

ENGINE MECHANICAL

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GENERAL

Construction and Operation

Engine Proper

1. Combustion Chamber

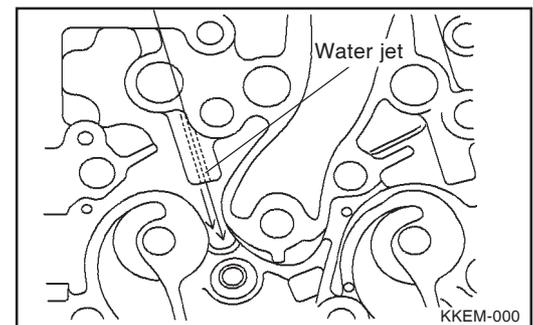
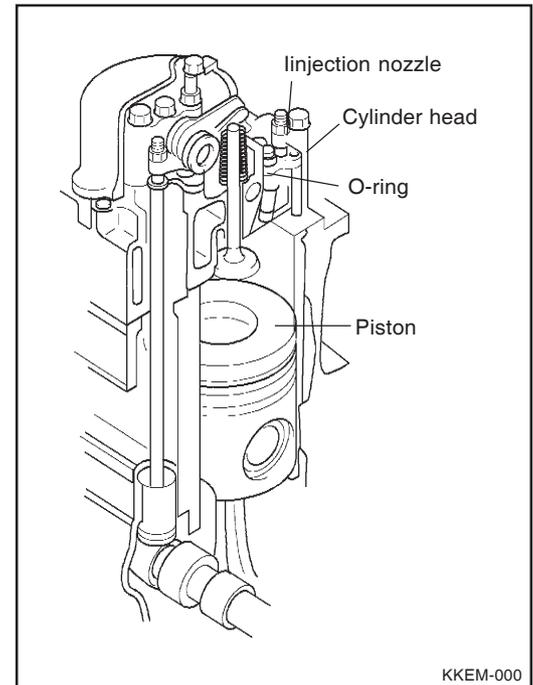
The combustion chamber is made up of the cylinder head and toroidal piston. The hole type injection nozzle is mounted to the cylinder head together with the nozzle tube.

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.

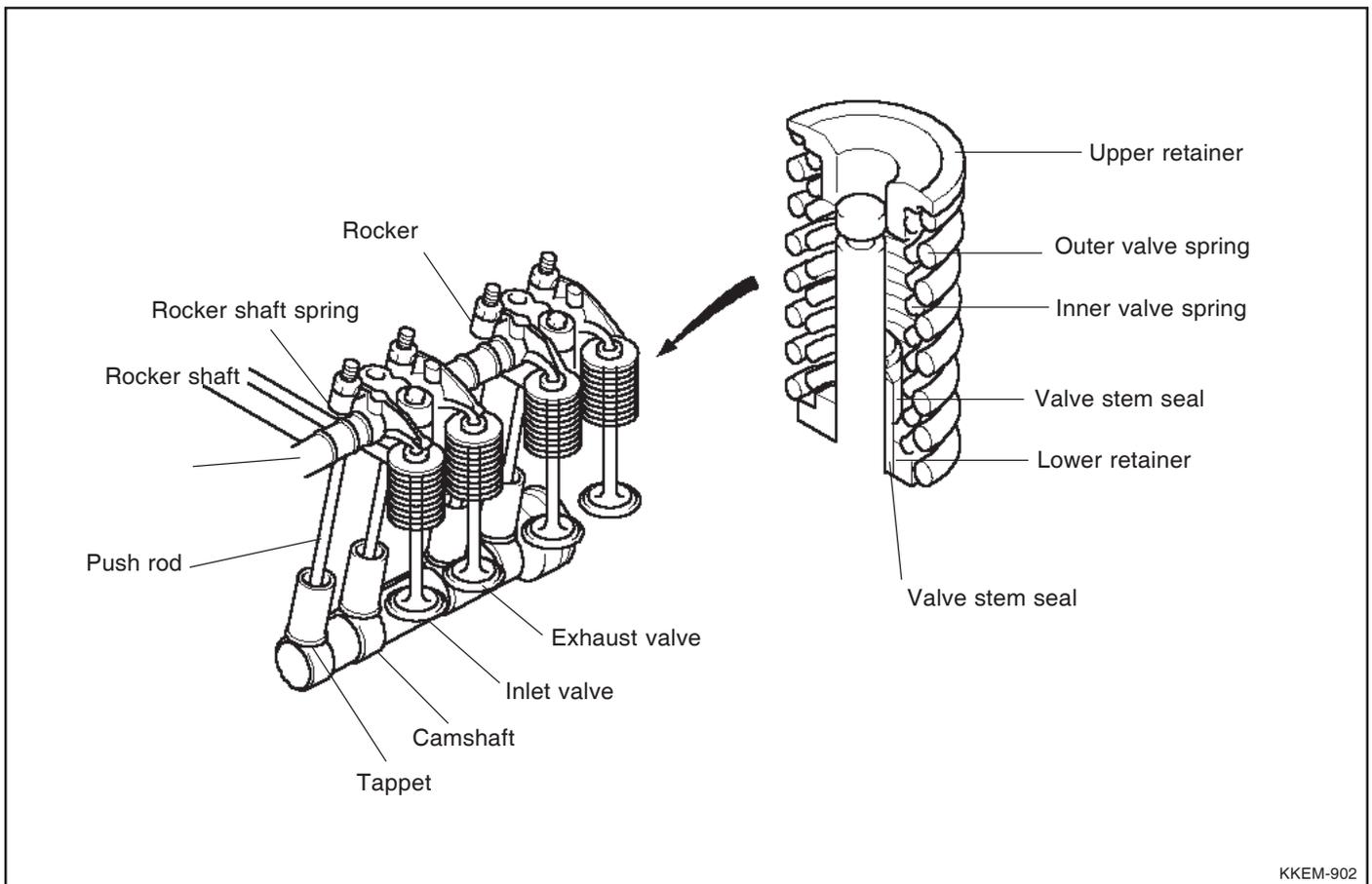
A valve recess is machined on the top of the piston for providing a clearance between the piston and exhaust valve.

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



2. Valve Mechanism

The valve mechanism is an overhead valve type and is constructed as shown.



KKEM-902

- (a) Both intake and exhaust valves are made of surface treated heat-resistant steel to increase durability.

The valve seat angle of both valves is 45°

A valve stem seal is provided on the stem of valve to control the quantity of lubricant of the valve and valve guide sliding portions. The inner and outer springs are different in coiled direction.

- (b) To prevent abnormal vibration during high speed operation, two unevenly pitched springs are provided as valve springs.

The inner and outer springs are different in coiled direction.

- (c) The rocker is a precision forged carbon steel product.

The rocker end sliding portion is quenched.

The rocker shaft is a hollow round rod with expansion plugs at both ends to seal off the rod. The inside of the shaft constitutes an engine oil passage.

- (d) A steel ball is welded to the bottom end taper side of the push rod, whereas a spherical concave type end cap is welded to the top end rocker side. Both ends are carburized and hardened.

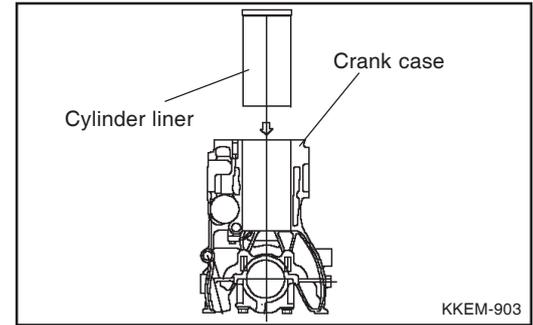
- (e) The tappet is a cylindrical type and has a spherical surface which makes contact with the camshaft. The tappet can be removed without removing the camshaft, provided that the cylinder head is removed.

- (f) Because of the high cam design, the push rod is shorter, assuring higher rigidity and higher dependability against high speed rotation.

- (g) To facilitate insertion and removal of the camshaft from the rear end of the crankcase, the diameter of the camshaft bearing is smaller toward the front.

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.

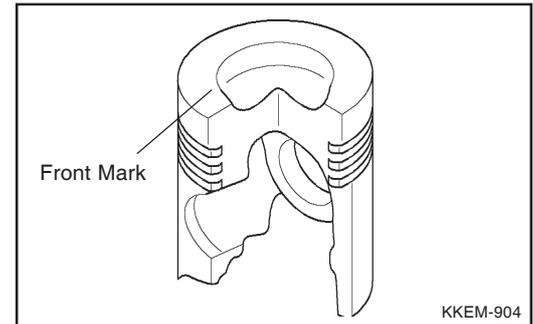


4. Piston and piston ring

(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.

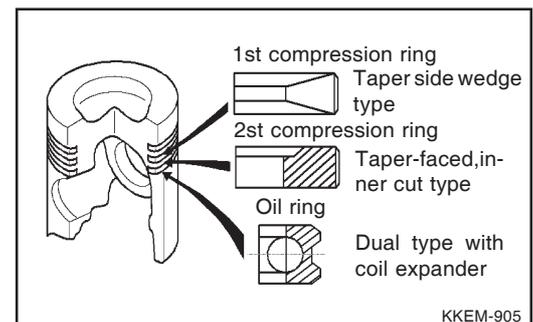
Piston pin for connecting piston to connecting rod is of full-floating type and is prevented from moving out by means of a snap ring type and is prevented from moving out by means of a snap ring installed on each end of the pin ends. On D6AU, a cavity is provided in the piston for colling.



(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.

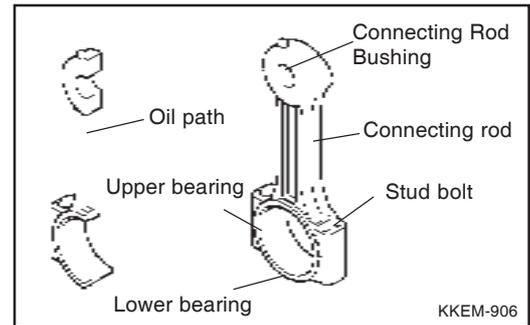
The piston rings are shaped as shown in the figure.



5. Connecting Rod Bearing

The connecting rod is an I-section stamp forging. A lead bronze bushing is press-fitted into small end. The connecting rod bearing for the big end is a split type plain bearing. This bearing is soft copper backed kelmet metal, the inside surface of which is plated with an alloy of lead, tin and copper. The whole bearing is then plated with tin.

The connecting rod and connecting rod cap are coupled by knurled connecting rod bolts.



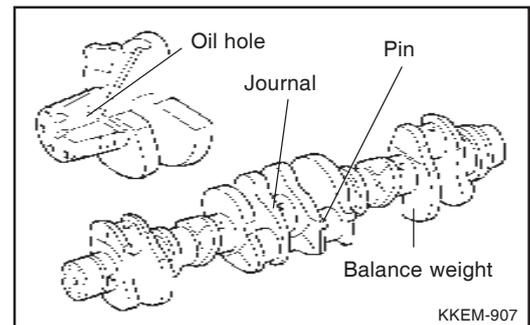
6. Crankshaft and Main Bearing

(a) Crankshaft

The crankshaft is a highly-rigid die forging integral with the balance weights. The pins, journals, and rear oil seal sliding surfaces are induction-hardened for improved wear resistance.

By means of oil passages drilled through the pins and journals, part of the main bearing lubricating oil is fed to pins for lubrication of the connecting rod bearing

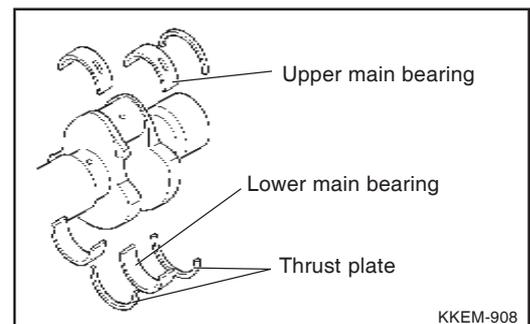
An oil hole in each journal is through to that in pin, feeding some of the main bearing lubricating to the pin for lubricating to the pin for lubrication of the connecting rod bearing.



(b) Main bearing

The main bearing is a split type plain bearing and is made of the same material as the connecting rod bearing.

The upper bearing has an oil groove, but the lower bearing has no oil groove. Split type thrust plates are mounted to the bearing to support the thrust of the crankshaft.



7. Timing Gear

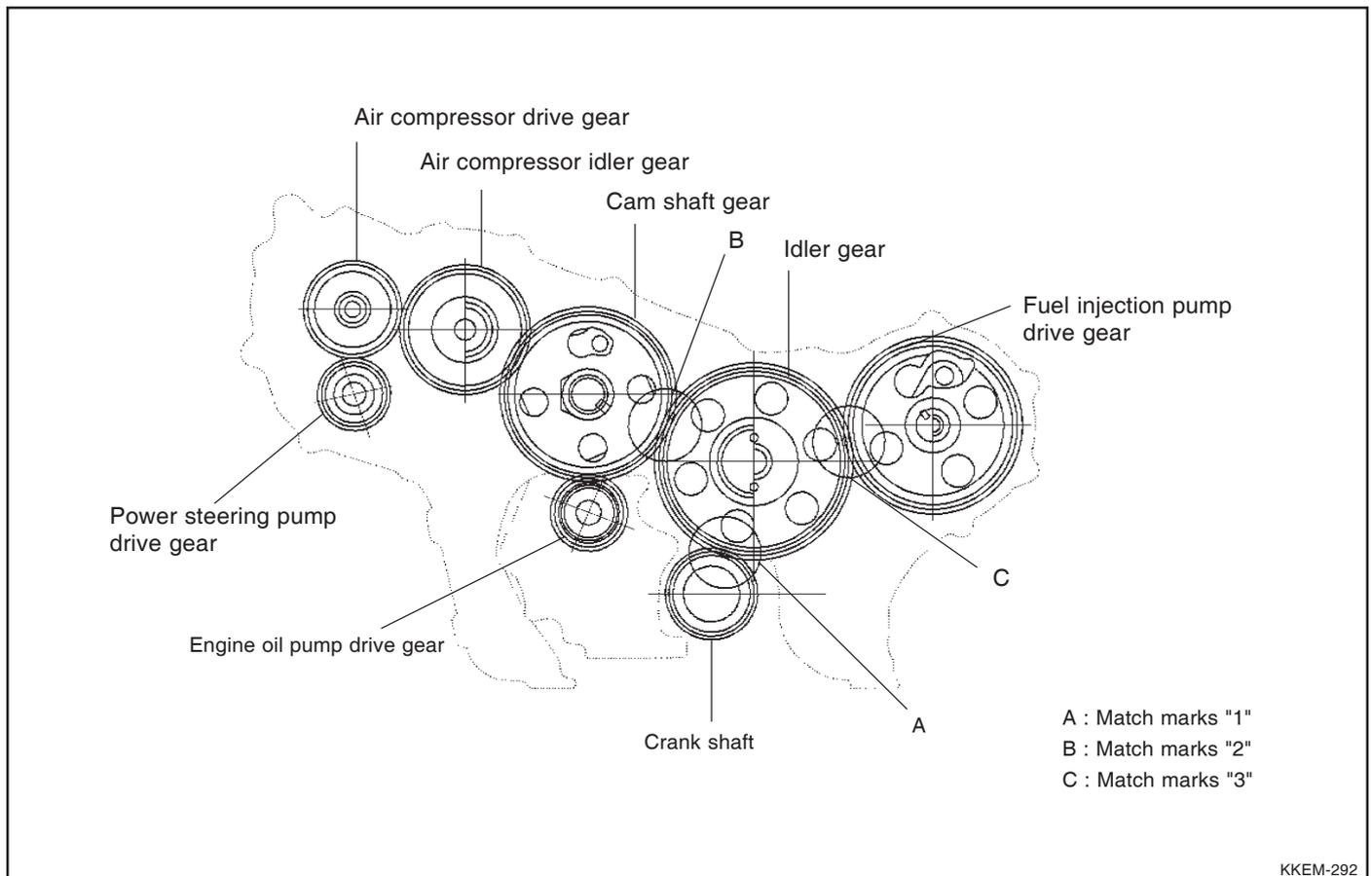
The timing gears are housed in the timing gear case at the front of the engine. Illustration shows the gear train.

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.

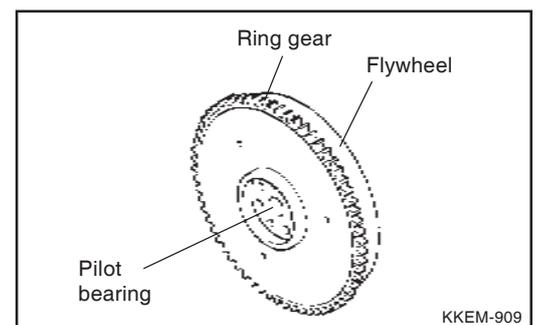
The oil hole drilled through the idler shaft and gear provides an oil passage for lubrication of bushing and gears.

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.

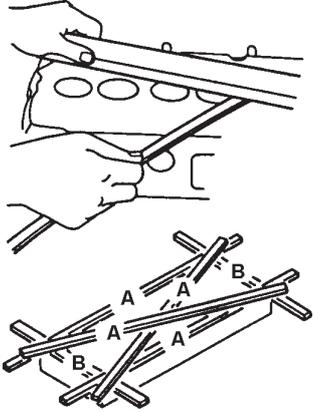
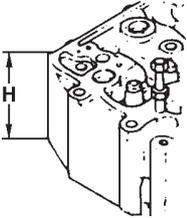
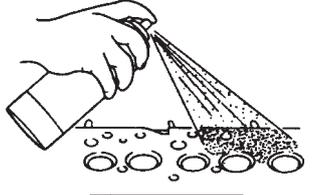
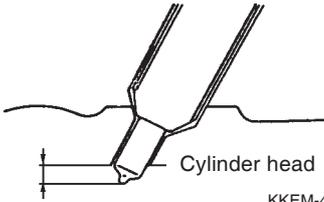
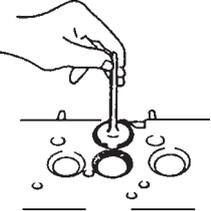
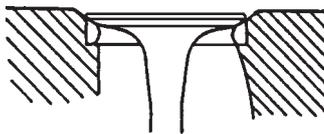
The ring gear tooth crests are induction-hardened for greater durability.

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

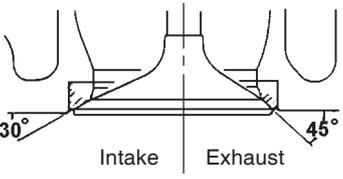
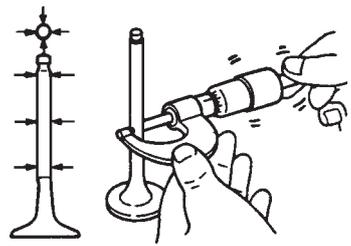
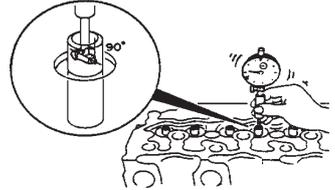
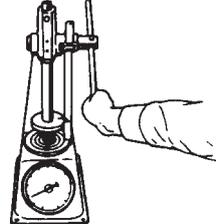
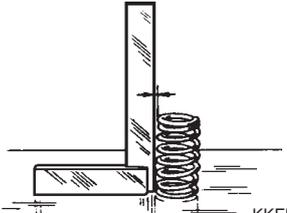


SERVICE STANDARD

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 Item		Standard	Limit	Remedy	Inspection Procedure	
Valve seat angle	Intake	29°45'-30°	-	Regrind or replace valve and /or valve seat	 <p>Intake Exhaust</p>	
	Exhaust	44°15'-45°45'				
Valve face angle	Intake	29°45'-30°				
	Exhaust	44°45'-45°				
Intake valve stem diameter		8.947-8.965	8.90	Replace valve guide and/or valve		
Exhaust valve stem diameter		8.932-8.950	8.80			
Intake and exhaust valve guide diameter		9.020-9.035	9.1			
Side clearance between valve stem and valve guide	Intake	0.055-0.085	0.18	Replace valve guide and/or valve stem		
	Exhaust	0.070-0.103	0.23			
Valve spring setting load	Inner	IN	14.4kgf at 47.2	-		
		Ex	14.2kgf at 47.4			
	Outer	IN	41.3kgf at 50.2	-		Replace
		Ex	40.6kgf at 50.4			
Squareness of valve spring		-	2.00	Replace if necessary		

KKEM-50

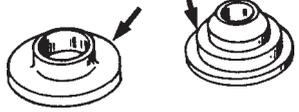
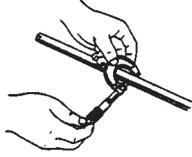
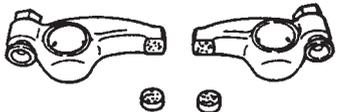
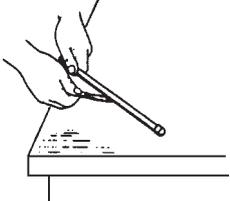
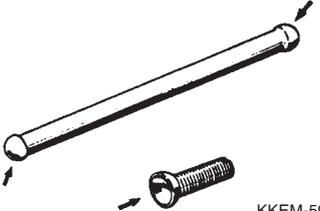
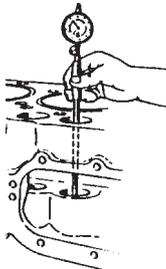
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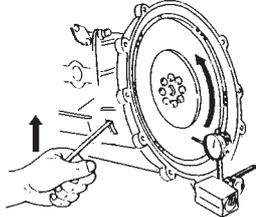
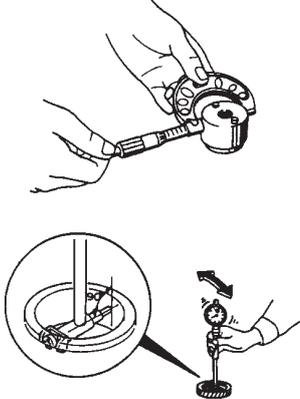
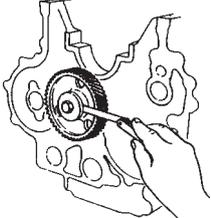
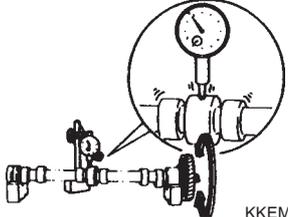
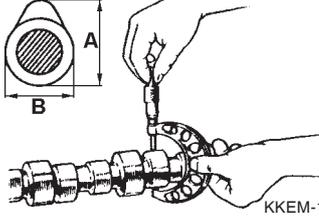
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KKEM-54

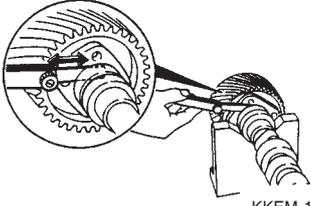
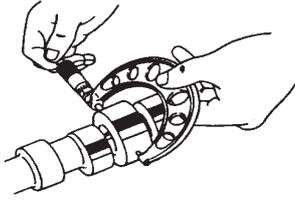
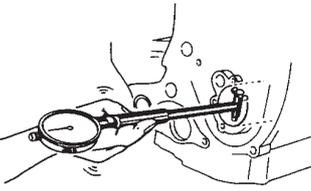
Unit : mm

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Valve spring seat for wear	-	-	Replace, if necessary	<p>Visual check</p>  <p>KKEM-55</p>
Rocker arm shaft diameter	24.159-24.180	24.14	Replace rocker arm bushing and/or shaft	  <p>KKEM-56</p>
Clearance between rocker arm shaft and bushing	0.030-0.101	0.15		
Rocker arm and valve step cap wear or damage	-	-	Resurface or replace	 <p>KKEM-57</p>
Push rod bend	-	0.25	Replace	 <p>KKEM-58</p>
Adjusting screws and push rods damage	-	-	Replace	 <p>KKEM-59</p>
Valve lifter diameter	31.950-31.975	31.92	Replace valve lifter	  <p>KKEM-60</p> <p>KKEM-61</p>
Valve lifter guide deformation	32.000-32.025	32.05		
Clearance between valve lifter and valve lifter guide	0.025-0.075	0.10		
Valve lifter	Should not be worn unevenly	-	Replace, if necessary	Visual check

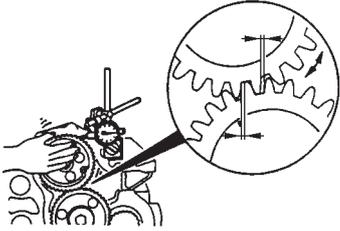
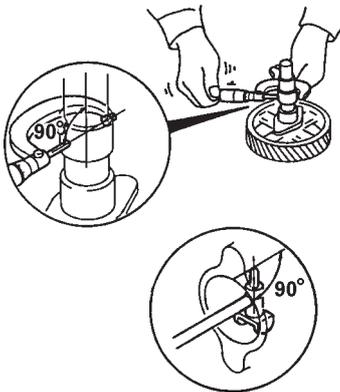
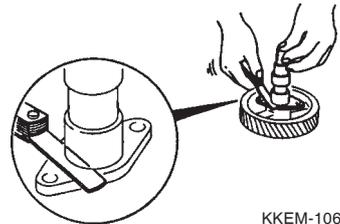
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Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Flantness of flywheel		-	0.04	Replace or grind	 <small>KKEM-76</small>
Gear teeth for pitting or wear		-	-	Replace if necessary	<p>Visual check</p>  <small>KKEM-97</small>
Oil clearance between idle gear shaft and bearing		0.030-0.080	0.20	Replace gear and shaft	 <small>KKEM-98</small>
Idler gear end play		0.070-0.125	0.30	Replace thrust bearing	 <small>KKEM-99</small>
Camshaft bend		-	0.05	Replace	 <small>KKEM-100</small>
camshaft, camlift (A-B)	Intake	6.66	6.58	Replace	 <small>KKEM-101</small>
	Exhaust	9.03	8.95		

Unit : mm

Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Camshaft end play		0.100-0.178	0.30	Replace thrust plate	 <small>KKEM-102</small>
Camshaft journal diameter journal No.	No.1	61.45-61.47	61.6	Replace camshaft	  <small>KKEM-103</small>
	No.2	61.05-61.07	61.2		
	No.3	60.65-60.67	60.7		
	No.4	58.25-58.27	58.4		
Oil clearance between camshaft journal and bearing		0.03-0.08	0.15	Replace camshaft and/or bearing	

Unit : mm

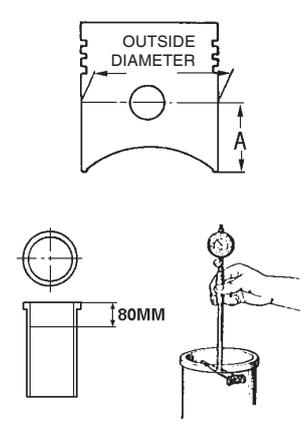
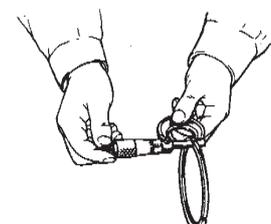
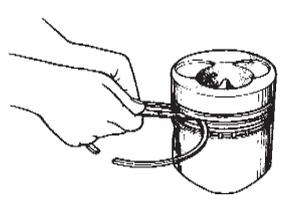
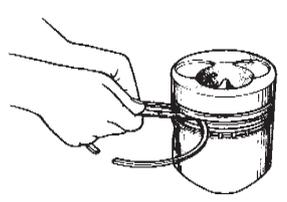
Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Timing gear backlash		-	-	Replace gear	
Full air brake	Crankshaft gear - idle gear	0.038-0.13	0.30		
	Idle gear - injection pump gear	0.03-0.12	0.30		
	Idle gear - camshaft gear	0.027-0.26	0.30		
	Camshaft gear - engine oil pump gear	0.07-0.18	0.30		
	Camshaft gear - air compressor idle gear	0.027-0.26	0.40		
	Air compressor gear - Air compressor idle gear	0.049-0.147	0.30		
	Air compressor gear - power steering oil pump gear (If so fitted)	0.046-0.173	0.30		
Clearance between injection pump drive shaft and bearing		0.030-0.072	0.30	Replace bearing and/or shaft	
Injection pump drive gear end play		0.100-0.200	0.30	Replace thrust bearing	

KKEM-104

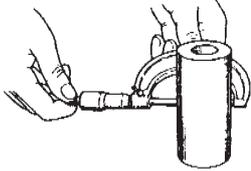
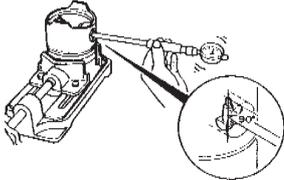
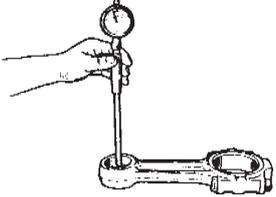
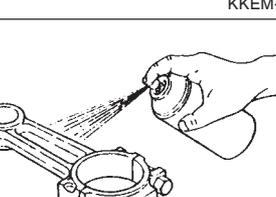
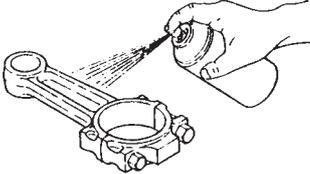
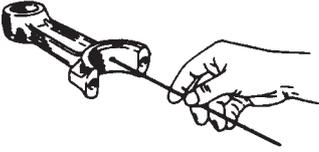
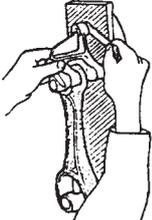
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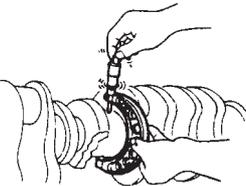
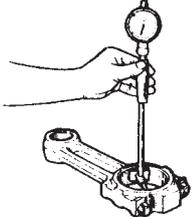
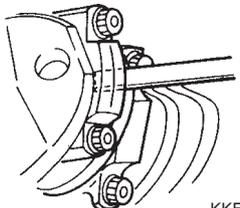
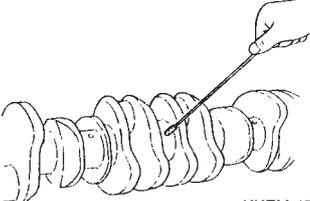
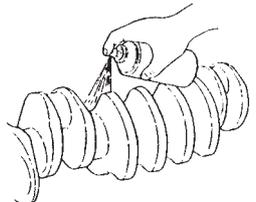
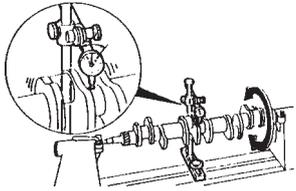
Unit : mm

Inspection Item		Standard	Limit	Remedy	Inspection Procedure
Piston diameter		109 at A:21	-	Replace piston and/or liner	 <p style="text-align: right;">KKEM-167</p>
Cylinder liner inside diameter		109	109.05		
Clearance between piston and cylinder liner		0.093-0.125	-		
Cylinder liner protrusion		0.01-0.08	-		
Piston ring breadth	Top	3.00	2.90	Replace	
	2nd	2.5	2.4		
	Oil	4.00	3.90		
Piston ring grooves breadth	Top	3.00	3.20	Replace piston	 <p style="text-align: right;">KKEM-168</p>
	2nd	5.0	2.70		
	Oil	4.00	4.10		
Clearance between piston ring and piston ring breadth	Top	0.06-0.10	-	Replace piston ring and/or piston	 <p style="text-align: right;">KKEM-168</p>
	2nd	0.04-0.08	-		
	Oil	0.02-0.06	-		
Piston ring gap * Insert the piston rings Where the wear of the liner is small	Top	0.30-0.40	1.5	Replace	 <p style="text-align: right;">KKEM-169</p>
	2nd	0.30-0.45	1.20		
	Oil	0.25-0.45	1.20		

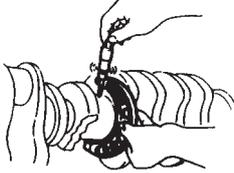
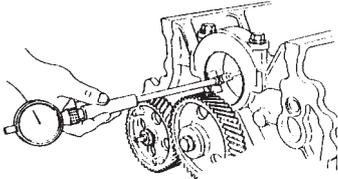
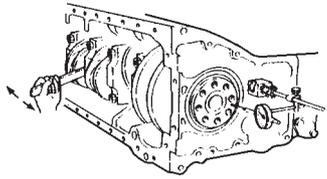
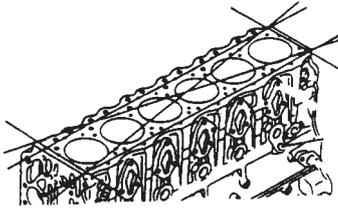
Unit : mm

Inspection Items	Standard	Limit	Remedy	Inspection Procedure
Piston pin diameter	38.987-39.000	36.96	Replace piston, piston pin and/or connecting rod	
Piston pin hole inside diameter	36.987-37.003	39.05		
Clearance between piston pin and piston pin hole T:Tight L:Clearance	39.015-39.025	39.10		
Connecting rod small end bushing inside diameter	37.015-37.025	37.10	Replace bushing and/or piston pin	
Clearance between piston ring and connecting rod small end bushing	0.15-0.036	0.08		
Connecting rod cracks or damage	-	-	Replace , if necessary	
Connecting rod oil hole clogged	-	-	Clean	
Connecting rod squareness		0.1 Par 200	Replace	

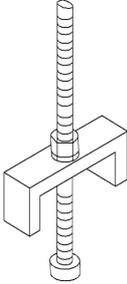
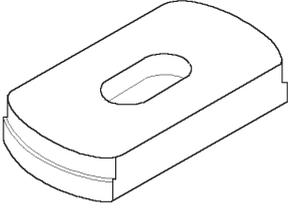
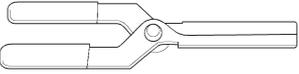
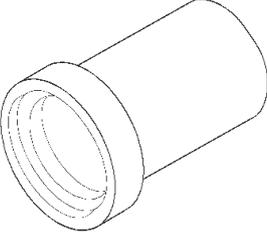
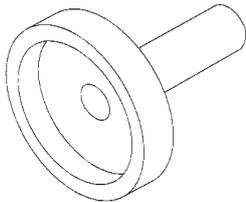
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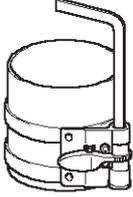
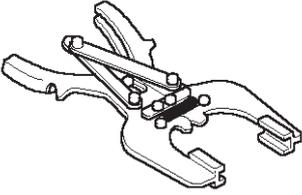
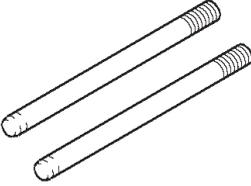
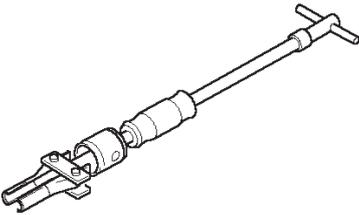
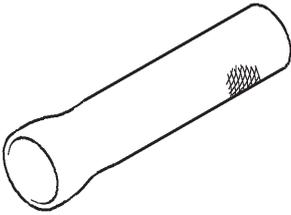
Inspection Items	Standard	Limit	Remedy	Inspection Procedure
Crankshaft pin diameter	64.94-64.96	64.80	Regrind crankshaft and use undersize bearings	
		63.80	Replace crankshaft	
Clearance between connecting rod and crank pin	0.031-0.082	0.20	Replace bearing	 <small>KKEM-175</small>
Connecting rod end 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>

