⚠ WARNING Danger of Fire and Explosion

● Keep flames away

Do not use flames or smoke at a site where fuel or engine oil is handled or cleaning solvent is used for washing parts.
Flames can ignite such materials and result in a dangerous situation.
Spilled fuel and oil should be wiped immediately and thoroughly. Spilled fuel and oil can ignite and cause fire.
When storing fuel or engine oil, make sure that the storage area is well ventilated and the caps of containers are tightly closed.

● Keep surrounding area neat and clean

Do not leave combustible or explosive materials, such as fuel and engine oil, near the engine. They can cause fire or explosion.
Remove dust, dirt and other foreign materials accumulated on or near the engine. They can cause fire or engine overheating. Be sure to remove dust from the top side of the battery after maintenance. Dust can cause a short-circuit.
The engine must be positioned at least 1 m [3.28 ft] away from buildings and other equipment to prevent possible fire caused by engine heat.

● Do not open crankcase until engine cools

After the engine stops operation, let the engine cool for at least 10 minutes before opening the side cover of the crankcase.
Inflow of fresh air into the crankcase of a hot engine can cause oil mist to ignite and explode.

● Check for fuel and oil leaks

When fuel or oil leaks are found, repair the leakage immediately.
Fuel or engine oil spilled on a hot surface of the engine can cause fire and result in personal injury or equipment damage.

● Use shatterproof light

Use a shatterproof light when inspecting the fuel system, lubrication system, cooling system or battery fluid level.
A non-shatterproof light may catch fire and explode.

● Do not short-circuit electrical wires

Do not inspect or repair the electrical system with the battery cables connected to the battery, since it can cause accidental short-circuiting and lead to fire. Be sure to disconnect the negative (-) battery cable from the battery before conducting work.
Loose terminals and damaged cables/wires can result in a short-circuit and cause fire. Inspect the terminals, cables and wires before servicing, and repair or replace when damage is found.

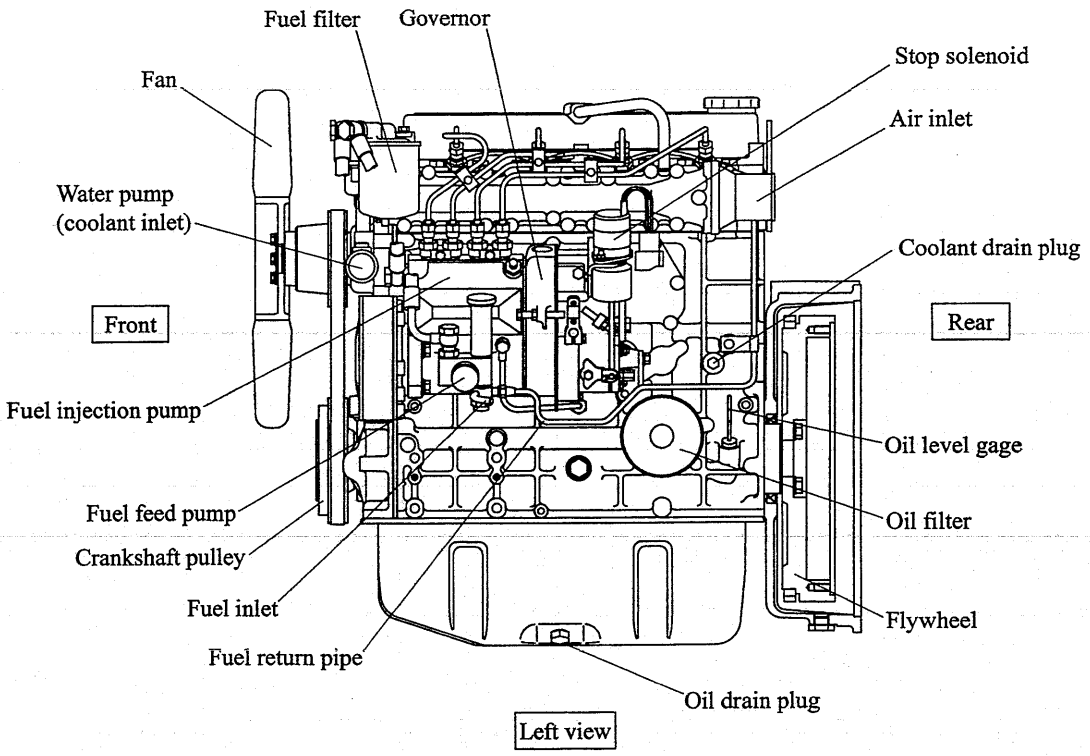
● Keep fire extinguishers and first aid kit nearby

Always keep fire extinguishers nearby, and be familiarized with their usage.
Keep a first aid kit at a designated place, and make sure it is easily accessible whenever needed.
Also, establish emergency response procedures to follow in the event of a fire or accident, and post emergency contact locations and contact methods.

