

GENERAL

Construction and Operation

Engine Proper

1. Combustion Chamber

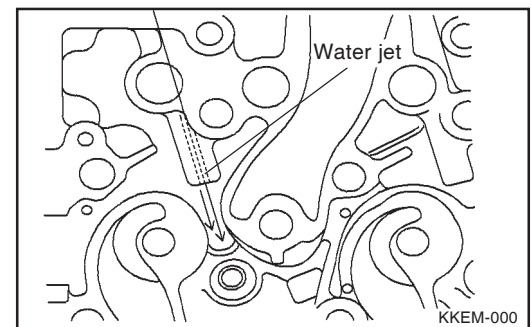
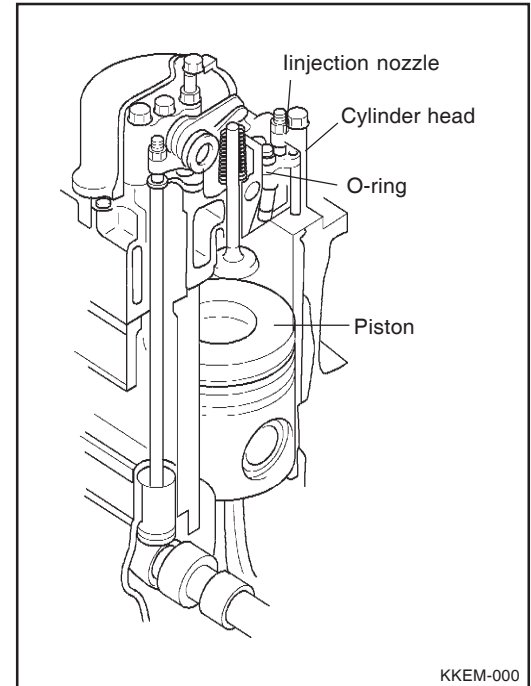
The combustion chamber is made up of the cylinder head and toroidal piston. The hole type injection nozzle is mounted to the cylinder head together with the nozzle tube.

The nozzle tube accomplishes the function of holding the nozzle in position and cooling it. Since the outside of the nozzle tube is exposed to the water jacket, the top end of the tube is sealed off with an O-ring and the bottom is staked to prevent water leakage.

Combustion is accomplished by direct injection of fuel into the combustion chamber.

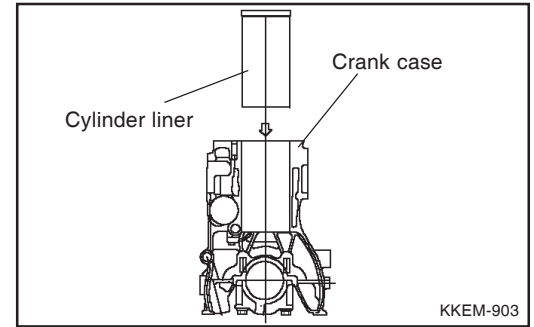
A valve recess is machined on the top of the piston for providing a clearance between the piston and exhaust valve.

For more effective cooling of the combustion chamber, water directors that direct coolant flow are pressed into the bottom of the cylinder head.



3. Crankcase and Cylinder Liner

- (a) The coolant enters the water jacket to flow around each cylinder and cool it, and then flows to the cylinder head.
- (b) The dry type cylinder liner is adopted and the liner is pressfitted to the crankcase in such a way as to facilitate removal.

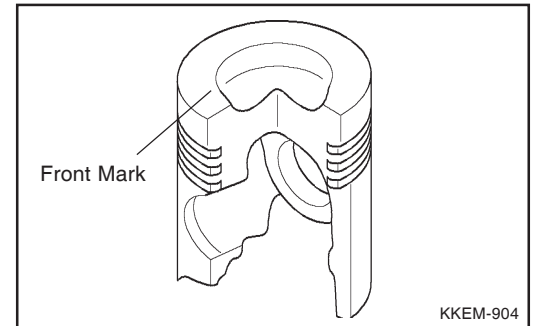


4. Piston and piston ring

(a) Piston

Stamped on the top surface of the piston are a size mark (or oversize dimension on oversize pistons) for selection fit with the cylinder liner, a piston weight mark, part number, and the "F" with an arrow for the front mark showing the piston installing direction.

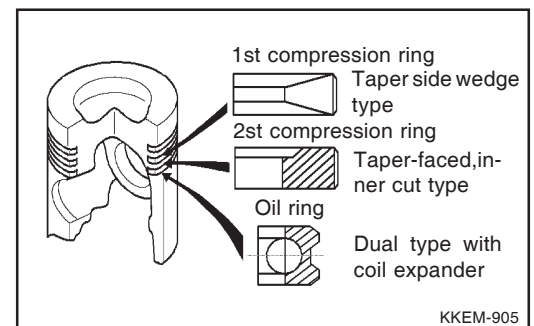
Piston pin for connecting piston to connecting rod is of full-floating type and is prevented from moving out by means of a snap ring type and is prevented from moving out by means of a snap ring installed on each end of the pin ends. On D6AU, a cavity is provided in the piston for colling.



(b) Piston ring

The piston rings are three in total; two compression rings and one oil ring. The sliding surface of each piston ring is hard chrome plated to improve wear resistance.

The piston rings are shaped as shown in the figure.