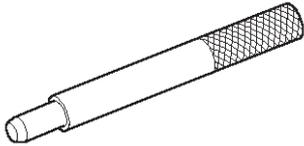
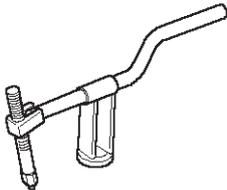
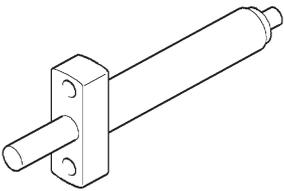
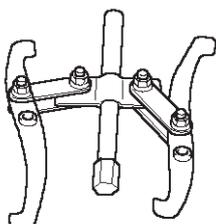
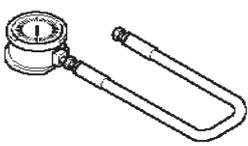
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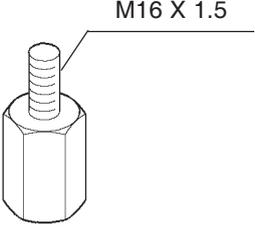
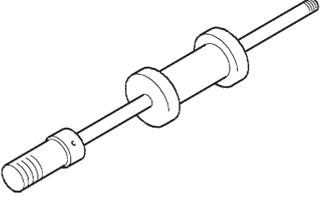
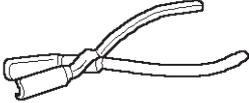
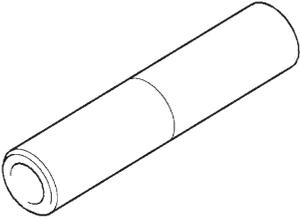
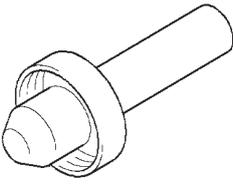
Inspection Items	Standard	Limit	Remedy	Inspection Procedure
Crankshaft journal diameter	79.940-79.960	79.8	Regrind crankshaft and use undersize bearings	
		78.8	Replace crankshaft	
Clearance between crankshaft journal and main bearing	0.051-0.102	0.30	Replace bearing	 KKEM-180
Crankshaft end play	0.050.219	0.50	Replace thrust bearing	 KKEM-181
Cylinder block flatness	Less than 0.05	0.10	Regrind and/or replace	 KKEM-182

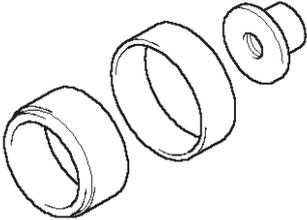
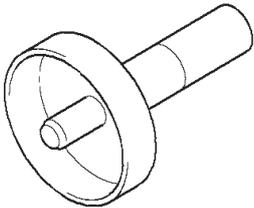
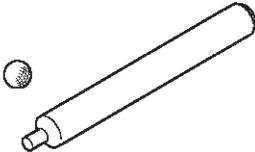
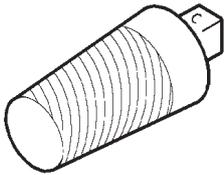
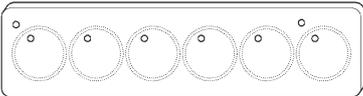
SPECIAL TOOLS

NAME	PART NO	ILLUSTRATON	USE
Cylinder liner Puller A	09222-62100	 KKST-001	Removal of cylinder liner
Cylinder liner Puller B	09222-8Y000	 KKST-002	Removal of cylinder liner
Valve tappet remover and installer	09221-8Y000	 KKST-003	Removal or Installation of valve tappet
Front oil seal installer	09231-8Y000	 KKST-004	Installation of oil seal
Rear oil seal Installer	09231-8Y100	 KKST-005	Installation of rear oil seal

NAME	PART NO	ILLUSTRATON	USE
Piston guide clamp	09222-88200	 <p style="text-align: right;">KKST-006</p>	Installation of piston
Piston ring tool	09222-83200	 <p style="text-align: right;">KKST-007</p>	Removal and Installation of piston ring
Flywheel guide bar	09231-8Y200	 <p style="text-align: right;">KKST-008</p>	Remove and Installation of flywheel
Ball bearing puller	09432-8Y000	 <p style="text-align: right;">KKST-009</p>	Removal of ball bearing
Valve stem seal installer	09222-93000	 <p style="text-align: right;">KKST-010</p>	Installation of valve stem seal

NAME	PART NO	ILLUSTRATON	USE
Valve guide remover	09211-8Y000	 <p style="text-align: right; font-size: small;">KKST-011</p>	Removal of valve guide
Valve spring compressor	09222-8Y100	 <p style="text-align: right; font-size: small;">KKST-012</p>	Removal and installation of intake valve spring and exhaust valve spring
Compression gauge adaptor	09353-8Y000	 <p style="text-align: right; font-size: small;">KKST-013</p>	For adaptor when checking the nozzle pressure
Rear oil seal sleeve remover	09231-8Y300	 <p style="text-align: right; font-size: small;">KKST-014</p>	Removal of rear oil seal sleeve
Compression gauge	09351-8Y000	 <p style="text-align: right; font-size: small;">KKST-015</p>	Checking nozzle compression

NAME	PART NO	ILLUSTRATION	USE
Sliding hammer adaptor	09450-75400	 <p>M16 X 1.5</p> <p>KKST-016</p>	Removal and Installation of idler gear shaft
Sliding hammer	09450-8Y000	 <p>KKST-017</p>	Removal and Installation of idler gear shaft (use with sliding hammer adaptor)
Valve stem seal remover	09222-29000	 <p>KKST-018</p>	Remove or valve stem seal
Valve guide installer	09211-8Y100	 <p>KKST-020</p>	Installation of valve guide
Front oil seal sleeve installer	09231-8Y400	 <p>KKST-021</p>	Installation of front oil seal sleeve

NAME	PART NO	ILLUSTRATON	USE
Front oil seal sleeve remover	09231-8Y500	 <p style="text-align: right; font-size: small;">KKST-022</p>	Removal of front oil seal sleeve
Rear oil seal sleeve installer	09231-8Y600	 <p style="text-align: right; font-size: small;">KKST-023</p>	Installation of rear oil seal sleeve
Nozzle sleeve installer	09222-8T300	 <p style="text-align: right; font-size: small;">KKST-025</p>	Installation of nozzle tube
Nozzle tube remover	09222-8Y400	 <p style="text-align: right; font-size: small;">KKST-026</p>	Removal of nozzle tube
Target plate	09222-8Y500	 <p style="text-align: right; font-size: small;">KKST-027</p>	For checking of piston cooling jet position

- c. For the model installed electric engine stop control:
Check whether the engine starter is at the "OFF" position and then connect engine stop motor harness.

WARNING

Do not connect electric harness to engine stop motor, when engine starter key is at "ON" position.

If starter key is at "ON" position, engine stop motor operates simultaneously then the link of engine stop motor and engine stop lever of fuel injection pump operate resulting in possible damages of hand.

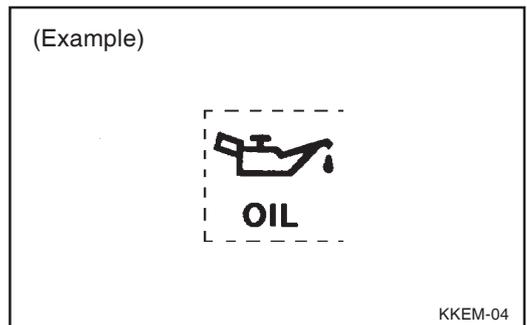
Unit : kg/cm²

Engine model	Compression pressure		Difference between each cylinder	Engine speed(rpm)
	Standard	Limit		
D6DA	36-39	28	Less than 3	280

2. When oil pressure decreases

Check the oil pressure warning lamp when the oil and coolant temperature are heated enough (about 80°C).

- a. If the warning lamp is on, check the oil level.
- b. Check oil deterioration
If oil quality is poor, replace with suitable grade oil.
- c. Remove the oil pressure switch and install the oil pressure gauge.
- d. Measure the oil pressure at coolant temperature of 80°C or above.
Standard oil pressure : 0.5-5.0 kg/cm²
Service limit : Below 0.5 kg/cm² (Idle condition)



3. Other factors

- a. The blow-by gas increases
- b. The engine does not start easily.
- c. Engine power decreases
- d. Fuel consumption increases
- e. Engine makes greater noise
- f. Excessive consumption of engine oil

Engine Dismounting and Installation

Dismounting

1. Park the vehicle on level ground and prop the wheels.
2. Remove coolant from radiator and cylinder block, and release the engine oil from the oil pan.

WARNING

Do not drain coolant or engine oil while engine or radiator is hot because it may cause burn.

3. Disconnect the oil pressure line of power steering and drain oil.

CAUTION

Please refer power steering maintenance section for the details.

4. Disconnect the engine stop cable.
 - a) Turn the engine starter key to "ON" position.

CAUTION

Do not operate engine.

- b) Check whether engine stop lever of fuel injection pump is at engine operation position, and disconnect the connector of engine stop motor harness.
 - c. Turn the engine starter key to "OFF" position.
5. Disconnect electric line, fuel line, air line, speedometer cable, accelerator control cable and parking brake cable.

CAUTION

- **Disconnect battery cable from the (-) terminal of the battery and remove electric line.**
- **Cover the hole of pipe, hose and pump so that no dust inflow.**

6. Disconnect all hoses (coolant, heater and air intake) and disconnect the radiator.

CAUTION

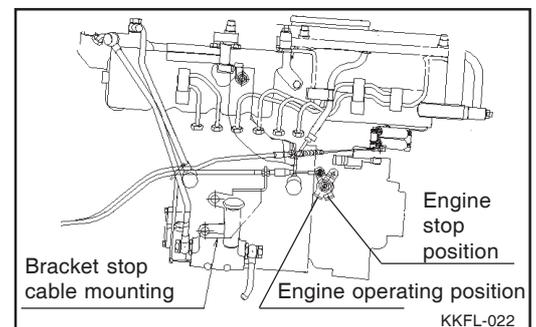
Be careful not to damage the radiator core.

7. Disconnect air intake and exhaust lines.
8. Disconnect clutch housing, transmission control and transmission from flywheel housing.

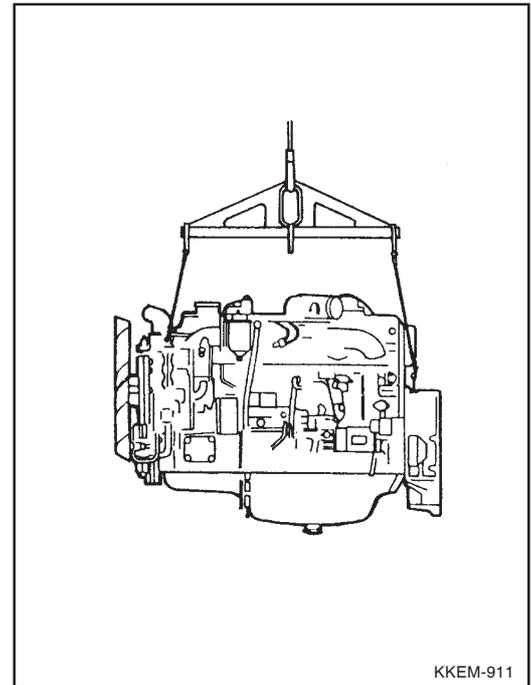
CAUTION

Please refer "transmission and transmission control" maintenance section for the details.

9. Disconnect cap mounting member from the frame.



10. Connect cable from the engine hanger to the hanger bracket at the front of the engine and to the hanger brackets at the upper flywheel housing at the rear of the engine. Loose the cable a bit and raise the hanger by using the hoist.
11. Remove the engine mounting nuts (both sides of front and rear).
12. Lift the engine hanger so that the cables are fully tightened, and then after checking that the cables are securely hooked on the hanger brackets, lift the engine assembly gently and remove it from the vehicle.



Installation

Install engine assembly.

Install engine assembly by reversed order of dismounting.

CAUTION

Check the leaks of oil, fuel, coolant or air.

Connect the engine stop cable.

1. Turn the ignition key at "ON" position.

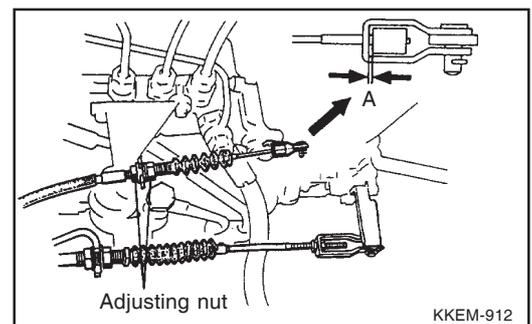
CAUTION

Do not start the engine yet.

2. Check the connector of engine stop motor harness
3. Connect the engine stop cable adjust the adjusting nut to make the gap "A" be 1-3mm, which is the distance between crevis and cable stopper.
4. Turn the ignition key to "OFF" position.

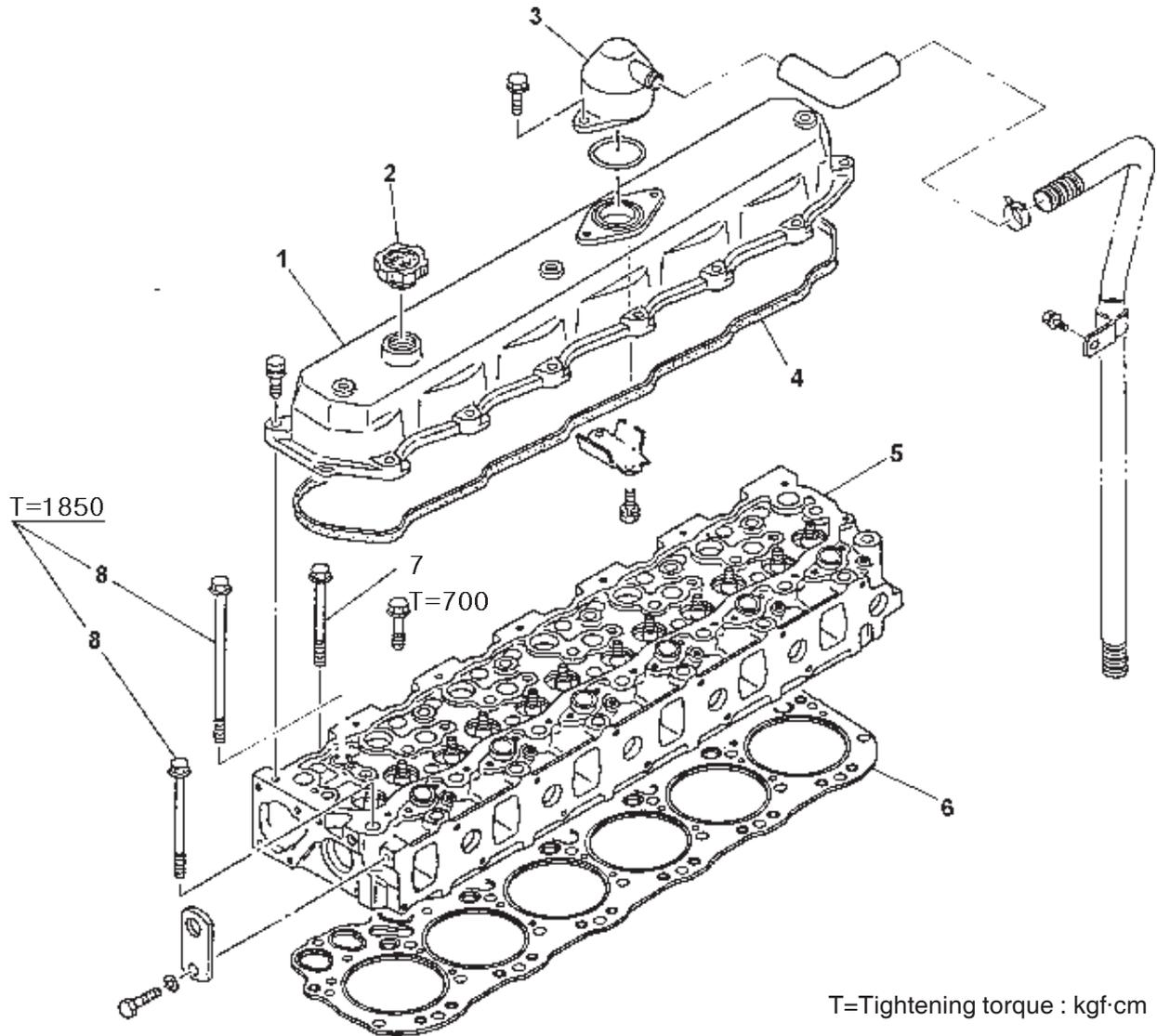
CAUTION

Check engine stop and start after adjustment.

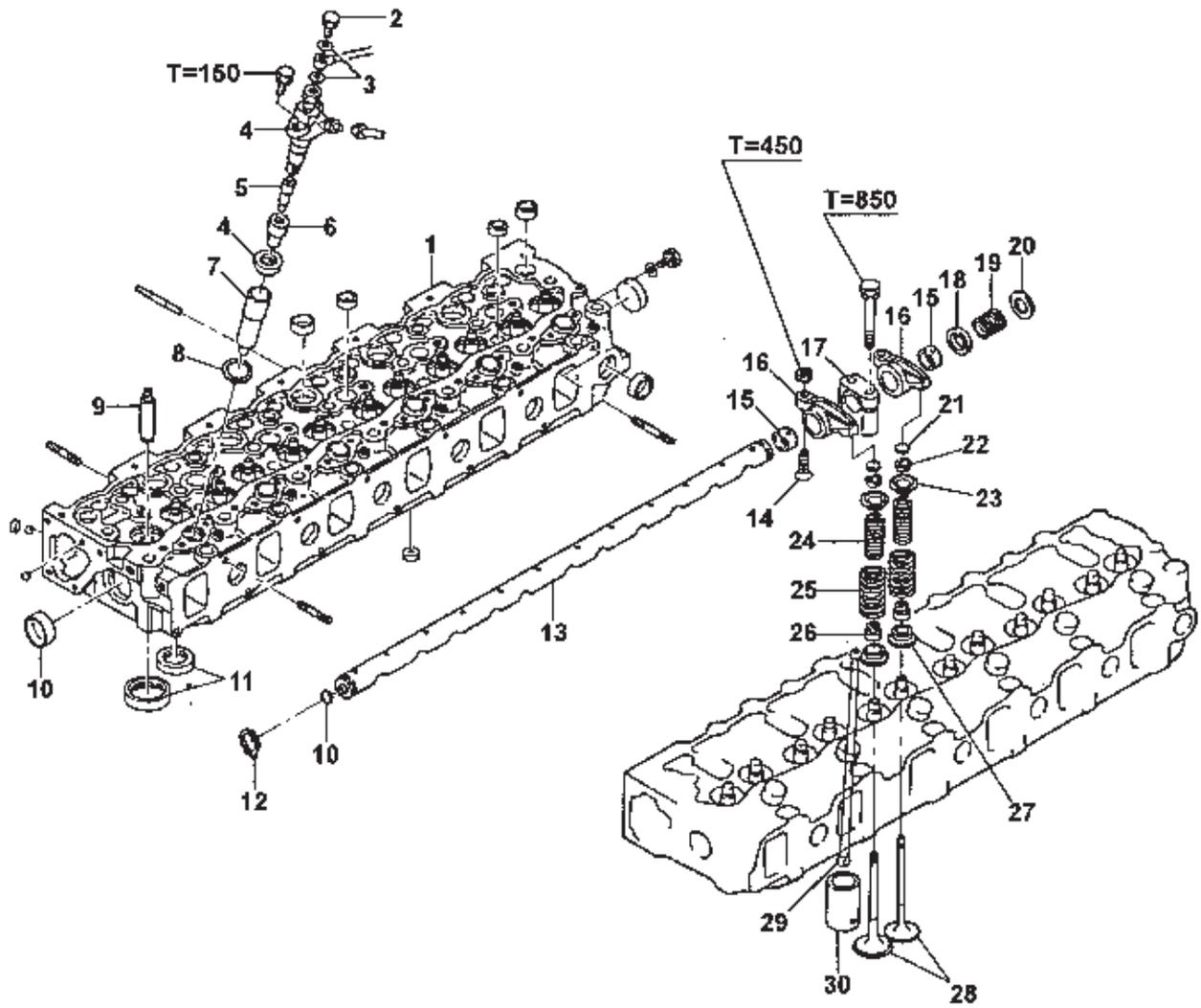


Engine Cylinder Head

OVERHAUL



- | | |
|-------------------------------|------------------------------|
| 1. Cylinder head cover | 5. Cylinder head |
| 2. Oil filler cap | 6. Cylinder head gasket |
| 3. Ventilator | 7. Cylinder head assist bolt |
| 4. Cylinder head cover gasket | 8. Cylinder head bolt |



T=Tightening torque : kgf-cm

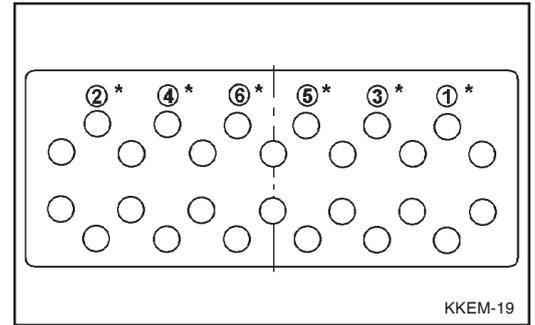
- | | | |
|------------------|----------------------------|-----------------------------|
| 1. Cylinder head | 11. Valve seat | 21. Valve stem cap |
| 2. Connect bolt | 12. Retainer ring | 22. Valve stem key |
| 3. Soft washer | 13. Valve lock shaft | 23. Valve spring upper seat |
| 4. Nozzle holder | 14. Valve gap adjust screw | 24. Inner valve spring |
| 5. Nozzle | 15. Bushing | 25. Outer valve spring |
| 6. Packing ring | 16. Rocker arm | 26. Valve stem seal |
| 7. Nozzle sleeve | 17. Valve lock support | 27. Valve spring lower seat |
| 8. O-ring | 18. Spacer | 28. Valve |
| 9. Valve guide | 19. Spring | 29. Push rod |
| 10. Plug | 20. Plain washer | 30. Valve lifter |

Disassembly

Disconnect fuel pipe and nozzle assembly.

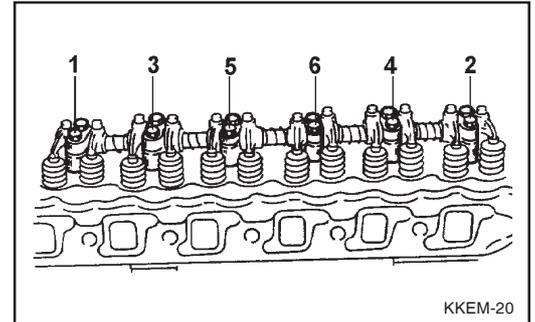
Disconnection of cylinder head and rocker arm assembly.

1. Remove the cylinder head additional bolts by loosening the bolts in the numerical order shown in the figure.



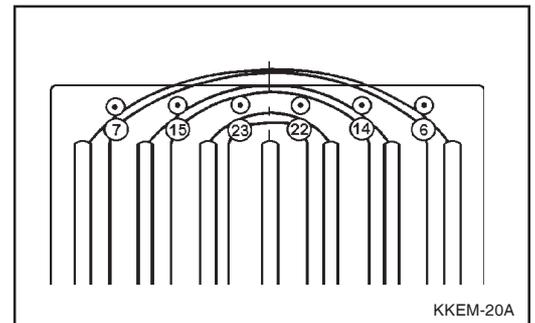
KKEM-19

2. Removal of rocker arm support bolts
Remove the rocker arm assembly by the loosening the bolts in the numerical order shown in the figure.



KKEM-20

3. Removal of cylinder head bolts
Remove the cylinder head bolts in the numerical order shown in the figure.



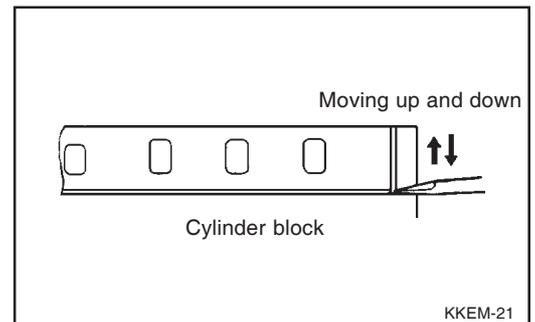
KKEM-20A

Lift the cylinder head from the dowels and place it on the wooden block.

1. If the cylinder head is difficult to lift, insert the chisel between the cylinder head and block to leverage.

CAUTION

Do not damage the machined surface of the head and block when removing the cylinder head.



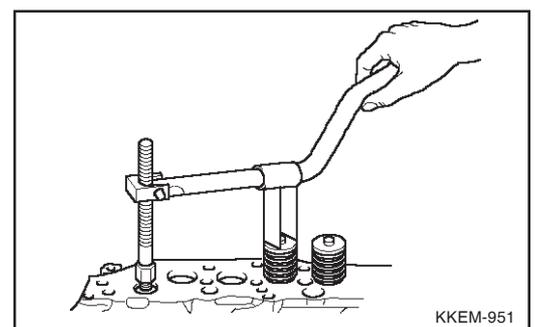
KKEM-21

Disassembly of valve spring

1. Remove valve stem key, upper spring seat inner valve spring and outer valve spring from cylinder head.

Special tool: Valve spring compressor (09222-8Y100)

2. Disassemble intake and exhaust valves.
3. Tag valves to identify the cylinder numbers and to eliminate valve lapping.



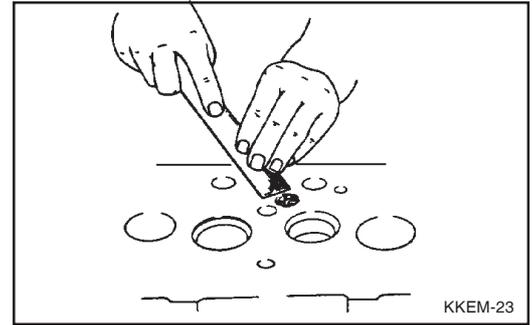
KKEM-951

Assembly

Clean the cylinder head completely with the solvent.

CAUTION

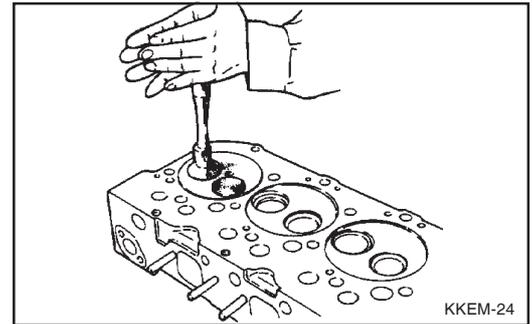
Be careful not to damage the cylinder head surface.



Hand-lap the valve and valve seat if needed.

Apply lapping compound lightly to the valve face. Install the valve using a special tool, tap and rotate the valve against the seat.

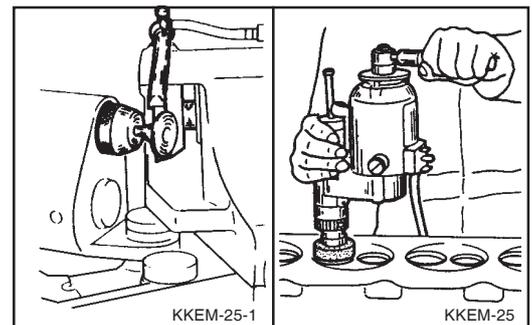
Special tool: Valve-lapping tool



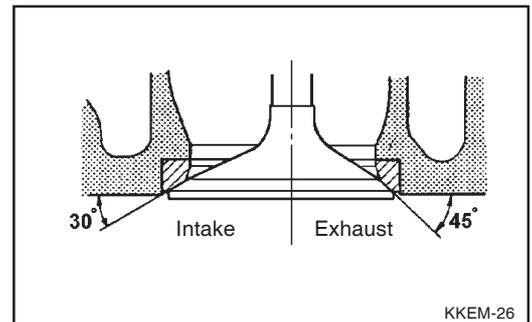
Grind the valve and valve seat, if needed.

CAUTION

- Grinding of valves and valve seats should only be performed when hand lapping does not result in proper seating.
- Recheck the valve sink after grinding at all times.

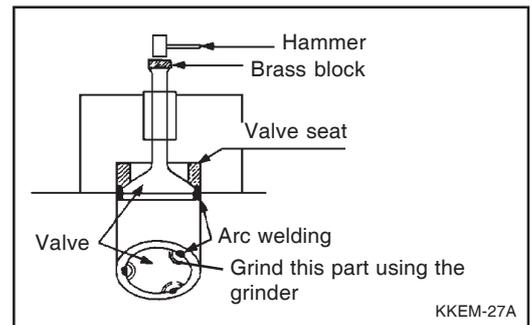


**Angles of valve face and valve seat ;
please refer the service standards.**



Replace the valve seat, if needed.

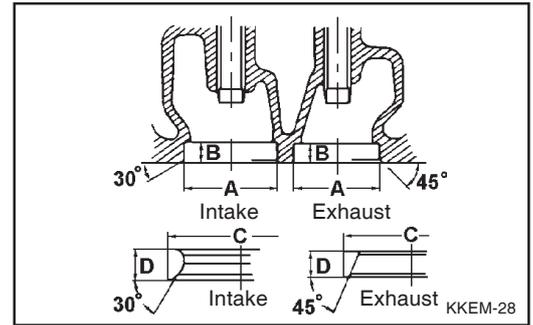
1. Cut the circumference of a valve head at three places with a grinder and, install it into the seat as shown and weld the valve to the seat.
Then push the valve and the seat out with a hammer and a brass bar.



2. Specifications of valve seat surface machining

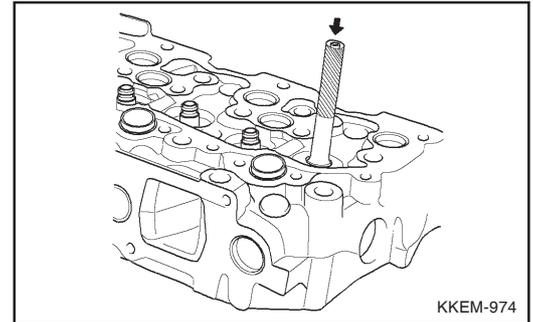
Unit: mm

		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

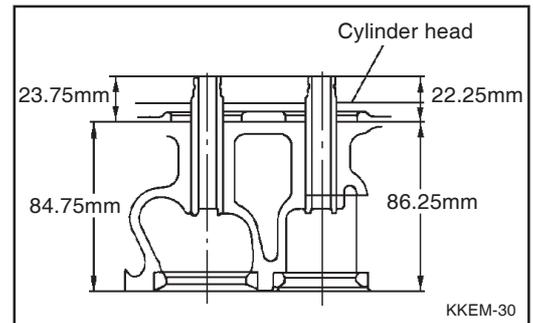
Heat the cylinder head to about 80°C - 100°C with hot water. On the other hand, cool the valve seat with dry ice or liquid freon for approximately 30 minutes. Hold the seat with pincers and place it into the heated cylinder head.

**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)

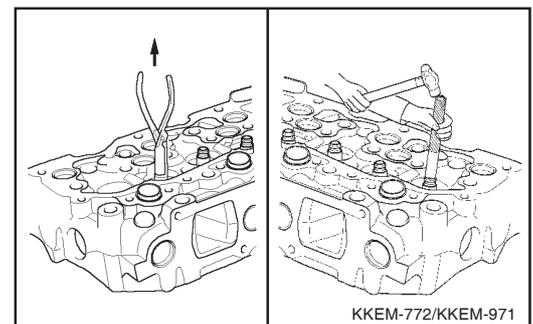
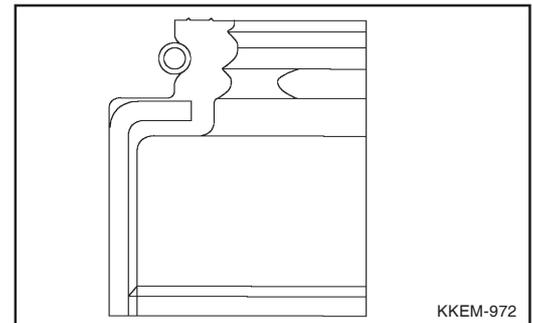
2. Install the valve stem seal.

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)

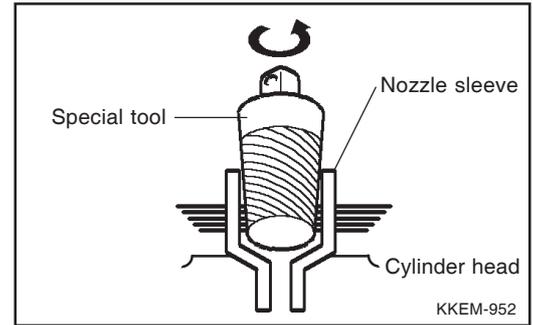
CAUTION

- 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.



Replace the nozzle sleeve, if needed.

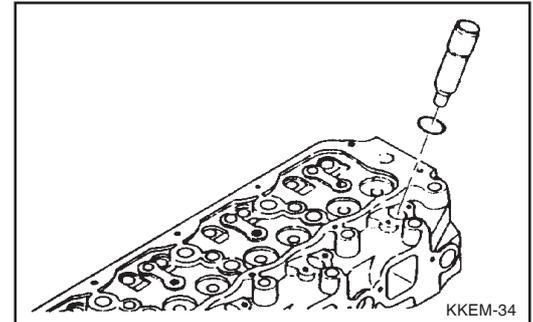
1. Remove the nozzle sleeve.
(Nozzle tube remover: 09222-8Y400)



2. Install nozzle sleeve.
Install O-ring to the cylinder head. Apply the adhesive (super three bond No. 1210 or equivalents) at the lower part of new copper nozzle sleeve and insert sleeve into the cylinder head.

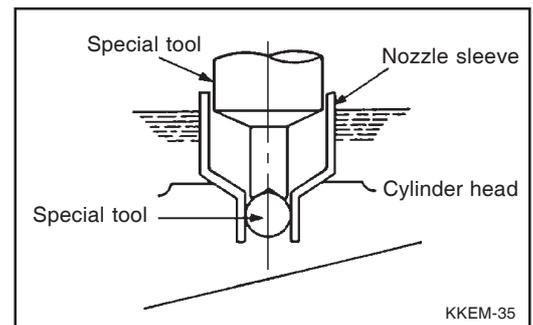
CAUTION

Damaged O-ring cause oil leaks, overheating or crack of head.



3. Stick the nozzle sleeve into the cylinder head tight using a special tool. Insert the seat press (special tool) into nozzle sleeve. Push the ball slowly through the hole with the special tool so that the end of nozzle sleeve be fastened tight to the cylinder head.

Special tool: (nozzle sleeve installer: 09222-8Y300)



Assemble the cylinder head.

CAUTION

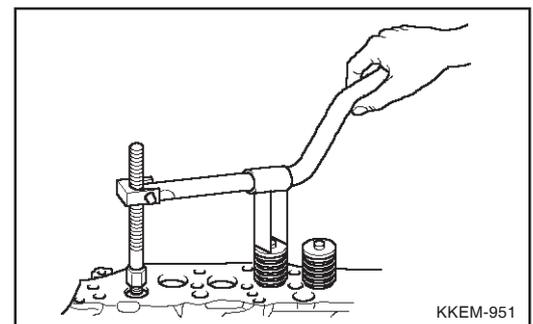
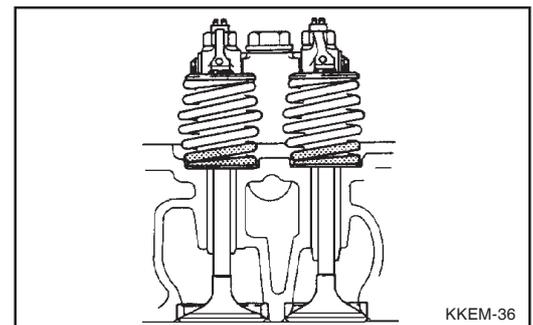
- Apply the engine oil to the contact points of all parts.
- Check the valves whether they are installed to the right cylinders.
- Since the valve spring has various pitches, install them as the painted parts facing downward.

Pressing the upper spring seat, install the valve stem key tight to the valve spring seat.

Special tool: Compressor (valve spring compressor: 09222 – 8Y100)

CAUTION

- When pressing with valve spring press, be careful not to damage the stem seal by the touch with upper seat.
- Push the valve stem gently by the hammer for the precise installation of valve stem key.