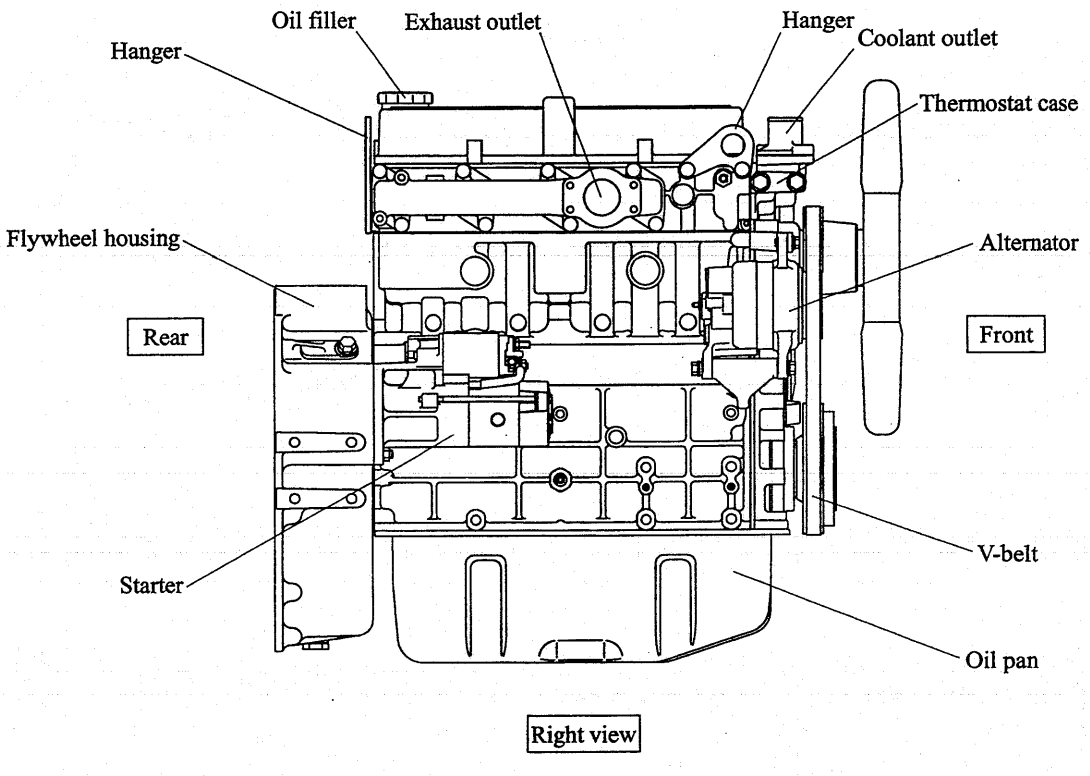
1. Outline

1.1 External View (In-line Fuel Injection Pump and Distributor-type Fuel Injection Pump)

(1) S4S in-line fuel injection pump specification

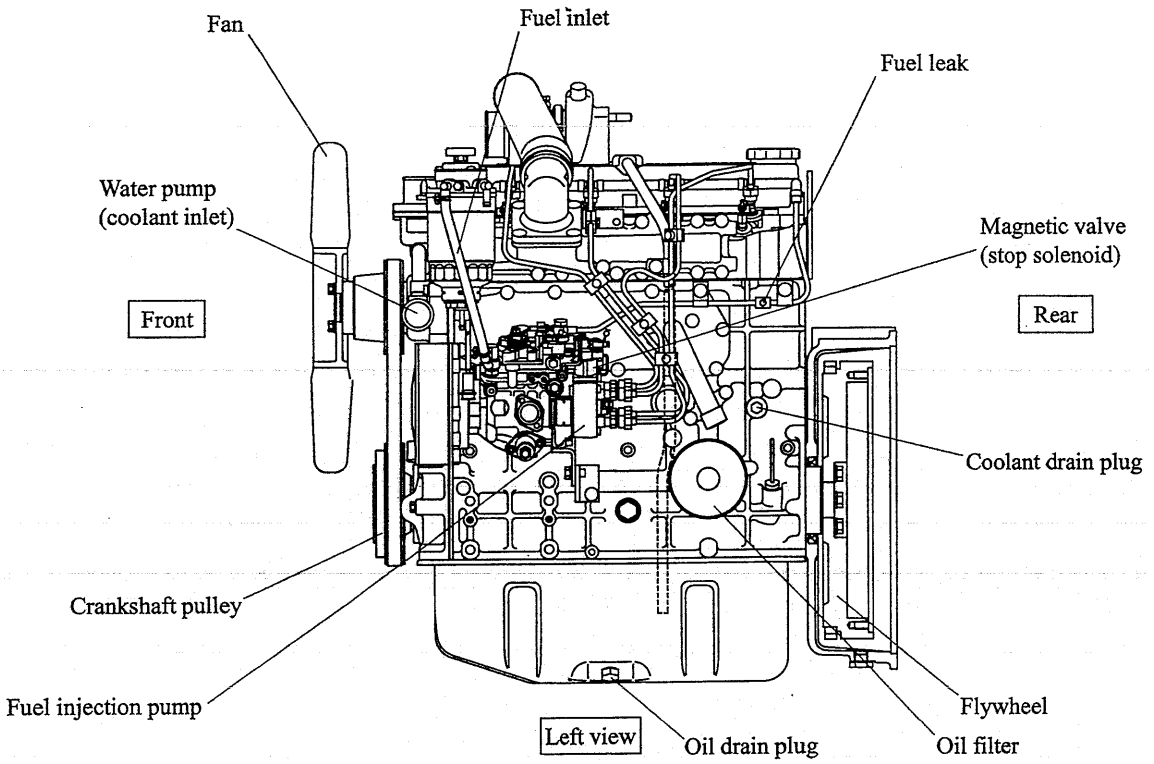


Left view of engine

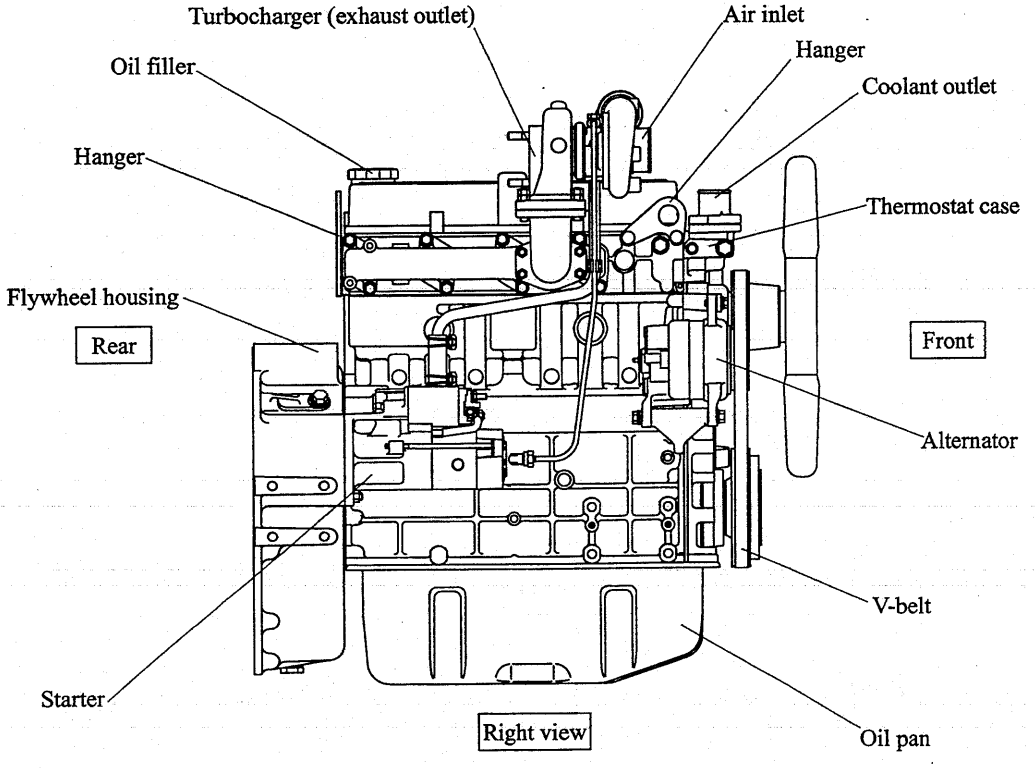


Right view of engine

(6) S4S-DT distributor-type fuel injection pump specification

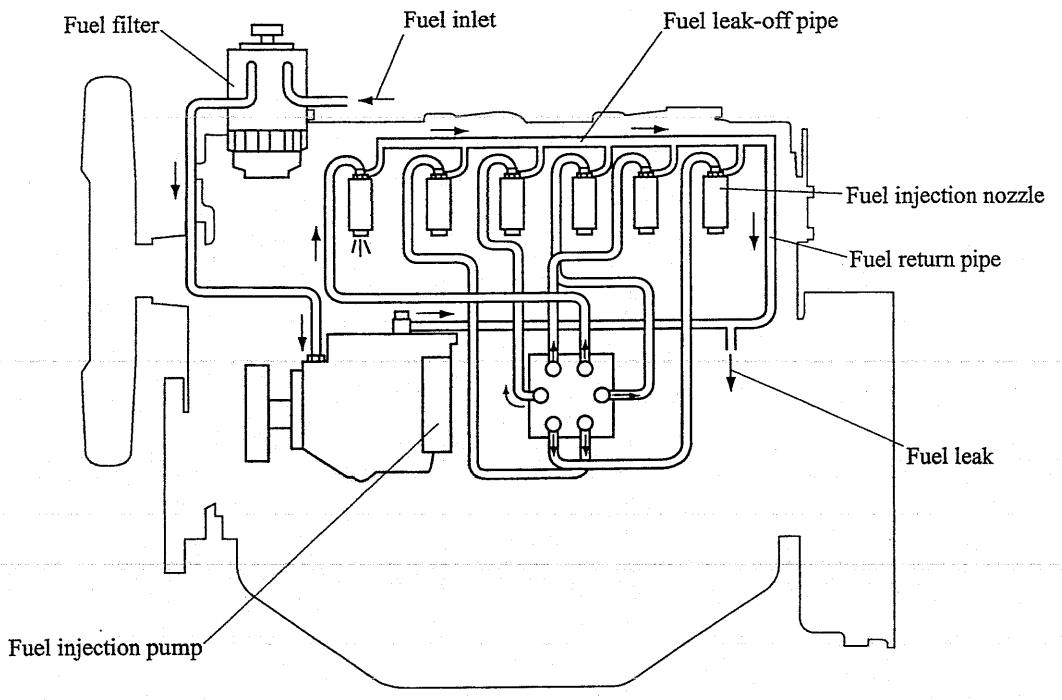


Left view of engine



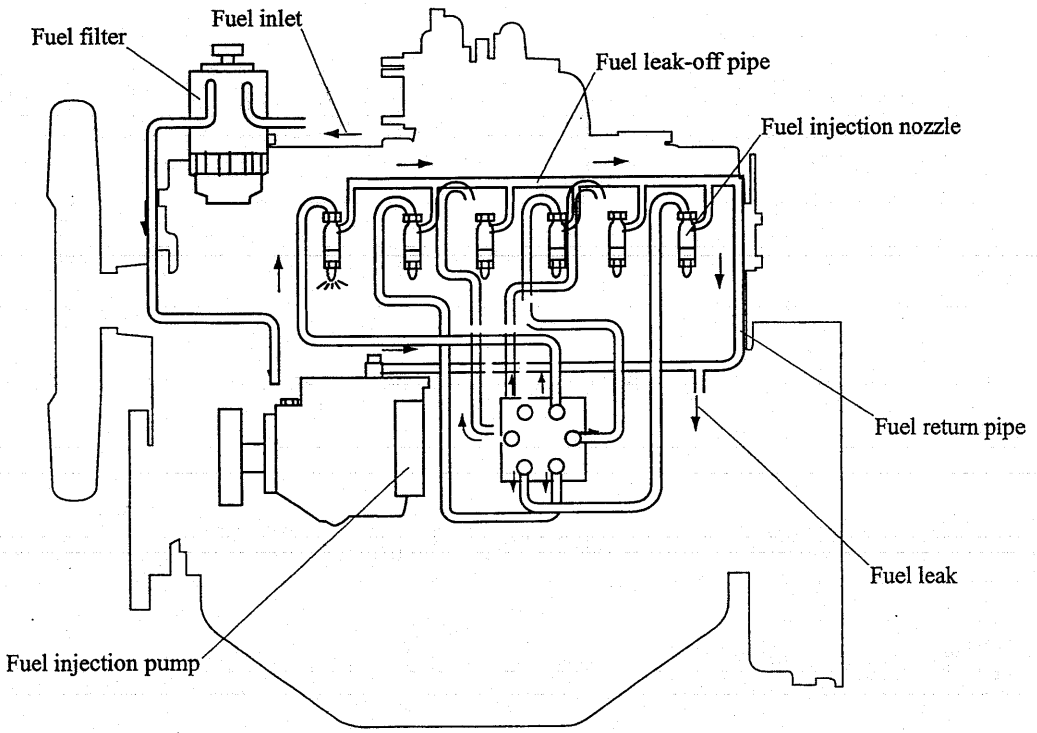
Right view of engine

(7) S6S distributor-type fuel injection pump (swirl chamber) specification



Outline of fuel system

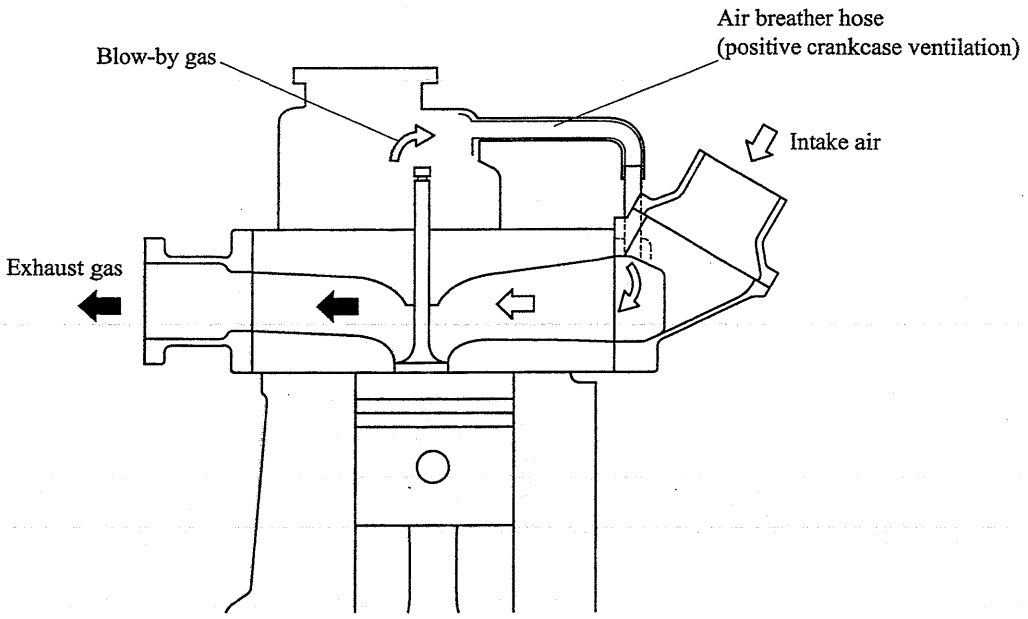
(8) S6S-DT distributor-type fuel injection pump (direct injection) specification



