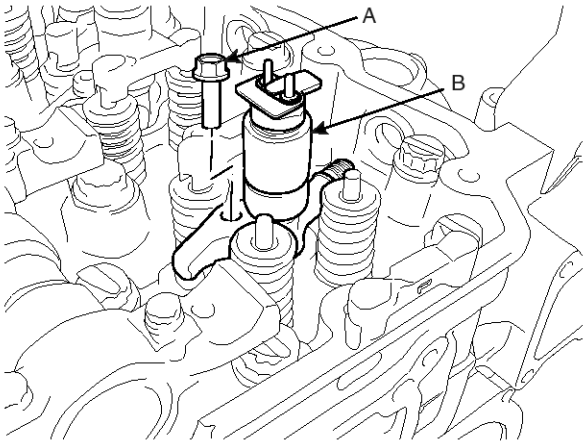
SDFEM7053D

6. Remove the high pressure pipe(A).



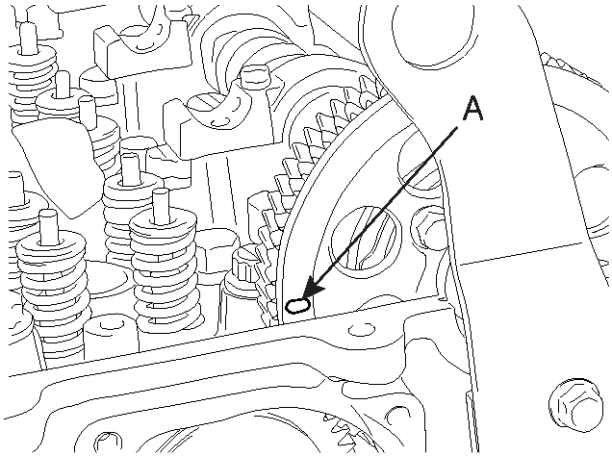
SDFEM7054D

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



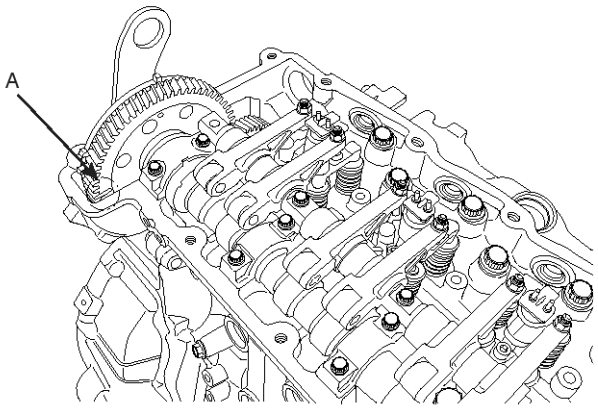
SDFEM7056D

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	
Valve	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

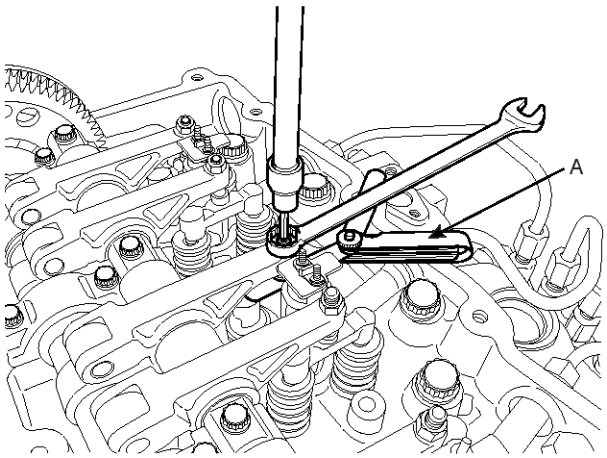
h. *If the valve clearance is out of specification, adjust the clearance with a thickness gauge by turning the adjusting screw after loosening the lock nut loosely.*