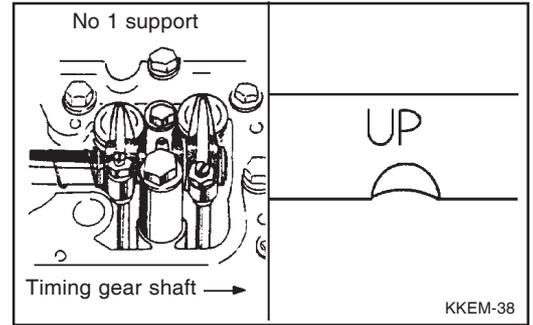


Rocker arm assembly

Apply the engine oil to the rocker arm shaft and bushing.

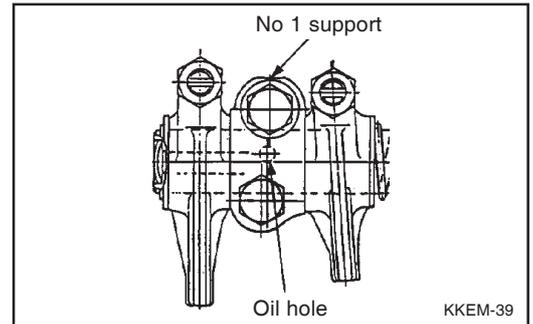
CAUTION

Check whether the rocker arm shaft is installed as the “UP” mark facing upward. Disassembly may cause the melting of valve stem.



CAUTION

Check whether the oil hole of rocker arm assembly number 1 coincides with the shaft oil hole. Incorrect installation may cause the burning of whole valve assembly.

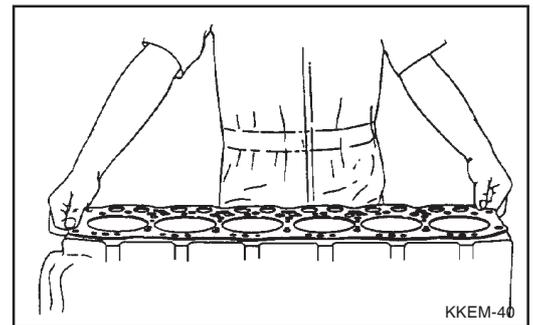


Installation of cylinder head and rocker arm assembly

1. Apply the engine oil to the valve lifter face and valve lifter guide, and then install the valve lifter guide.
2. Install the cylinder head gasket.

CAUTION

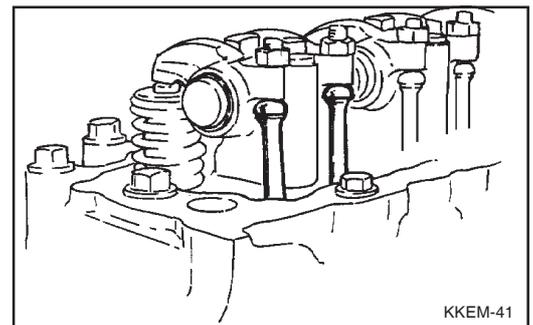
When using the new cylinder head gasket, clean the surface of the cylinder head, cylinder block and head gasket free of all dirt, water and grease.



3. Install the cylinder head over the dowels on the cylinder block.
4. Apply the engine oil to the both ends of push rods and install in the right order.
5. Install rocker arm assembly to the cylinder head and check whether push rod contacts adjusting screws.

CAUTION

Unfasten the lock nut loose and raise the adjusting screw fully to the maximum.



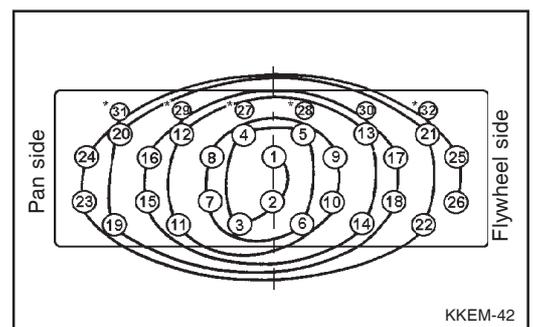
6. Fasten the cylinder head bolts and additional bolts (marked *) in three steps by the order shown in the figure.

CAUTION

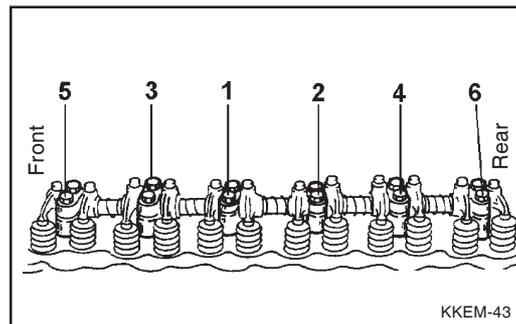
Apply engine oil at the thread of bolts and at the lower part of bolt head.

1-26 bolts (at the cylinder head bolts)

27-32 bolts (additional bolts)

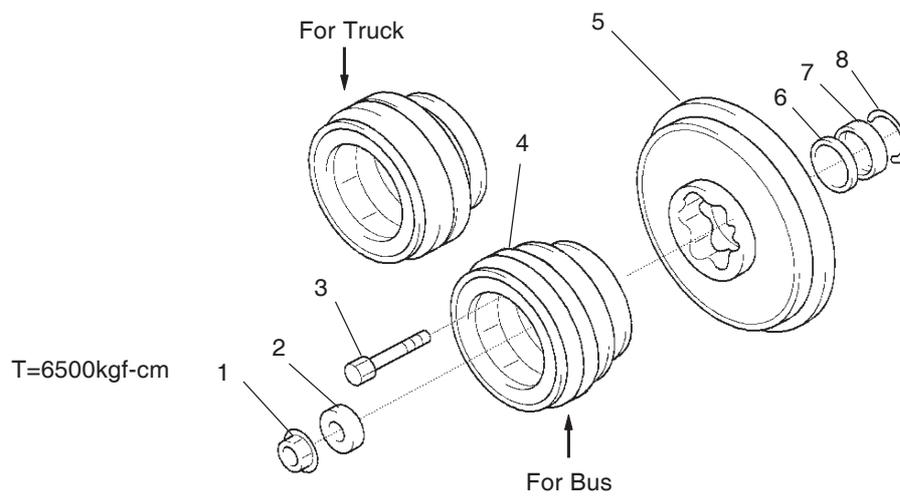


7. Fasten the rocker arm support bolts in three steps in the numerical order shown in the figure. Fasten the bolts by the specified torques at the final step.



Crank Shaft Pulley

COMPONENTS



1. Nut
2. Spacer
3. Bolt
4. Crank shaft pulley
5. Crank shaft damper
6. O-ring
7. Sleeve
8. O-ring

Disassembly

Remove the crankshaft pulley.

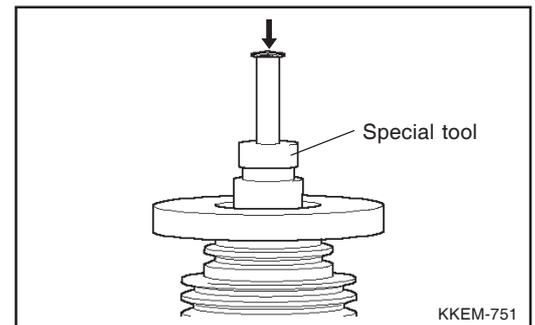
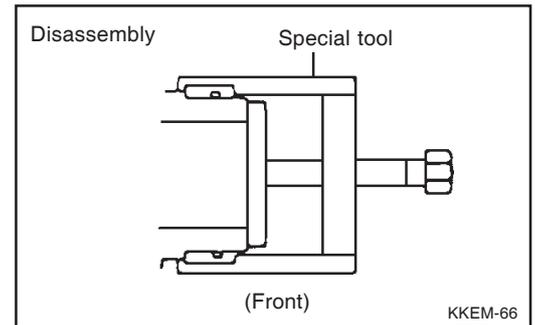
CAUTION

- Use the plug, if needed.
- Do not remove the crankshaft pulley, if it is not necessary.

Assembly

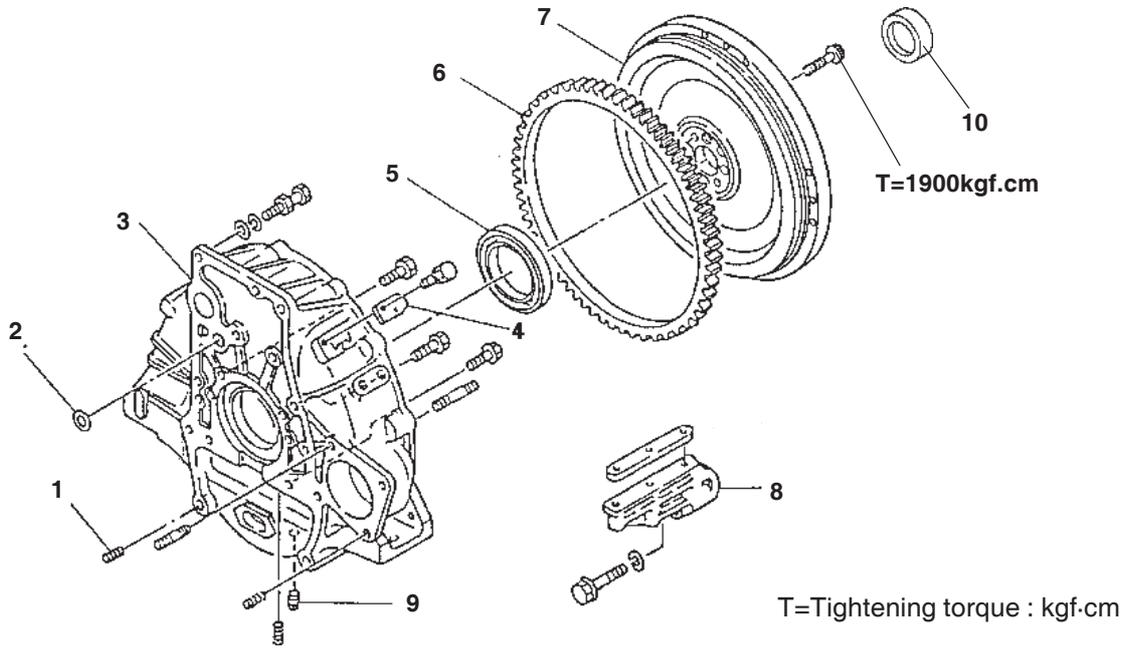
Replace the crankshaft front oil seal sleeve, if needed.

1. Remove the oil seal sleeve by using the special tool (Front oil seal remover: 09231-8Y500, sliding hammer: 09450-8Y000).
2. Install the new sleeve (Special tool: front oil seal sleeve installer: 09231-8Y400) Install the new O-ring to the sleeve, apply the enough oil to the center part of the pulley. Use the crankshaft sleeve press to insert the crankshaft sleeve. Then take care not to damage or wear out the O-ring.



Flywheel and Flywheel Housing

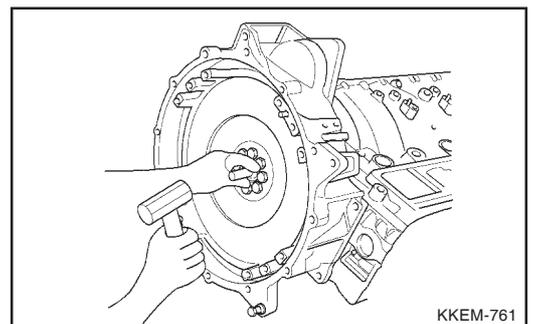
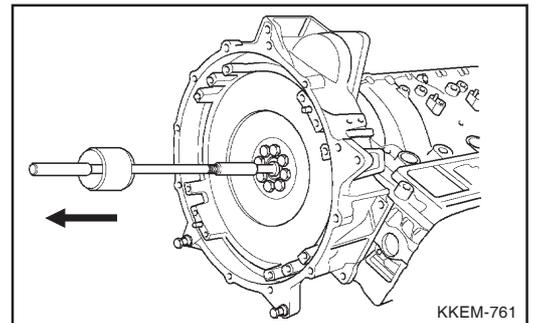
COMPONENTS



- | | |
|------------------------------|------------------|
| 1. Helicert | 6. Ring gear |
| 2. O-ring | 7. Flywheel |
| 3. Flywheel housing | 8. Stay |
| 4. Dust cover | 9. Plug |
| 5. Crank shaft rear oil seal | 10. Ball bearing |

KKEM-761

1. Replace the bal bearing if necessary.
SST : Ball bearing puller (09432-8Y000)



Assembly

Replace the oil seal, if needed.

1. Remove the oil seal.
2. Lightly apply the engine oil to the outer circumference of oil seal, and install the oil seal to the flywheel housing. (Special tool: 09231-8Y100). Check whether the oil seal is securely installed to the flywheel housing.

CAUTION

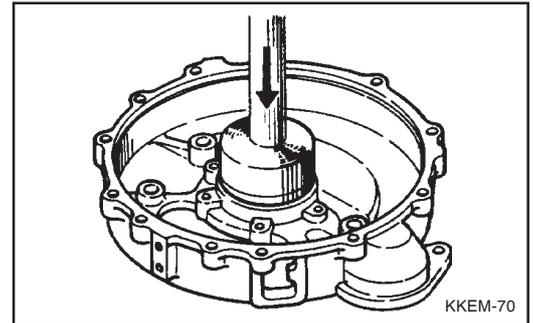
Apply the oil seal lubrication grease (Lithium based) to the oil seal rib.

Replace the O-ring, if needed.

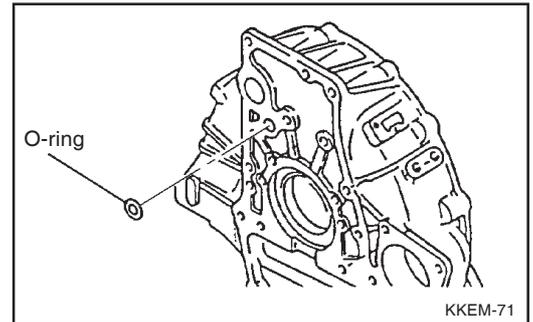
1. Install the O-ring.

CAUTION

Apply the adhesive to the flywheel housing so that the O-ring is not detached. Install the flywheel housing.



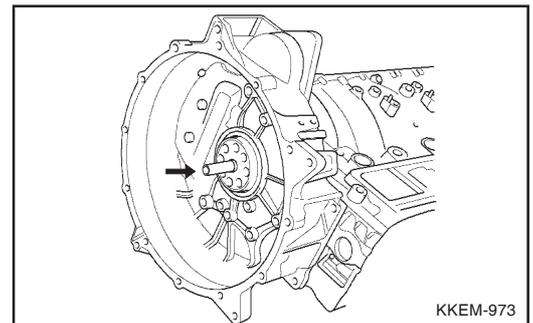
KKEM-70



KKEM-71

2. Assemble the rear oil seal sleeve.

Special tool: Rear oil seal sleeve installer (09231-8Y600)



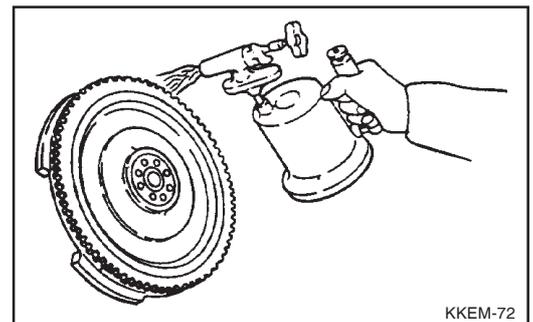
KKEM-973

Replace the flywheel ring gear, if needed.

1. Remove the ring gear.
 - a. Heat the ring gear around 200°C.
 - b. Tap the ring gear evenly around the circumference to remove the ring gear with the metal rod.

CAUTION

Do not overheat the ring gear.

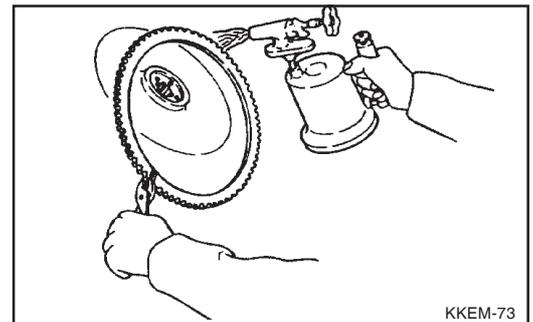


KKEM-72

2. Install the ring gear.
 - a. Heat the ring gear evenly about 200°C.
 - b. Insert the ring gear using the metal rod so that the chamfered gear faces the block of the flywheel.

CAUTION

Do not overheat the ring gear.



KKEM-73

Install the flywheel.

1. Make sure that there is no dust or coarse parts at the holes of crankshaft and flywheel and each contact points. Insert the guide bar to the crankshaft.

Special tool: Flywheel guide bar (09231-8Y200)

CAUTION

Insert one of the bars to the collar knock and insert the other bar to the other side of collar knock.

2. Insert the flywheel into the guide bar gently as flywheel touches the collar knock, and push it fully to be securely installed.
3. Apply the engine oil to the surface of flywheel bolt bearing and threads of flywheel bolts. Fasten the flywheel bolts tentatively by hands.
4. Remove the bars, and fasten the remaining two flywheel bolts tentatively as described in no 3.
5. When fastening the bolts, fasten them gradually and slowly with the specified torques. And then loosen them a little bit and fasten them again by the specified order and torques.

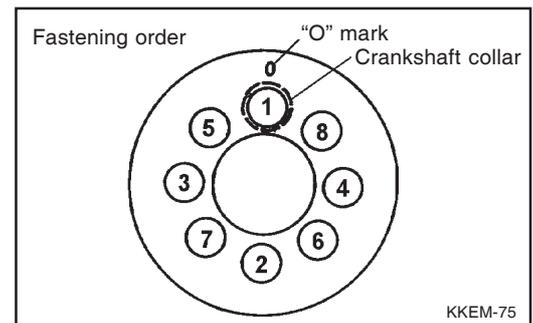
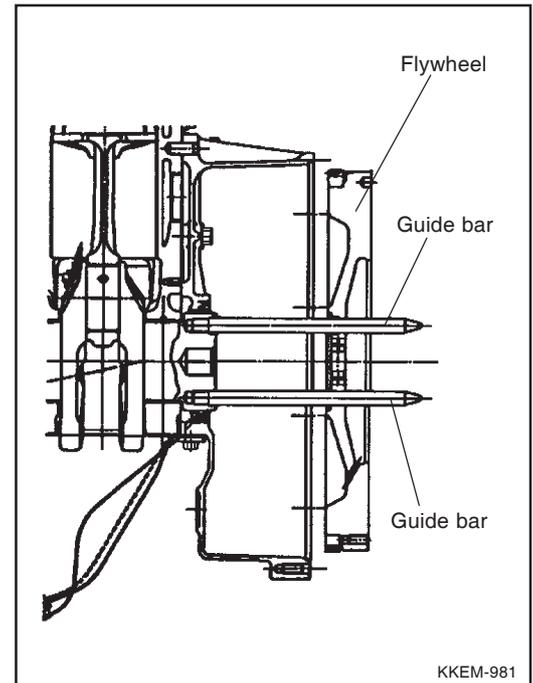
WARNING

Be careful not to drop the flywheel, since it is heavy.

CAUTION

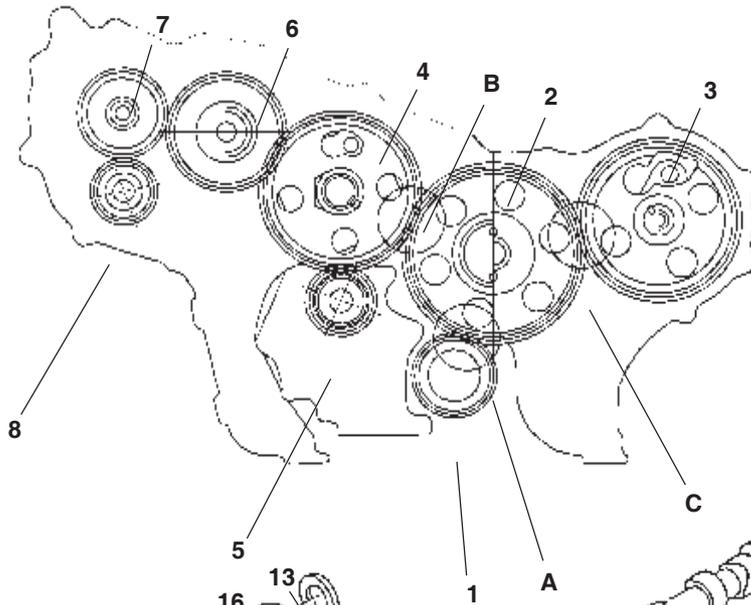
- **Align the "O" marks of flywheel and crankshaft collar knock to be coincided.**
- **When fastening bolts, apply the engine oil the bolts threads and flywheel face.**

Fastening torques: 1900kgf-cm

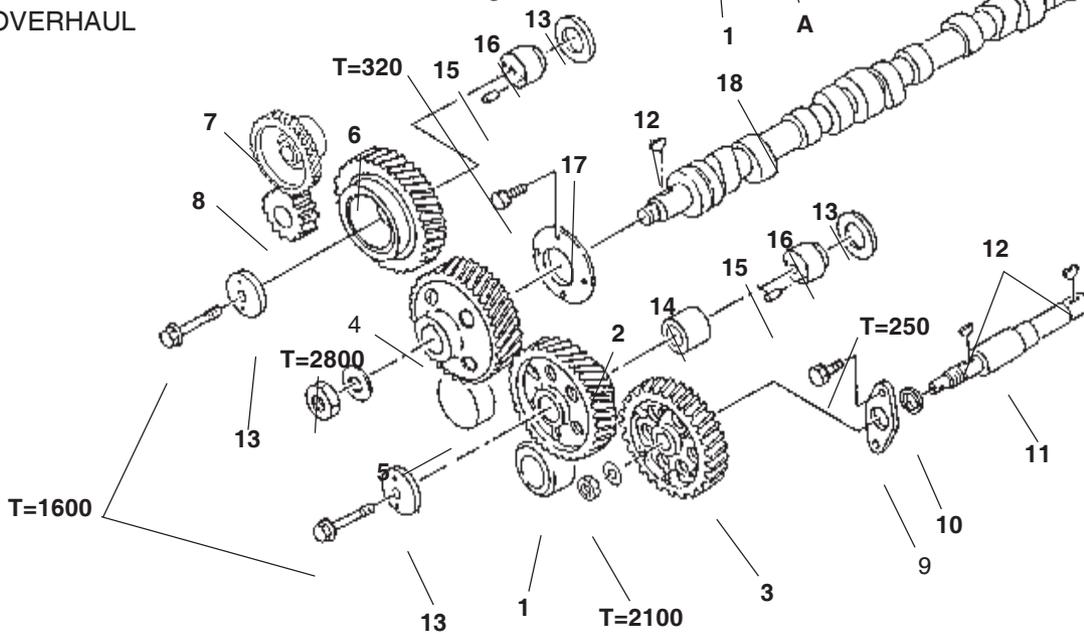


Timing Gear and Camshaft

DESCRIPTION



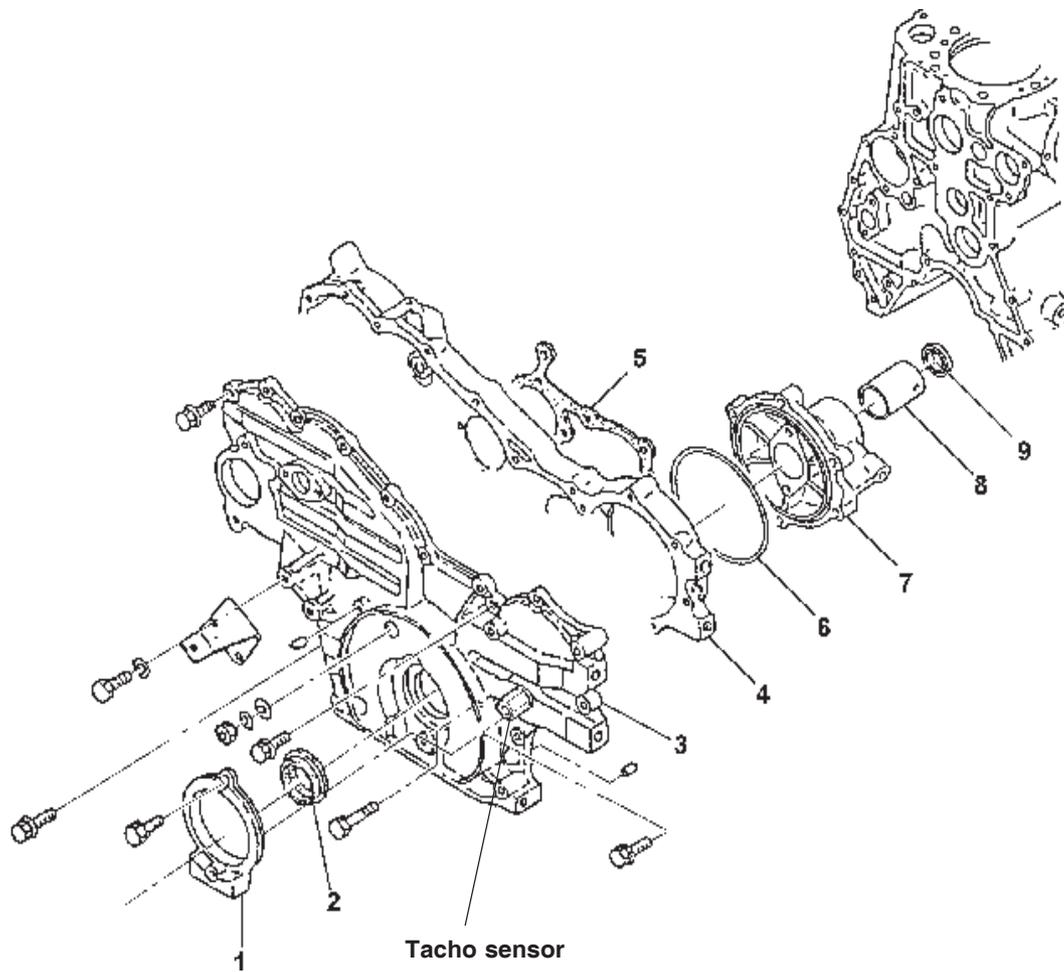
OVERHAUL



T=Tightening torque : kgf·cm

- | | | |
|---|-------------------------------------|--------------------|
| 1. Crank shaft gear | 9. Injection pump gear thrust plate | 18. Camshaft |
| 2. Idler gear | 10. Collar | A. Match marks "1" |
| 3. Fuel injection pump drive gear | 11. Injection pump drive shaft | B. Match marks "2" |
| 4. Camshaft gear | 12. Key | C. Match marks "3" |
| 5. Engine oil pump drive gear | 13. Thrust plate | |
| 6. Air compressor idler gear | 14. Bushing | |
| 7. Air compressor drive gear | 15. Pin | |
| 8. Power steering pump drive gear
(If so fitted) | 16. Idler gear shaft | |
| | 17. Camshaft thrust plate | |

OVERHAUL



- | | |
|-------------------------------|------------------------|
| 1. Seal sub assembly | 6. O-ring |
| 2. Crank shaft front oil seal | 7. Bearing holder case |
| 3. Timing gear case cover | 8. Bearing |
| 4. Timing gear case | 9. Oil seal |
| 5. Gasket | |

Disassembly

Disassemble crankshaft pulley.

Caution: Use the puller, if needed.

Remove idler gear shaft.

Remove idler gear shaft using special tool.

Special tool: Sliding hammer (09450-75400)

Sliding hammer adapter (09450-75400)

Removal of camshaft

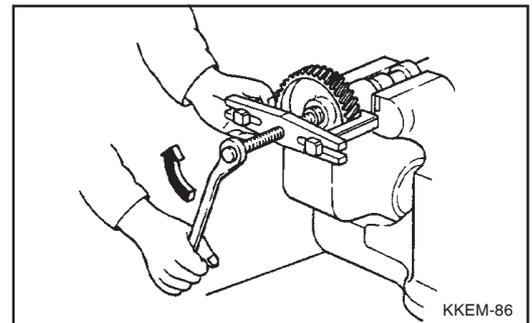
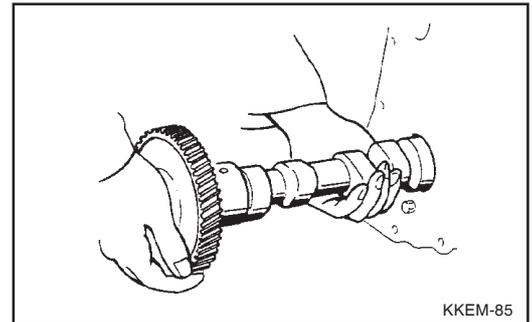
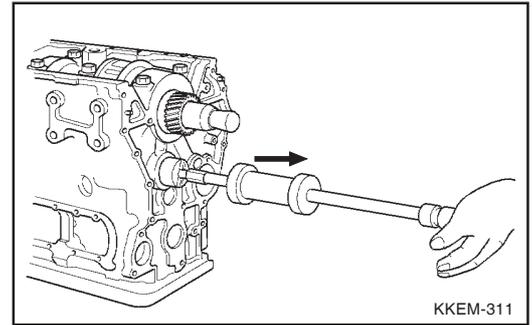
Remove thrust plate set bolts, and remove camshaft and gear.

CAUTION

Rotate the camshaft slowly so that the bearing should not be damaged.

Remove camshaft gear and injection pump drive gear, if needed.

Place the shaft assembly on the wooden plate and fix it with vise.
Remove the nut, and remove the gear by using gear puller.

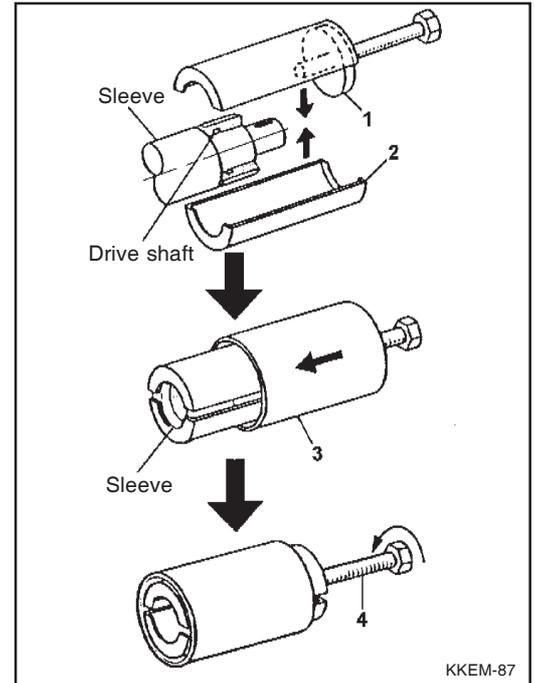


Assembly

Replace drive shaft oil seal sleeve of fuel injection pump, if needed.

1. Remove sleeve by using special tools.
 - a. Place the puller (1) and (2) on sleeves.
 - b. Hook the puller between shaft and sleeve.
 - c. Insert the puller (3).
 - d. Fasten the center bolt (4) after inserting puller, and remove sleeve.

Special tool: Puller



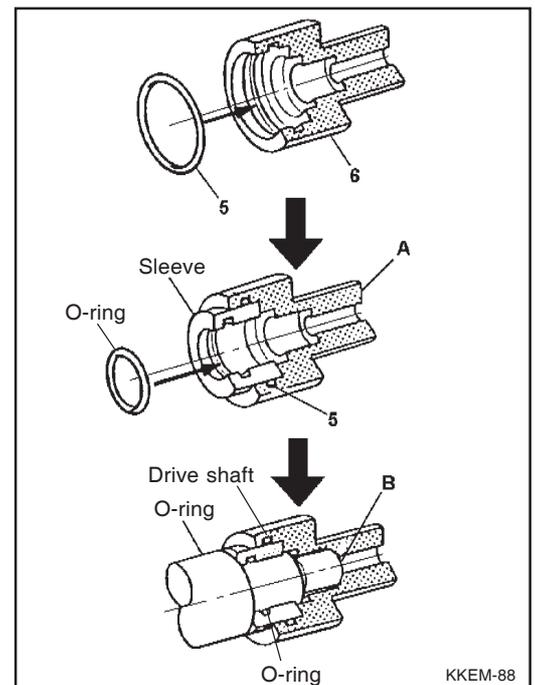
KKEM-87

2. Insert shaft sleeve along with the new O-ring by using special tool.
 - a. Install O-ring (5) inside of the press (6).
 - b. Insert oil seal sleeve into press with new O-ring and insert it into drive sleeve.
 - c. Tap the part (A) lightly with hammer to connect the edge of the press with shaft edge (B) and then oil sleeve is positioned.

CAUTION

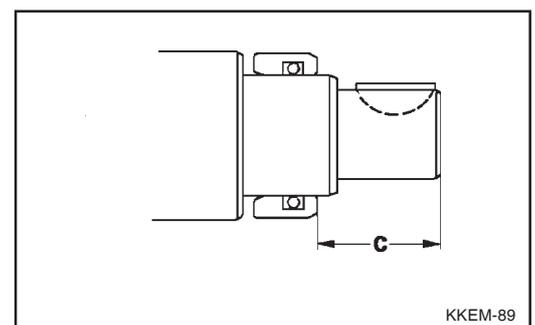
- Install O-ring on sleeve and apply the oil on the shaft.
- When installing shaft sleeve, be careful no to damage the O-ring.
- Do not reuse the sleeve once it is removed.

Special tool: Press



KKEM-88

Distance from the shaft edge to sleeve end (c): 85.2 – 85.8 mm

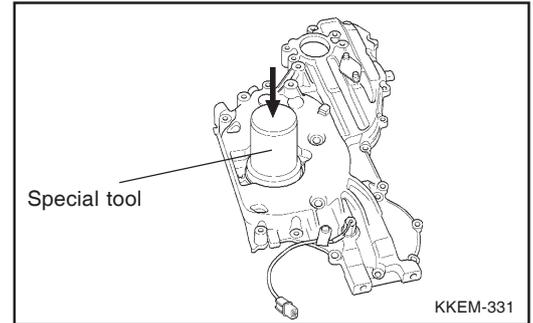


KKEM-89

Replace oil seal of timing gear cover, if needed.

1. Remove oil seal using screwdriver.
2. Install the new oil seal.

Special tool: Front oil seal installer (09231- 8Y000)

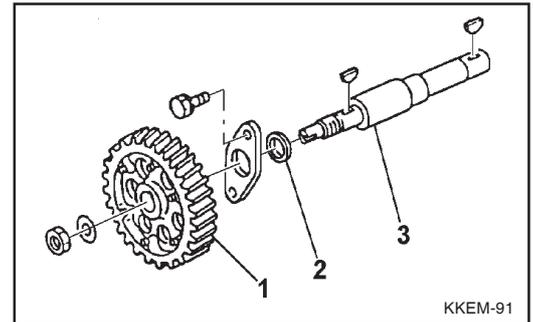


Install drive gear of fuel injection pump to the shaft.

1. Install collar thrust bearing and key to the shaft.
2. Install the preheated gear (1) about 100°C to the shaft.

CAUTION

Check whether gear (1) is securely installed to collar (2) and shaft (3).

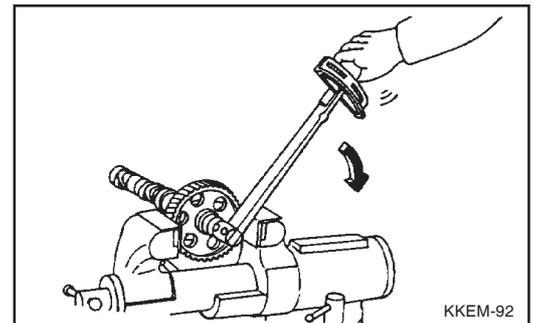


Install camshaft gear to shaft.

Install camshaft gear along with thrust plate.

CAUTION

- When installing gear to camshaft,
- Heat the gear with the hot water (approximately 100°C) and install gear to camshaft by using the press.
- When fastening the bolts, apply the engine oil to the bolts thread and nut surfaces.