7. Timing Gear

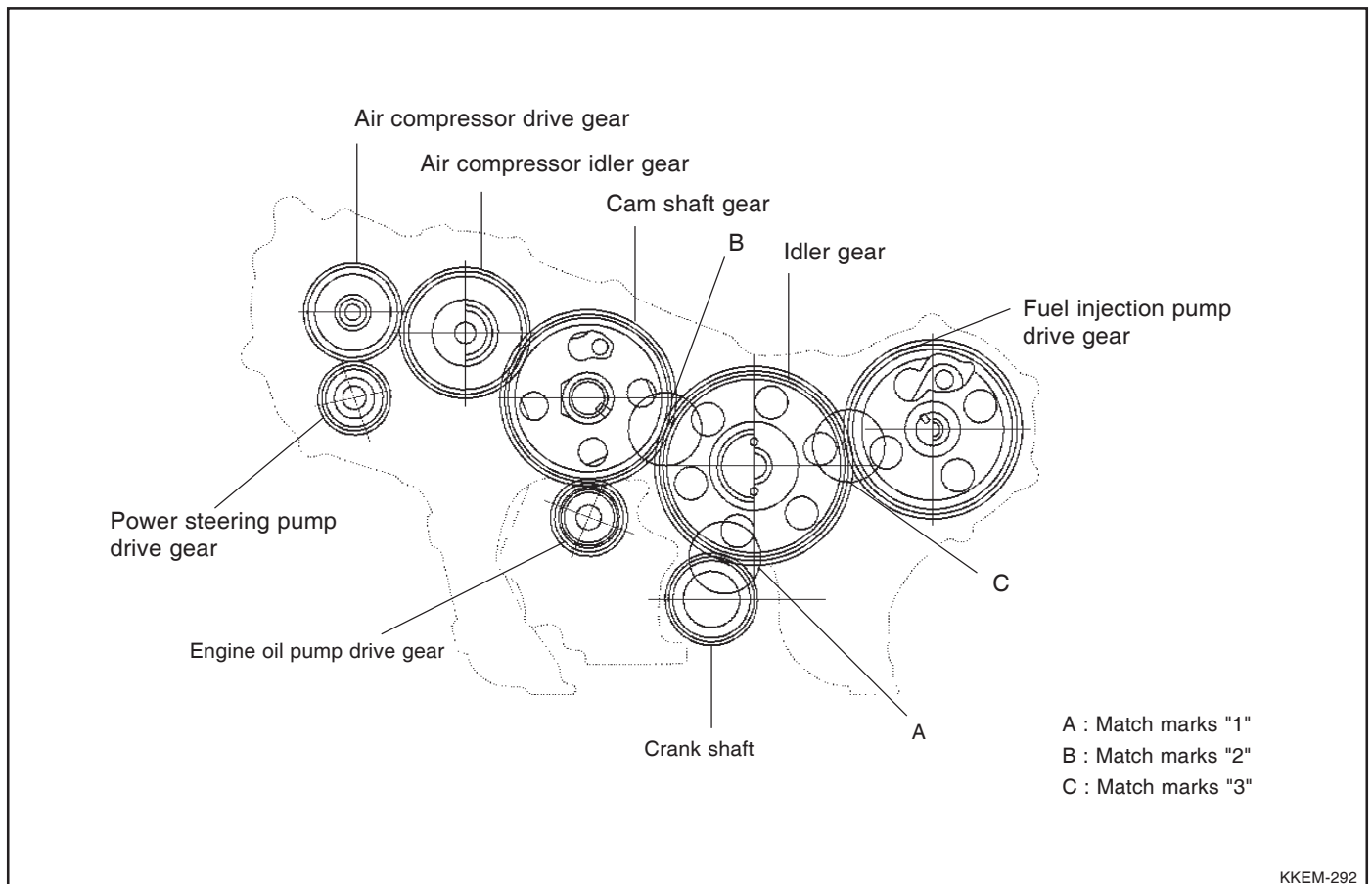
The timing gears are housed in the timing gear case at the front of the engine. Illustration shows the gear train.

Each gear is a helical gear machined by a shaving machine to high precision and surface-treated for enhanced durability.

A timing mark is a stamped on each gear.

At resassembly, correct meshing can be achieved by aligning these marks.

On D4A, an oil pipe is installed in the idler shaft that is used for forced lubrication of the injection pump gear.



A bushing is press-fitted into the idler gear which turns on the idle shaft.

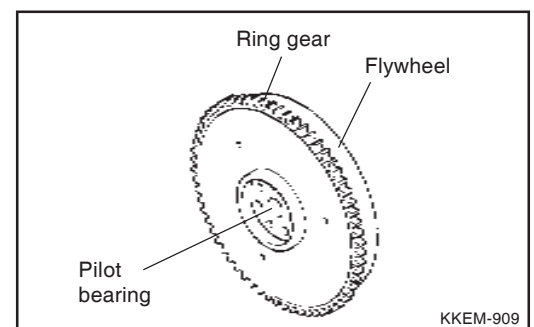
The oil hole drilled through the idler shaft and gear provides an oil passage for lubrication of bushing and gears.

8. Flywheel

The flywheel is made of cast iron. The pilot bearing of the transmission drive pinion is installed at its center. On its periphery, the ring gear is shrink-fitted that meshes with the starter pinion.