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

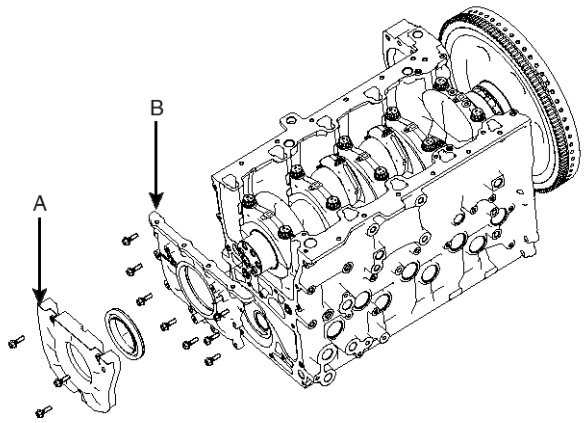
Make sure that the valve clearance is within specification after adjusting it.



SDFEM7078D

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).

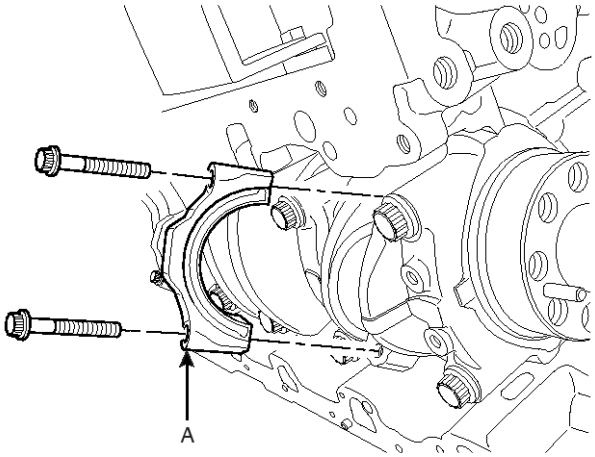


SDFEM7632D

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

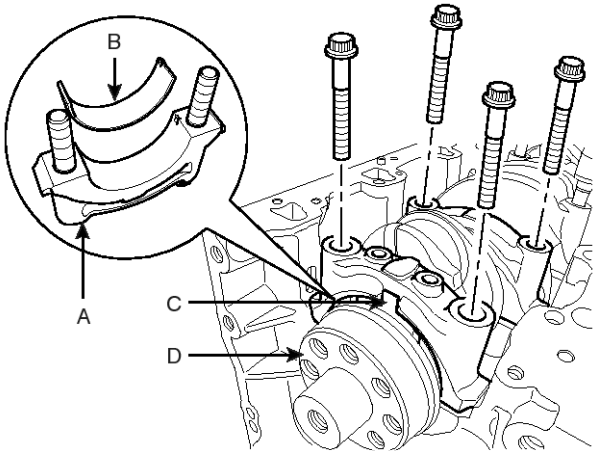
NOTICE

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).

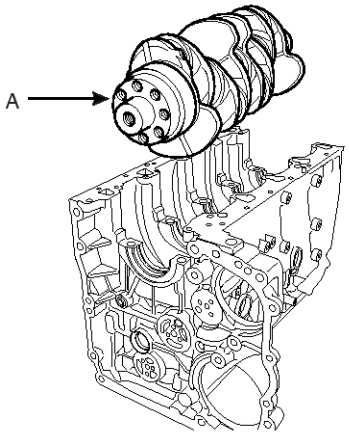


SDFEM7095D

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

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

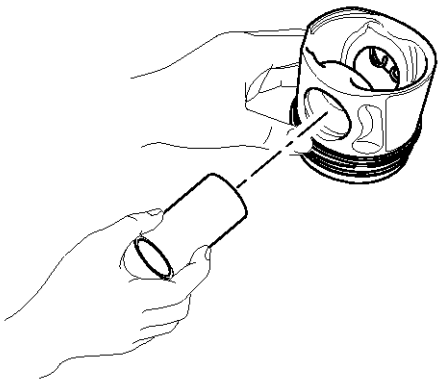
6. **The piston and the piston ring should be replaced with the same as oversize.**
7. **The connecting rod should be replaced with the new one which has identical weight and grade with the old one.**

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.