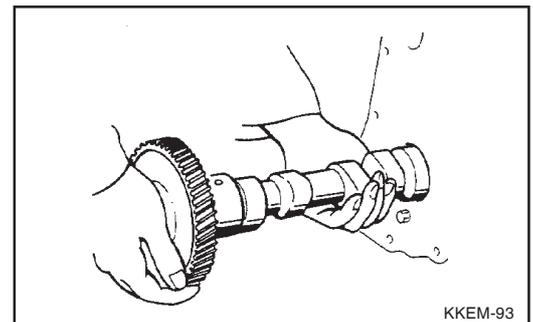


Install camshaft.

Lubricate the camshaft and install the camshaft assembly to cylinder block.

CAUTION

When installing camshaft, rotate the camshaft slowly so that the bearing is not damaged.

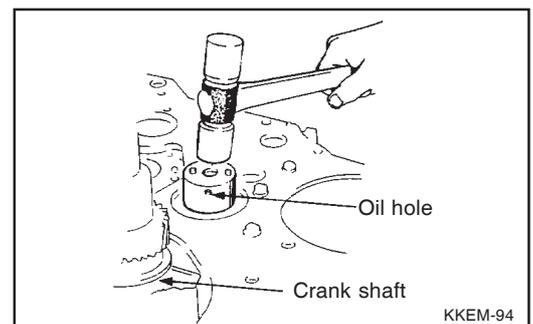


Install idler gear shaft.

Install idler gear shaft with thrust plate using plastic hammer.

CAUTION

Make sure that oil hole faces downward. If it doesn't, idler gear shaft and bushing will be damaged.



Installation of Idler Gear

When installing idler gear, coincide the assembly marks of crankshaft, camshaft gear, fuel injection pump drive gear and idler gear.

CAUTION

- **If installed wrong, it may cause improper injection timing and finally engine damage or engine performance deterioration will be resulted.**
- **When fastening bolts, apply the engine oil to the bolts threads and surface.**

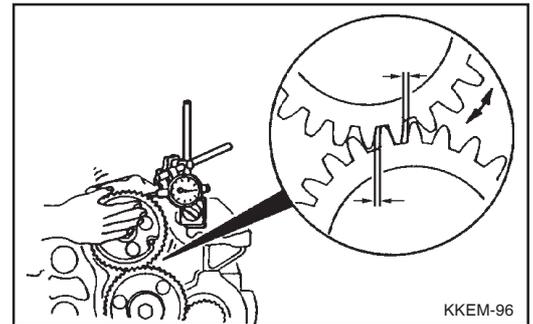
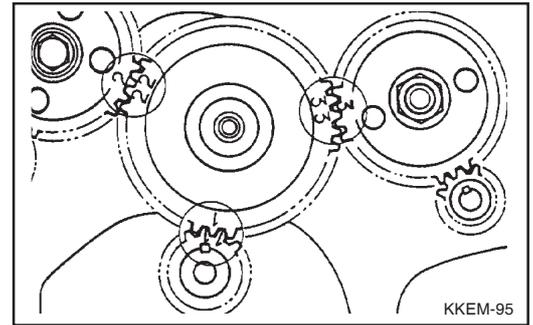
Measurement of gear backlash

Measure the backlash of each gear using dial indicator.
Replace gear, when needed. (Refer the maintenance standard)

Timing gear cover installation

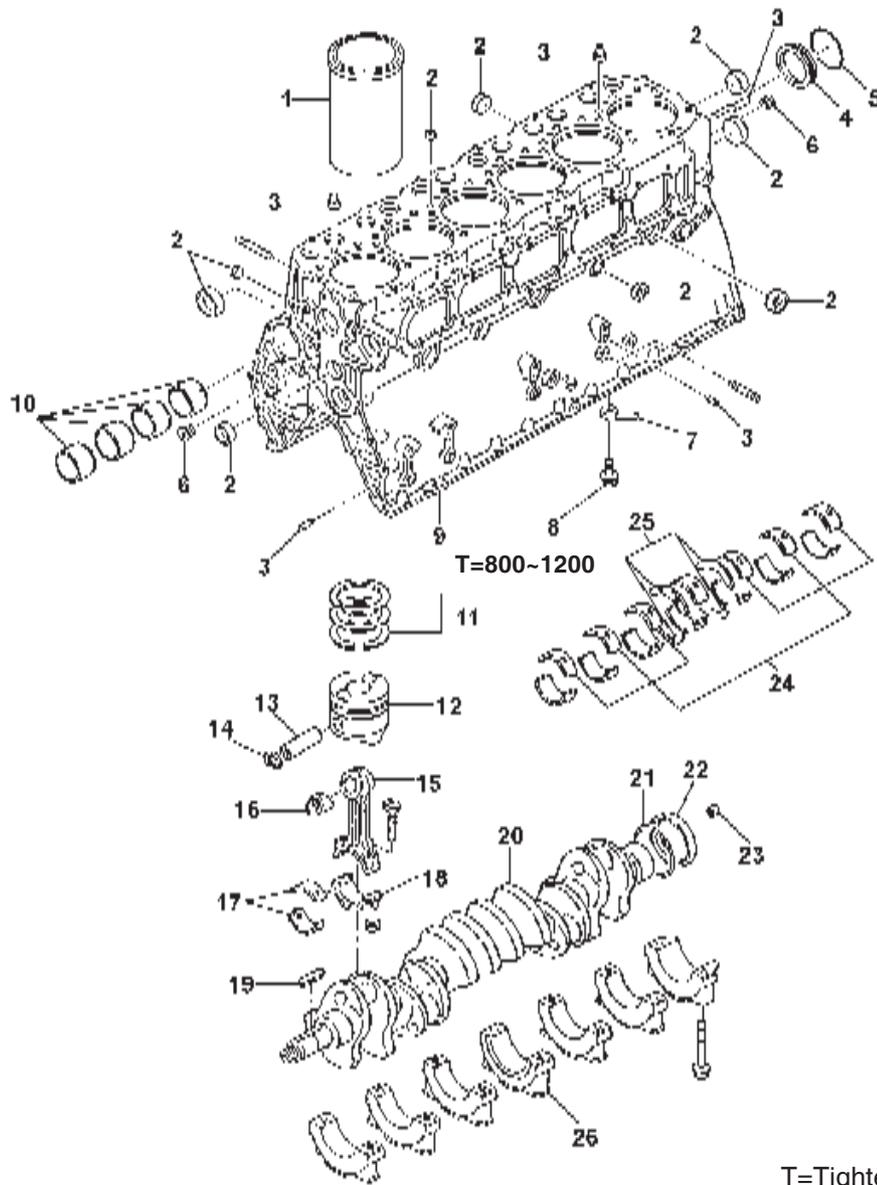
Install oil pump and oil strainer.

Install crankshaft pulley.



Piston, Crankshaft, Cylinder Block and Oil Pan

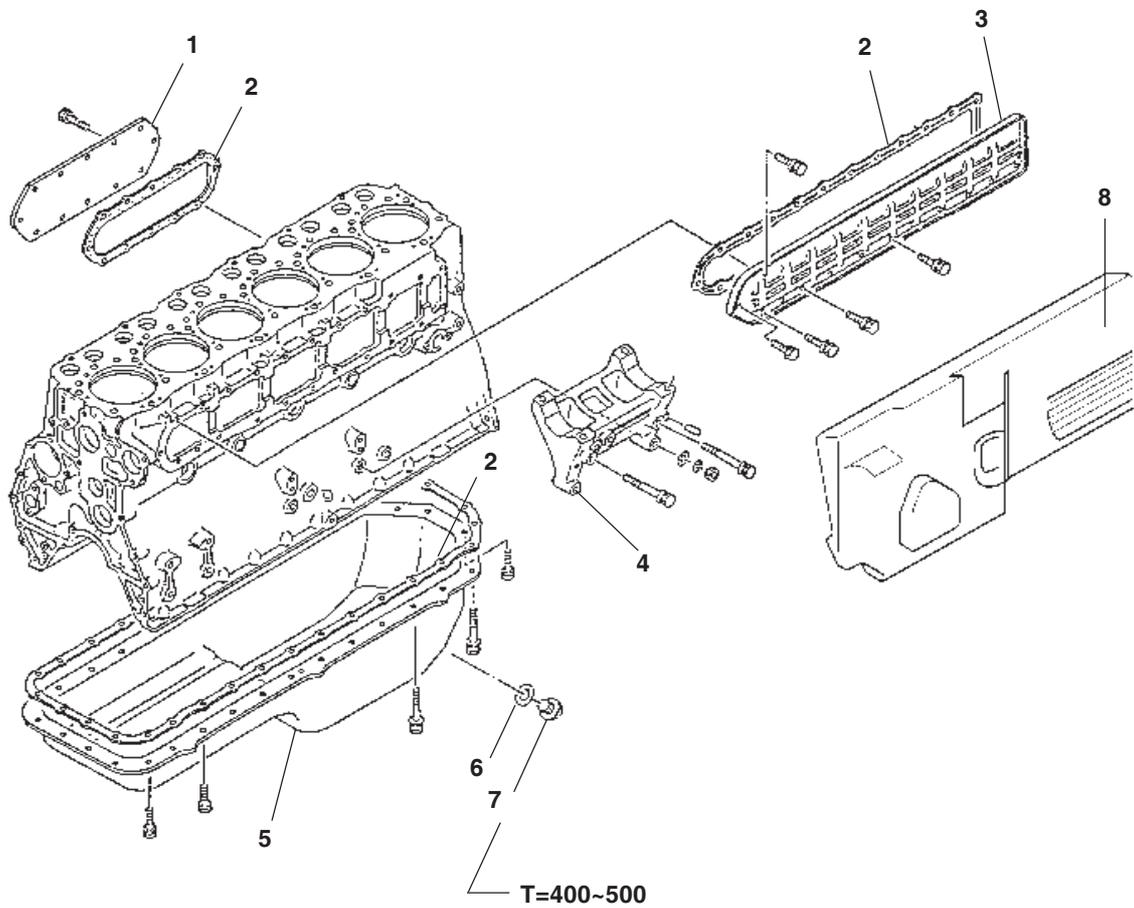
OVERHAUL



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 |

OVERHAUL



T=Tightening torque : kgf-cm

1. Push rod cover
2. Gasket
3. Water gallery cover
4. Injection pump bracket
5. Oil pan
6. Soft washer
7. Plug
8. Sound insulator

Disassembly

Disassemble piston along with connecting rod.

1. Remove the carbon dirt of the cylinder liners by scrubbing the liner edges to the circumference direction by scraper or sand paper (No. 150).

2. Pull out the piston and connecting rod assembly out of upper cylinder.

CAUTION

- **Disassemble connecting rod, as connecting rod do not touch the cooling jet.**
- **Arrange the piston and connecting rod caps orderly.**

Remove the connecting rod.

Remove the retainer rings that installed at both ends of pistons by using retainer ring pliers.

CAUTION

Preheat the piston for about 5 minutes by soaking in the hot water of 80 - 90°C, before disassembling pins.

Remove piston rings.

Special tool: Piston ring tool (09222 – 83200)

CAUTION

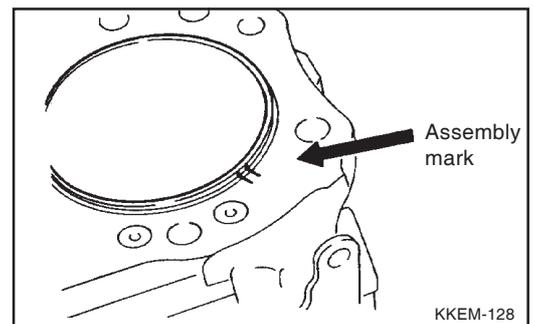
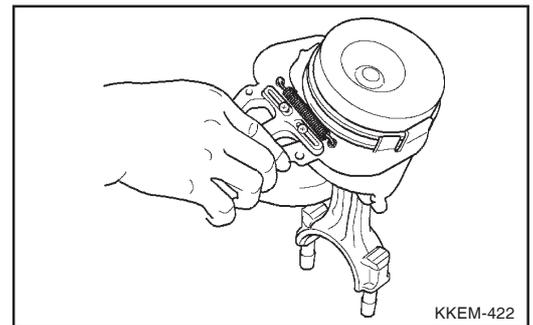
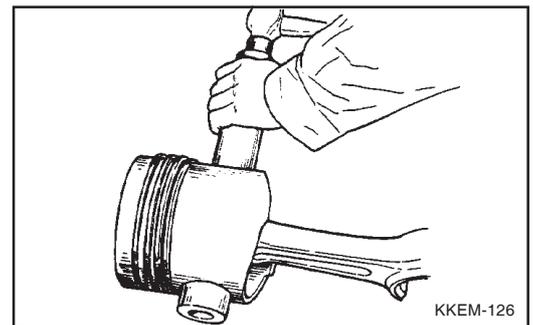
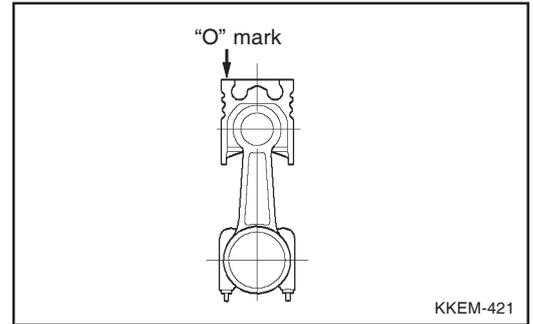
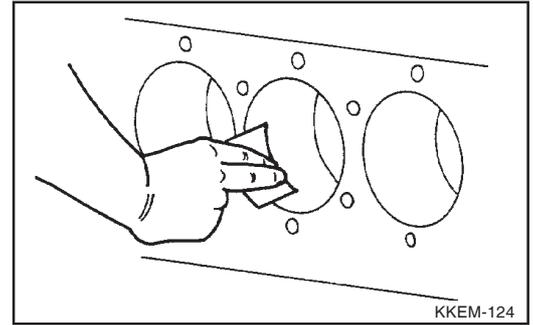
- **Since piston rings are made of special forgery and brittle, handle them with special care.**
- **Distinguish the rings by the equivalent cylinders and separate them each other.**

Remove cylinder liners.

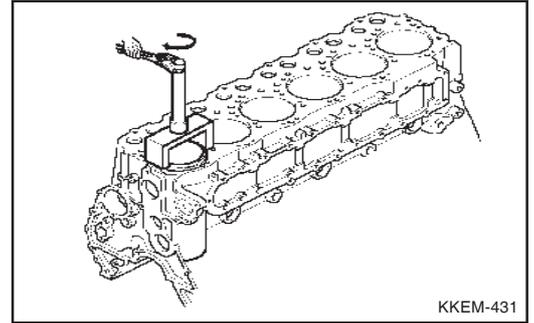
Draw assembly mark at the cylinder block and liner flange, before disassembling cylinder liners.

CAUTION

- **Do not draw assembly mark with punch.**
- **After disassembling cylinder liners, write down numbers at the circumference or arrange them orderly.**



Special tool : Cylinder liner puller A(09222-62100)
Cylinder liner puller B(09222-8Y100)



KKEM-431

Assembly

Check piston cooling jet position.

CAUTION

- Do not disassemble cooling jet except disassembly inspection or when it is necessary.
- When cooling jet is disassembled, replace the cooling jet check valve of cylinders.

Cooling jet position checks are as follows.

1. Remove connector bolts of piston cooling jet, and install the special tools.
2. Use the oil pump; whose pressure is approximately 2kgf/cm² and oil speed is 2.5 L/min.
3. Prepare the new engine oil.
4. Connect the oil line. Connect the outlet of oil pump to special tool (connector bolts).
5. Install special tool on the cylinder block.

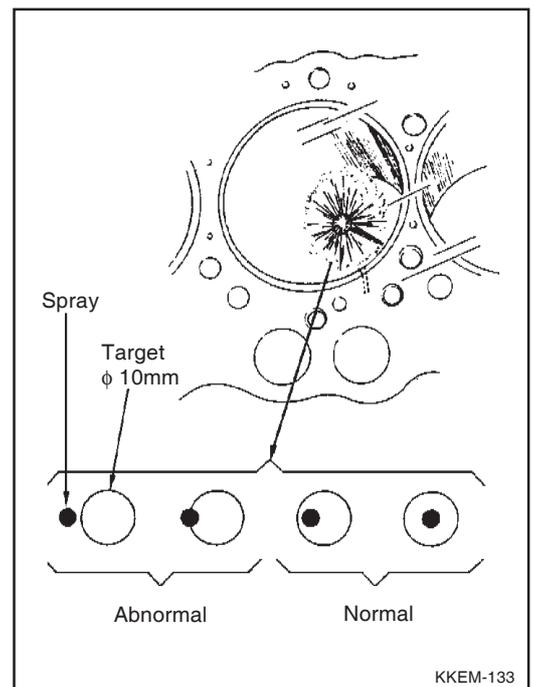
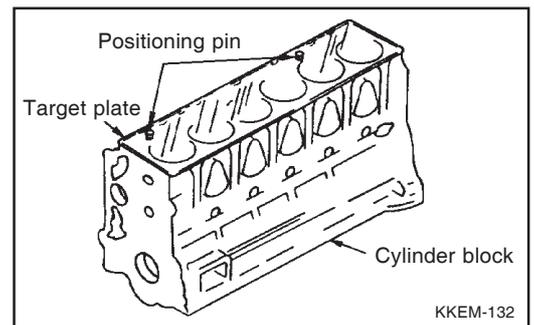
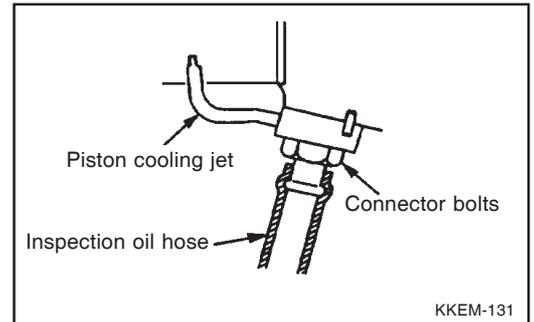
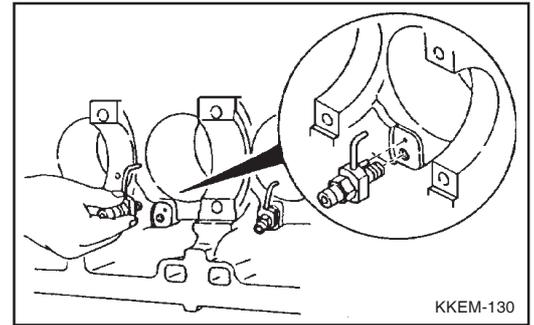
Special tool: Target plate (09222 – 8Y500)

6. Perform an injection test by operating the oil pump to maintain the oil pressure as approximately 2kgf/cm² and by pumping the new oil from jet. It is normal, if the spray of the injection is centered at around ϕ 10mm of the plate.

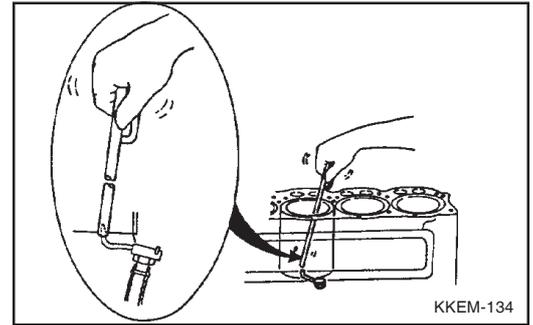
WARNING

Engine oil is extremely flammable.

Spray test should be performed at the places where ventilation is excellent.



7. If the spray of the cooling jet is scattered around the target plate, readjust the nozzle.

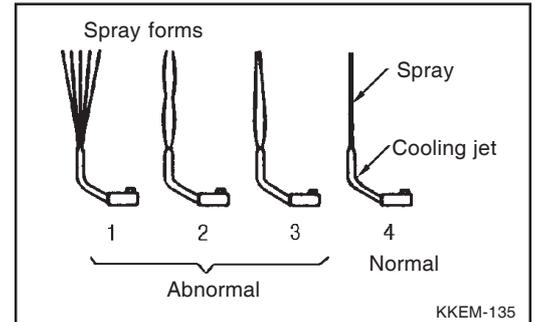


8. Spray form

When checking the piston cooling jet position, make sure that spray is like number 4 in the figure not like the other 1,2 and 3.

CAUTION

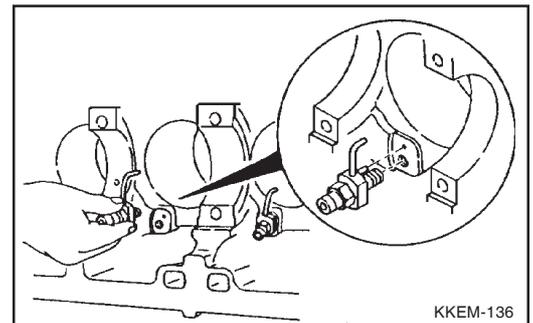
If the end of jet is damaged, spray is poor, so replace it with the new one. Whenever replacing the cooling jet, check the piston cooling jet position of the new one always.



9. After checking piston cooling jet position, install the cooling jet on the cylinder block by using the right bolts (with soft washer).

Fastening torque: 270 ~ 320kgf-cm

10. After installing piston, check the interference of cooling jet and piston when the piston is at the bottom dead center position.



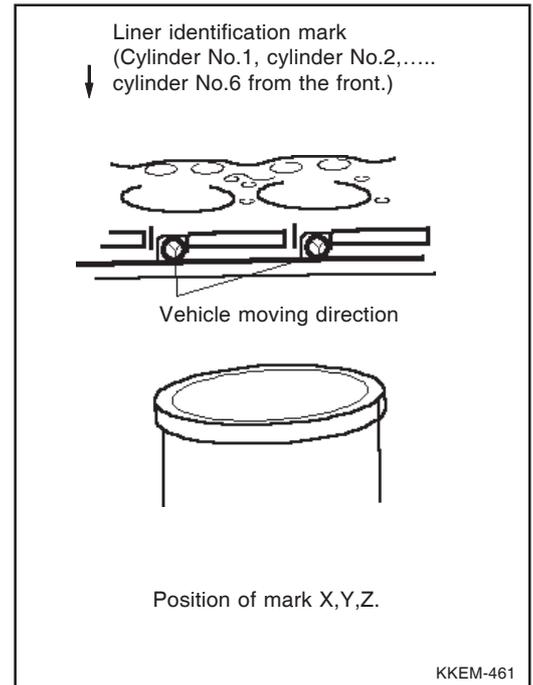
Insert the cylinder liners into the cylinder block.

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

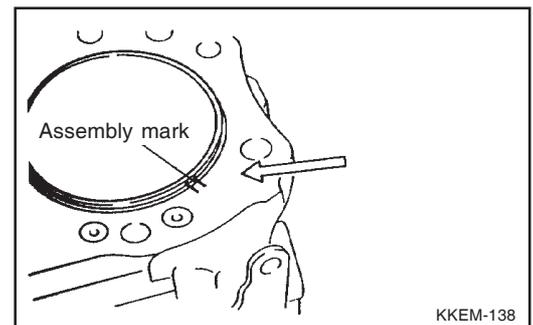
CAUTION

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.



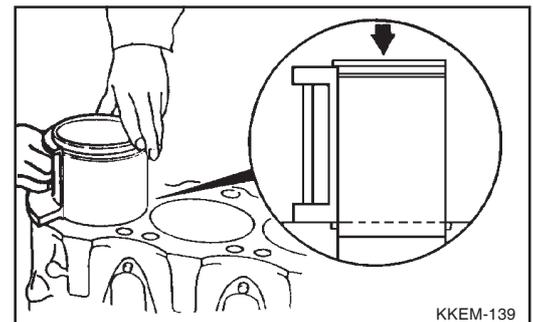
2. When reusing the liner, install the liner at the right position by coinciding the assembly marks that was drawn before the disassembly.



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.



Replace the camshaft seal plate, if needed.

1. Remove the seal plate.
2. Install the seal plate.
Install O-ring to end plate and install this assembly to the cylinder block.

CAUTION

- **Take care not to damage the cylinder block and end plate in installing. Besides, apply the liquid gasket around the O-ring (three bond 1215).**
- **Don't reuse the O-ring after removal.**

Replace the crankshaft rear oil seal sleeve, if needed.

1. Remove the crankshaft sleeve using special tool.
(Rear oil seal sleeve remover: 09231 – 8Y300)

CAUTION

Do not disassemble the crankshaft, if necessary.

2. Install the new sleeve.
(Special tool – rear oil seal sleeve installer: 09231 – 8Y600)
Install the new O-ring to the sleeve and apply enough oil to crankshaft.
Use the crankshaft sleeve press in installing crankshaft sleeve.
Take care not to damage the O-ring.

Special tool: Press

Dimension: 4.3 – 4.7 mm

Grind the crankshaft pin or journal and use the undersize bearing, if necessary.

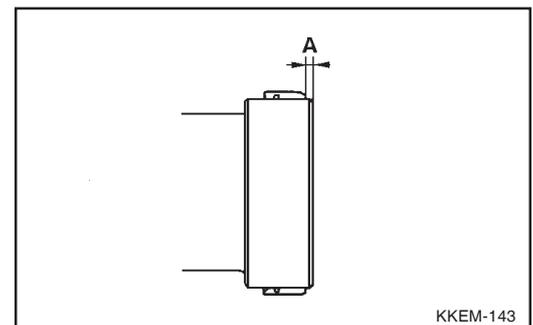
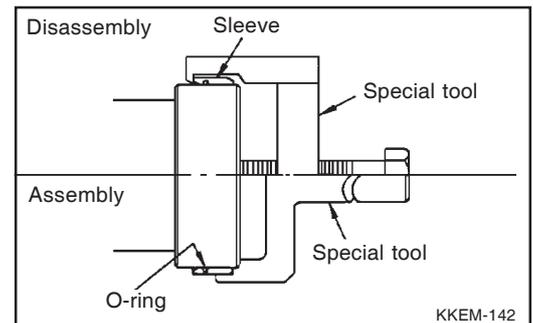
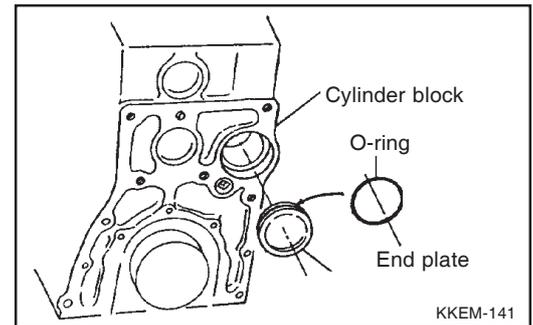
CAUTION

- **When crankshaft pin or journal is worn out, 4 different types of under size bearing can be used.
0.25 mm, 0.50 mm, 0.75 mm, 1.00 mm**
- **Bearing set consists of upper and lower bearing. So it should be replaced by the set.**

Filler dimension (R)

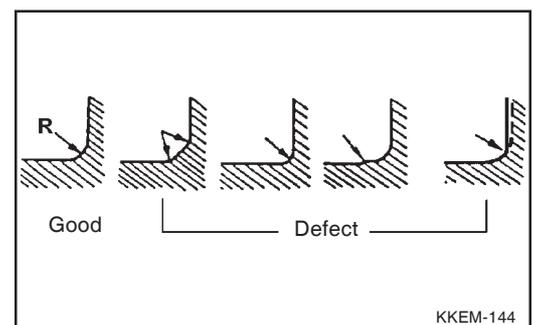
Crank pin: 3.75 – 4.25 mm

Journal: 3.00 – 3.50 mm



Unit: mm

Undersize	Outer diameter	
	Pin	Journal
0.25US	64.69-64.71	79.69-79.71
0.50US	64.44-64.46	79.44-79.46
0.75US	64.19-64.21	79.19-79.21
1.00US	63.94-63.96	78.94-78.96



Install the crankshaft.

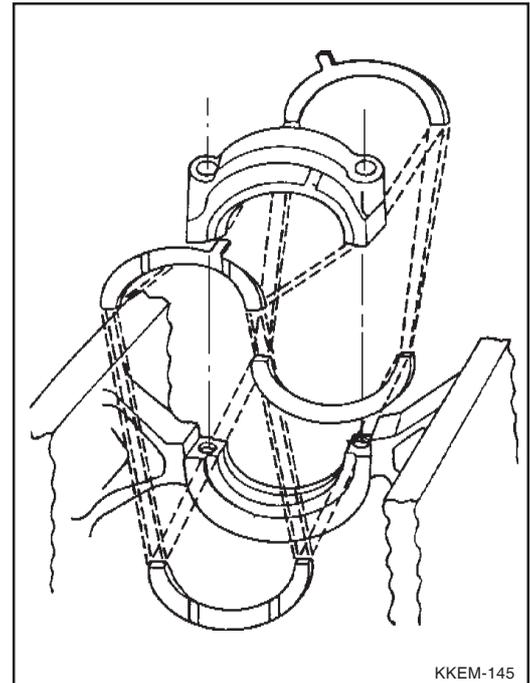
1. Install the crankshaft bearing to the cylinder block and bearing cap.

CAUTION

- Install the bearing with oil hole to the block side, and bearing without the oil hole to the bearing cap side.
 - Apply the clean engine oil to the bearing surface.
2. Install the crankshaft to the cylinder block.
 3. Insert the crankshaft thrust bearing to the cylinder block groove.
 4. Insert the thrust bearing at the side of number 4 bearing.

CAUTION

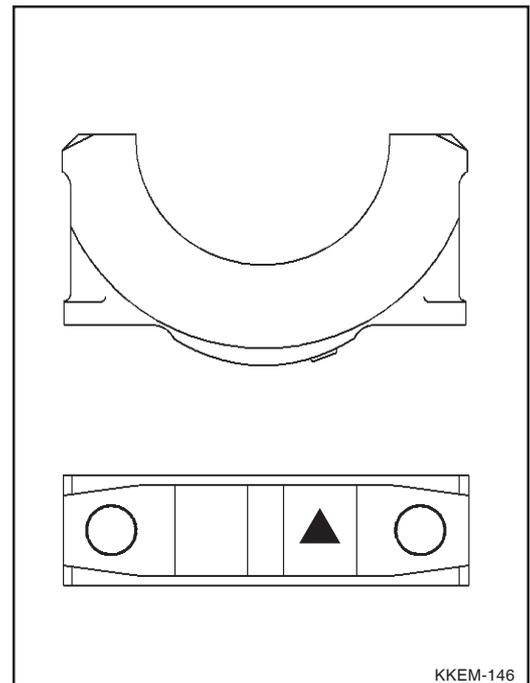
Apply the engine oil to each thrust bearing surface.



KKEM-145

5. Install the crankshaft-bearing cap.

Install the bearing caps by the numerical order from the timing gear side by placing the arrow mark of the bearing cap face the timing gear side.



KKEM-146

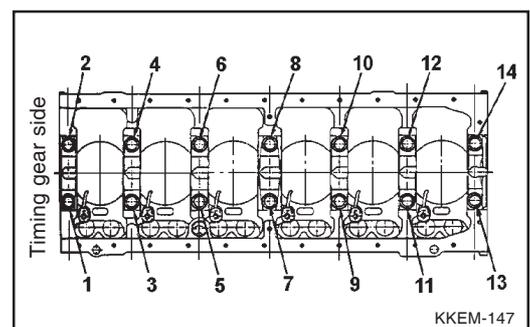
6. Fasten the cap bolts by the following order.

Unit: kgf-cm

#1, #2, #3, #5, #6, #7	# 4
$700 + 57^{+2}_0$	$700 + 52^{+2}_0$

CAUTION

- Apply the engine oil to the lower part of bolt thread and head.
- Check whether the crankshaft rotates smoothly.
- Check the clearance of crankshaft end.



KKEM-147

Replace the piston pin bushing, if needed.

1. Remove the bushing using hydraulic press.

CAUTION

Operate the press slowly and gently.

2. Assemble the piston bushing.

Grind the one side of bushing hole at the connecting rod homogenously wide 0.5 – 1.0 mm.

CAUTION

- **Unbalance chamfering cause the wrong grinding of pressed bushing, and finally results in the melting during installation.**
- **Remove the dust from the inside of the hole.**

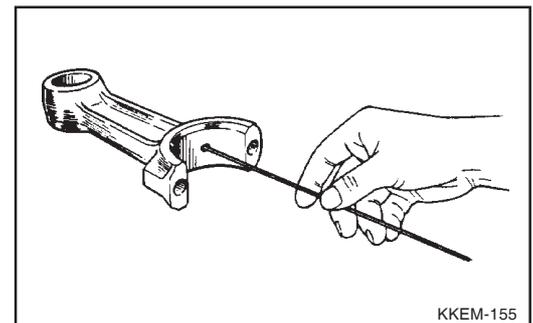
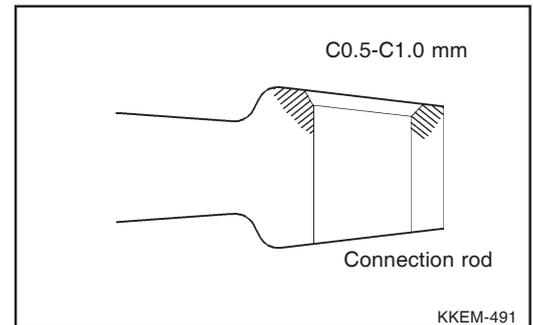
3. Check the bushing position after installation.

- a. Check the oil hole of bushing and oil passage of connecting rod whether they are arranged as the rod of 6 mm in diameter can be inserted.

CAUTION

Misalignment of oil holes may cause insufficient lubrication and melting.

- b. The new piston pin inserted to the piston pin bushing must be rotated easily without shaking.

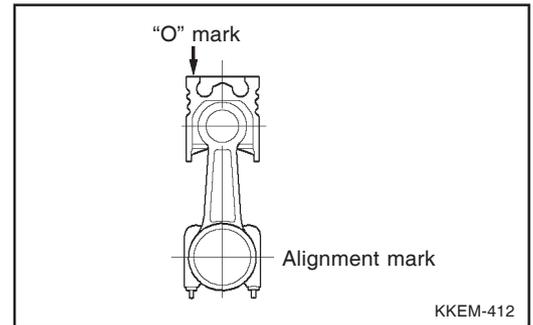


Assemble the piston and connecting rod.

Let the O-mark of upper piston be opposite direction of connection rod assembly mark.

CAUTION

- Use the new retainer ring.
- Heat the piston for about 5 minutes by soaking it into the water of 80 –90°C.



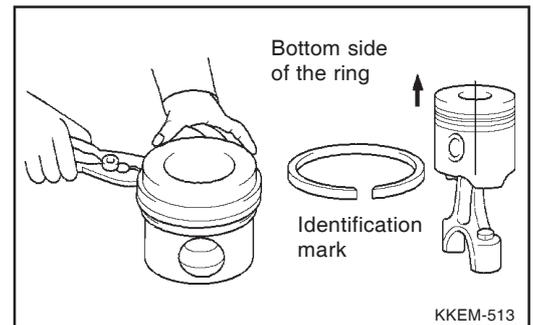
Install the piston ring.

1. When installing the piston rings, install by the order of oil ring, No. 2 ring and top ring, and identification mark of ring end should face upward.

CAUTION

Apply the engine oil to piston ring.

Special tool: piston ring tool (09222 – 83200)

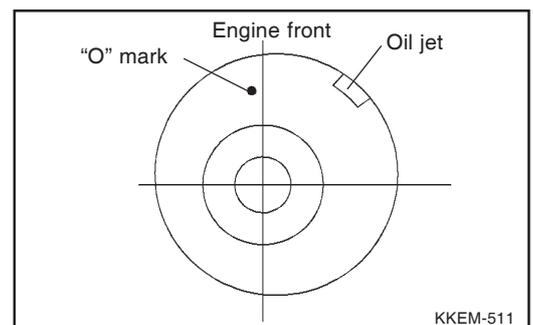
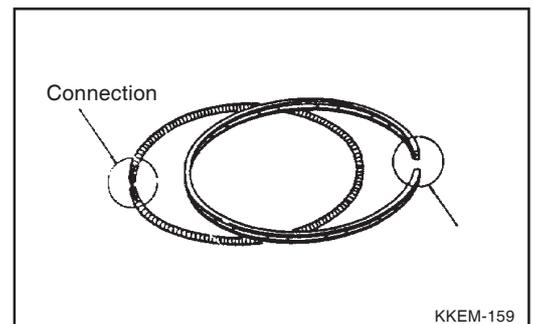


2. Connect the end of coil expander, and install the coil inside the piston ring by letting the gap of piston ring should be at the 180° distant from the joint part of the coil.