Outline of fuel system

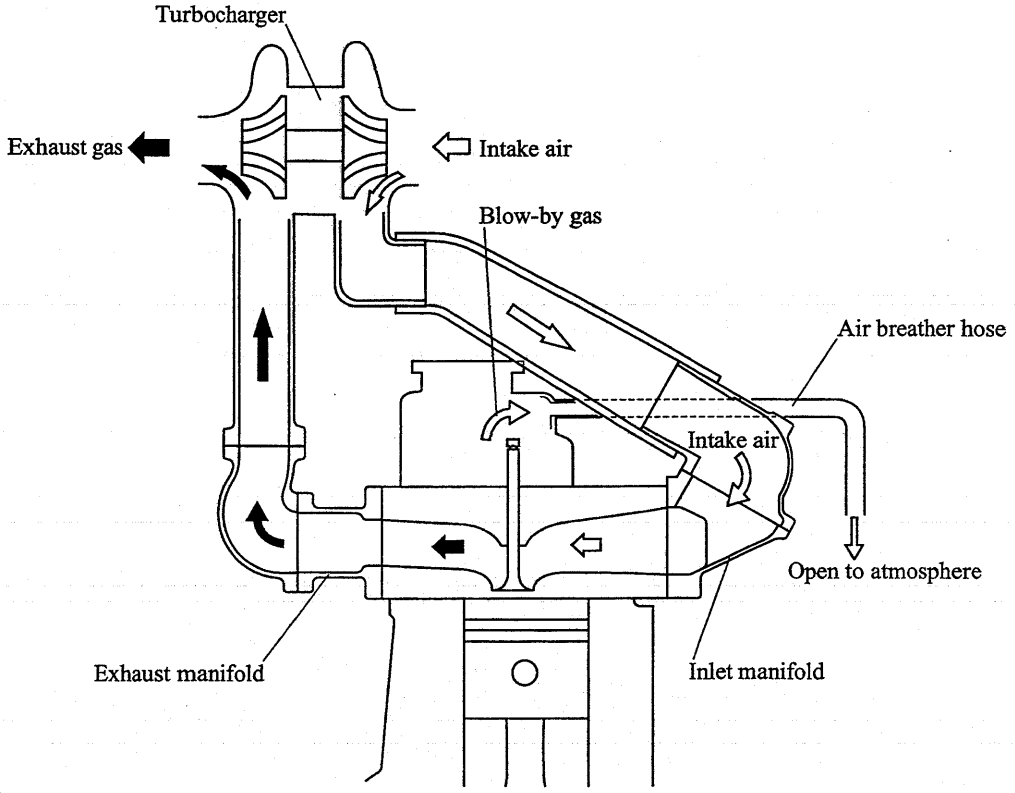
1.5 Outline of Inlet and Exhaust Systems

(1) Non-turbocharged engine



Outline of inlet and exhaust systems

(2) Turbocharged engine



Outline of inlet and exhaust systems

Engine type				S6S	S6S-DT
Electrical system	Voltage - polarity			12 V - negative (–) ground	24 V - negative (–) ground
	Starter	Type		M3T67671	M8T60373
		Pinion mesh type		Pinion shift	
		Output V-kW		12-3	24-5
		Pinion/ring gear ratio		10/122	
	Alternator	Type		3-phase alternating-current generator, built-in rectifier	
		Output V-A		12-50	24-25
		Working speed min^{-1}		1000 to 18000	
		Rated output generating speed min^{-1}		5000	
		Maximum permissible speed min^{-1}		22000	
		Speed ratio to crankshaft		2.0	
	Glow plug	Type		Sheathed	
		Rated voltage - current V-A		10.5-9.7 (30-second application)	23-3.0 (30-second application)
	Stop solenoid (option)	Type ETR (RUN-ON)	Rated voltage V	12	24
			Power consumption W	20	14
			Start voltage V	6.3 or less	13 or less
			Recovery voltage V	2.5 or more	5 or more
			Coil resistance Ω	8	37

1. Determination of Overhaul Timing

In most cases, the engine should be overhauled when the compression pressure of the engine is low and decreased compression pressure results in a noticeable increase in engine oil consumption and blow-by gas and these symptoms can be used to evaluate the engine condition.