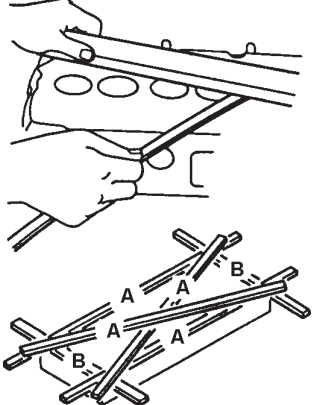
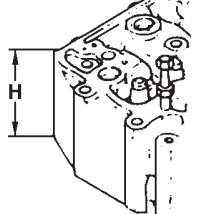
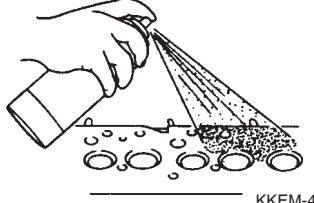
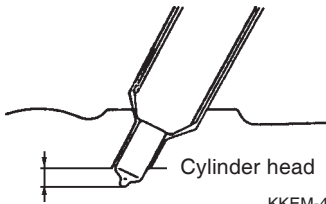
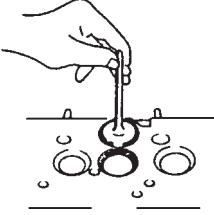
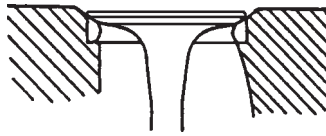
The ring gear tooth crests are induction-hardened for greater durability.

At the same time, one side of the crests is chamfered to ensure that the starter pinion meshes easily when starter is operated.

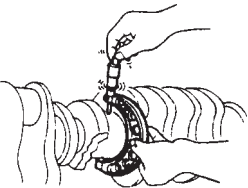
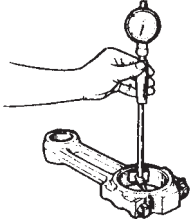
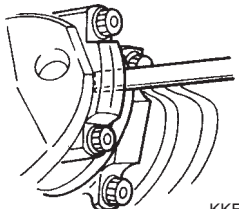
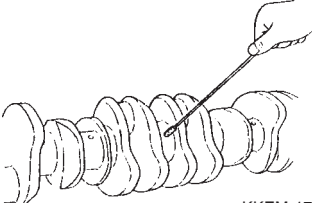
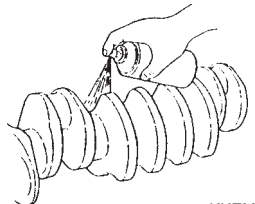
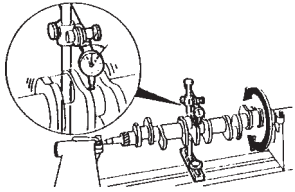


SERVICE STANDARD

Unit : mm

Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Cylinder head flatness		Less than 0.05 (0.0019) at direction A	0.1	Grinding or replace	 KKEM-44
		Less than 0.03 (0.0012) at direction B			
Cylinder head height		94.9-95.1	94.7	Replace	 KKEM-45
Cylinder head cracks and Damage * Using a dye penetrant		-	-	Replace if necessary	 KKEM-46
Nozzle protrusion from cylinder head surface		2.1-2.7	-	Replace Nozzle sleeve	 KKEM-47
Valve seating condition * Using red lead marking compound		There should be good contact around entire circumference of valve head.	-	Hand lapping using lapping compound	 KKEM-48
Valve sink	Intake	0.65-0.95	1.2	Replace valve or valve seat if necessary	 KKEM-49
	Exhaust	1.15-1.45	1.7		

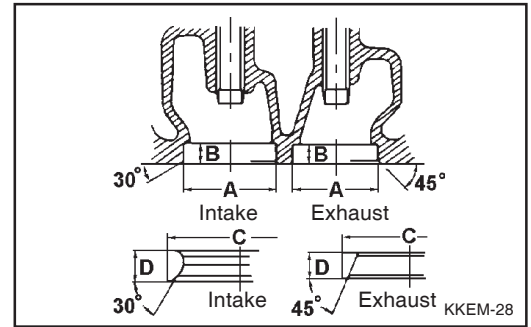
Unit : mm

Inspection Items	Standard	Limit	Remedy	Inspection Procedure
Crankshaft pin diameter	64.94-64.96	64.80	Regrind crankshaft and use undersize bearings	
		63.80	Replace crankshaft	
Clearance between connecting rod and crank pin	0.031-0.082	0.20	Replace bearing	 <small>KKEM-175</small>
Connecting rod end play	0.20-0.52	1.00	Replace connecting rod	 <small>KKEM-176</small>
Crankshaft oil hole clogged	-	-	Clean	 <small>KKEM-177</small>
Crankshaft cracks and damage	-	-	Replace	 <small>KKEM-178</small>
Crankshaft bend	-	0.09	Replace	 <small>KKEM-179</small>

2. Specifications of valve seat surface machining

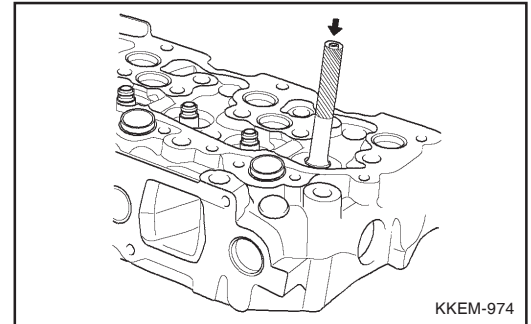
Unit: mm

		Intake	Exhaust
Cylinder head dimension	A	52.000-52.019	45.500-45.516
	B	10.1-10.3	10.4-10.6
Valve seat dimension	C	52.085-52.100	45.63-45.645
	B	7.6-7.8	8.0-8.2



3. Valve seat installation

Heat the cylinder head to about 80°C - 100°C with hot water. On the other hand, cool the valve seat with dry ice or liquid freon for approximately 30 minutes. Hold the seat with pincers and place it into the heated cylinder head.