Ring number	Shape
Top	
Number 2	
Oil	

KKEM-512

3. Align the piston ring, as the gap positions of rings are equal.



Install the connecting rod and piston to cylinder liners.

1. Apply the engine oil to piston, cylinder liner and connecting rod bearing surface.
2. Fix the piston ring using the special tool and insert the piston and connecting rod assembly using wooden rod.

CAUTION

- Check whether the O-mark of upper piston is at the engine front (crank pulley) side.
- Align the oil holes when installing bearing on connecting rod and cap.
- When assembling connecting rod assembly to piston, take care not to damage the piston cooling jet by the connecting rod. If piston-cooling jet is hit, then adjust or replace it.

Special tool: Piston guide clamp (09222 – 88200)

Install the connecting rod cap.

1. Apply the engine oil to the bearing surface.
2. Coincide the assembly mark of connecting rod and cap.

Fasten the cap bolts.

1. Measure the total length of bolt. If the length is more than 8.5 mm, replace it with the new bolt.

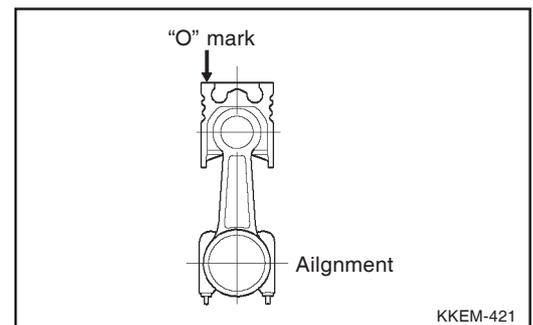
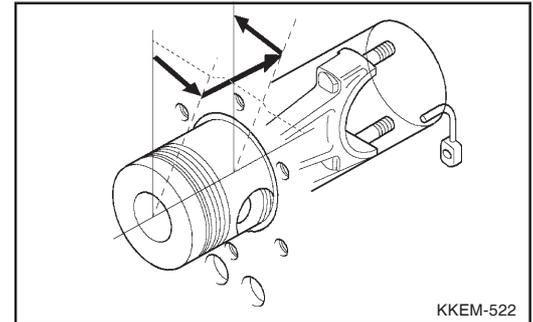
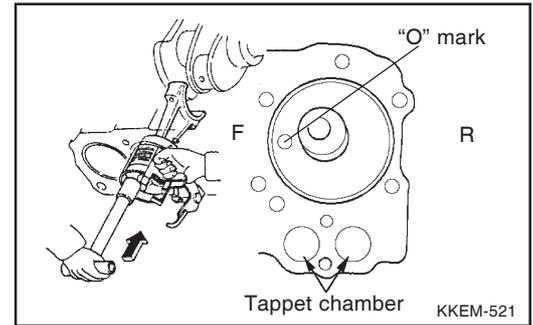
Fastening torque (1650 ~ 1850 kgf.cm)

Dimension (A): 83.5 mm

2. Fasten the bolts by the following order.
 - a. Fasten the nut by the force of 700kgf-cm
 - b. Fasten the nut again around 1/4 rotation(90°)
 - c. Fasten the nut again around 1/8 rotation(45°)

CAUTION

- Apply the engine oil at the lower part of bolt threads and nuts.
- Fasten the nut again, even if the nut is fully fastened.



Liquid Gasket and Oil Application Points

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

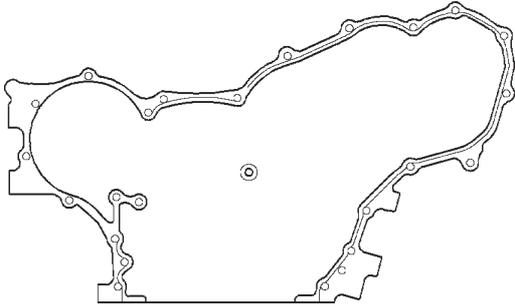
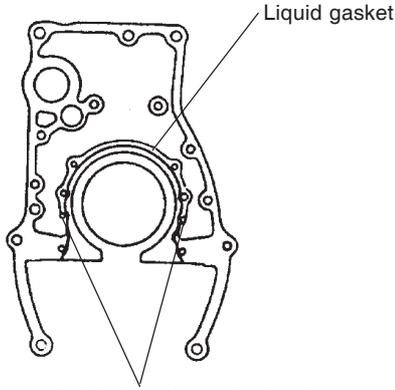
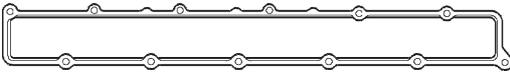
1. Application points and width of liquid gasket.

Liquid gaskets in use.

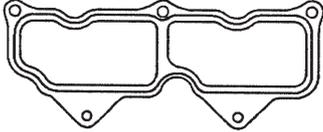
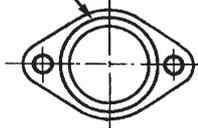
Three bond TB1207D or general electric NO. 2992 – 10: 04132 – 1207 (a), (b), (c) silver color

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

Unit: mm

Parts name	Application points	Application width
(d) Intake air pipe	Flange face where contacts intake air-fold Liquid gasket  KKEM-581	1.5-2.5
(e) Coolant pipe (for the model, which adopts air compressor)	Flange face where contacts coolant pump Liquid gasket  KKEM-582	1.5-2.5

2. Application of liquid gasket and assembly order of components

- 1) Remove the old liquid gaskets completely among junction parts, and also remove the oil, water and dirt by the cloth.
- 2) Apply the proper amount of liquid gasket only. Let the beginning and end of the gasket be overlapped.
- 3) When assembling the liquid gasket applied parts, align the parts orderly. If not, apply the gasket again.
- 4) Assemble the parts within 20 minutes after applying the liquid gasket. If 20 minutes have passed, remove the applied gasket and apply the new gasket again. (Adhesion is weak due to the hardening)
- 5) Wait for more than 15 minutes to engine start after assembly.

3. Components disassembly

When disassembling each component, try to lift various parts in turn instead of lifting only one side of the flange.

CAUTION

Oil pan flange are deformed sometimes in removing oil pan.

Therefore, insert several plates along the circumference and remove the oil pan using screwdrivers.

THOUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine overheating	Coolant <ul style="list-style-type: none"> • Insufficient coolant • Defective thermostat • Overflow of coolant due to leakage of exhaust into cooling system • Coolant leakage from cylinder head gasket • Defective coolant pump 	<ul style="list-style-type: none"> • Add coolant. • Replace the thermostat. • Repair. • Repair gasket. • Repair or replace.
	Radiator <ul style="list-style-type: none"> • Clogged with rust and scale • Clogged with iron oxide due to leakage of exhaust into cooling system • Clogged radiator core due to mud or other debris • Defective radiator cap pressure valve 	<ul style="list-style-type: none"> • Clean radiator. • Clean coolant passage and correct exhaust leakage. • Clean radiator. • Replace radiator cap
	Abnormal combustion <ul style="list-style-type: none"> • Incorrect injection timing • Reduced injection pressure • Poor fuel • Poor nozzle spray • Unsatisfactory automatic timer true angle 	<ul style="list-style-type: none"> • Adjust injection timing • Adjust injection pressure. • Use good quality fuel. • Adjust or replace nozzle. • Repair or replace timer.
	Other problems <ul style="list-style-type: none"> • Defective or deteriorated engine oil • Unsatisfactory operation of oil pump • Insufficient oil 	<ul style="list-style-type: none"> • Change engine oil. • Replace or repair. • Add oil.
Excessive oil consumption	Pistons, cylinder liners, and piston rings <ul style="list-style-type: none"> • Wear of piston ring and cylinder liner • Worn, sticking or broken piston rings • Insufficient tension on piston rings • Unsuitable oil (viscosity too low) • Incorrectly fitted piston rings (upside down) • Gaps of piston rings in line with each other 	<ul style="list-style-type: none"> • Replace piston rings and cylinder liner. • Replace piston rings and cylinder liner. • Replace piston rings and cylinder liner. • Change oil as required. • Replace piston rings. • Reassemble piston rings.
	Valve and valve guides <ul style="list-style-type: none"> • Worn valve stem • Worn valve guide • Incorrectly fitted valve stem seal • Excessive lubricant on rocker arm 	<ul style="list-style-type: none"> • Replace valve and valve guide. • Replace valve guide. • Replace stem seal. • Check clearance between rocker arm and shaft.

Symptom	Possible cause	Remedy/Prevention
Excessive oil consumption	Excess oil feed <ul style="list-style-type: none"> Defective oil level gauge Oil level too high 	<ul style="list-style-type: none"> Replace oil level gauge. Drain excess oil.
	Other problems <ul style="list-style-type: none"> Over cooled engine (low temperature wear) Oil leakage from miscellaneous parts 	<ul style="list-style-type: none"> Warm up engine before moving vehicle. Check cooling system. Repair.
Piston stick	Operation <ul style="list-style-type: none"> Abrupt stoppage of engine after running at highspeed Hill climbing using unsuitable gear 	<ul style="list-style-type: none"> Operate engine properly. Select suitable gear.
	Oil <ul style="list-style-type: none"> Insufficient oil Dirty oil Poor quality oil High oil temperature Low oil pressure Defective oil pump Reduced performance due to worn oil pump Suction strainer sucking air 	<ul style="list-style-type: none"> Add oil. Change oil. Replace with proper engine oil. Repair. Repair. Repair oil pump. Replace oil pump. Add oil and/or repair strainer.
	Abnormal combustion	• See Symptom : "Engine overheating"
	Coolant	• See Symptom : "Engine overheating"
	Lack of power	Intake <ul style="list-style-type: none"> Clogged air cleaner
	Overheating	• See Symptom " Engine overheating"
	Fuel and nozzle <ul style="list-style-type: none"> Poor nozzle spray 	<ul style="list-style-type: none"> Adjust or replace injection nozzle.
	<ul style="list-style-type: none"> Clogged nozzle with carbon Wear or seizure of nozzle Air in fuel system Clogged fuel filter Use of poor fuel 	<ul style="list-style-type: none"> Clean nozzle. Replace nozzle. Repair and bleed air from fuel system. Replace element. Use good quality fuel.
	Abnormal combustion	• See Symptom : "Engine overheating."
	Piston, cylinder liners, and piston rings	• See Symptom : "Engine overheating."
	Other problems <ul style="list-style-type: none"> Breakage of turbine or blower (If so equipped turbocharger) 	<ul style="list-style-type: none"> Replace turbine, blower or/and turbocharger

Symptom	Possible cause	Remedy/Prevention
Difficult starting engine	Electrical system <ul style="list-style-type: none"> • Discharged battery • Defective wiring in starter circuit. • Loose or open-circuit battery cable • Break of glow plug or intake air heater (If so equipped) 	<ul style="list-style-type: none"> • Charge battery. • Repair wiring of starter. • Tighten battery terminal connections or replace battery cable. • Replace.
	Air cleaner <ul style="list-style-type: none"> • Clogged element 	<ul style="list-style-type: none"> • Clean or replace the element.
	Fuel system <ul style="list-style-type: none"> • No fuel in tank • Clogged fuel line. • Air sucked into fuel system through fuel line connections. • Clogged fuel filter • Loose connection in high-pressure line • Water in fuel 	<ul style="list-style-type: none"> • Supply fuel or bleed of fuel system. • Clean fuel line. • Tighten fuel line connections. • Replace element. • Tighten sleeve nut of high pressure line. • Drain and clean fuel system
Difficulty starting engine	Nozzles <ul style="list-style-type: none"> • Seized nozzle • Broken or fatigued nozzle spring 	<ul style="list-style-type: none"> • Replace nozzle. • Replace spring.
	Oil system <ul style="list-style-type: none"> • Oil viscosity too high 	<ul style="list-style-type: none"> • Use proper viscosity oil, or install an oil immersion heater and warm up oil.
	Other problems <ul style="list-style-type: none"> • Seized piston • Seized bearing • Reduced compression pressure • Ring gear damaged or worn • Improperly adjusted or broken accelerator cable 	<ul style="list-style-type: none"> • Replace piston, piston rings, and liner. • Replace bearing and/or crankshaft. • Overhaul engine. • Replace the ring gear and/or starter pinion. • Adjust or replace the accelerator cable.
Rough idling	Injection pump	<ul style="list-style-type: none"> • Refer to "FUEL INJECTION PUMP".
	Nozzles <ul style="list-style-type: none"> • Uneven injection pressure • Poor nozzle spray • Carbon deposit on nozzle tip • Seized needle valve 	<ul style="list-style-type: none"> • Adjust. • Adjust or replace nozzle. • Remove carbon. • Replace nozzle.

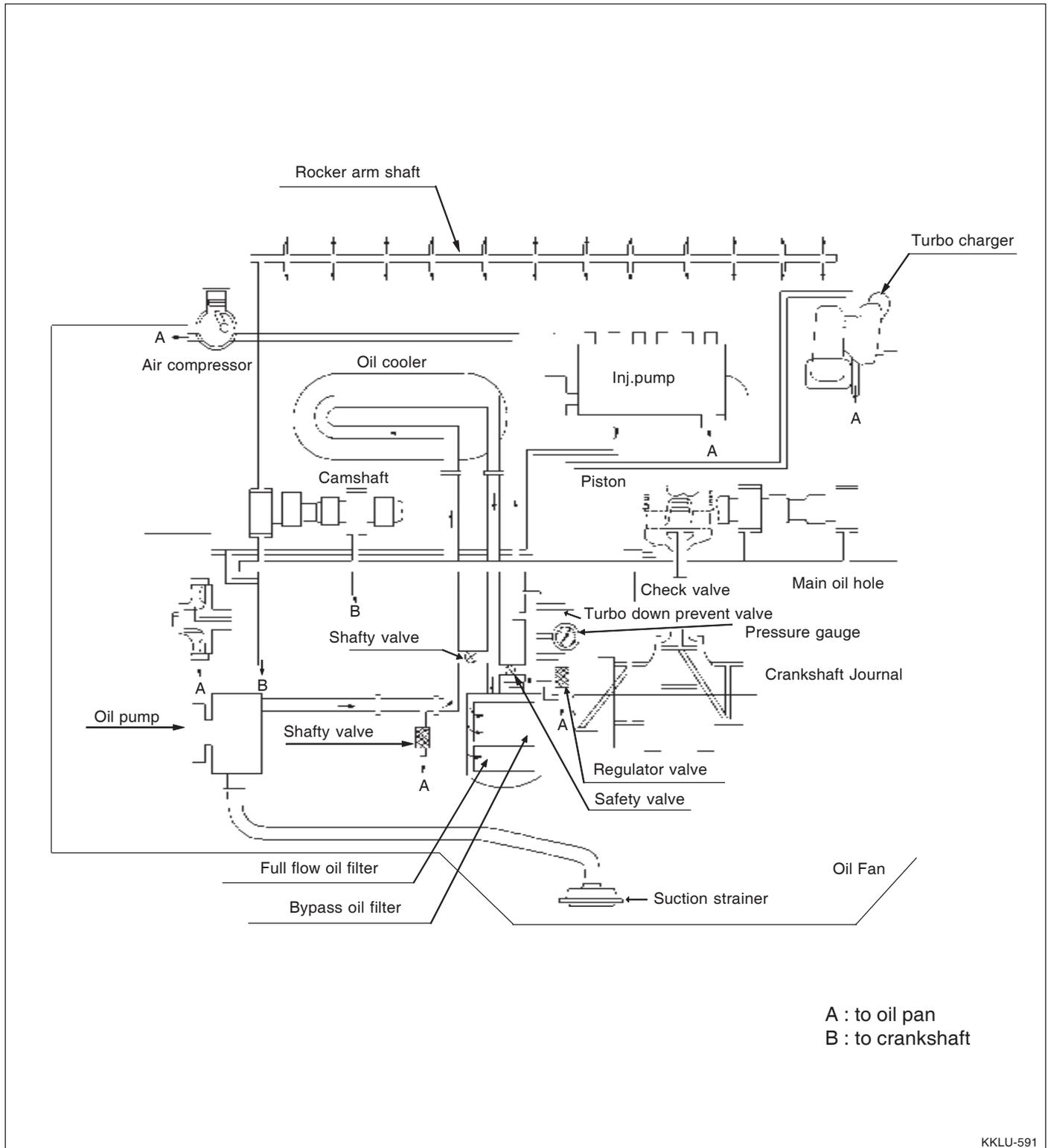
Symptom	Possible cause	Remedy/Prevention
Rough idling	Engine body <ul style="list-style-type: none"> • Improper valve clearance • Improper contact of valve seat • Idling speed too low • Compression pressure of cylinders markedly different from one another 	<ul style="list-style-type: none"> • Adjust valve clearance. • Replace or repair valve and valve seat. • Warm up engine. • Overhaul engine.
Leakage of exhaust gas	Cylinder head gasket <ul style="list-style-type: none"> • Fatigued gasket (aging) • Damage • Improper installation 	<ul style="list-style-type: none"> • Replace gasket. • Replace gasket. • Replace gasket.
	Cylinder head bolts <ul style="list-style-type: none"> • Loose bolts • Elongated bolts • Improper tightening torque or tightening sequence 	<ul style="list-style-type: none"> • Tighten bolt. • Replace bolt. • Tighten properly.
	Cylinder block <ul style="list-style-type: none"> • Cracking • Surface distortion • Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner) 	<ul style="list-style-type: none"> • Replace cylinder block. • Repair or replace. • Replace cylinder liner or cylinder block.
	Cylinder head <ul style="list-style-type: none"> • Cracking • Surface distortion 	<ul style="list-style-type: none"> • Replace cylinder head. • Repair or replace.
	Cylinder liners <ul style="list-style-type: none"> • Cracking • Corrosion • Insufficient protrusion of cylinder liner 	<ul style="list-style-type: none"> • Replace cylinder liner. • Replace cylinder liner. • Replace cylinder liner.
	Other problems <ul style="list-style-type: none"> • Incorrect injection timing 	<ul style="list-style-type: none"> • Adjust injection timing.

LUBRICATION SYSTEM

GENERAL	LU- 2
SPECIFICATIONS	LU- 3
SERVICE STANDARD	LU- 4
SERVICE PROCEDURES	
Oil Pump and Oil Strainers	LU- 7
Oil Filter and Oil Cooler	LU- 9
TROUBLESHOOTING	LU-11

GENERAL

Engine lubrication is accomplished by forced lubrication system using gear pump. The engine oil in the oil pan is drawn up through the oil strainer by the oil pump and force-fed to the filter and oil cooler to lubricate all parts.

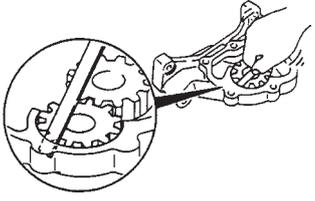
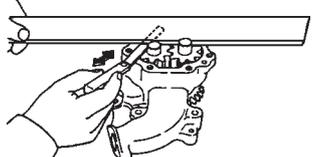
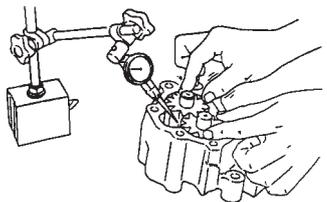
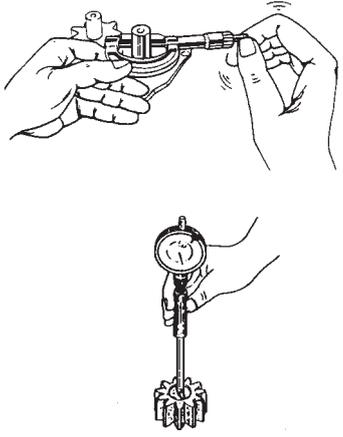


SPECIFICATIONS

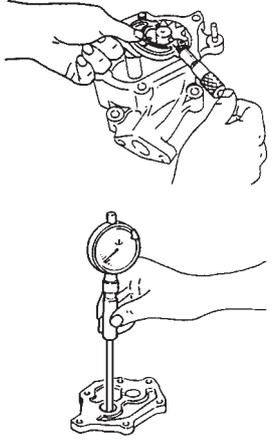
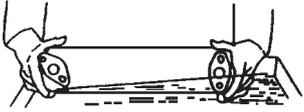
Items	Specification	Remarks
Lubricating type	Forced circulation with oil pump	
Oil pump	Gear pump	
Relief valve	Plunger valve	
Oil filter	One-piece, element filter	
Oil cooler	Shell and plate type	
Regulator valve	Plunger valve	

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>

Unit : mm (in)

Inspection Item	Standard	Limit	Remedy	Inspection Procedure
Clearance between drive shaft and oil pump cover	0.040-0.085	-	-	 <p style="text-align: right;">KKLU-198</p>
Oil cooler air tightness air pressure : 6kg/cm ² (85.3 lb/sq.in)	-	-	Replace, if necessary	 <p style="text-align: right;">KKLU-202</p>

Tightening torque

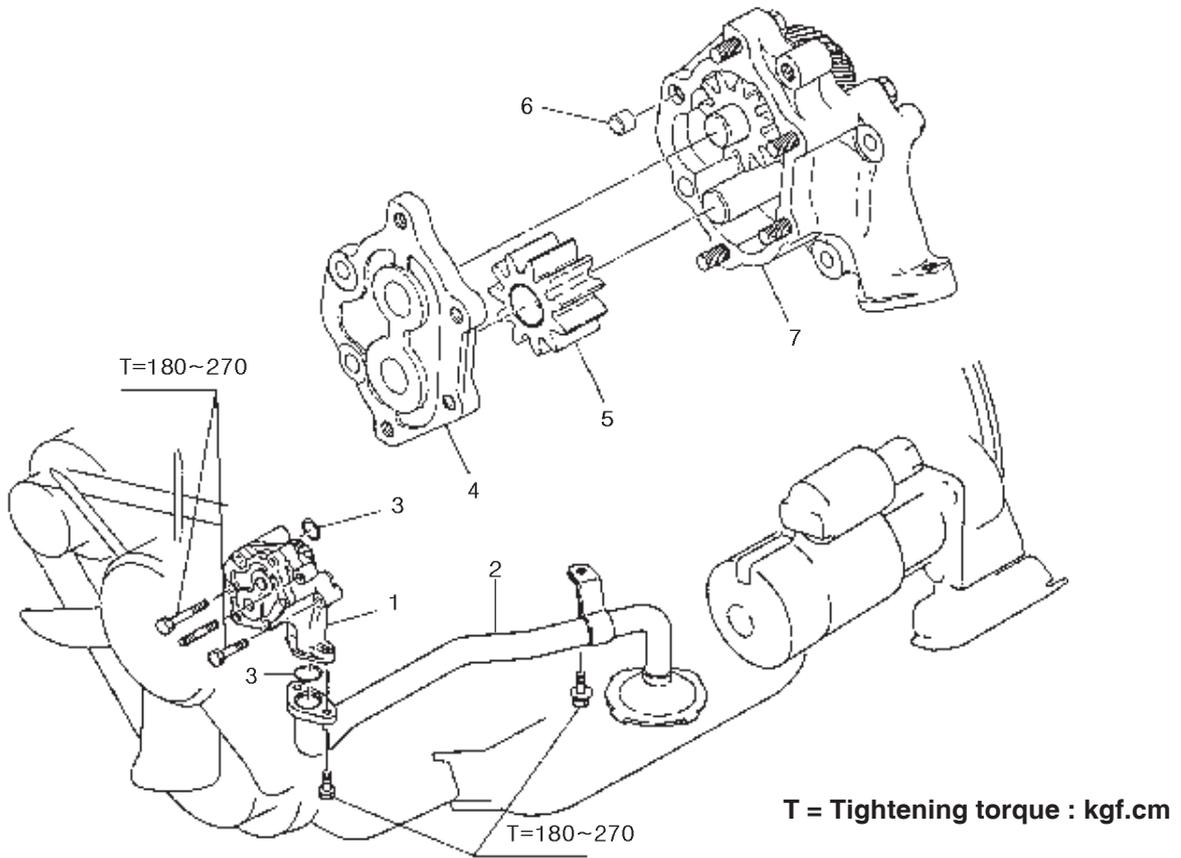
Unit : kg·m

Items	D6DA		Remarks
	Size	Torque	
Oil pump cover bolt	M8 x 1.25	1.8~2.7	
Oil cooler nut	M8 x 1.0	1.0~1.5	
Oil filter cartridge	M38 x 1.5	4.0~5.0	
Oil cooler bypass valve	M22 x 1.5	3.0~4.0	
Oil jet check valve	M12 x 1.5	2.7~3.2	
Main relief valve cylinder (Cylinder block side)	M28 x 1.5	8.0~12.0	
Regulator valve	M22 x 1.5	3.0~4.0	
Oil cooler plug	M20 x 1.5	2~3	

SERVICE PROCEDURES

Oil Pump and Oil Strainers

COMPONENTS



- | | |
|-------------------|---------------------------|
| 1. Oil pump | 5. Rotor |
| 2. Oil strainer | 6. Collar |
| 3. O-ring | 7. Oil pump body assembly |
| 4. Oil pump cover | |

KKLU-189

Installation

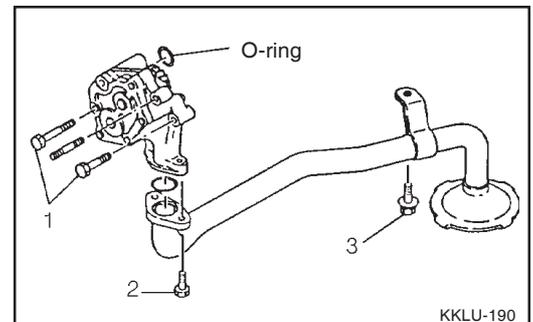
Oil strainer installation

Oil strainer

1. Fasten bolts 1,2 and 3 tentatively.
2. Center cylinder block with the bolt hole of the bracket.
3. Fasten the bolt 3 tentatively.
4. Fasten the bolts 1,2 and 3 with the specific torques.

CAUTION

Make sure whether the O-ring is installed securely.
Apply the oil when inserting O-ring.

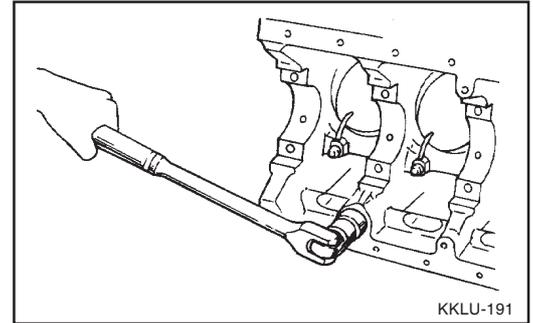


KKLU-190

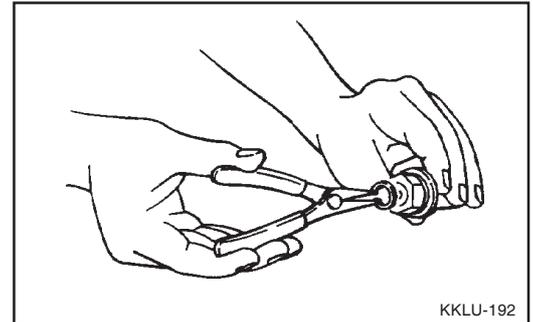
Assembly

Disassemble and inspect the safety valve of oil pump, if needed.

1. Remove safety valve from the cylinder block.



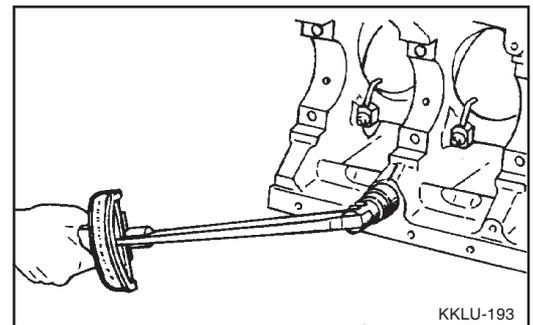
2. Disassemble safety valve after removing retainer ring.



3. Install the valve, spring, seat and retainer ring orderly.

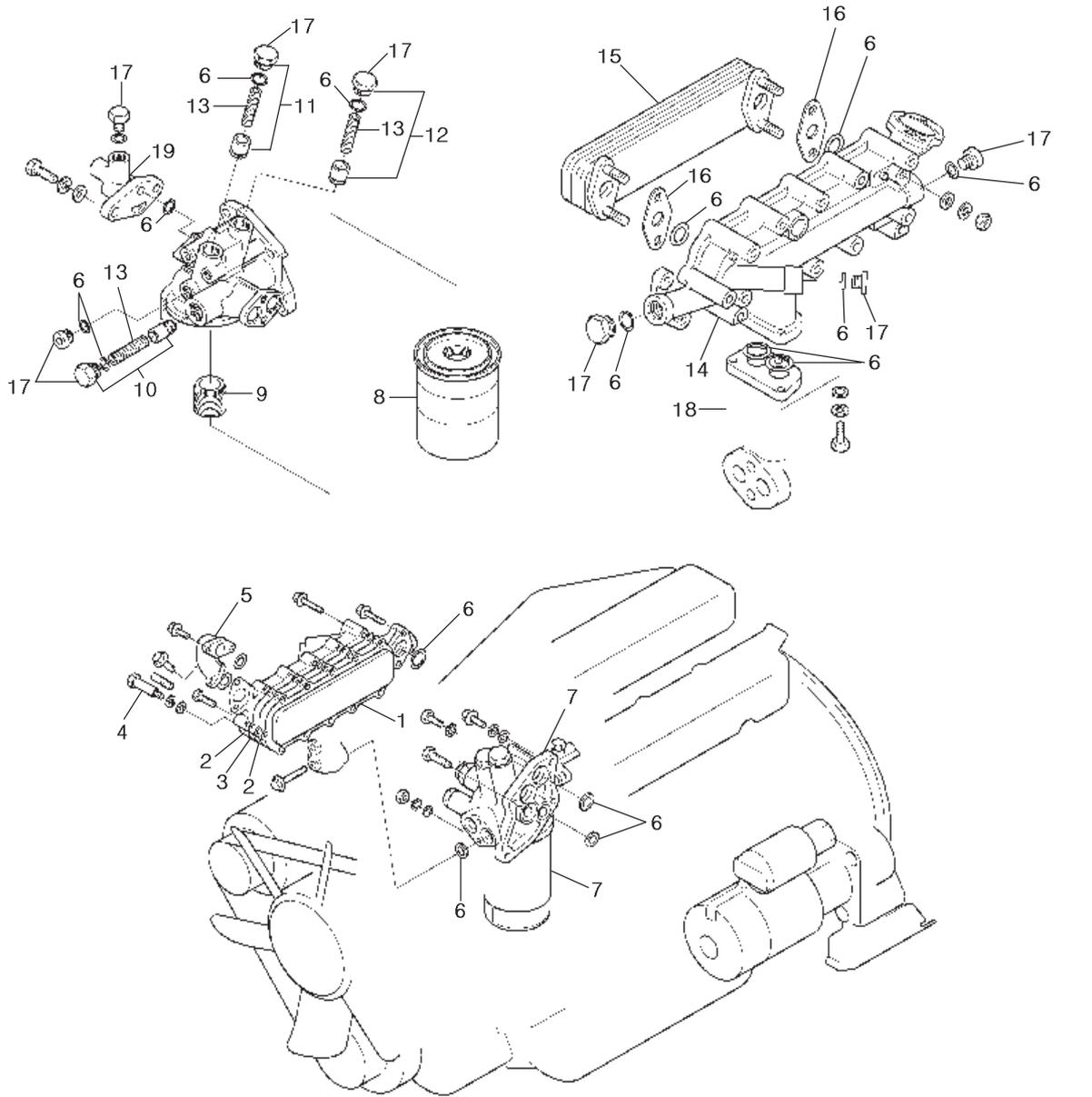
4. Install the safety valve to the cylinder block.

Tightening torque: 800-1200



Oil Filter and Oil Cooler

OVERHAUL



- | | | |
|---------------------------|------------------------------|------------------------------------|
| 1. Oil cooler | 8. Oil filter element | 15. Oil cooler element |
| 2. Oil cooler case gasket | 9. Center Bolt | 16. Gasket |
| 3. Water gallery color | 10. Oil cooler safety valve | 17. Plug |
| 4. Reamer bolt | 11. Oil filter safety valve | 18. Oil pipe |
| 5. Coolant pipe | 12. Pressure regulator valve | 19. Turbocharger oil one-way valve |
| 6. O-ring | 13. Spring | |
| 7. Oil filter assembly | 14. Oil cooler case | |

Disassembly

Remove the oil filter element

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

Special tool: Wrench

Assembly

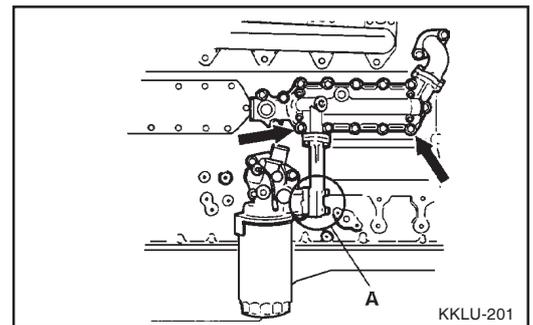
Oil filter element installation.

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.