Reduced power output, increased fuel consumption, low oil pressure, difficulty in starting, and increased operating noise are also signs that suggest the need for an overhaul, however, since these problems can be caused by various factors, they do not serve as reliable sources for assessing the need for an overhaul.

Reduced compression pressure manifests a variety of symptoms and engine conditions, thus making it difficult to accurately determine when the engine needs an overhaul. The following shows typical problems caused by reduced compression pressure.

(a) Decreased output power

(b) Increased fuel consumption

(c) Increased engine oil consumption

(d) Increased blow-by gas through the breather due to worn cylinder liners and piston rings

(e) Increase gas leakage due to poor seating of inlet and exhaust valves

(f) Difficulty in starting

(g) Increased noise from engine parts

(h) Abnormal exhaust color after warm-up operation

The engine can exhibit these conditions in various combinations.

Some of these problems are directly caused by worn engine parts, while others are not.

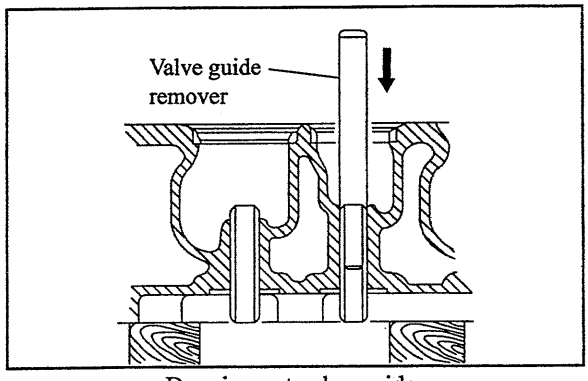
Phenomena described in items (b) and (f) can result from improper fuel injection volume and timing of the fuel injection pump, worn plunger, faulty nozzles and also faulty conditions of electrical devices such as battery and starter.

The most valid reason to overhaul an engine is a decrease in compression pressure due to worn cylinder liners and pistons, as described in item (d), and once this is determined, it is reasonable to take other problems into consideration for making the final judgment.

1.4 Replacing Valve Guides

(1) Use the valve guide remover (special tool) to draw out the valve guide.

Special tool name	Part No.
Valve guide remover	32A91-00300



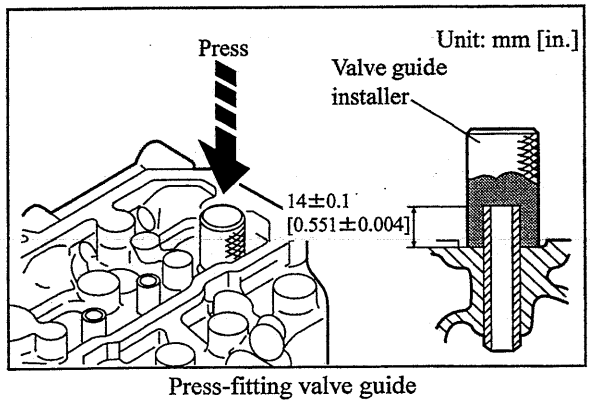
Drawing out valve guide

(2) Use the valve guide installer (special tool) to press-fit the valve guide.

Special tool name	Part No.
Valve guide installer	32A91-00100

⚠ CAUTION

The amount of press-fitting the valve guide is specified. Thus, be sure to use the valve guide installer.

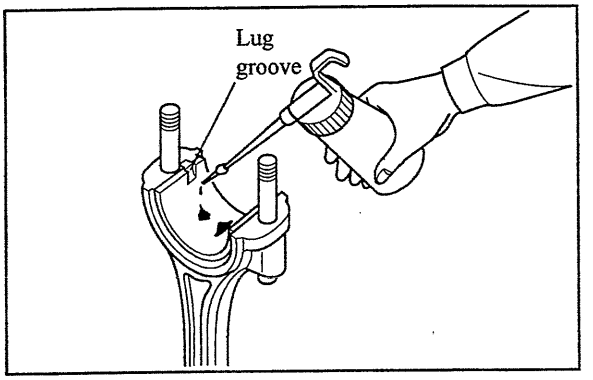


Press-fitting valve guide

1.9 Installing Connecting Rod Tightening Bolts and Bearings

(1) Insert the notch surface on the head of the connecting rod cap tightening bolt firmly before installing the bearing.

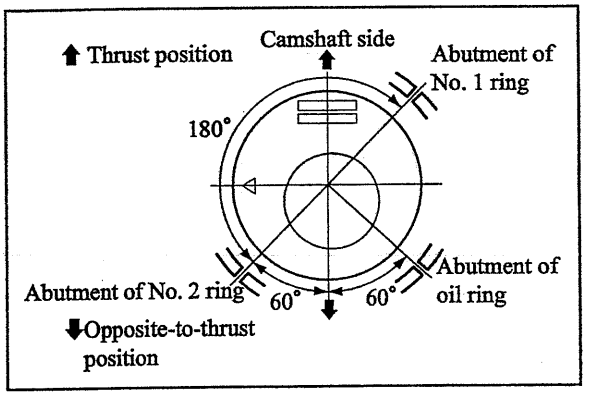
(2) Insert the rod bearing (upper) to the larger end of the connecting rod to fit into the lug groove, and apply engine oil to the inner surface.



Installing connecting rod tightening bolts and bearing

1.10 Orienting Piston Ring Abutments

Apply engine oil to the piston rings, and orient the abutments of the piston rings to the proper positions by avoiding the pin position, thrust position, and the position opposite to the thrust.



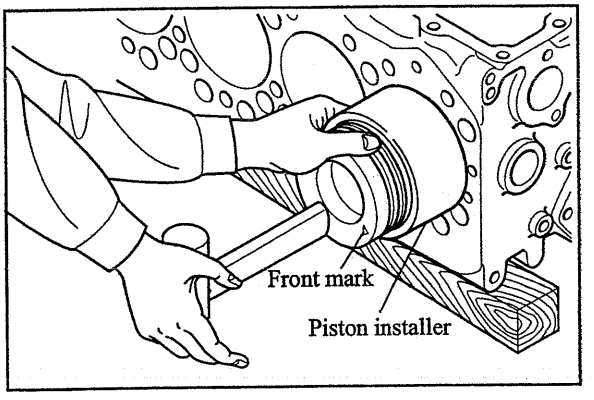
Orienting piston ring abutments

1.11 Installing Pistons

(1) Move the crank pin for installing the piston to the top position, turn the front mark (O) on the piston to the front of the engine, and insert the piston into the cylinder using the piston installer (special tool).