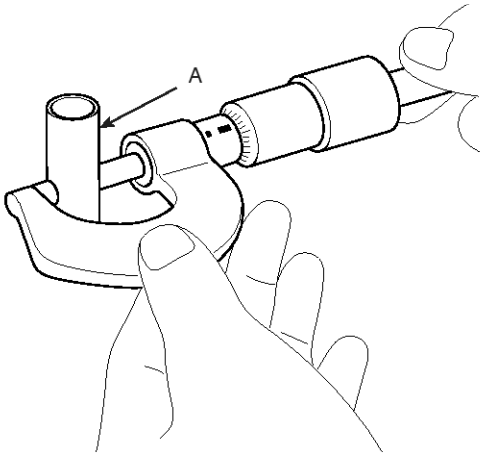
   The piston pin should slide into the piston pin hole smoothly when it is pushed by hand.



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.

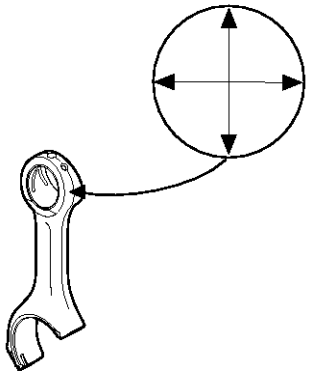
Outer diameter of piston pin : 43.994~44mm
Inner diameter of piston pin hole : 44.007~44.015mm
Clearance reference value : 0.007~0.021mm
Clearance limit value : 0.05mm



SDFEM7113D

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

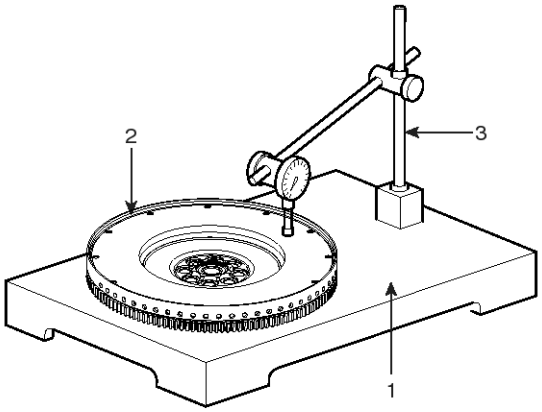
Inner diameter of connecting rod smaller end : 44.030~44.040mm
Outer diameter of piston pin : 43.994~44mm
Clearance reference value : 0.03~0.046mm
Clearance limit value : 0.1mm



SDFEM7114D

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

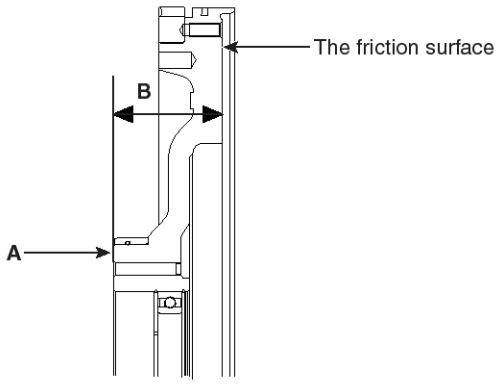
2. Repairing the friction surface of flywheel.

   Repair the friction surface of flywheel using a grinder.

   Grind the friction surface of the flywheel by a grinder.

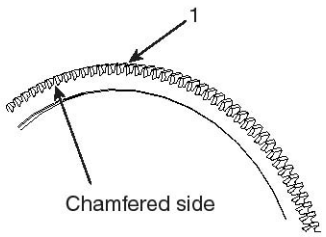
   ⚠CAUTION
   a. After repairing the friction surface, the runout of the friction surface should be within 0.1 mm. (On the basis of surface "A")
   b. The height of the friction surface(dimension B) should not exceed the limit.