TROUBLESHOOTING

Symptom	Probable cause	Remedy	Remarks
Does not increase oil pressure	Low oil level • Oil leakage in the cooling system • Oil leakage	Repair and add oil	
	Poor oil viscosity • Oil aging • Fuel added in oil	Replace	
	Faulty oil pressure switch	Replace	
	Clogged oil filter element	Replace element	
	Clogged oil strainer, Loosen oil line connector, pipe crack faulty of relief valve and by pass valve	Repair or replace	
	Abrasion or damage in oil pump	Replace	
Excessive oil consumption	Oil leakage in engine	Repair or replace	Refer Engine Body
	Oil leakage in crankshaft oil seal	Repair or replace	
	Oil leakage in cooling system • Defect of water jacket in oil cooler	Repair or replace	
	Abnormal compression	Check compression	Refer Engine Body

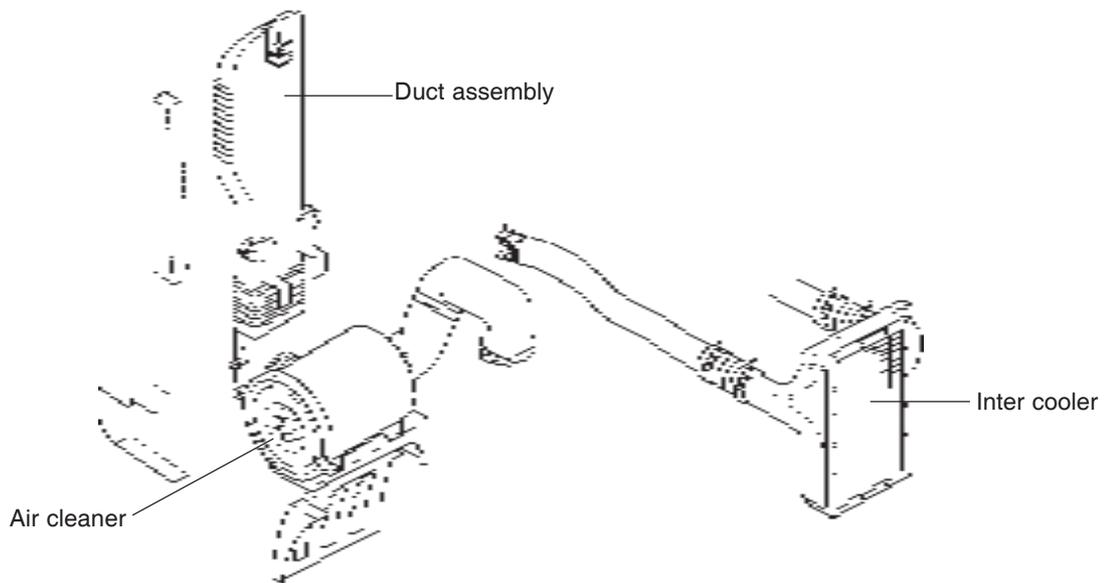
INTAKE AND EXHAUST

GENERAL	IE - 2
SPECIFICATIONS	IE - 5
SERVICE STANDARD	IE - 6
SPACIAL TOOLS	IE - 7
SERVICE PROCEDURES	
Air Intake and Exhaust System	IE - 8
Air Cleaner and Duct	IE-11
Muffler	IE-15
Turbo Charger	IE-17
TROUBLE SHOOTING	IE-21

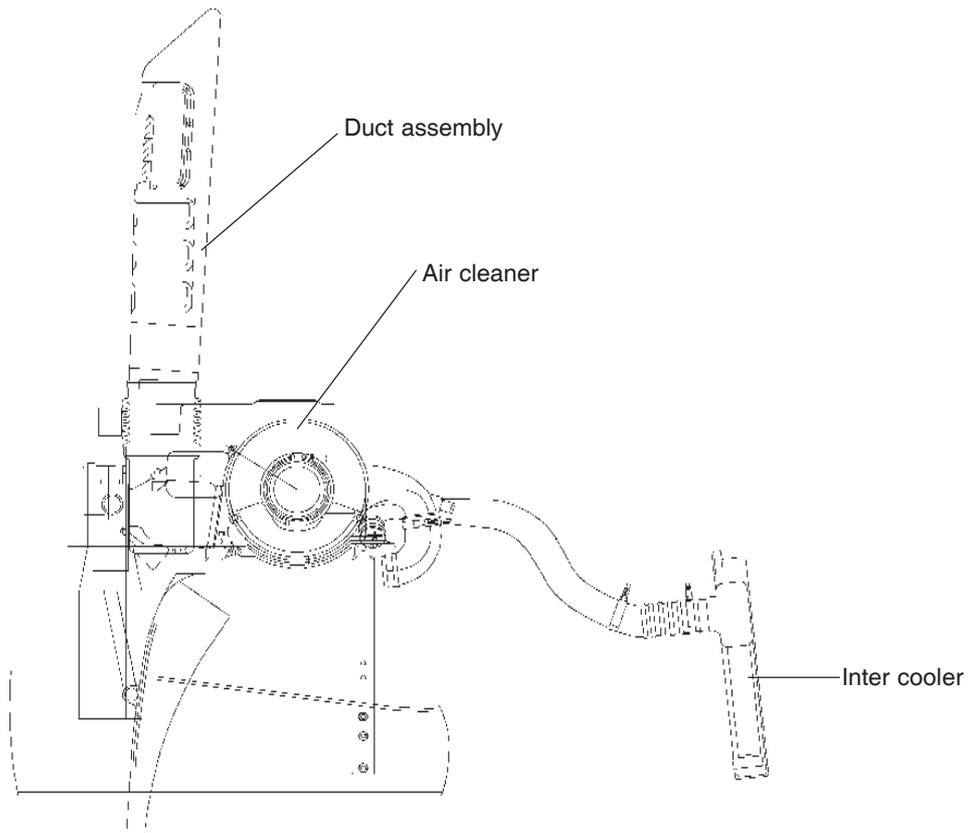
GENERAL

Air Intake System

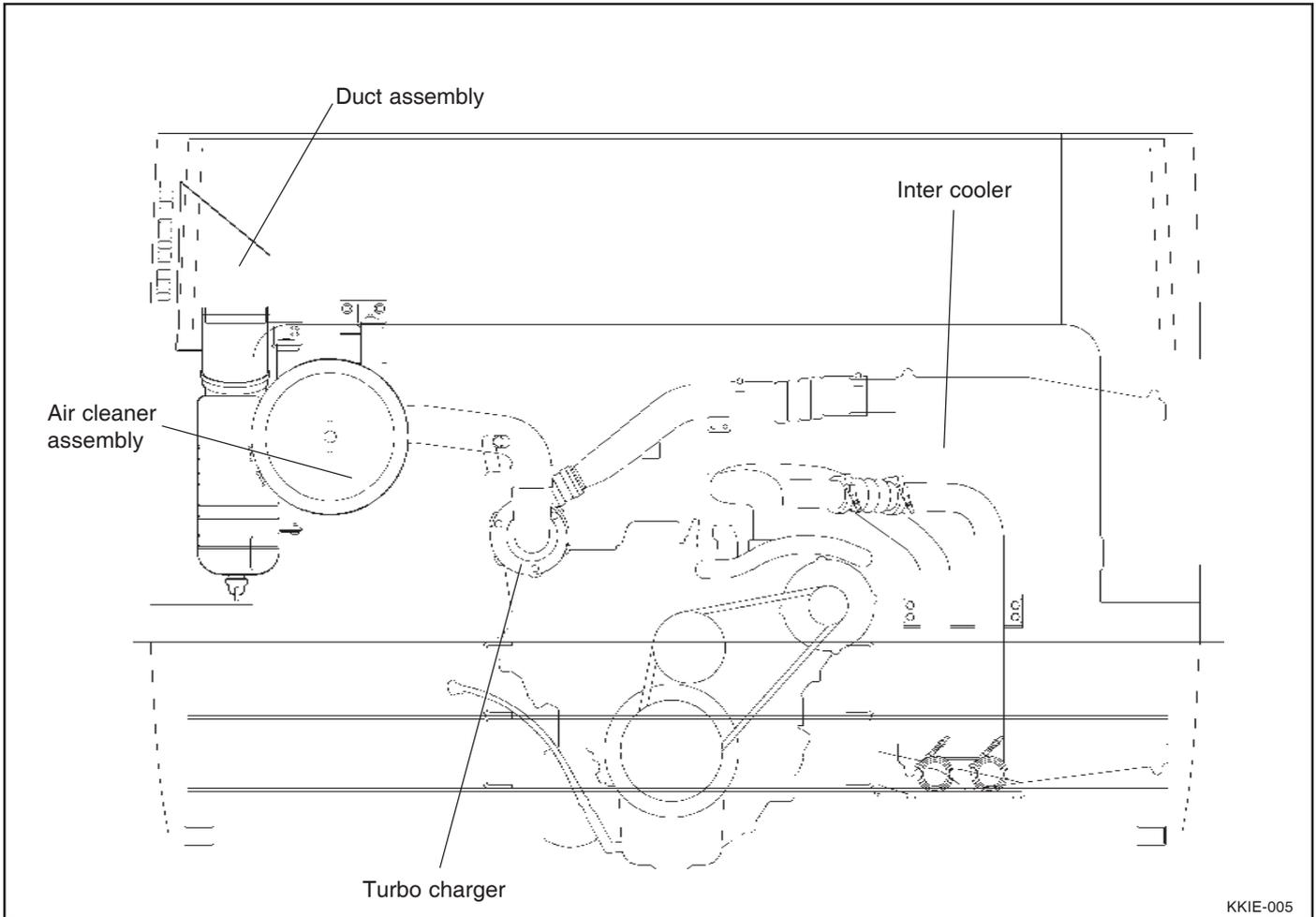
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Aero town



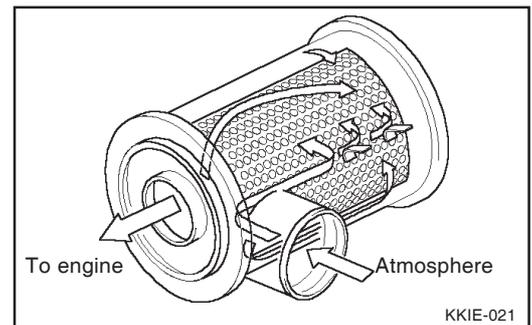
KKIE-005

Paper element type

The paper filter is plastic coated and heat treated for better water and oil resistance.

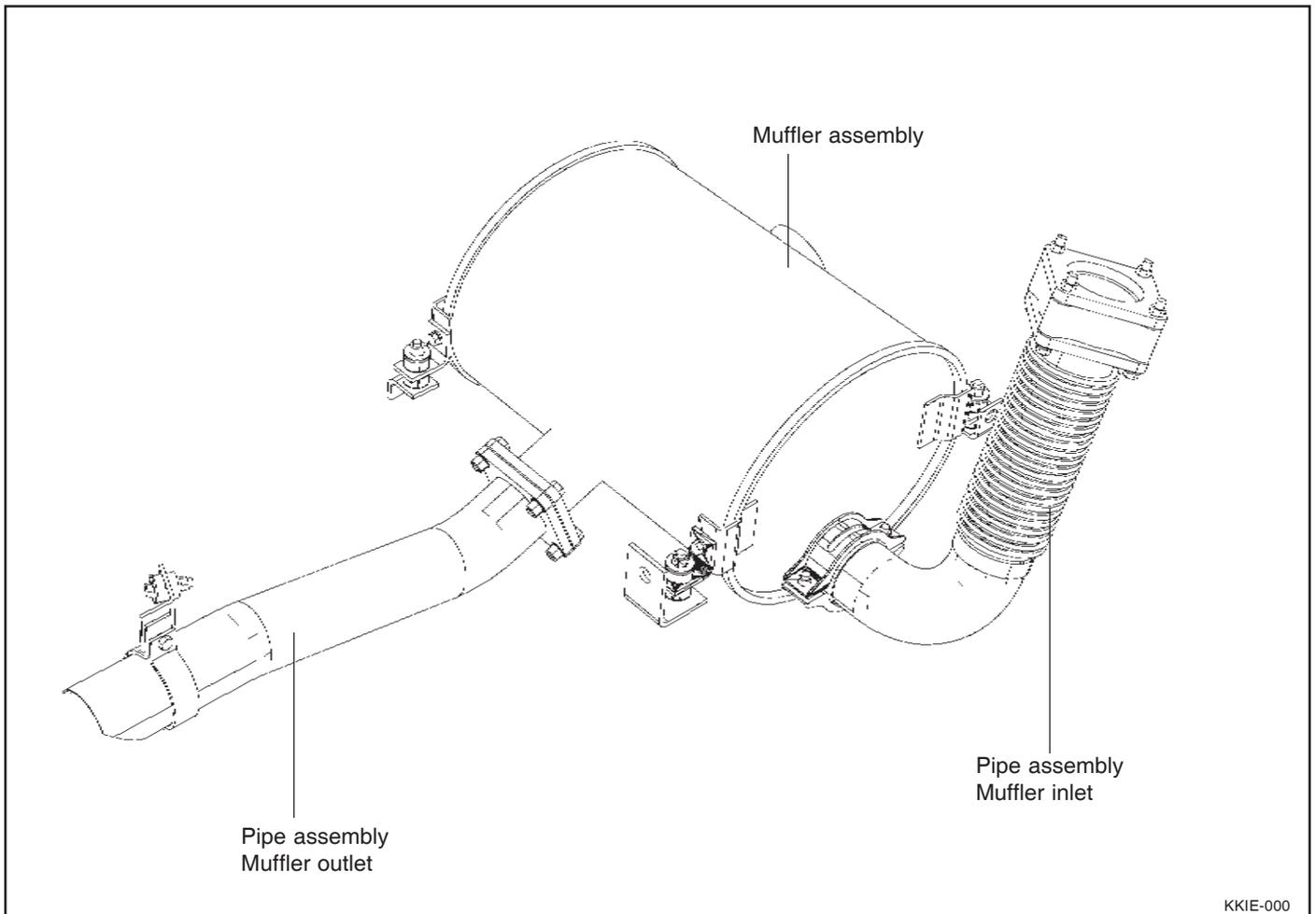
The incoming air is whirled by the guide vanes or blades at a high speed and the larger particles of dusts are centrifugally separated by the "cyclone effect". The smaller particles of dusts are eliminated by the filter paper element, and the air filtered clean is sucked by the engine.

The double-element type of paper element air filter is optionally available. The inner element of this type should not be removed unless the filter replaced. The air cleaner for buses has a resonant chamber at its top to reduce noise.



KKIE-021

Aero town

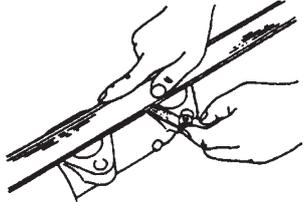
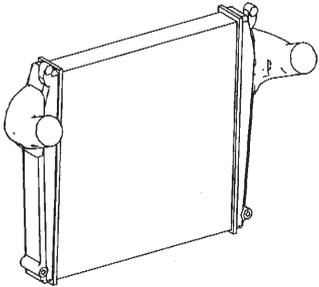


SPECIFICATIONS

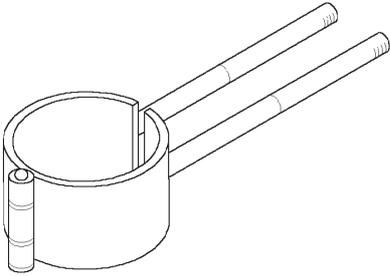
Engine model	D6DA	Remarks
Air cleaner type	Dry air cleaner type	
Element type	Paper type	
Super charger	Turbo charger	Water cooled

SERVICE STANDARDS

Unit : mm

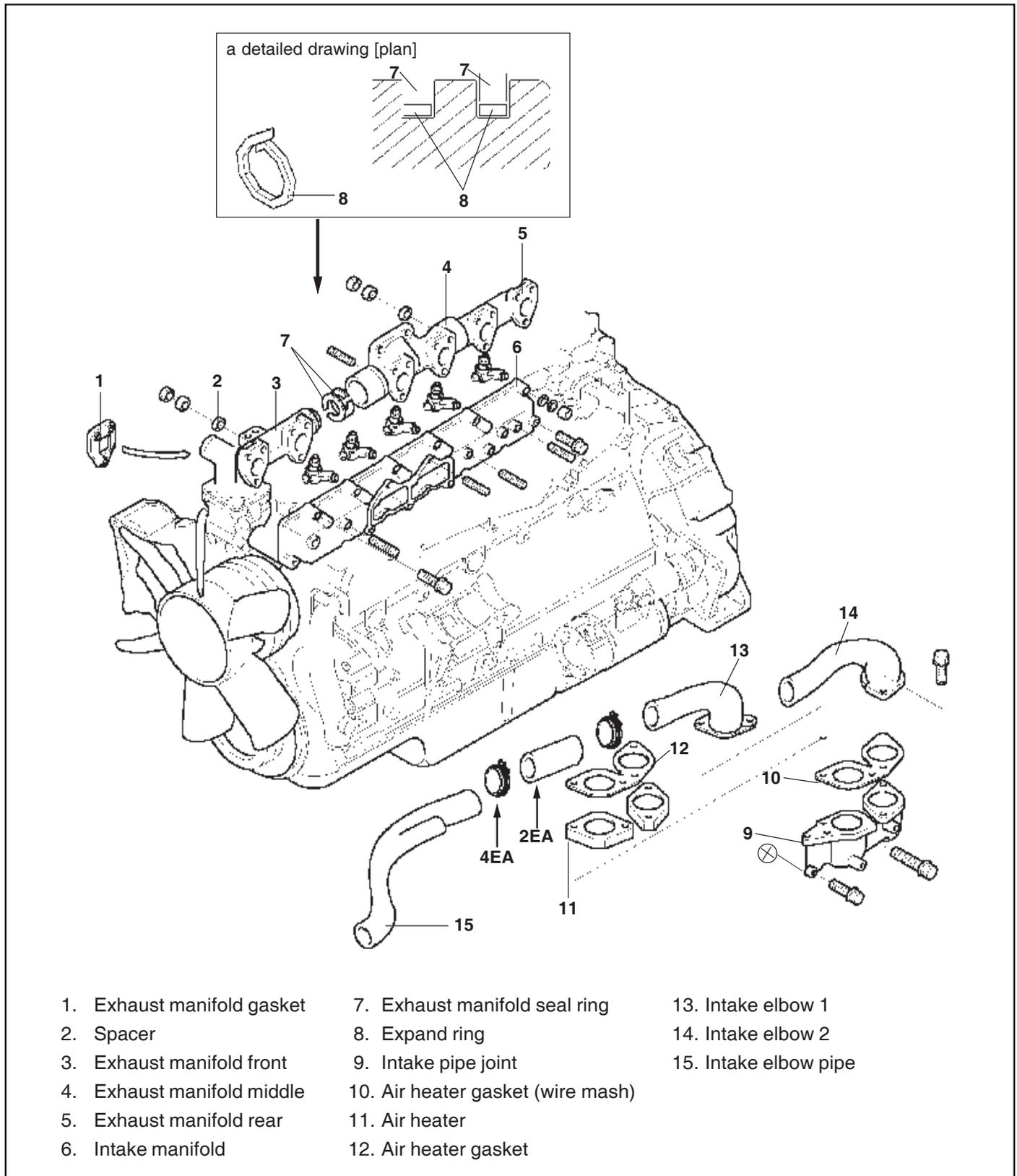
ITEM	STANDARD	LIMIT	REMEDY	REMARK
Flatness of intake manifold	Less than 0.1	0.50	Grind or replace : Grind limit : 0.05mm each flange	
Abrasion or damage of exhaust manifold	-	-	Grind or replace	KKIE-248
Air leakage in inter cooler	Doesn't have any air leakage in 2.0kg/mm ² air pressure	-	Replace intercooler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

SPECIAL TOOL

NAME	PARTS	ILLUSTRATION	USE
Exhaust manifold compression ring clamp	09285-8Y000	 KKST-024	Using exhaust manifold ring compression

SERVICE PROCEDURE

Air Intake and Exhaust System



Installation

Intake Pipe Installation

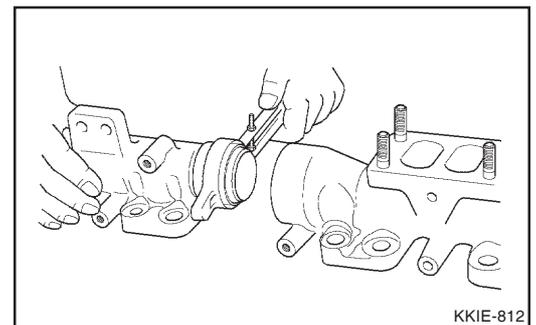
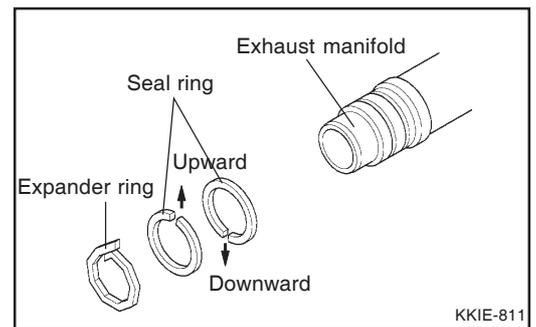
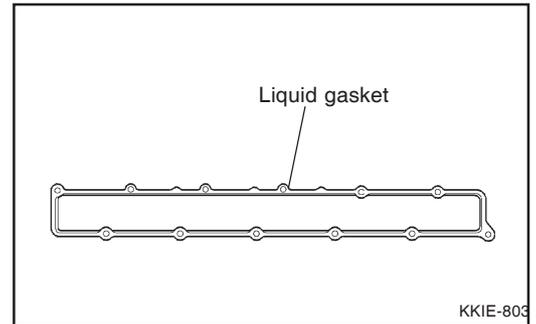
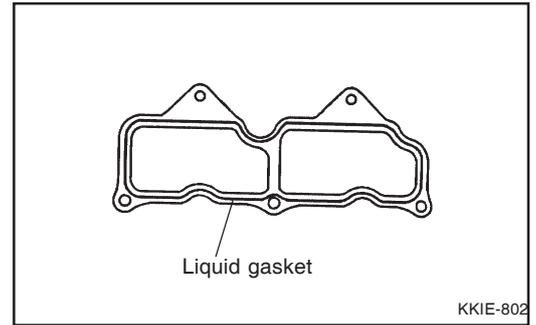
Install the intake manifold.

Exhaust Manifold Assembly (Assembly Type)

1. As shown in the seal ring installation to the exhaust manifold, install them by keeping the same distance between seal rings to prevent the leak of gas and oil.

Special tool: Exhaust manifold compression ring clamp (09285 – 8Y000)

- Assemble expander ring and seal ring to the ring groove. (The expander ring to inside and the seal ring to outside)



Exhaust manifold Installation

1. Install the gasket at the right place of exhaust manifold.

CAUTION

Put the gasket as the “HEAD” mark faces the opposite direction of exhaust manifold.

2. Install the spacer at the right place as shown in the figure.
Corresponding cylinder number.

Manifold Combination	Assembling method
I	Except 7 and 9
II	7, 9

3. Fasten the flange nut by hands.

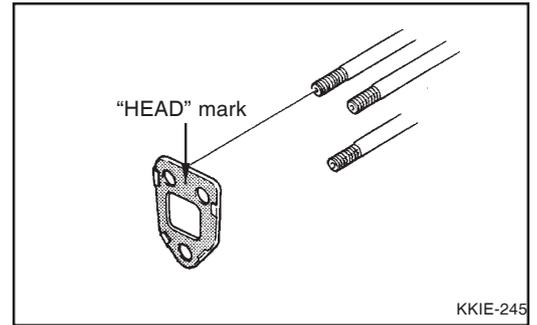
CAUTION

When fastening flange nut, assemble the spacer carefully not to touch the machined parts of the flange (A).

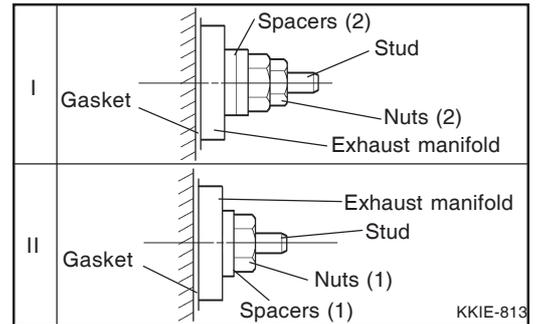
4. Fasten the flange nuts orderly and gradually (3 steps) and fasten the nuts with the specified torque at the final stage.

Tightening torque: 300-350 kgf-cm

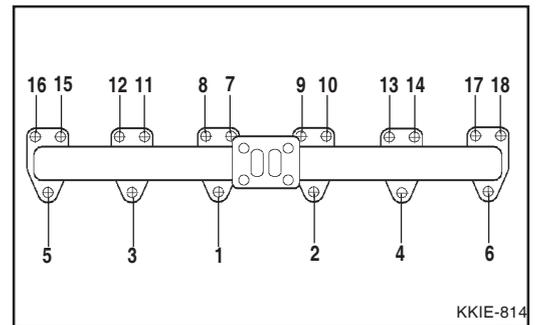
5. Fasten lock nuts.



KKIE-245



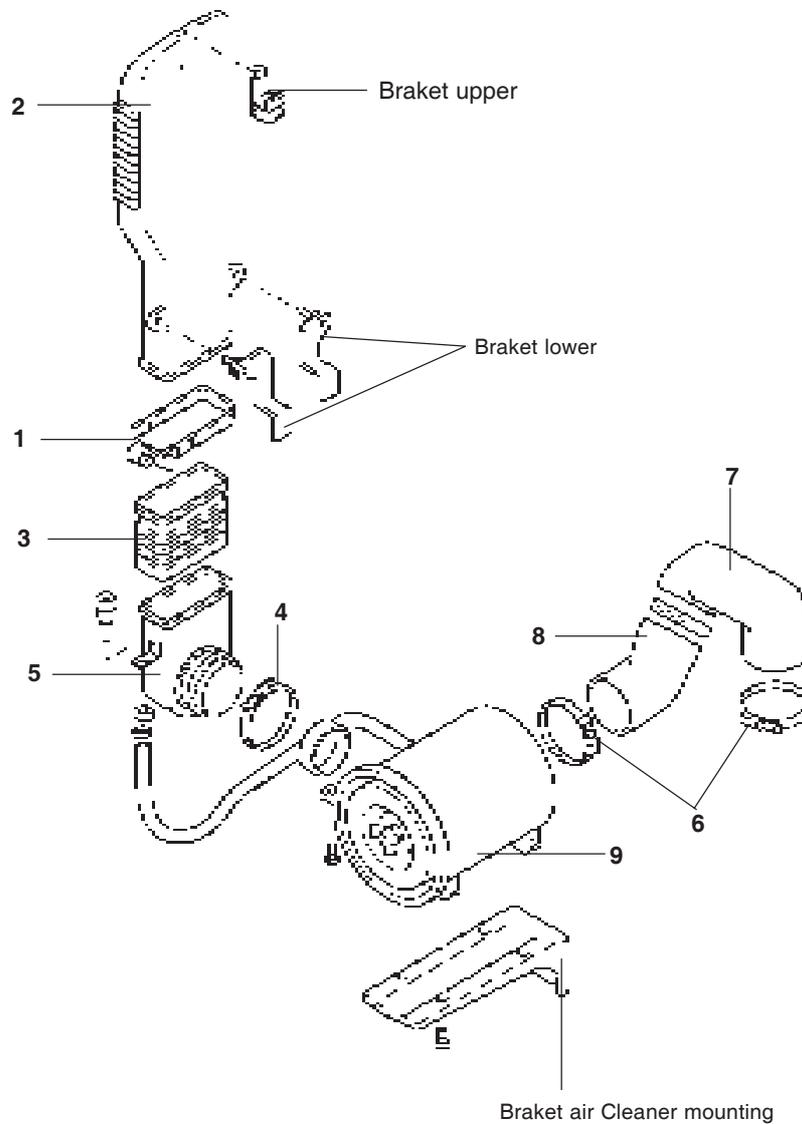
KKIE-813



KKIE-814

Air Cleaner and Duct

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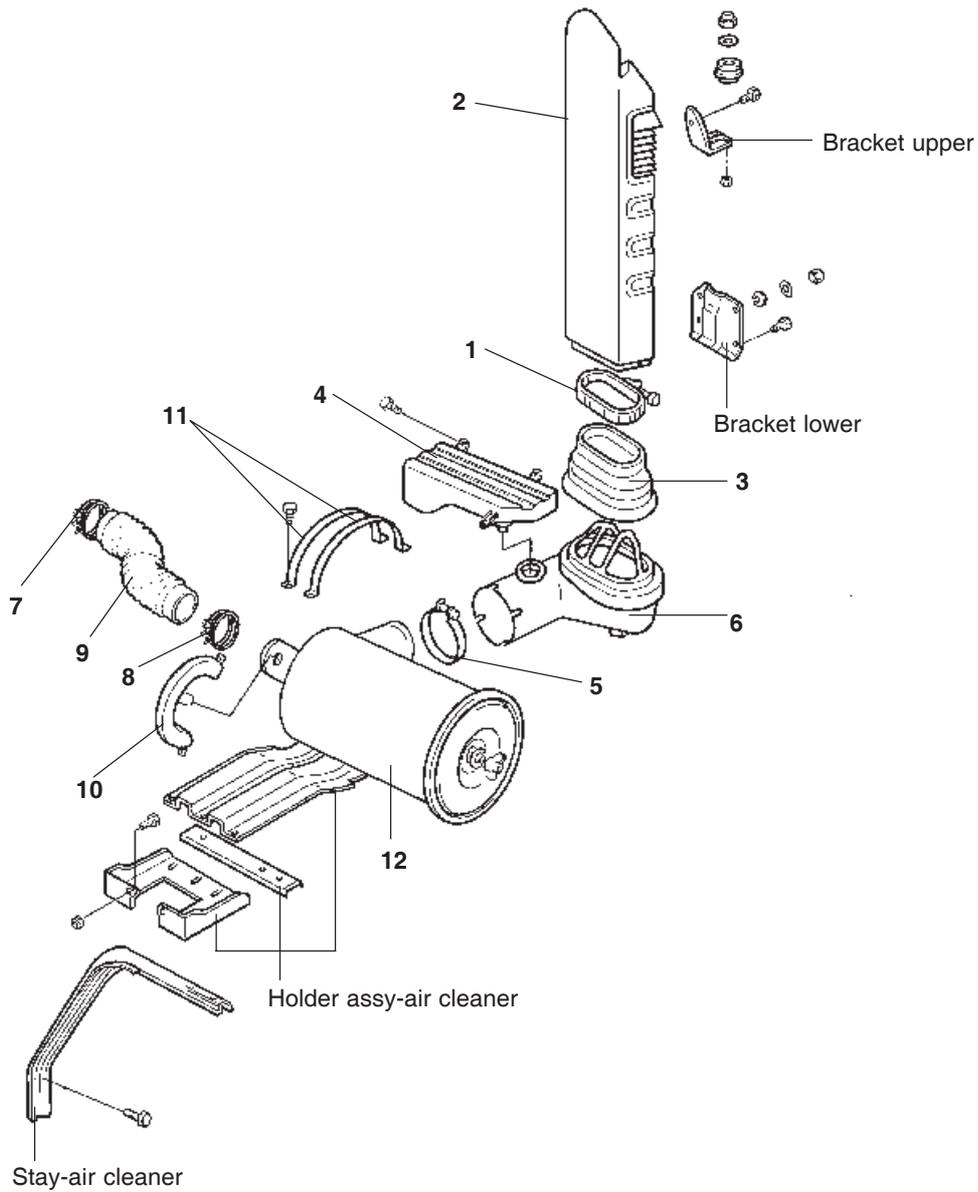


Disassembly

1. Clamp-Boot
2. Duct assembly
3. Rubber-Boot
4. Clamp
5. Duct assembly air Cleaner lower
6. Clamp
7. Duct hose turbo charger
8. Hose-air cleaner duct
9. Air cleaner assembly

*Reassembly is the reverse of disassembly procedure.

<8.5ton>

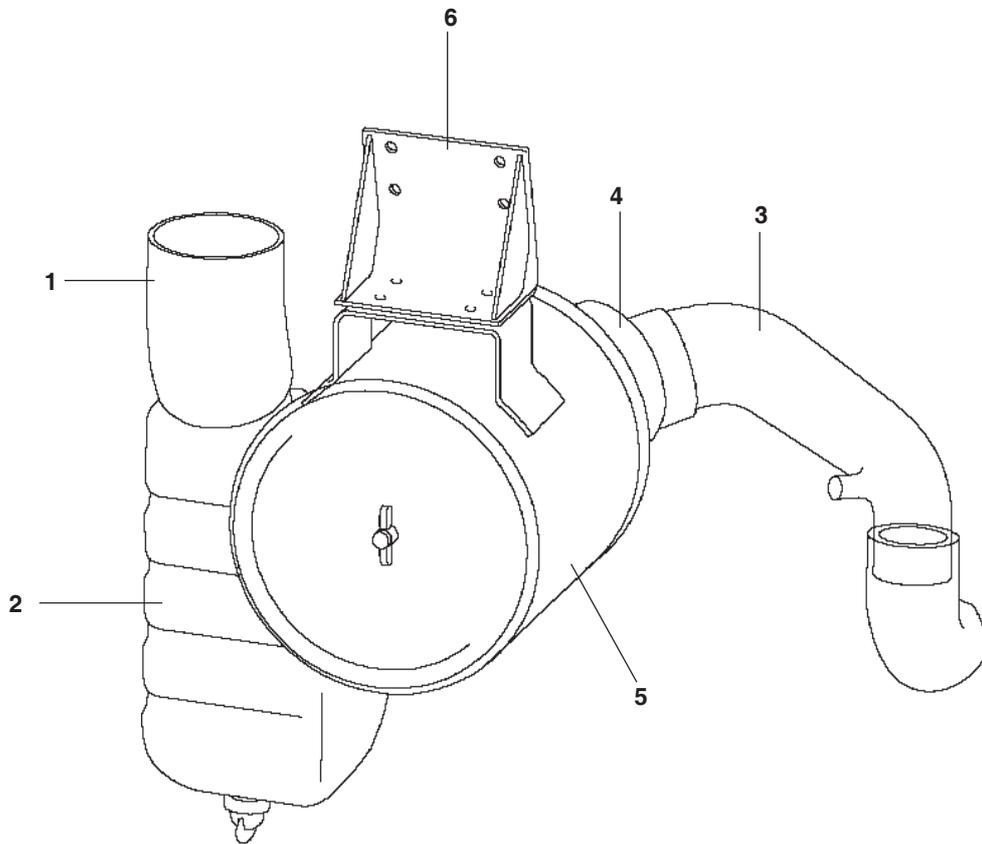


Disassembly

- | | |
|------------------------|-------------------------------|
| 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.

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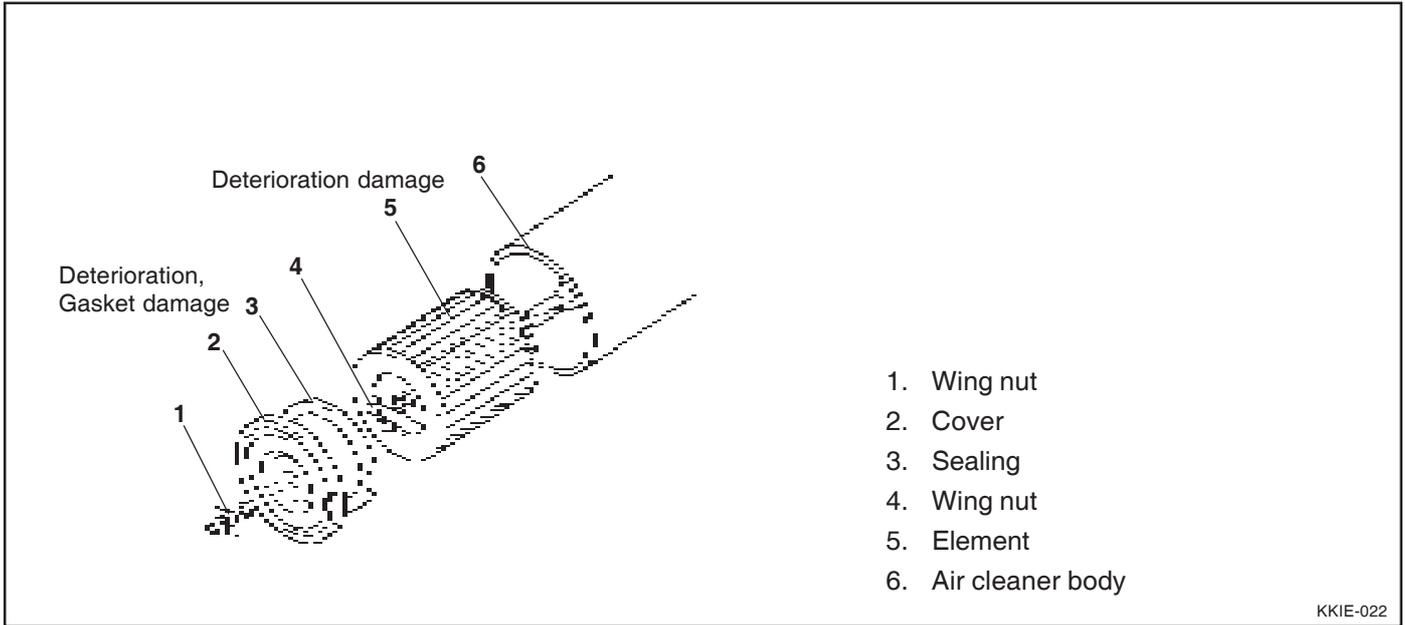


Disassembly Procedure

1. Hose-duct to free cleaner
2. Free cleaner assembly
3. Duct air outlet
4. Hose-air cleaner to engine
5. Air cleaner assembly
6. Holder-air cleaner

*Assembly is the reverse of disassembly.

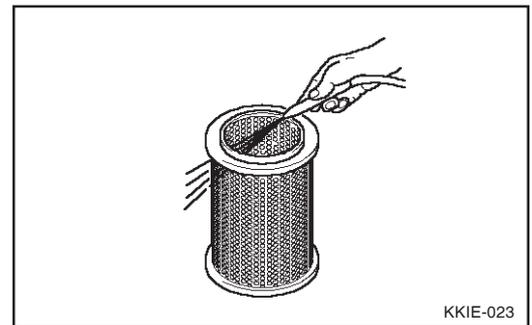
Air Cleaner



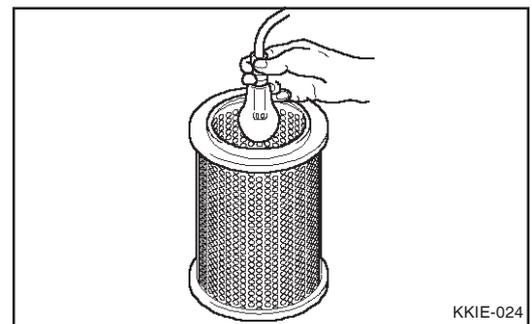
1. When there is dry dust on the element
If there is dry dust on the element, clean the dust by blowing 100 PSI {7 kgf/cm²} or lower compressed air against the element. Blow the compressed air from inside the element up and down along the frills of the filter paper and clean the whole element evenly.