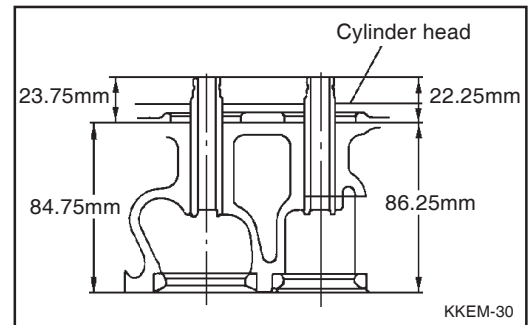


Replace the valve guide, if needed.

1. Remove the valve stem seal.
2. Remove the valve guide using a special tool. (Valve guide remover: 09211-8Y000)
3. Install the valve guide. (Valve guide installer: 09211-8Y100)

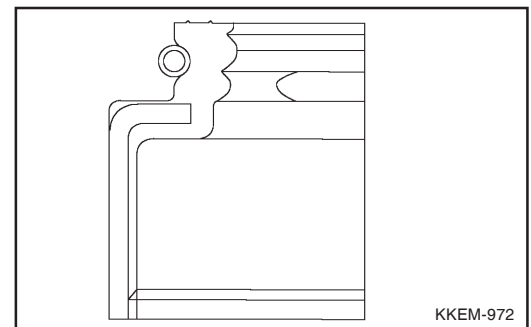
CAUTION

Apply engine oil lightly to the outer circumference of valve guide before installation.



Replace the valve stem seal, if needed.

1. Remove the valve stem seal.
(valve stem seal remover: 09222-8Y000)



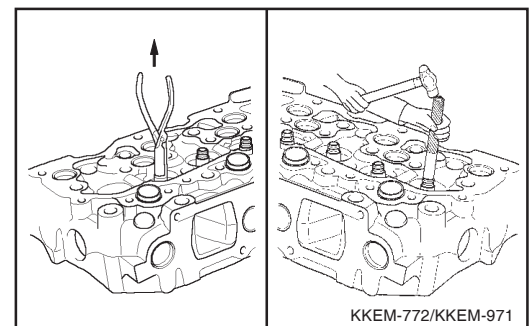
2. Install the valve stem seal.

Install the lower spring seat and valve first. Then apply engine oil to the lip of the stem seal and push the guide with a special tool.

Special tool: valve stem seal installer(09222-93000)