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



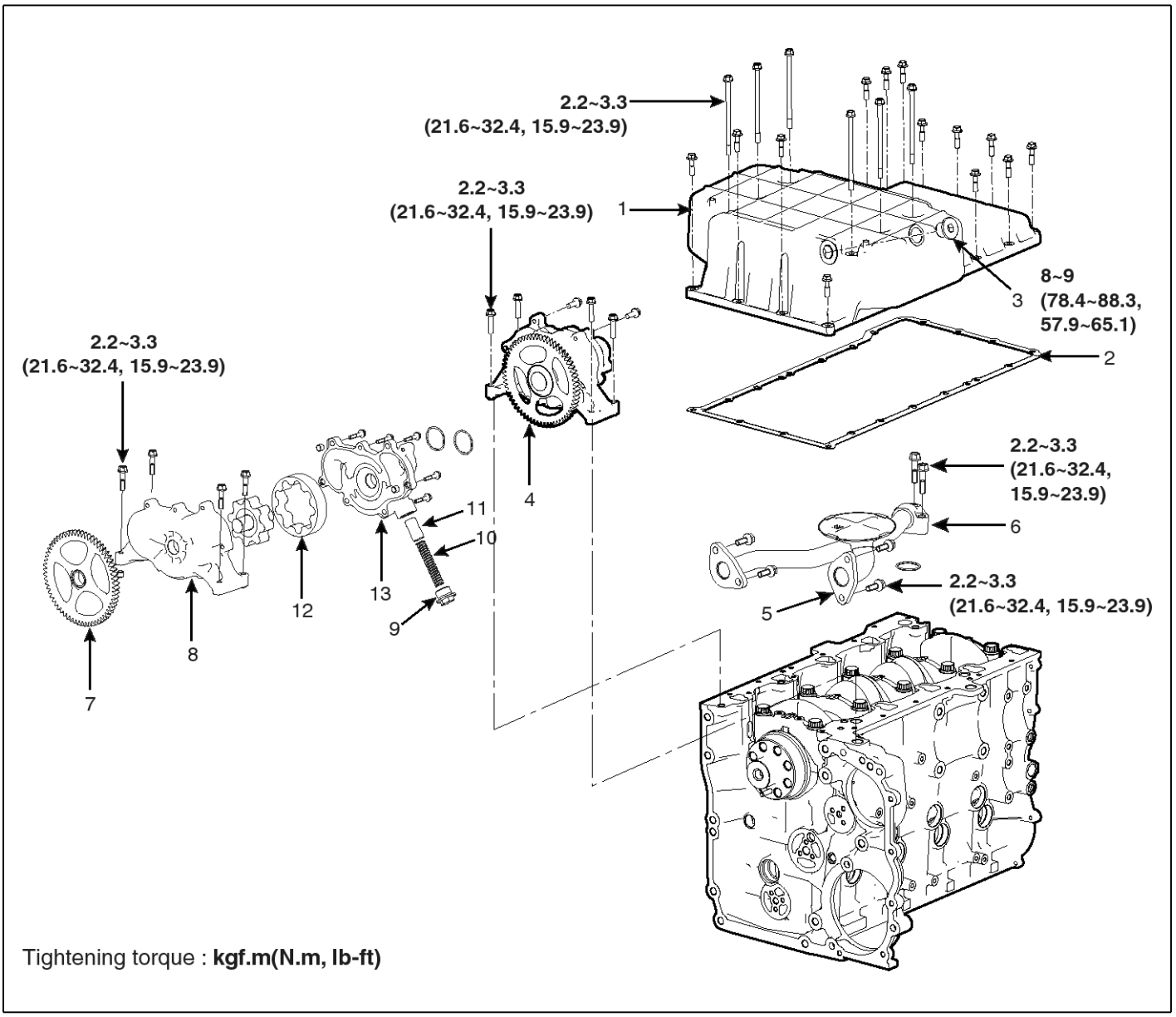
SDFEM9056L

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 ℃). Assemble the ring gear to the flywheel to direct the surface which is not chamfered toward the flywheel.