NOTE:

1. Do not strike the element or strike it against other object to remove dust.
 2. Do not blow compressed air from outside the element.
2. When there is moist dust on the element
If the element is contaminated with moist soot, replace it regardless of the specified replacement frequency.

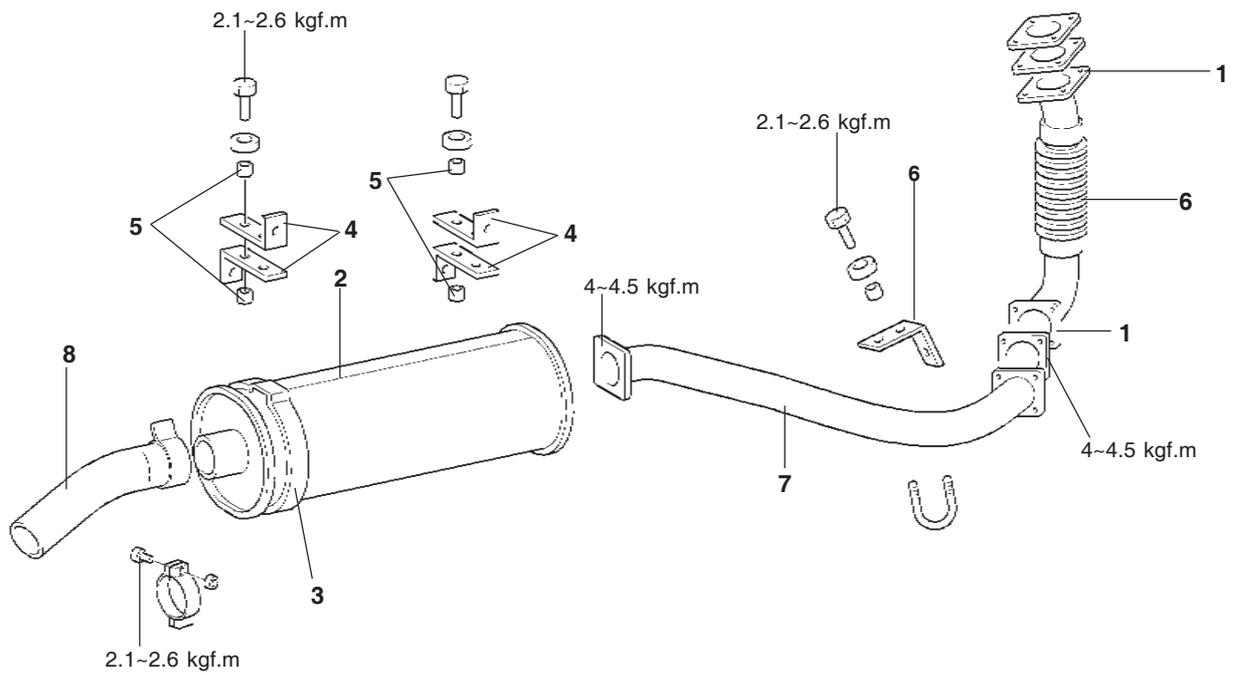


3. Inspection of element
After the element has been cleaned, put an electric lamp inside the element to check for damage and pin holes. If there are thin portions in the filter paper, replace the element. If the packing on the top surface of the element is broken, replace the packing.
4. Cleaning of air cleaner body
Clean the inside of the air cleaner body and discharge the deposited dust.



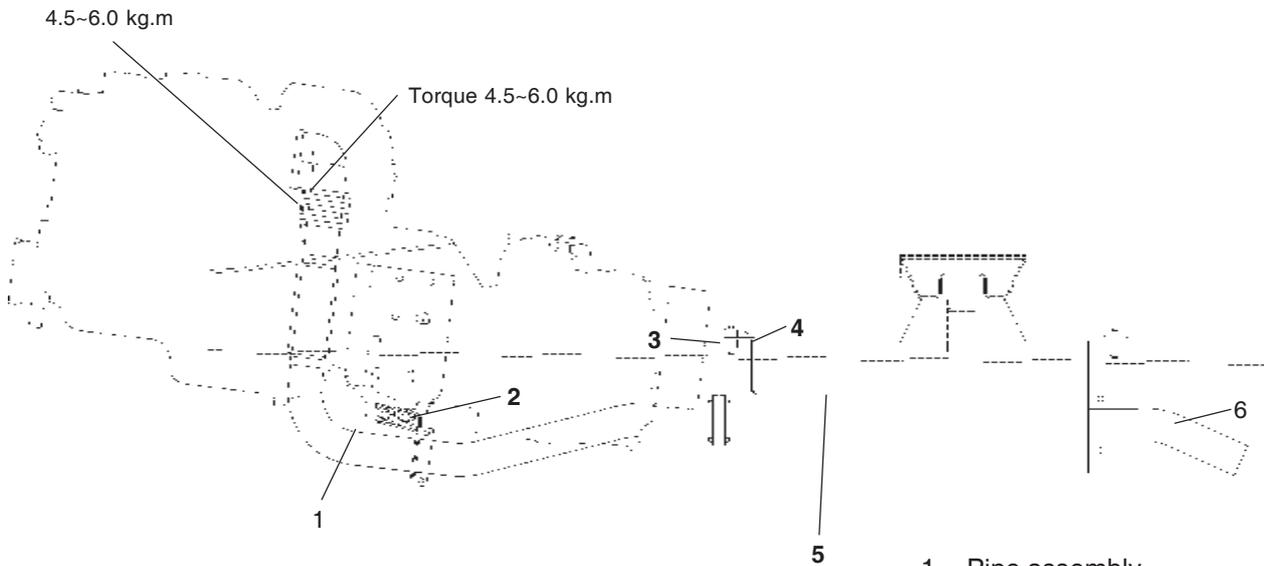
Muffler

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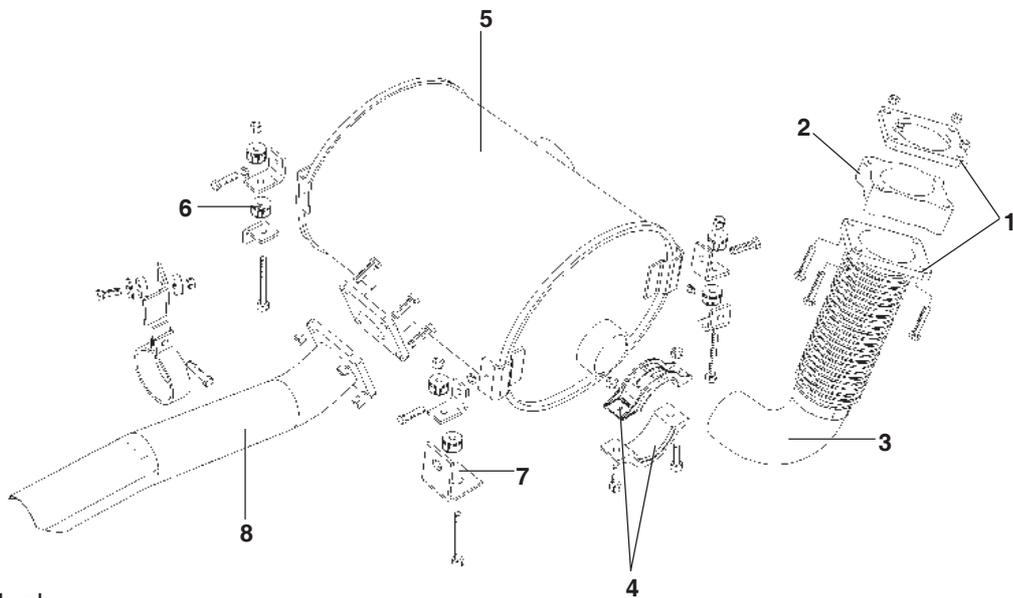
- | | |
|----------------------------|--------------------------------------|
| 1. Gasket exhaust pipe | 6. Pipe assembly - exhaust front "A" |
| 2. Muffler assembly | 7. Pipe assembly - exhaust front |
| 3. Strap muffler | 8. Pipe assembly - tail |
| 4. Bracket-muffler support | |
| 5. Cushion rubber | |

<8.5ton>



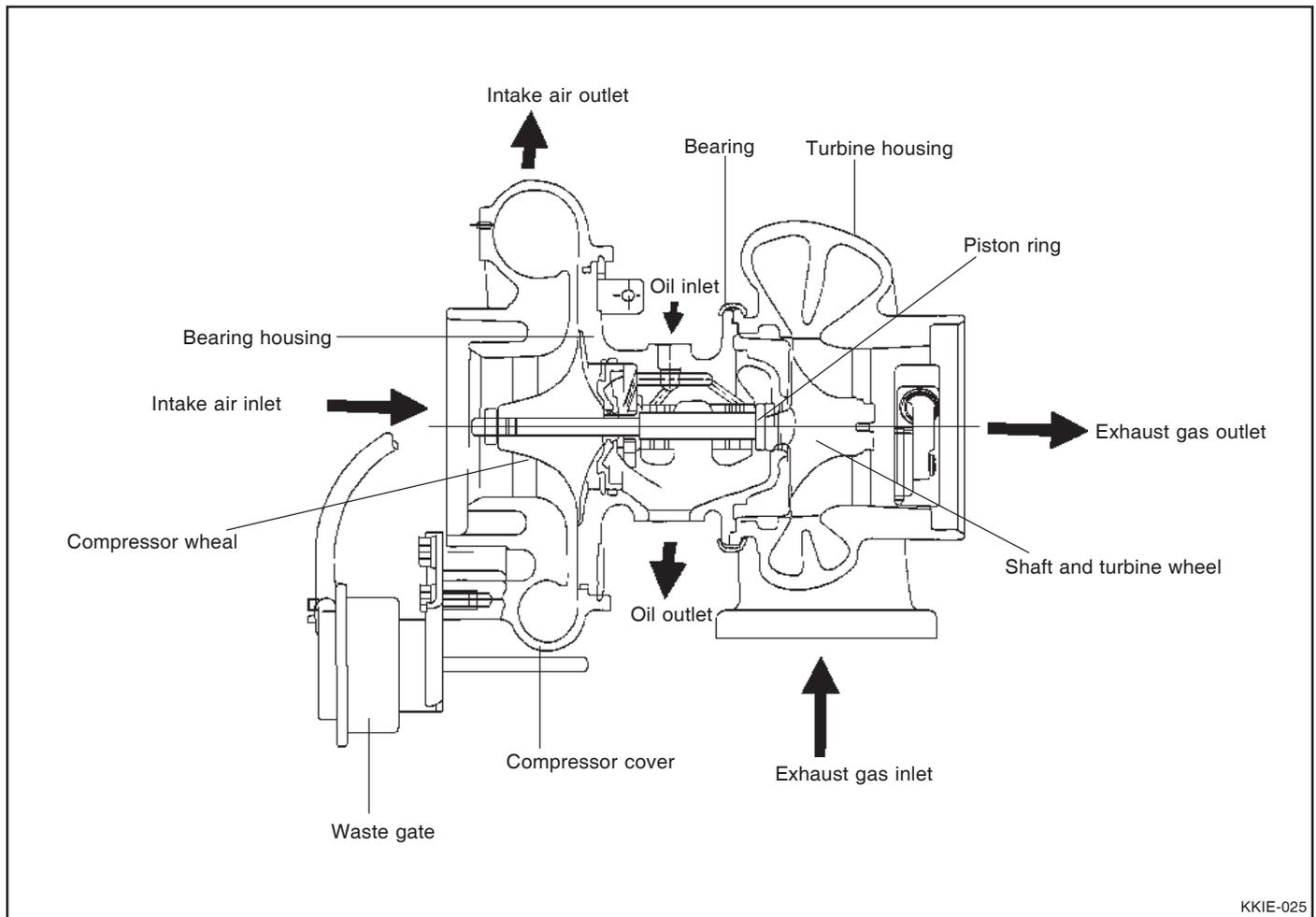
- 1. Pipe assembly
- 2. Bracket pipe
- 3. Cushion rubber
- 4. Bracket muffler
- 5. Muffler assembly
- 6. Pipe assembly

<Aero town>



- 1. Gasket
- 2. Exhaust brake
- 3. Pipe assembly muffler inlet
- 4. Clamp
- 5. Muffler assembly
- 6. Cushion rubber
- 7. Bracket
- 8. Pipe assembly muffler outlet

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.

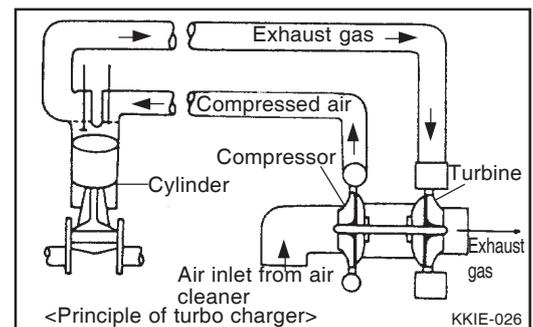
This spins the compressor wheel, which results in the intake air being forced into the engine cylinders.

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.

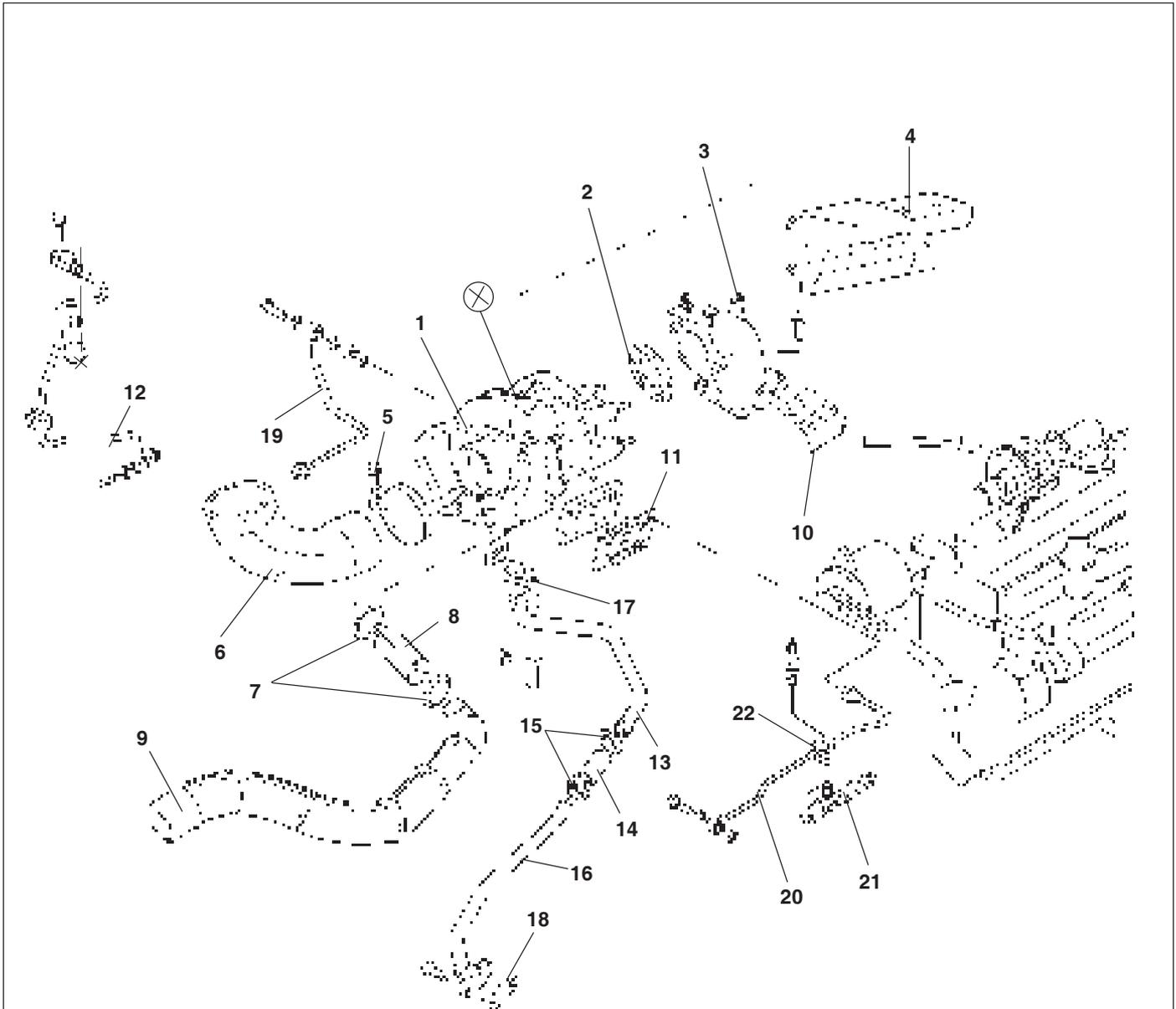
The shaft axial load is borne by the thrust bearing.

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



KKIE-026

Turbo Charger Disassembly



- | | | |
|----------------------------|--------------------------|--------------------|
| 1. Turbo charger | 10. Bracket-joint pipe | 19. Pipe-water in |
| 2. Gasket-joint pipe | 11. Turbo gasket-charger | 20. Pipe-water out |
| 3. Joint pipe | 12. Pipe-oil inlet | 21. Bracket-pipe |
| 4. Insulator turbo charger | 13. pipe-oil out No.1 | 22. Holder-pipe |
| 5. Clamp hose | 14. Hose-oil pipe | |
| 6. Air inlet hose | 15. Clamp | |
| 7. Clamp-hose | 16. Pipe-oil out No.2 | |
| 8. Hose-turbo charger | 17. Gasket-upper | |
| 9. Pipe-inter cooler in | 18. Gasket-lower | |

Management Instructions

Attentions in driving

1. Check the engine oil level, and check whether the oil pressure increases normally after engine start.
2. Avoid from sudden start or acceleration immediately after engine start and drive the vehicle after enough idling.
3. If abnormal conditions like strange noise, vibration, output decrease or excessive smoke, pull over the car and check the car.
4. Stop the engine after enough idling instead of stopping the engine immediately after pull over. (Sudden engine stop may damage the turbo charger)

CAUTION

If the car is driven without air-cleaner filter, dust and dirt may cause a detrimental damage to engine and turbo-charger. Check and replace the oil periodically since oil deficiency, oil deterioration and pollution are critical causes of engine and turbocharger defect. If the car is started or accelerated suddenly after start, or engine is stopped immediately after pull over, oil supply to the turbocharger is discontinued to cause the bearing melting inside the turbocharger, which rotates with high speed (90,000 – 100,000 rpm). Therefore, perform enough idling.

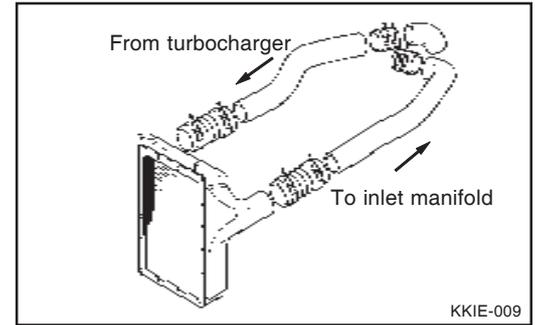
Treatment instruction

1. Use the genuine parts when replacing air cleaner and engine oil filter.
2. Clean and change the air cleaner filter periodically.
3. As for the engine oil, use the standard oil recommended by our company, which is better or equivalent to API C, D class.
4. Check engine oil leaks or any abnormal noise from turbo-charger frequently.
5. Check the exhaust pipe periodically to prevent gas leak.

Intercooler

The intercooler is the air-to-air heat exchange system using a corrugated-fin heat exchanger installed in front of the radiator. The intake air compressed by the turbocharger to have high temperature is cooled through heat exchange with the atmosphere. The resultant high-density air is sent into the engine cylinders.

This improves the combustion efficiency and as a result, the fuel economy and power output, while reducing harmful exhaust gases to a minimum.



TROUBLE SHOOTING

Sympton	Probalbe cause	Remedy
Low output	Insufficient intake air	
	o Loaded air cleaner element	Clean
	o Air suction (with dust and other foreign matter) from intake system	Repair
	o Defective turbocharger	
	o Intake shutter kept closed	Check
Low exhaust efficiency	Low exhaust efficiency	
	o Deformed front pipe, muffler and/or tail pipe (large exhaust resistance)	Replace
	o Exhaust brake valve kept closed	Adjust
Whitish and much ex-haust gas	Incorrect injection timing	Adjust
	Low compression pressure	Check
	Low quality fuel	Replace
	Defective turbocharger	
	o Oil leaks due to worn piston ring, and/or insert	Replace
o Damaged oil seal due to clogged oil return pipe	Replace	
Dark and much exhaust gas	Loaded air cleaner element	Clean
	Trouble in engine proper	Check
	Nonuniform fuel injection amount to cylinders	Adjust
	Incorrect injection timing	Adjust
Abnormal noise and/or vibration from intake and exhaust system	Poor connection of intake and exhaust systems	Correct
	Deformed front pipe, mufler or tail pipe (large exhaust resistance)	Replace
Turbo charger makes abnormal noises and vibration	Rotor rubbing on adjacent parts beacause of worn bearings :	
	o Failure of oil supply-clogged or damaged oil screen and oil line.	Check oil line, condition of oil and oil filter
	o Unadequate oil filtering or solid matter in oil line.	
	o Contaminated oil	
	Unbalaced rotor	Disassemble and repair. Also check air inlet system.
o Foreign material in air inlet system or exhaust manifold and striking wheel		
o Bent shaft		

Sympton	Probalbe cause	Remedy
Engine output decreases.	Excessive exhaust gas leaks	Check specifically exhaust manifold at turbocharger inlet and cylinder head.
	Restricted or deformed muffler	Repair or replace.
	Air leaks from compressor outlet side	Repair or replace.
	Restricted air cleaner	Clean or replace element.
	Dirt accumulation in compressor cover and wheel	Clean.
	Carbon build-up behind turbine wheel	Clean.
Oil leaks in exhaust or air inlet manifolds (white exhaust smoke)	Clogged or crashed oil drain system	Replace.
	Excessive piston ring or ring groove wear	Repair or replace.
	Restricted air cleaner	Clean or replace element.
	Damaged piston rings under operation with worn bearings	Replace.

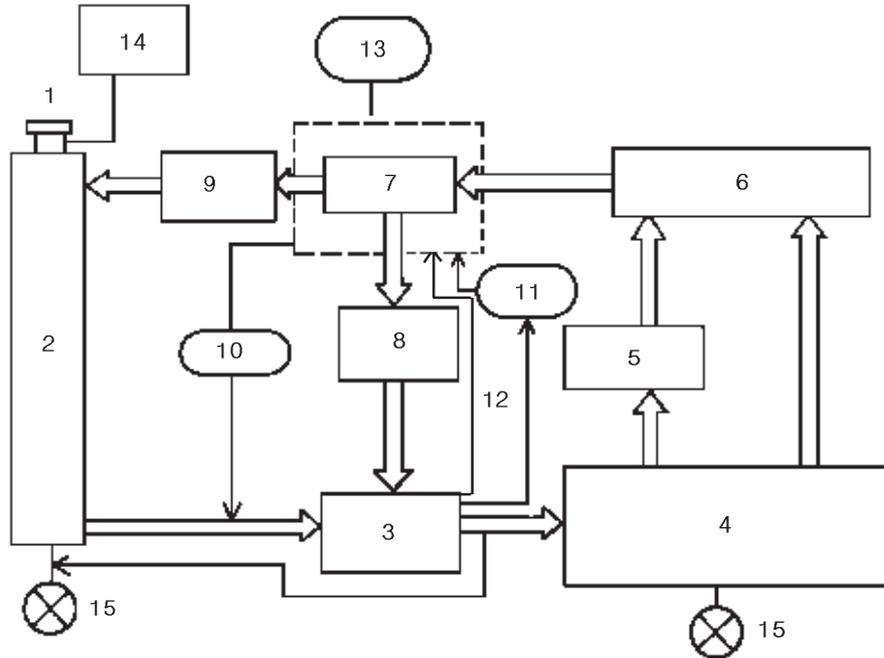
COOLING SYSTEM

GENERAL	CL- 2
SPECIFICATION	CL- 3
SERVICE STANDARD	CL- 4
SERVICE PROCEDURES	
Cooling Pump	CL- 6
Thermostat	CL- 9
Radiator	CL-10
Cooling Fan	CL-11
TROUBLESHOOTING	CL-12

GENERAL

The engine is cooled by forced circulation of coolant by the water pump.

COOLING SYSTEM DIAGRAM



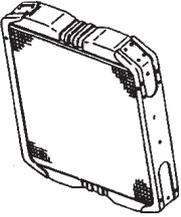
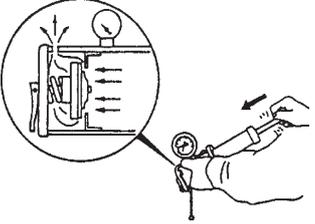
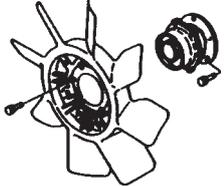
- | | | |
|-------------------|-------------------------------|-----------------------------------|
| 1. Radiator cap | 6. Cylinder head | 11. Air compressor (If so fitted) |
| 2. Radiator | 7. Thermostat | 12. Turbo charger |
| 3. Coolant pump | 8. Bypass hose | 13. Coolant temperature gauge |
| 4. Cylinder block | 9. Thermostat cover | 14. Reservoir tank |
| 5. Oil cooler | 10. Car heater (If so fitted) | 15. Drain flug |

SPECIFICATION

Item		Specification	Remark
Engine model		D6DA	
Cooling method		Water cooled	
Water pump		Centrifugal type	
Thermostat	Type	Wax pillet type	
	Valve opening temperature	82°C	
Fan operating oil		Silicon oil	

SERVICE STANDARD

Unit : kgf-cm²

Maintenance items		Nominal value	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.

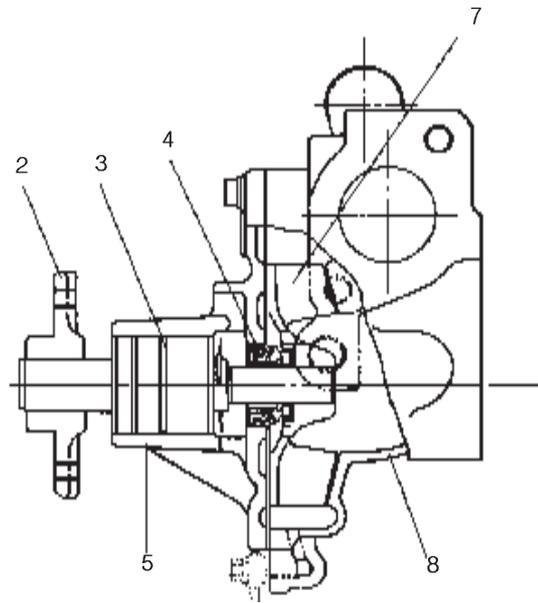
Tightening torque

Unit : kg·m

Item	D6DA		Remark
	Size	Torque	
Cooling fan nut and bolt	M8 x 1.25	2.2	
Cooling fan coupling nut and bolt	M10 x 1.5	4.4	
Water pump pulley and nut	M10 x 1.5	4.8	

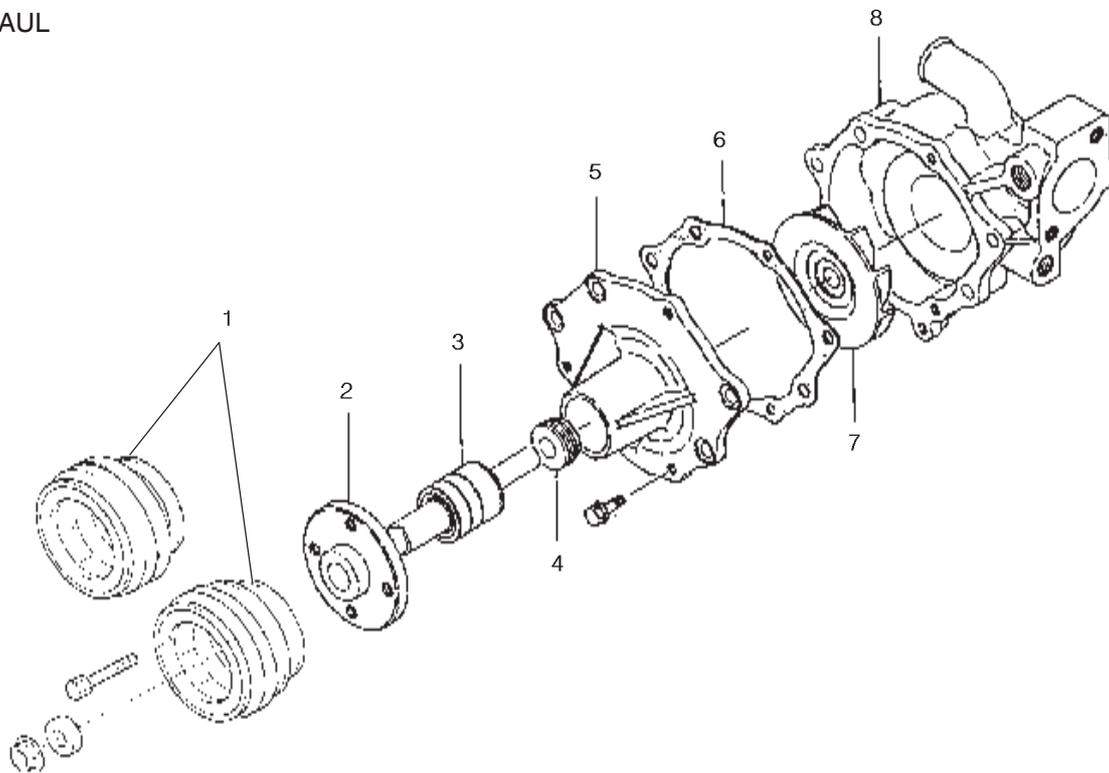
SERVICE PROCEDURE**Cooling Pump**

COMPONENTS



1. Fan coupling
2. Pulley center
3. Shaft assembly
4. Seal
5. Case
6. Gasket
7. Vane
8. Cover

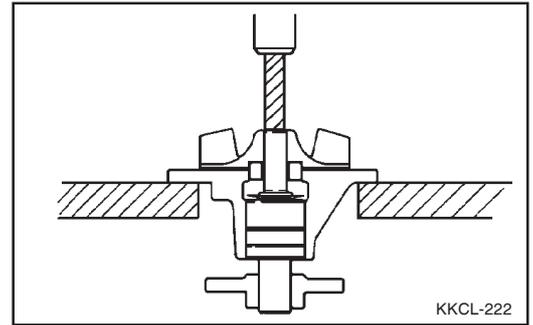
OVERHAUL



Disassembly

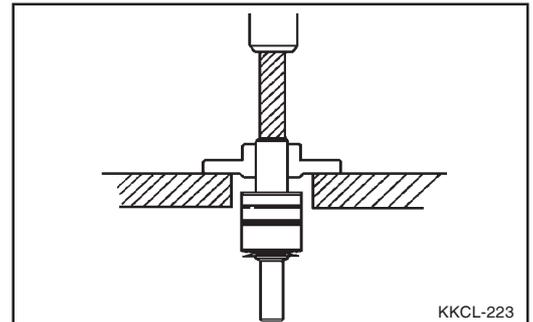
Vane and shaft removal

Using the press, push the shaft end.



Pulley center removal

Using the press, push the shaft end which touches pulley center.

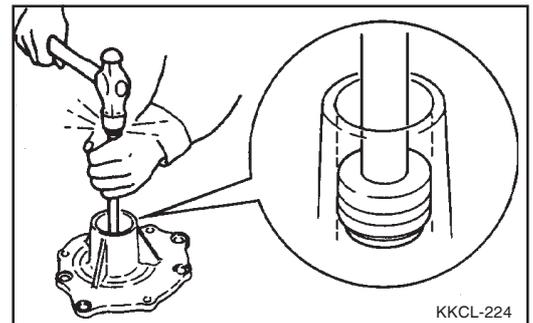


Seal removal from case

Tap the seal with the brass bar.

CAUTION

After removing seal from case, replace it with the new one.
(Do not reuse)



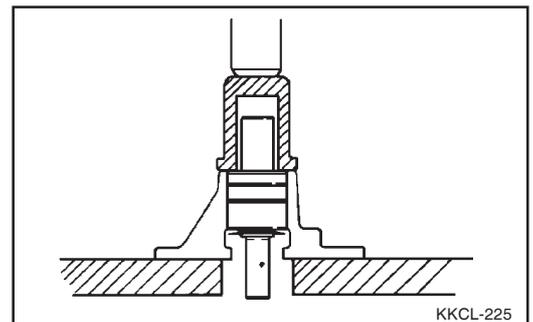
Assembly

Shaft assembly installation

Insert shaft assembly into the case.

CAUTION

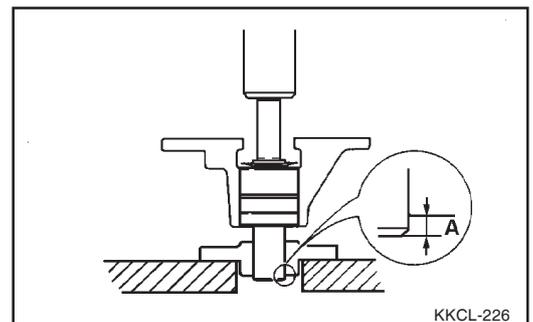
Let the bearing side coincides with shaft fringe.



Pulley center installation

Insert the pulley center into the shaft.

A: 18mm

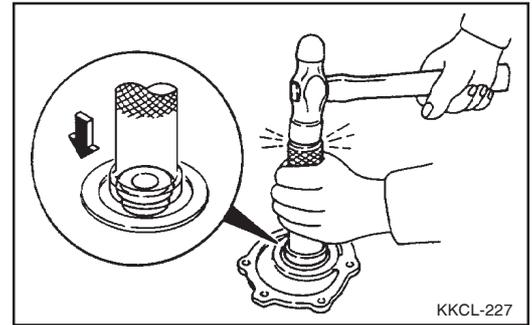


Seal Installation

1. Apply some liquid seal around the cooling seal and case
2. Install the seal.

CAUTION

Replace the seal with the new one.

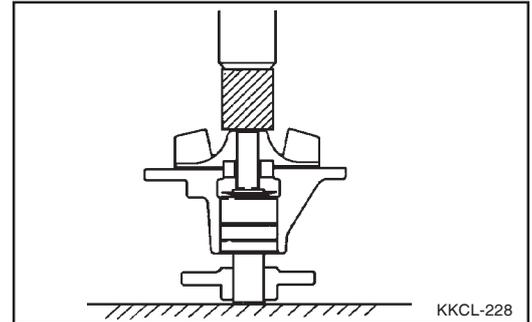


Vane assembly

Insert the vane into the shaft.

CAUTION

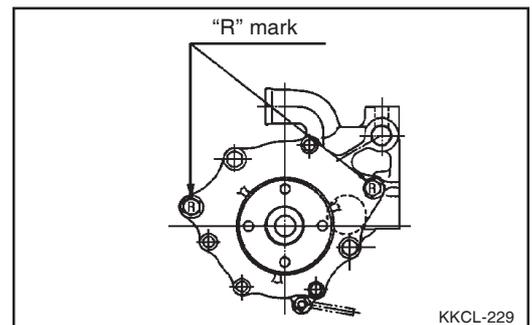
Push the vane until the vane face touches the shaft end.