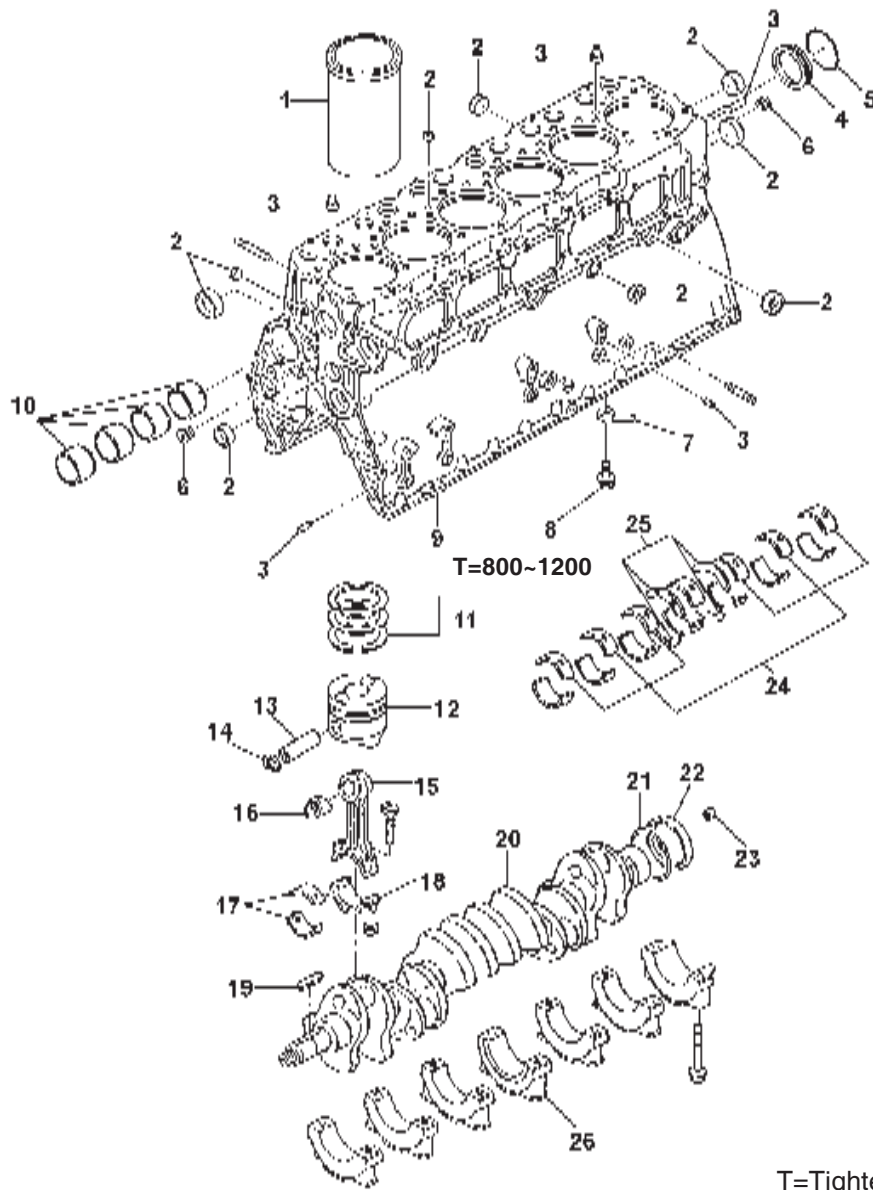
CAUTION

- Check for any cracks or damages of rubber, after valve stem seal installation.
- If the tip that touches the lower spring seat is worn or deformed, do not use the special tool.



Piston, Crankshaft, Cylinder Block and Oil Pan

OVERHAUL



T=Tightening torque : kgf-cm

- | | | |
|--|----------------------------|--------------------------------|
| 1. Cylinder liner | 9. Cylinder block | 18. Connecting rod bearing cap |
| 2. Plug | 10. Camshaft bearing | 19. Key |
| 3. Pin | 11. Piston ring | 20. Crank shaft |
| 4. Seal plate | 12. Piston | 21. O-ring |
| 5. O-ring | 13. Piston pin | 22. Sleeve |
| 6. Plug | 14. Retainer ring | 23. Collar |
| 7. Oil jet pipe for piston cooling | 15. Connecting rod | 24. Crankshaft main bearing |
| 8. Connector bolt
(Oil check valve) | 16. Bushing | 25. Crankshaft thrust bearing |
| | 17. Connecting rod bearing | 26. Crankshaft bearing cap |

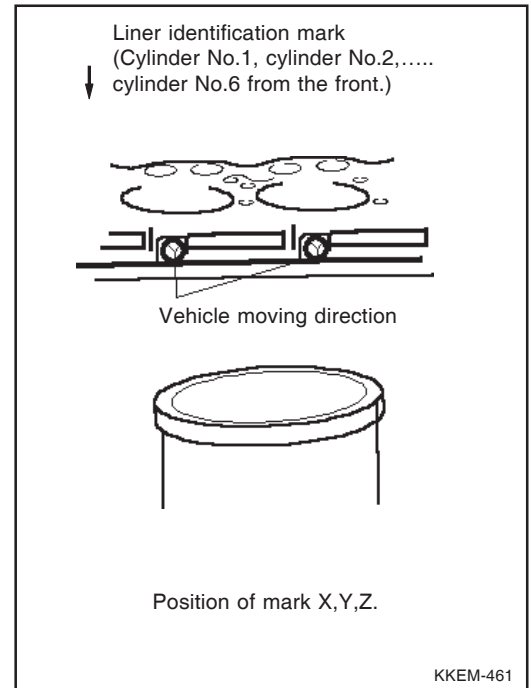
Insert the cylinder liners into the cylinder block.

1. When installing the new cylinder liner, check the mark of cylinder block with mark of liner.

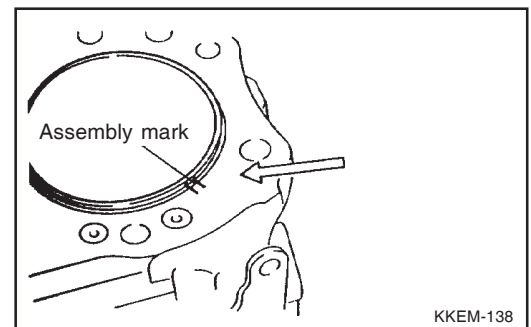
CAUTION

When installing the cylinder liner and block, be careful to choose the right ones.

In case of using the new cylinder liner, check the X,Y and Z mark of cylinder liner flange with the same marks of upper cylinder block.



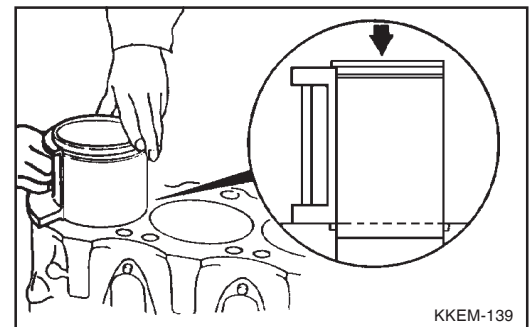
2. When reusing the liner, install the liner at the right position by coinciding the assembly marks that was drawn before the disassembly.



3. Lightly apply the engine oil around the outer circumference of liner, and install the liner by pressing the whole flange. If it is hard to install by hand, use the cylinder liner guide.

CAUTION

- Use the new one, if the liner has been dropped.
- Handle with care so that the liner is not damaged.



Liquid Gasket and Oil Application Points

General gaskets and liquid gaskets are used in engine. Apply the liquid gasket considering the following facts.