Special tool name	Part No.
Piston installer	34491-00200

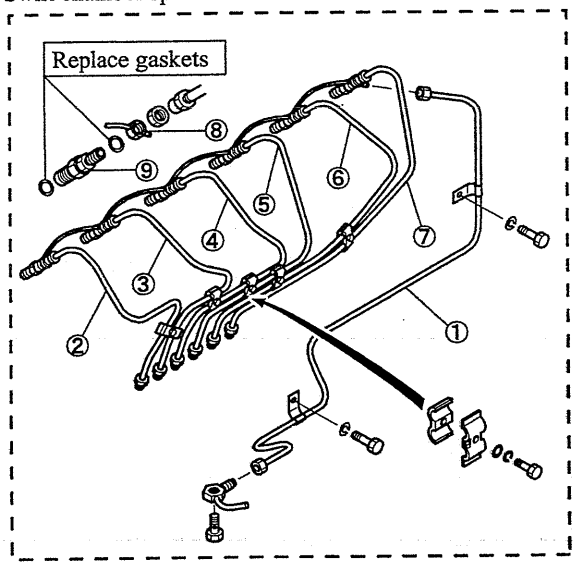
(2) When the larger end of the connecting rod is brought into close contact with the crank pin, turn the crankshaft 180° while pressing the piston head to the position where the cap may be installed easily.



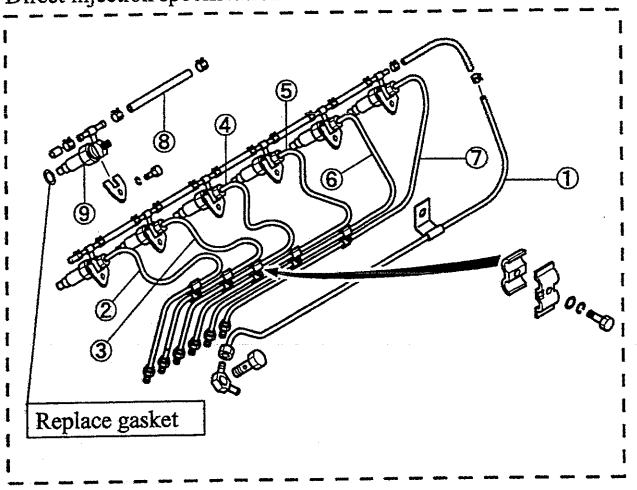
Installing piston

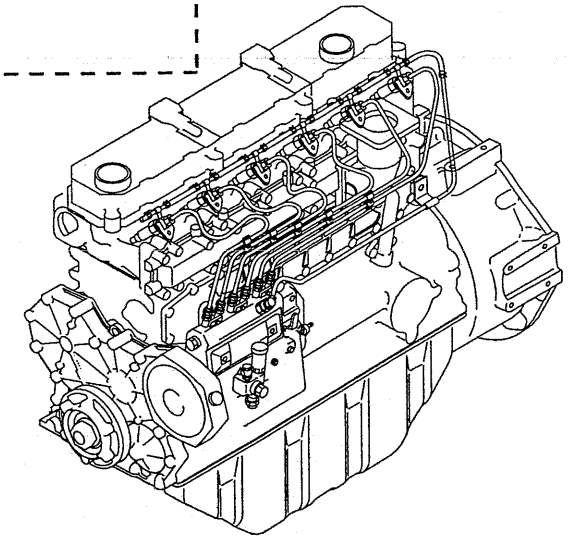
2. Fuel Injection Pipes, Fuel Leak-Off Pipes and Fuel Injection Nozzles (In-line fuel injection pump)

Swirl chamber specification



Direct injection specification





Removal of fuel injection pipes, fuel leak-off pipes and fuel injection nozzles (in-line fuel injection pump)