Installation

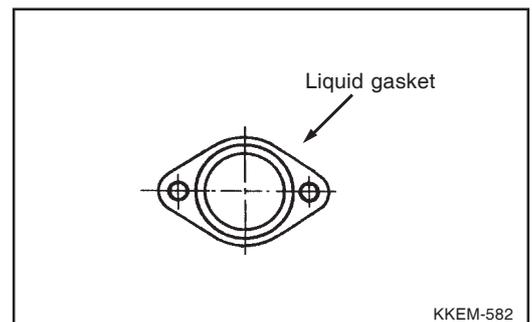
Cooling pump assembly installation

Reamer bolt installation position



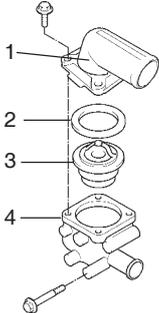
Installation of cooling pump suction pipe

Refer "liquid gasket application position" section of Engine maintenance.



Thermostat

Assembly chart



1. Thermostat cover
2. Gasket
3. Thermostat
4. Thermostat case

KKCL-761

Inspection and Maintenance

Thermostat function check

1. Check the valve opening temperature (T1) and valve lift by soaking into the hot water.

CAUTION

Check the valve opening temperature (T1) written on the thermostat seat.

Thermostat valve opening temperature

Temperature to start open valve(T1)	Service standard
71 °C	69-70 °C (125-195 ° F)
82 °C	80-84 °C (145-215 ° F)

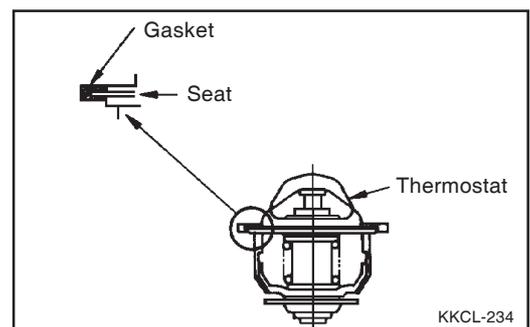
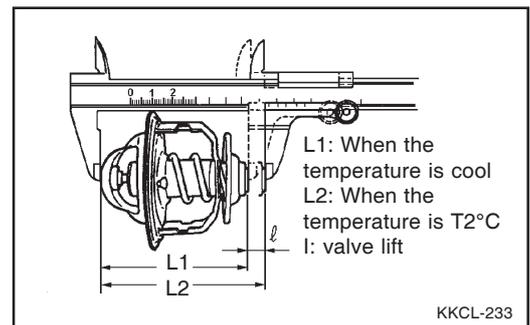
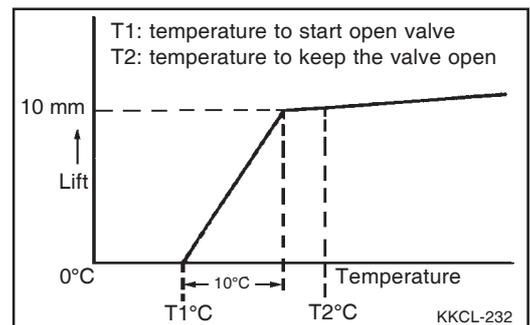
Thermostat valve lift

Temperature to start open valve(T1)	Measured temperature(T2)	Valve lift(l)
71 °C	85 °C (185 ° F)	100mm or more
82 °C	95 °C (203 ° F)	

2. Soak the heated thermostat into the normal temperature water. It is normal, if it closes completely within 5 minutes. If not, it is defective to be replaced.

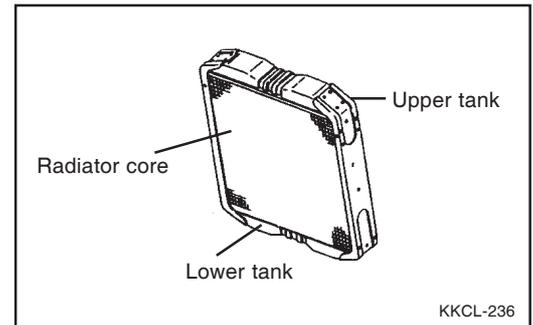
Assembly

1. Remove water and dust from the thermostat case.
2. If the gasket is corroded, damaged or deformed, then replace it with the new one.
3. Before installing hoses, apply the liquid gasket on the thermostat case.
4. To prevent radiator clogging, do not use too much liquid gasket.



Radiator

Radiator consists of the upper tank, radiator core, lower tank and other components. It functions to cool down the heated coolant through circulating inside the engine. Coolant passes through the radiator core, which consists of many tubes and pins and goes back to the water pump by way of upper tank and lower tank. The external air cool coolant as it passes the radiator core.



Disassembly

Remove the radiator.

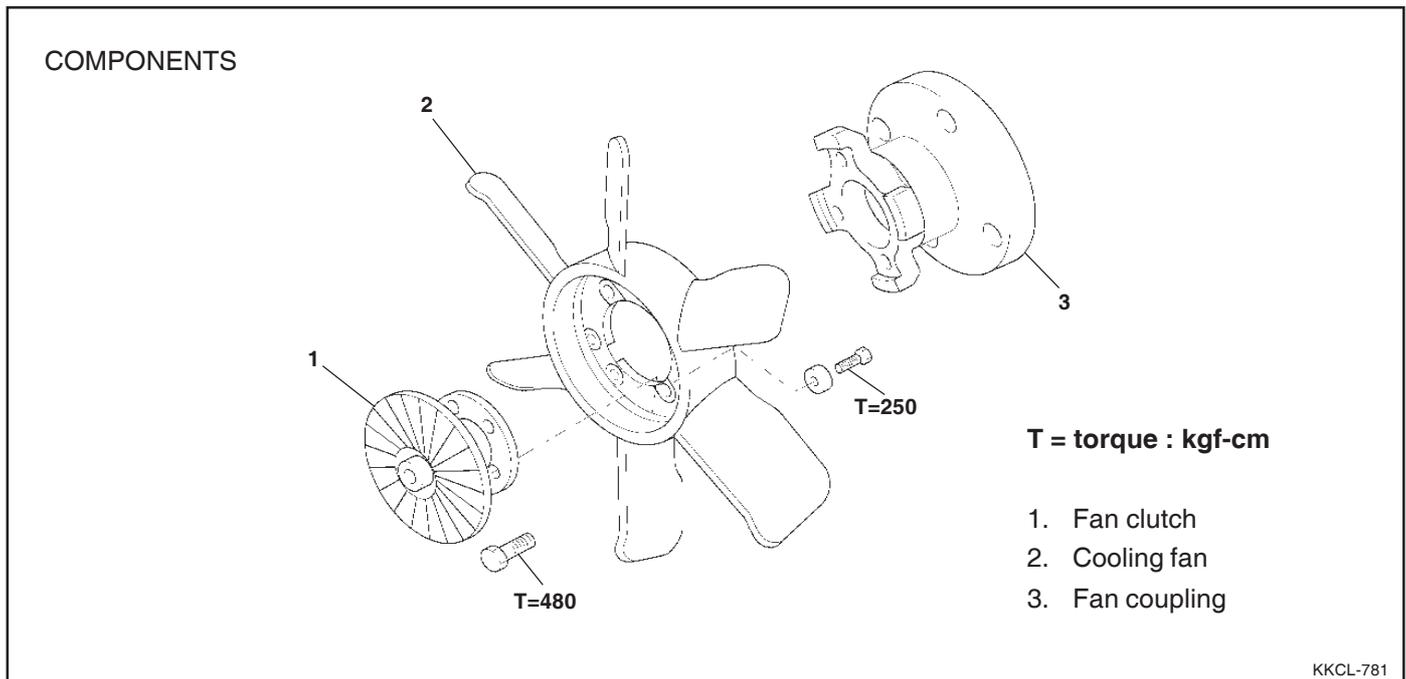
WARNING

To prevent the risk of burn, do not drain the coolant when the engine and radiator are hot.

CAUTION

When disassembling or reassembling radiator, take care not to damage the radiator core.

Cooling Fan



1. Impact the fan clutch and fan

Take care not to damage the fan and fan clutch while maintenance and inspection. If damaged, it may hurt the cooling capacity. Besides, since the fan is made of plastic, it may be damaged or deformed when excessive force is applied.

2. Replace the fan

Fan does not have to be replaced, if it is free from defect. When replacing the fan, use the same type fan. If the fan is replaced with the bigger or smaller one in terms of capacity, it may cause over-cooling or overheating respectively. Then cooling capacity and durability deteriorate in the end.

3. Other factors

Check whether the temperature sensor (bimetal) contains dust or mud. If it is the case, it may cause inconstant cooling, overheating or overcooling. Remove the mud or dust from the bimetal surface using brush or equivalents. Do not apply the excessive force. Do not paint the fan or fan clutch.

TROUBLESHOOTING

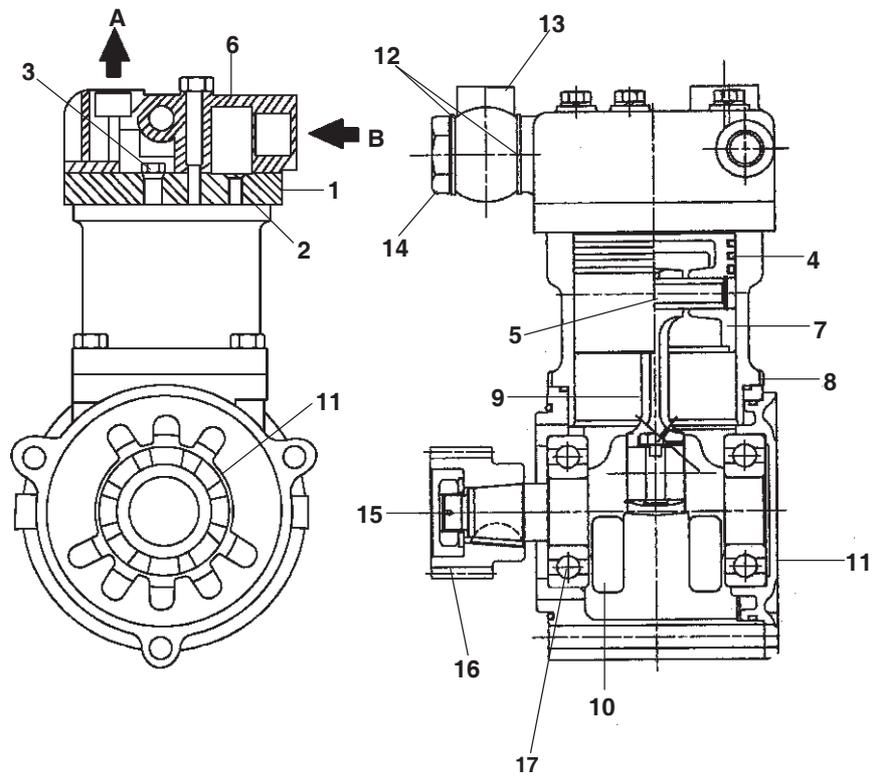
Symptom	Probable cause	Remedy	Remarks	
Over heat	Defection V-belt • Defective tension • Belt cut	Adjust Replace		
	Clogged cooling pipe	Clean		
	Faulty thermostat	Replace		
	Faulty water pump • Loosen water pump shaft with flange • Loosen water pump shaft with impeller • Defect impeller • Poor clearance impeller and case	Replace		
	Clogged radiator fin	Clean		
	Faulty auto cooling fan coupling • Faulty bi-metal • Faulty auto cooling fan coupling body • Clogged bi-metal	Replace Clean		
	Faulty cooling fan	Replace		
	Low coolant	Add		
	Over cool	Faulty thermostat		Replace
Coolant is very fast deminish	Faulty radiator hose • Loosen hose connection • Crack or damage cooling hose	Retighten Replace		
	Faulty radiator • Loosen radiator core from body • Loosen pressure cap	Replace		
	Faulty water pump • Faulty seal • Faulty oil seal • Defective pump gasket	Replace		
	Faulty oil cooler	Replace		Refer Lubrication system
	Defective thermostat gasket	Replace		
	Faulty heater hose • Loosen hose connection • Crack or damage hose	Retighten Replace		
	Faulty cylinder head gasket	Replace		Refer Engine

AIR COMPRESSOR

GENERAL	AC - 2
SPECIFICATIONS	AC - 3
SERVICE STANDARD	AC - 3
SERVICE PROCEDURE.....	AC - 6
TROUBLE SHOOTING	AC-11

GENERAL

Description



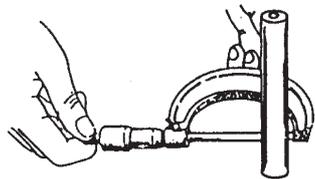
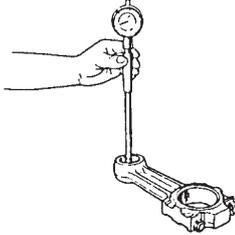
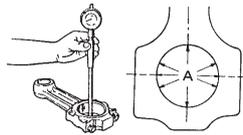
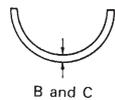
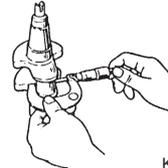
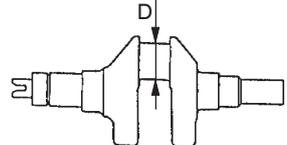
- | | | |
|-------------------|-------------------|---------------------|
| 1. Valve seat | 7. Piston | 13. Air intake pipe |
| 2. Suction valve | 8. Cylinder block | 15. Bolt |
| 3. Delivery valve | 9. Connecting rod | 16. Air compressor |
| 4. Piston ring | 10. Crank shaft | 17. Bearing |
| 5. Piston pin | 11. Bearing hold | A. To tank |
| 6. Cylinder head | 12. Soft washer | B. Air suction |

SPECIFICATIONS

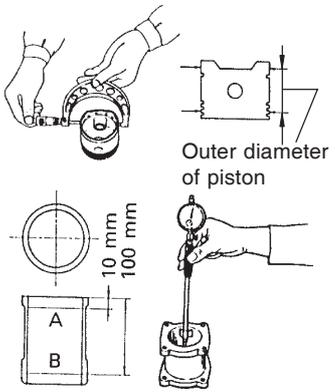
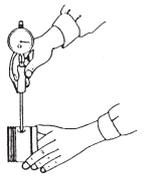
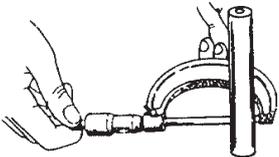
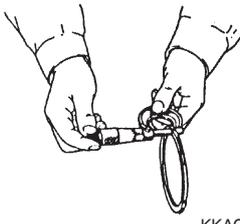
ITEM		SPECIFICATION	REMARKS
Air compressor	Type	Water cooled	
	Cylinder bore X stroke	85 X 50	
	Cylinder capacity	285cc	

SERVICE STANDARDS

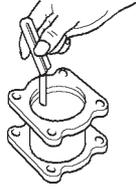
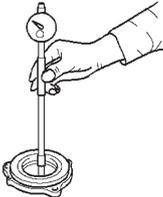
Unit : mm

ITEM	STANDARD	LIMIT	REMEDY	REMARKS
Outer diameter of piston	18.0		Replace bushing or piston pin	
Clearance between piston pin and connecting rod	0.016-0.044	0.08		 <p style="text-align: right;">KKAC-103</p>
Inner diameter connecting rod	37.0	-	Replace	
Thickness of connecting rod bearing	1.51	-		 <p style="text-align: center;">B and C</p> <p style="text-align: right;">KKAC-111</p>
Outer diameter of crank pin	34.0	-		 <p style="text-align: right;">KKAC-112</p>
Clearance between connecting rod and crank pin	0.017-0.083	0.1		 <p style="text-align: center;">D</p> <p style="text-align: right;">KKAC-113</p>

Unit : mm

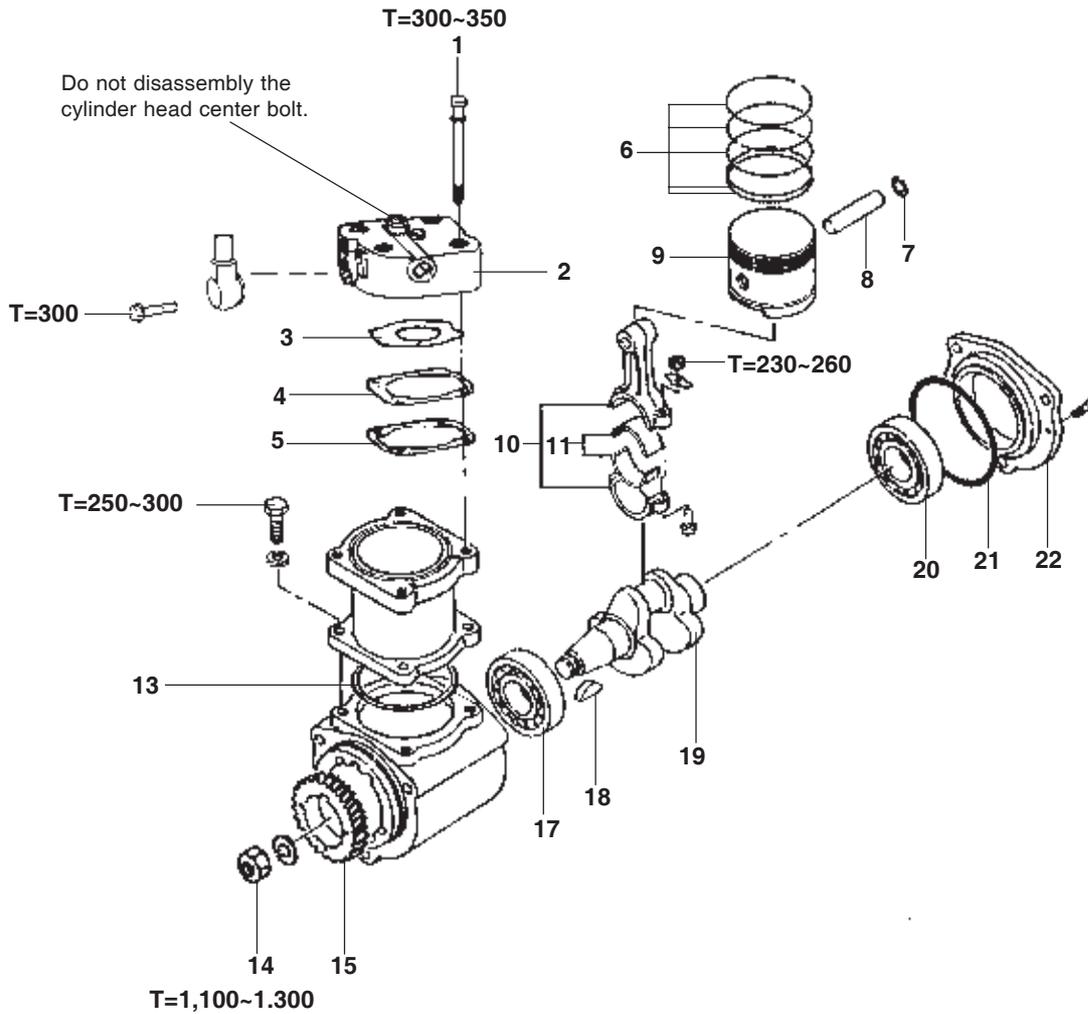
ITEM		STANDARD	LIMIT	REMEDY	REMARKS
Piston outer diameter (skirt part)		84.940-84.960	-	Replace	
Inner diameter of cylinder liner		90.00-90.022			
Clearance between piston and liner		0.0400-0.0820	0.18		
Clearance piston pin hole and piston pin T=tightening L=Loosening		0.012T-0.16L	0.08	Replace	 <p style="text-align: right;">KKAC-116</p>
Outer diameter of piston pin					 <p style="text-align: right;">KKAC-121</p>
Thickness of piston ring	Compression ring	2.0	1.92	-	 <p style="text-align: right;">KKAC-122</p>
	Oil ring	4.0	-		
Gap of piston ring	Compression ring	2.0	2.07	Replace	
	Oil ring	4.0	-		
Clearance between ring and ring groove	Compression ring	0.005-0.040	0.08	-	 <p style="text-align: right;">KKAC-123</p>
	Oil ring	-			

Unit : mm

ITEM		STANDARD	LIMIT	REMEDY	REMARKS	
Piston ring cap	Compression ring	0.15-0.30	1.0		 KKAC-124	
	Oil ring	0.2-0.70	1.0			
Outer diameter of crank shaft journal		40.002-40.013	39.98	Replace	 KKAC-125	
Inner diameter of bearing holder	Cylinder block	89.975-90.010	90.030	Replace		
	Bearing holder				 KKAC-126	

SERVICE PROCEDURE

Disassembly and Assembly



- | | | |
|-----------------------------|-----------------------------|------------------|
| 1. Cylinder head bolt | 9. Piston | 17. Ball bearing |
| 2. Cylinder head assembly | 10. connecting rod assembly | 18. Woodruff key |
| 3. Suction valve | 11. connecting rod bearing | 19. Crank shaft |
| 4. Cylinder packing (Upper) | 12. Cylinder liner | 20. Ball bearing |
| 5. Cylinder packing (Lower) | 13. O-ring | 21. O-ring |
| 6. Piston set | 14. Rod nut | 22. Bearing hold |
| 7. Retainer ring | 15. Drive gear | |
| 8. Piston pin | 16. Cylinder block | |

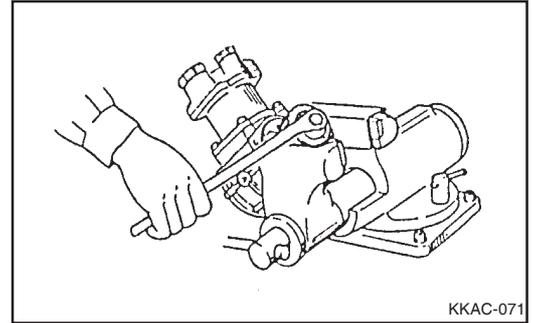
Disassembly

Remove the drive gear.

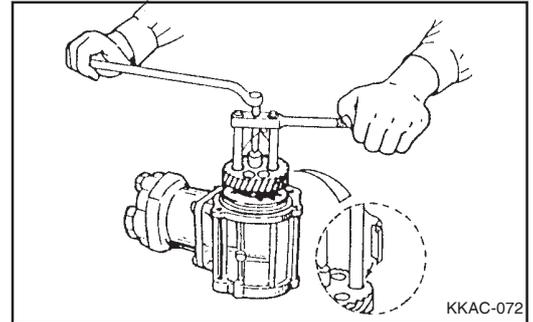
1. Remove the lock nut from the compressor drive gear.

CAUTION

Drive gear may be damaged, if lock nut is not fully loosened.

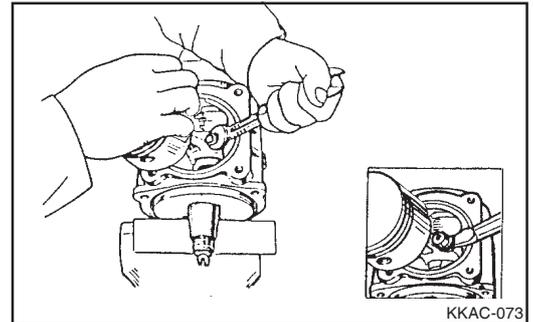


2. Pull the gear form the shaft, and remove the woodruff key.



Remove the connecting rod and piston.

1. Rotate the crankshaft to the top dead center position.
2. Fully open the nut staking by the chisel, and loosen the nut.
3. Remove the connecting rod and piston.



Remove the piston ring.

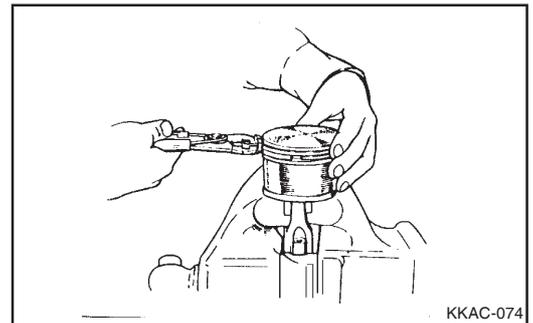
Special tool: Piston ring tool (09222-83200)

CAUTION

- Since the piston rings are so brittle, which are made by special forgery, handle with special care.
- When reusing the piston rings, align the parts orderly to prevent the mis-assembly first of all.

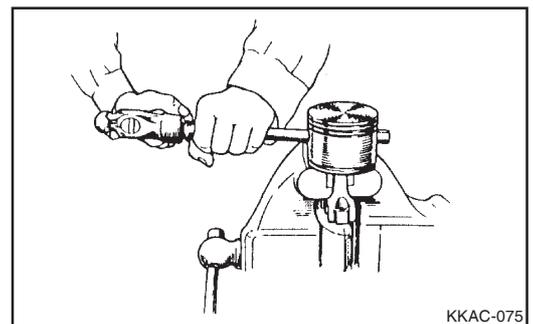
Remove the connecting rod.

1. Using the retainer ring pliers, remove the retainer ring installed at both ends of the spring.
2. Put the metal pad to the pin, and tap it with the special tool and hammer.



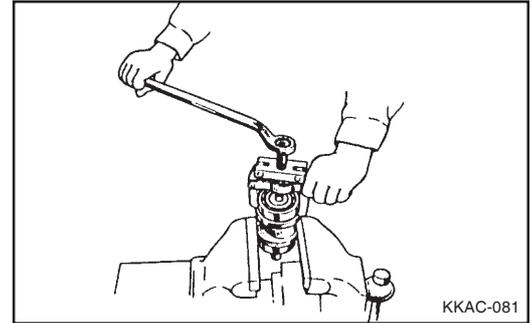
CAUTION

Before disassembling pin, heat the piston for about 5 minutes with the hot water of 80-90°C (176°F ~ 194°F).



Remove the ball bearing.

Using the special tool, remove the ball bearing from the end of crankshaft.

Disassembly**CAUTION**

Before assembly, make sure to apply the engine oil to every frictional part and replace the O-ring and gaskets with the new ones.

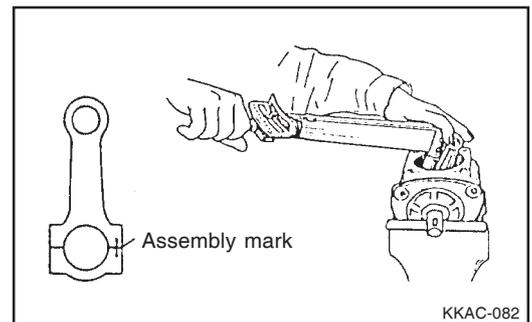
Install the connecting rod and measure end play.

1. Install connecting rod.

CAUTION

Check whether the assembly marks coincide.

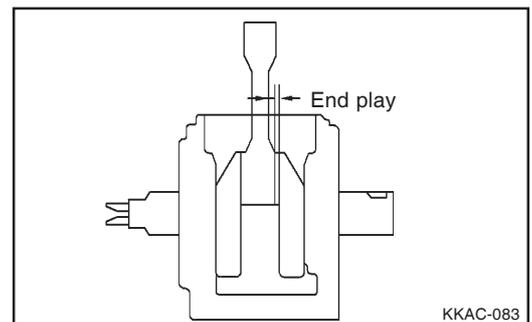
2. Apply the enough engine oil to the connecting rod bolts and threads, and fasten the bolts.



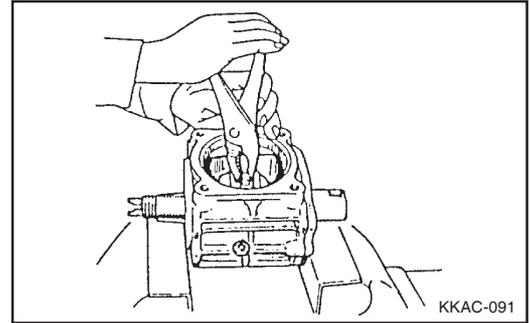
3. Measure the endplay of connecting rod. If the clearance exceeds the service limit, replace the connecting rod.

Assembly standards: 0.2 – 0.4 mm

Service limit: 0.50 mm



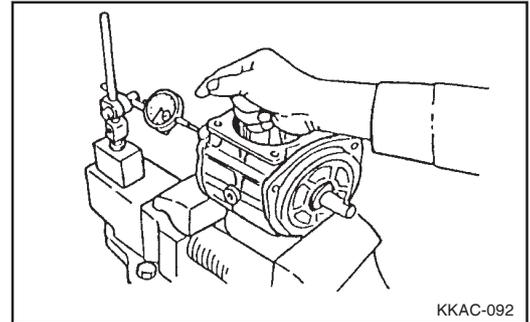
4. Fasten nut with the lock washer.



If the clearance exceeds the limit, replace the crankshaft bearing or cylinder block.

Assembly standard: 0.30 mm – 0.84 mm

Limit: 1.0 mm

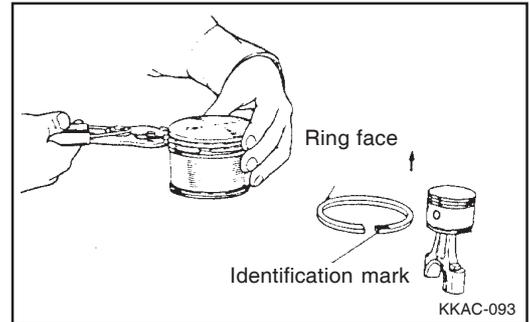


Assemble piston

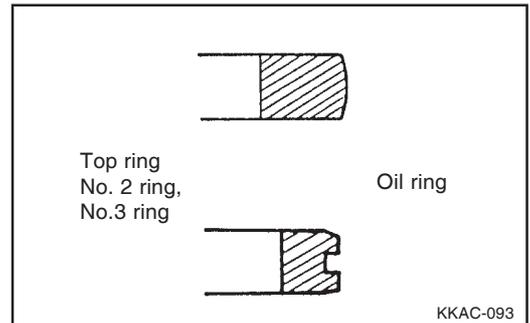
CAUTION

Apply the engine oil to the slippery places of the parts, and then assemble them.

1. Assemble the piston ring. When assembling piston ring to piston, check whether the skirt is at the bottom and use special tool. Assemble the piston ring as the ring face identification mark faces upward.



Special tool: Piston ring tool (09222- 83200)

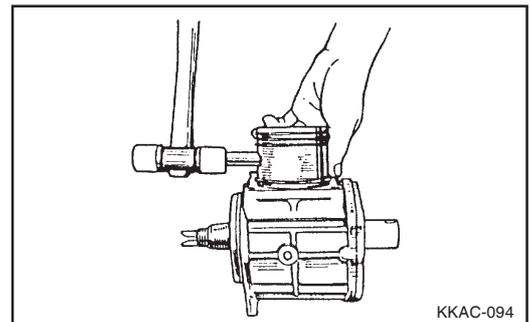


Assemble the piston and connecting rod.

When inserting piston pin into piston, install the retainer one ring to the end of piston and then apply the oil to the piston pin. Fix the piston and connecting rod and insert the new retainer ring to the other end.

CAUTION

Heat the piston for about 5 minutes with the hot water of approximately 80-90°C (176-194°F).



Assemble cylinder liner and cylinder head.

1. Rotate the crankshaft to the top dead center position.
2. Align the pistons with the same distance between rings.
3. Assemble the cylinder liner and cylinder head.

CAUTION

When assembling O-ring to cylinder liner and cylinder head, be careful not to be twisted.

Assemble the cylinder head assembly.

1. Assemble the suction valve of cylinder head assembly.
2. Assemble the cylinder packing.

CAUTION

Packing thickness (upper part, lower part).

Packing must be replaced after used once.

3. Assemble the valve seat pin smoothly to the upper part of cylinder by aligning the center.

CAUTION

Do not apply the excessive force in assembling pin to the holes.

Take care so that dust and dirt are not included.

Do not disassemble the cylinder head assembly (center bolt).

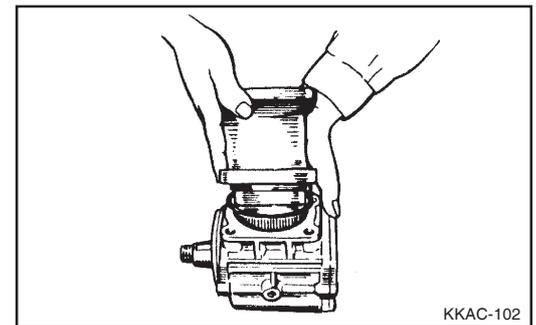
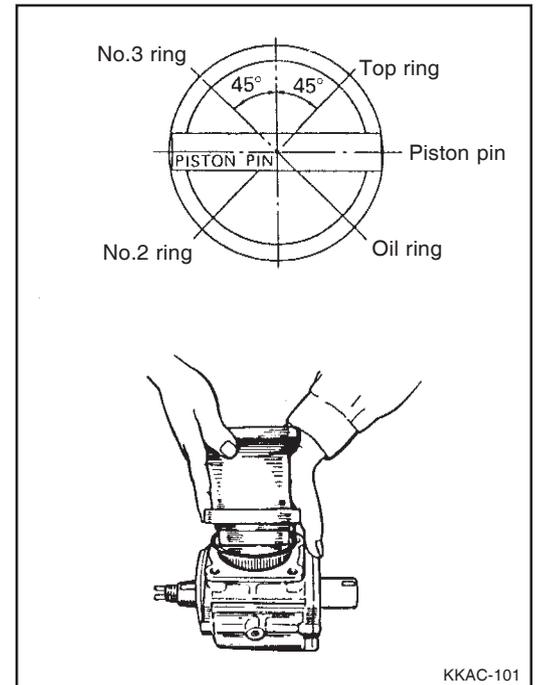
4. Connect the cylinder head bolt.

CAUTION

Abide by the fastening torque (300 – 350kg-cm).

Abide by the fastening torque of center bolt (250 – 300 kg-cm).

(Do not disassemble the center bolt nor apply any torque).



TROUBLE SHOOTING

Sympton	Probably cause	Remedy
Malfunction of unloader valve	Unloader valve <ul style="list-style-type: none"> o Sticky o Deflection or wear 	Clean or replace
	Air pipe and joints <ul style="list-style-type: none"> o Air leakage 	Repair or replace unloader valve assembly
	Pressure regulator <ul style="list-style-type: none"> o Function 	Replace or tighten pipe joints
		Adjust and/or repair pressure regulator.
Noisy operation	Piston <ul style="list-style-type: none"> o Wear of piston pin boss or piston pin o Seized, damaged or worn connecting rod small end o Worn piston or liner o Damaged or seized piston o Inclusion of foreign matter on top surface of the piston o Carbon deposit 	Replace it
		Replace piston
		Clean piston
	Valve <ul style="list-style-type: none"> o Inlet valve is lowered excessively o Loosened discharge valve holder 	Repair or replace
		Tighten it
	Bearing <ul style="list-style-type: none"> o Damaged or worn ball bearing and/or connecting rod metal 	Replace bearing
Charging efficiency dropped	Valve <ul style="list-style-type: none"> o Abnormal wear, damage, or poor contact 	Replace valve assembly
	Piston, liner, and piston rings <ul style="list-style-type: none"> o Worn piston and liner o Seized piston 	Replace
		Replace piston, piston rings and liner
		Replace it
	Air pipe and joints <ul style="list-style-type: none"> o Leakage of high pressure air o Clogged air pipe 	Replace or tighten pipe joint
		Replace
	Air cleaner <ul style="list-style-type: none"> o Clogged element 	Clean or replace element

Sympton	Probably cause	Remedy
Excessive carbon or oil in the compressor cylinder head or discharge line	Piston rings <ul style="list-style-type: none"> <li data-bbox="395 320 879 353">o Worn, sticking or broken piston rings 	Replace piston rings and/or cylinder liner
	<ul style="list-style-type: none"> <li data-bbox="395 409 799 443">o Insufficient piston ring tension 	Replace piston rings and/or cylinder liner
	<ul style="list-style-type: none"> <li data-bbox="395 499 759 533">o Unsatisfactory piston rings 	Replace piston rings and/or cylinder liner
	Cylinder liner, piston, and rings <ul style="list-style-type: none"> <li data-bbox="395 633 788 667">o Wear of liner, piston, or rings 	Replace