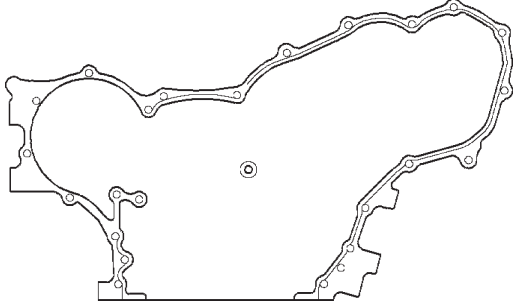
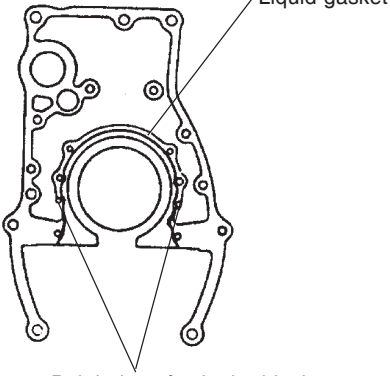
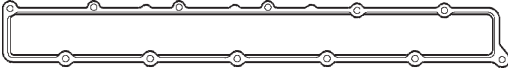
1. Application points and width of liquid gasket.

Liquid gaskets in use.

Three bond TB1207D or general electric NO. 2992 – 10: 04132 – 1207 (a), (b), (c) silver color

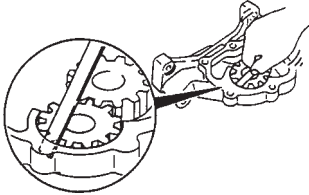
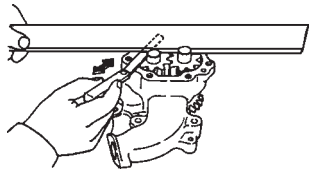
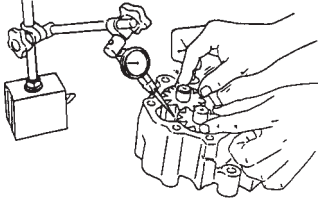
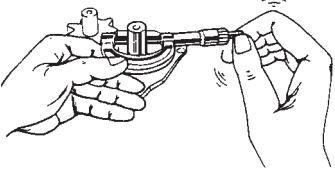
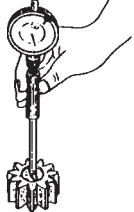
Three bond TB1207B: 04132 – 1217 (c), (d) black color

Unit: mm

Part name	Application points	Application width
(a) Timing gear cover	<p>Where contacts the cylinder block</p> <p>Liquid gasket</p>  <p>Liquid gasket</p> <p style="text-align: right;">KKEM-571</p>	1.5-2.5
(b) Flywheel housing	<p>Flange face where contacts cylinder block</p>  <p>Liquid gasket</p> <p>Bolt holes of cylinder block</p> <p style="text-align: right;">KKEM-573</p>	1.5-2.5
(c) Intake manifold	<p>Flange face where contacts cylinder head</p> <p>Liquid gasket</p>  <p>Liquid gasket</p> <p style="text-align: right;">KKEM-572</p>	1.5-2.5

SERVICE STANDARD

Unit : mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Clearance between gear and case	0.075-0.135	0.17	-	 <p style="text-align: right;">KKLU-194</p>
Gear end play	0.050-0.095	0.15	-	 <p style="text-align: right;">KKLU-195</p>
Gear backlash	0.073-0.207	0.40	-	 <p style="text-align: right;">KKLU-196</p>
Clearance between driven gear and shaft	0.040-0.083	-	-	  <p style="text-align: right;">KKLU-197</p>

Disassembly

Remove the oil filter element

Using special tool, loosen the nuts of oil filter and oil cooler.

Special tool: Wrench

Assembly

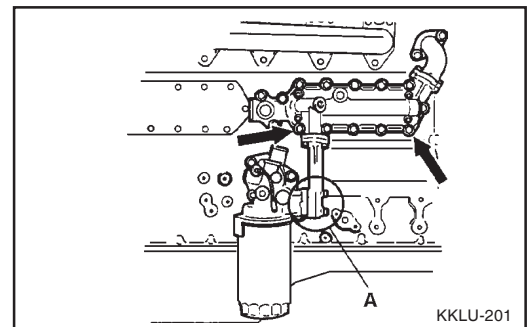
Oil filter element installation.

1. Apply some oil to the new filter gasket.
2. Fasten the new filter by hand until the gasket touches the cover.
Then, using special tool, fasten it again by 1/4 – 1 rotation.

Special tool: Wrench

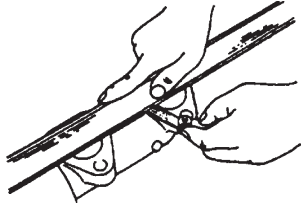
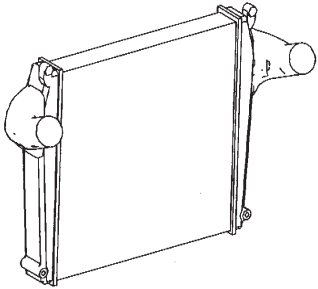
Install the oil cooler assembly.

1. Fasten the 2 reamer bolts.
2. When the gap between oil pipe and oil filter (A) becomes 0.5 mm or less, fasten another bolts.