SDFEM9057L

COMPONENTS



SDFEM9026L

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

ADJUSTMENT

ENGINE OIL INSPECTION

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

NOTICE

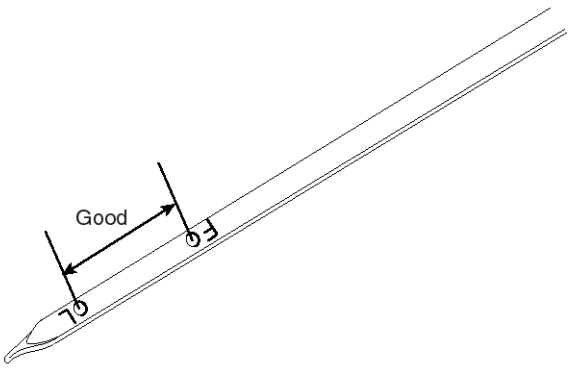
1. Warm up the engine for several minutes if the vehicle has not been inspected for a long period of time.

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 cooant 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

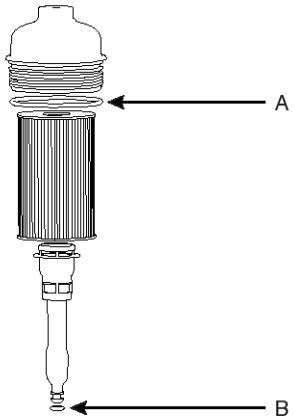
CAUTION

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).



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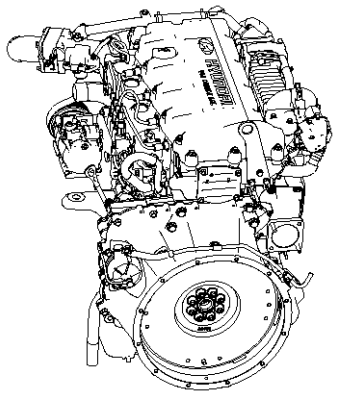
4. Install the oil filter to the specified torque.
5. Start the engine and check the oil for leak.
6. Stop the engine and check oil level. Refill the engine oil as required.

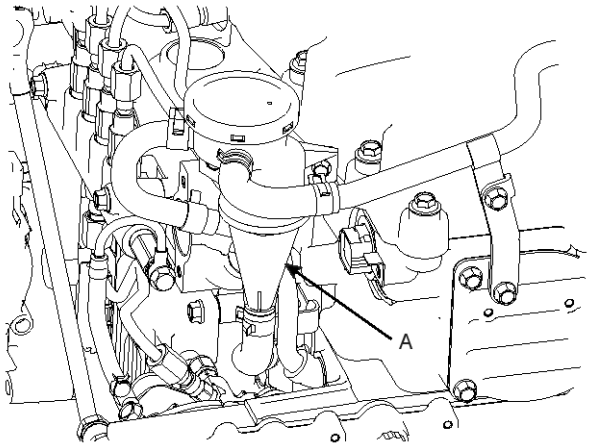
REPLACEMENT

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



SDFEM9064L

(Without oil separator)



SDFEM7601D

(With oil separator)

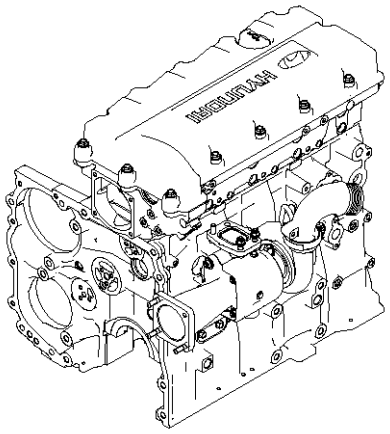
2. Remove the bracket mounting bolt and then remove the oil separator(A).
3. Installation is in the reverse of removal.

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



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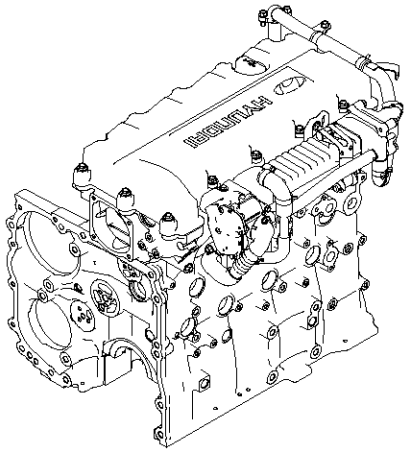
EGR SYSTEM

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.



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