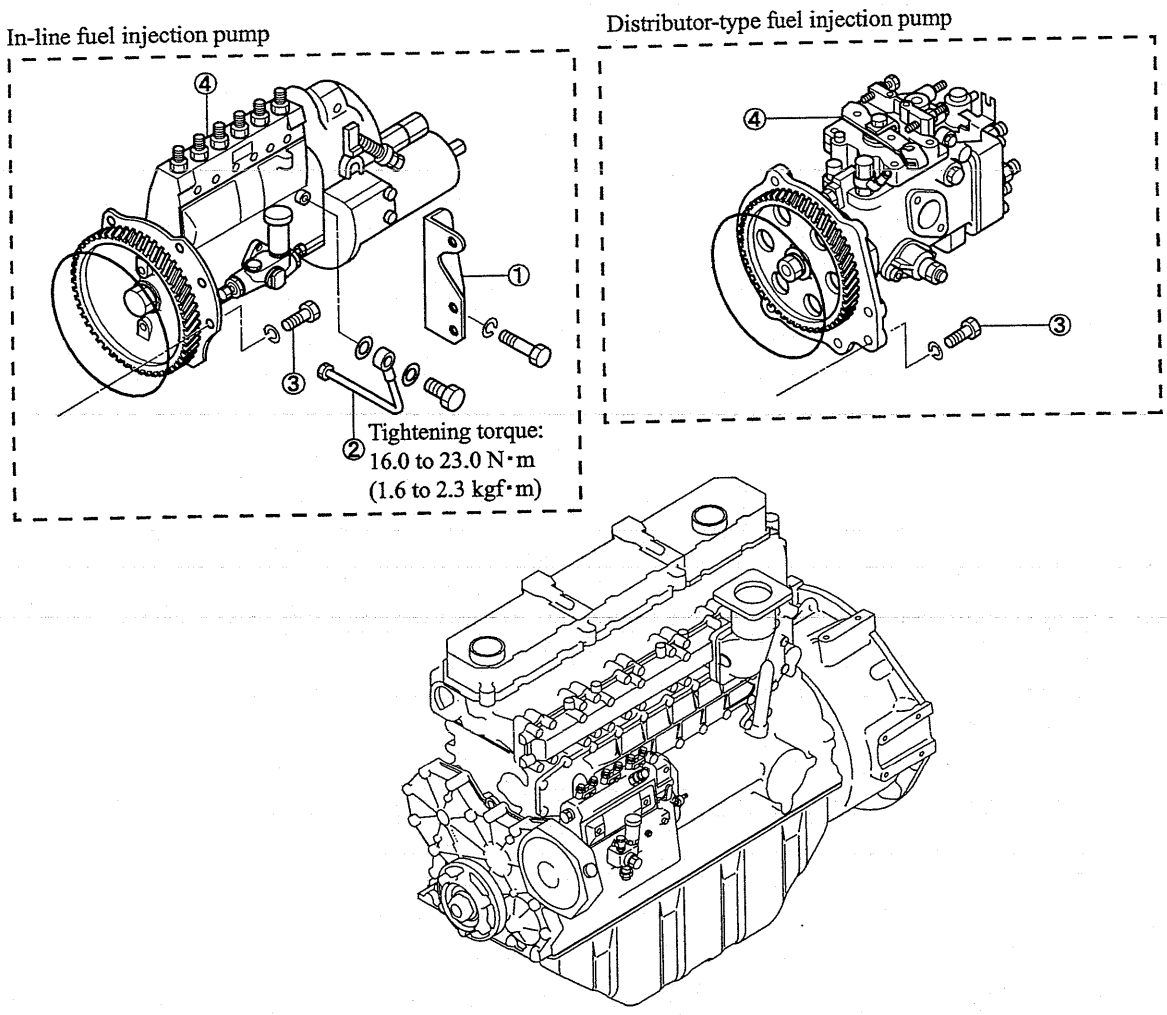
< Removal sequence >

① Fuel return pipe
② No. 1 fuel injection pipe
③ No. 2 fuel injection pipe
④ No. 3 fuel injection pipe
⑤ No. 4 fuel injection pipe
⑥ No. 5 fuel injection pipe
⑦ No. 6 fuel injection pipe
⑧ Fuel leak-off pipe (swirl chamber specification)
Fuel hose (direct injection specification)
⑨ Fuel injection nozzle

⚠ CAUTION

To prevent dust from entering the fuel system, cover all the openings in the injection pump, nozzle inlet connectors and injection pipes.

1. Fuel Injection Pump

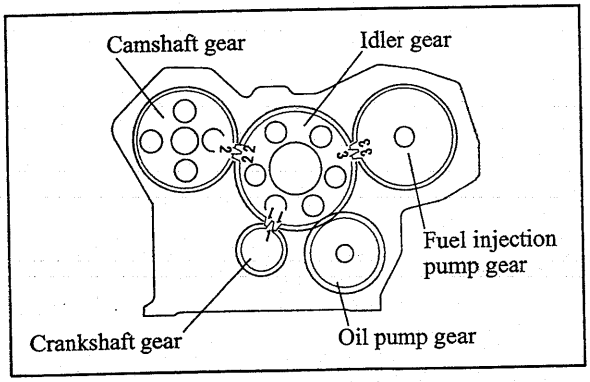


Installation of fuel injection pump
(in-line and distributor-type fuel injection pumps)

< Installation sequence >
④→③→②→①

Install the fuel injection pump after aligning its gear alignment mark with the idler gear alignment mark, and confirm that the alignment marks of the timing gears are as shown in the right diagram.

Note: When the alignment marks of the timing gears are as shown in the right diagram, the No.1 piston is positioned at the top dead center on the compression stroke.



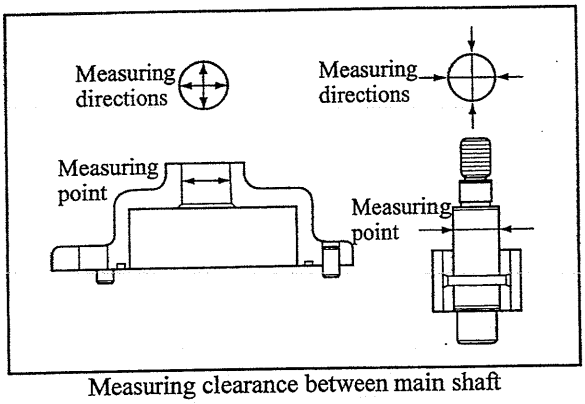
Alignment marks of timing gears

(4) Measuring clearance between main shaft and pump case

Measure the diameter of the main shaft and the inside diameter of the hole in the pump case to find the clearance between the two. If the clearance exceeds the limit, replace the entire oil pump assembly.

Unit: mm [in.]

	Standard	Limit
Diameter of shaft (case side)	15.985 to 16.000 [0.6293 to 0.6299]	—
Clearance between shaft and case	0.032 to 0.074 [0.0013 to 0.029]	0.150 [0.0059]



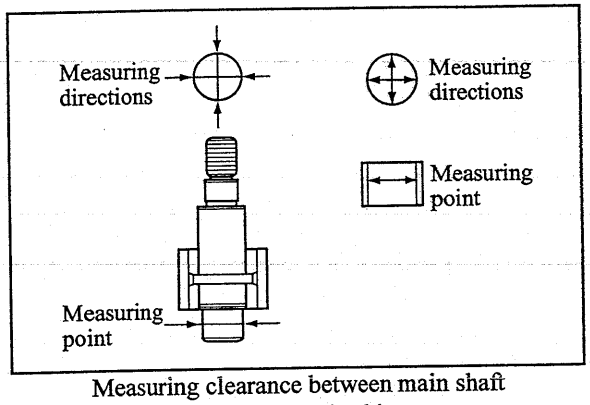
Measuring clearance between main shaft and pump case

(5) Measuring clearance between main shaft and oil pump bushing

Measure the diameter of the main shaft and the inside diameter of the oil pump bushing in the crankcase to find the clearance between the two. If the clearance exceeds the limit, replace the oil pump bushing or the entire oil pump assembly.

Unit: mm [in.]