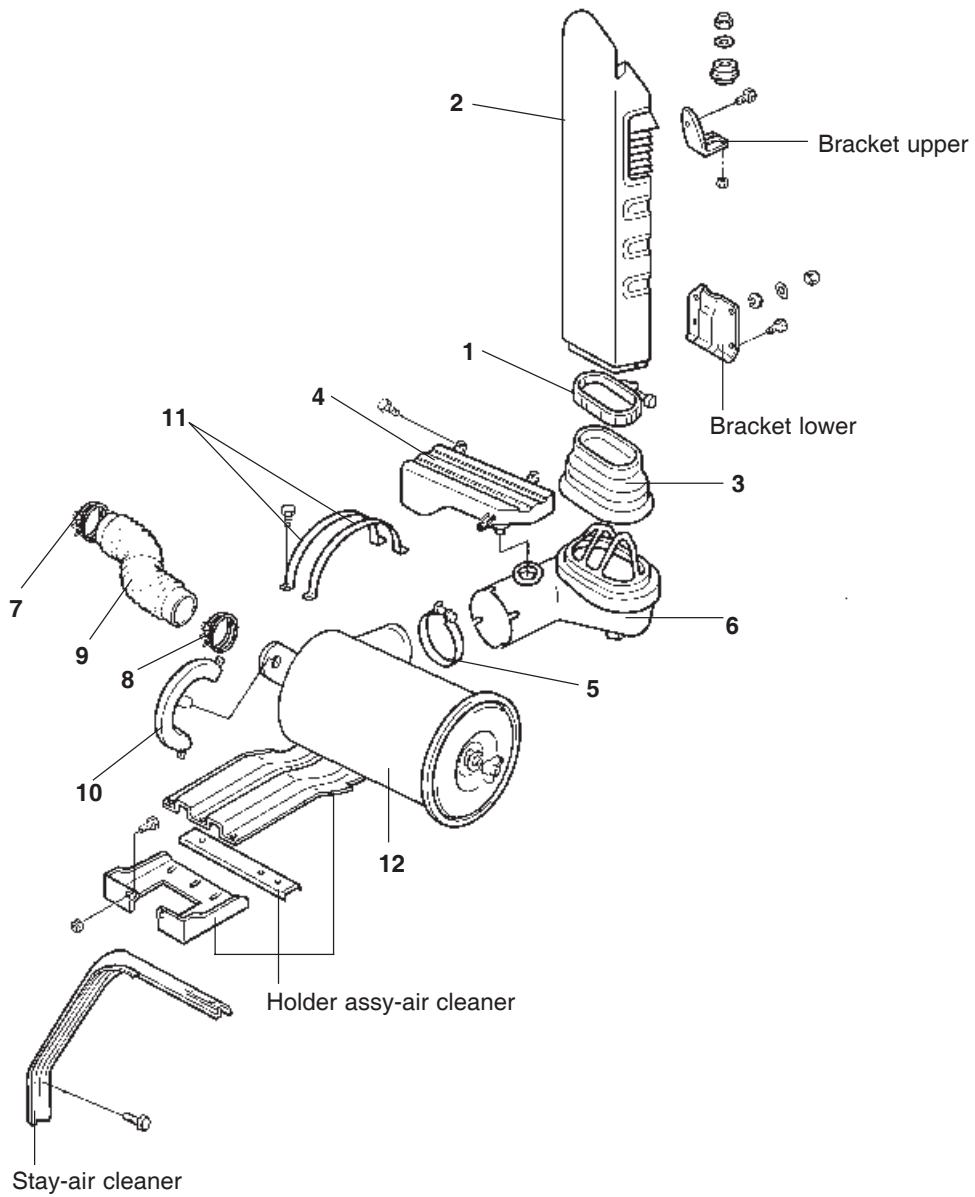


SERVICE STANDARDS

Unit : mm

ITEM	STANDARD	LIMIT	REMEDY	REMARK
Flatness of intake manifold	Less than 0.1	0.50	Grind or replace : Grind limit : 0.05mm each flange	
Abrasion or damage of exhaust manifold	-	-	Grind or replace	KKIE-248
Air leakage in inter cooler	Doesn't have any air leakage in 2.0kg/mm ² air pressure	-	Replace intercooler	
Clogged intercooler pin	-	-	Clean	KKIE-771

<8.5ton>

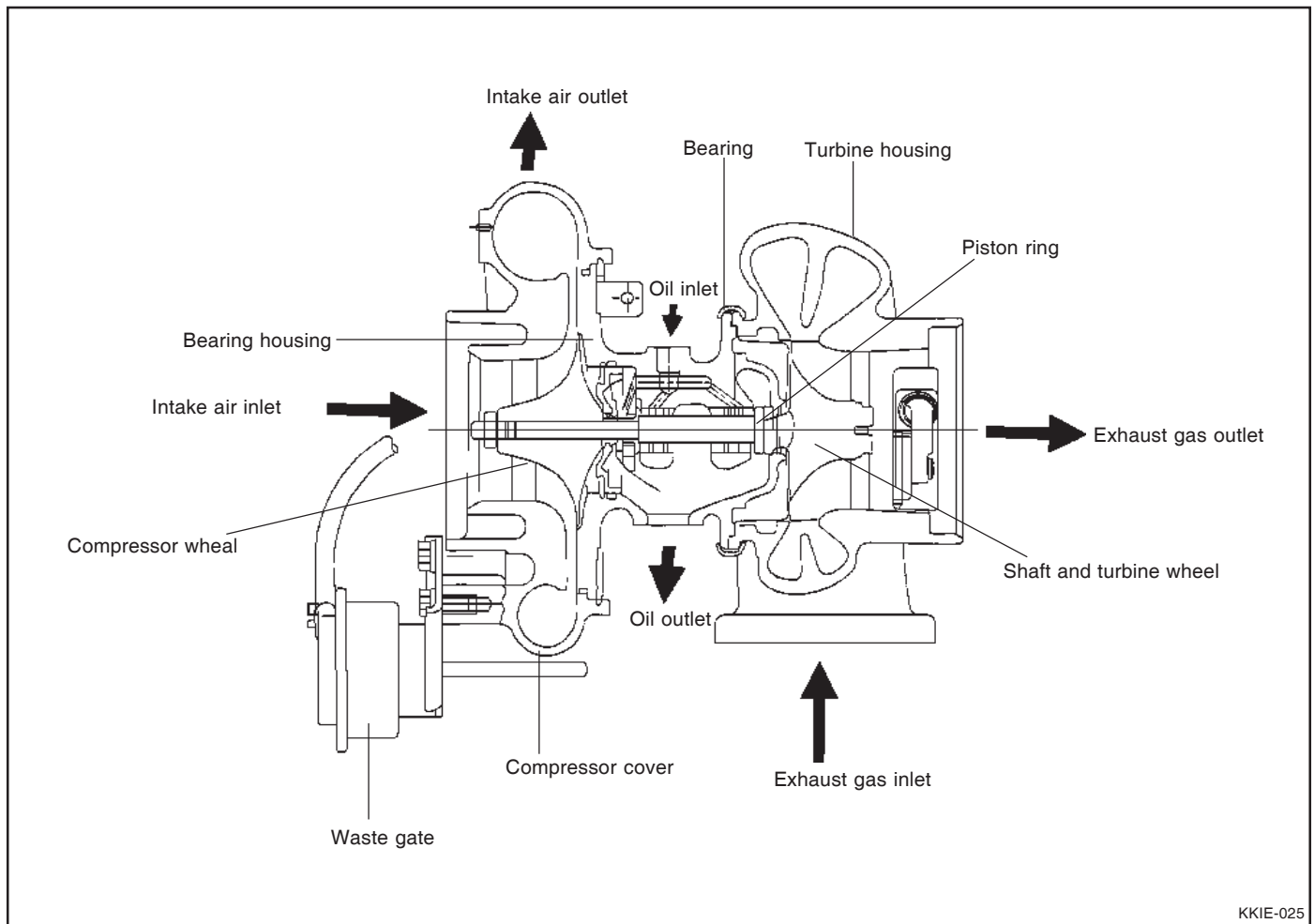


Disassembly

- | | |
|------------------------|-------------------------------|
| 1. Clamp-boot | 8. Clamp hose |
| 2. Duct assembly upper | 9. Hose-air cleaner to engine |
| 3. Rubber-boot | 10. Resonator-rear |
| 4. Resonator front | 11. Band air cleaner |
| 5. Clamp hose | 12. Air cleaner assembly |
| 6. Duct assembly lower | |
| 7. Clamp hose | |

*Reassembly is the reverse of disassembly procedure.

Turbo Charger



KKIE-025

The turbocharger uses the energy of the exhaust gases to feed more air under pressure into the engine.

The exhaust gases are accelerated in the turbine housing and directed onto the turbine wheel to turn it.

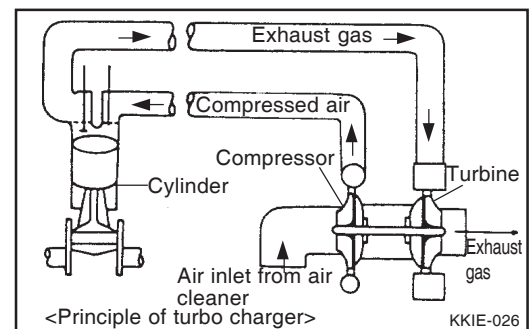
This spins the compressor wheel, which results in the intake air being forced into the engine cylinders.

The turbocharger can be divided into two basic sections: the turbine wheel that is driven by the exhaust gases and the compressor wheel which forces intake air into cylinders.

The shaft connecting the turbine wheel with the compressor wheel is supported in floating type bearings, which absorb vibrations during high speed operation that are caused by slight imbalance of the shaft.

The shaft axial load is borne by the thrust bearing.

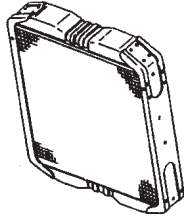
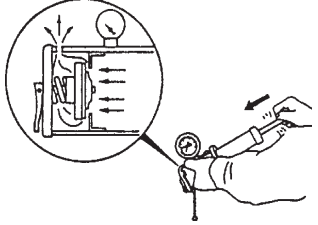
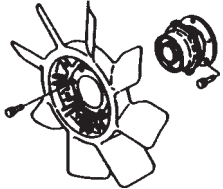
The bearing housing has its inside cooled and lubricated by engine oil to prevent seizure and other troubles of the sliding parts.



KKIE-026

SERVICE STANDARD

Unit : kgf-cm²

Maintenance items		Nominal valve	Limit	Remedy	Inspection procedure
Coolant leak		-	-	Radiator replacement	 KKCL-236
Pin clog		-	-	Cleaning	
Opening pressure of radiator cap valve	0.5	0.4-0.6	-	Replacement	 KKCL-237
	0.9	0.75-1.05			
Deformation and damage of cooling fan and clutch		-	-	Replacement if necessary	 KKCL-239

CAUTION

Check the opening pressure of coolant filter cap valve written on the cap.

If the cap pressure is not correctly controlled, due to the abnormal high pressure of coolant system, hoses may be disconnected and burnt and engine may be damaged.