	Standard	Limit
Diameter of shaft (bushing side)	13.957 to 13.975 [0.5495 to 0.5502]	—
Clearance between shaft and bushing	0.025 to 0.111 [0.0010 to 0.0044]	0.200 [0.0079]



Measuring clearance between main shaft and oil pump bushing

(6) Installing oil pump bushing

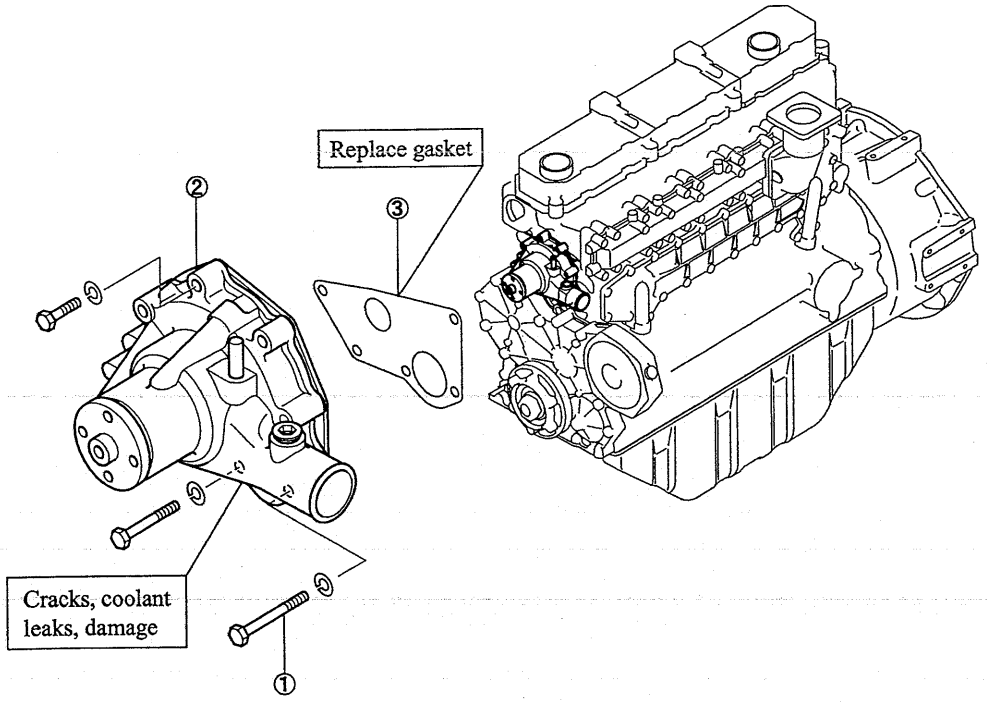
To install the oil pump bushing, use the specified oil pump bushing installer.

Name of special tool	Part No.
Oil pump bushing installer	32A91-00400

⚠ CAUTION

Install the oil pump bushing in the crankcase so that it is even with the front face of the crankcase.

3. Water Pump

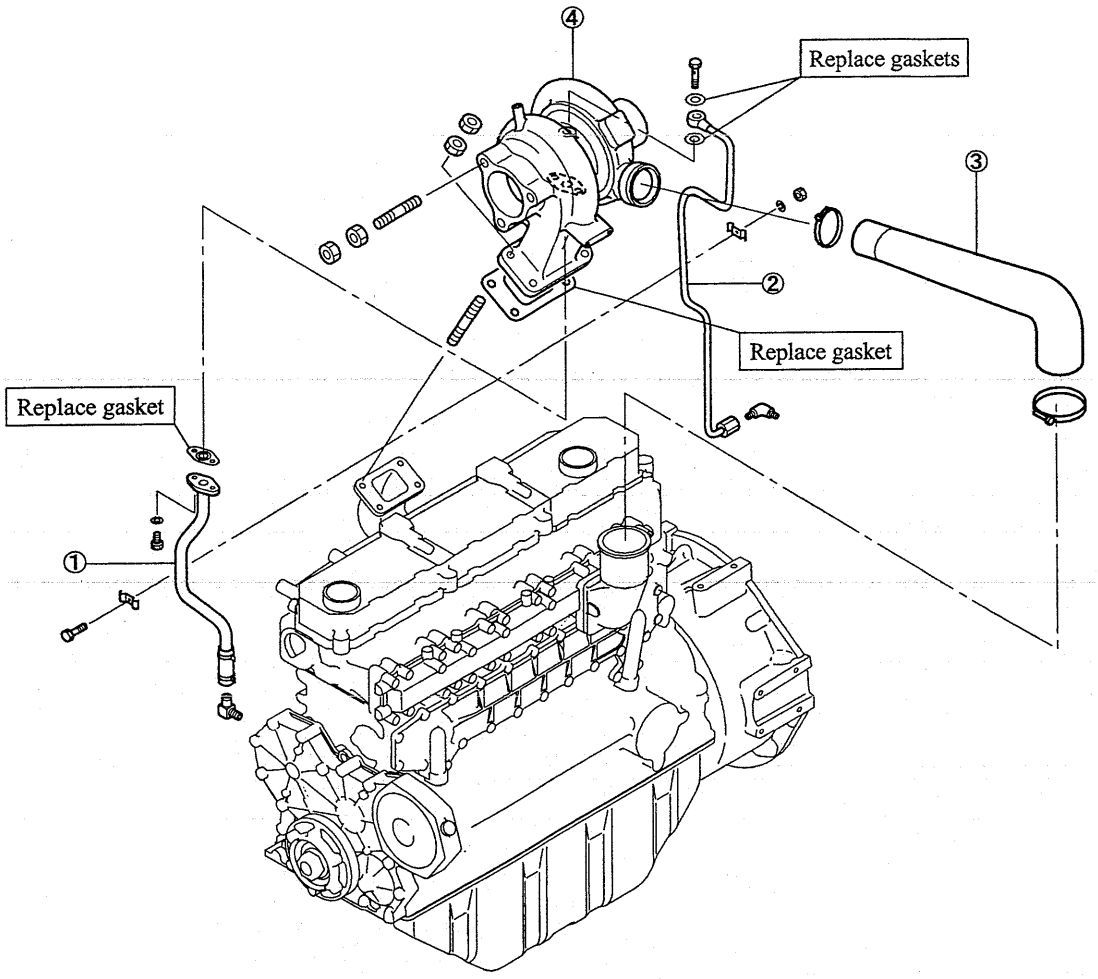


Removal of water pump

< Removal sequence >
① Bolt
② Water pump assembly
③ Gasket

1. Turbocharger

(In-line fuel injection pump specification)



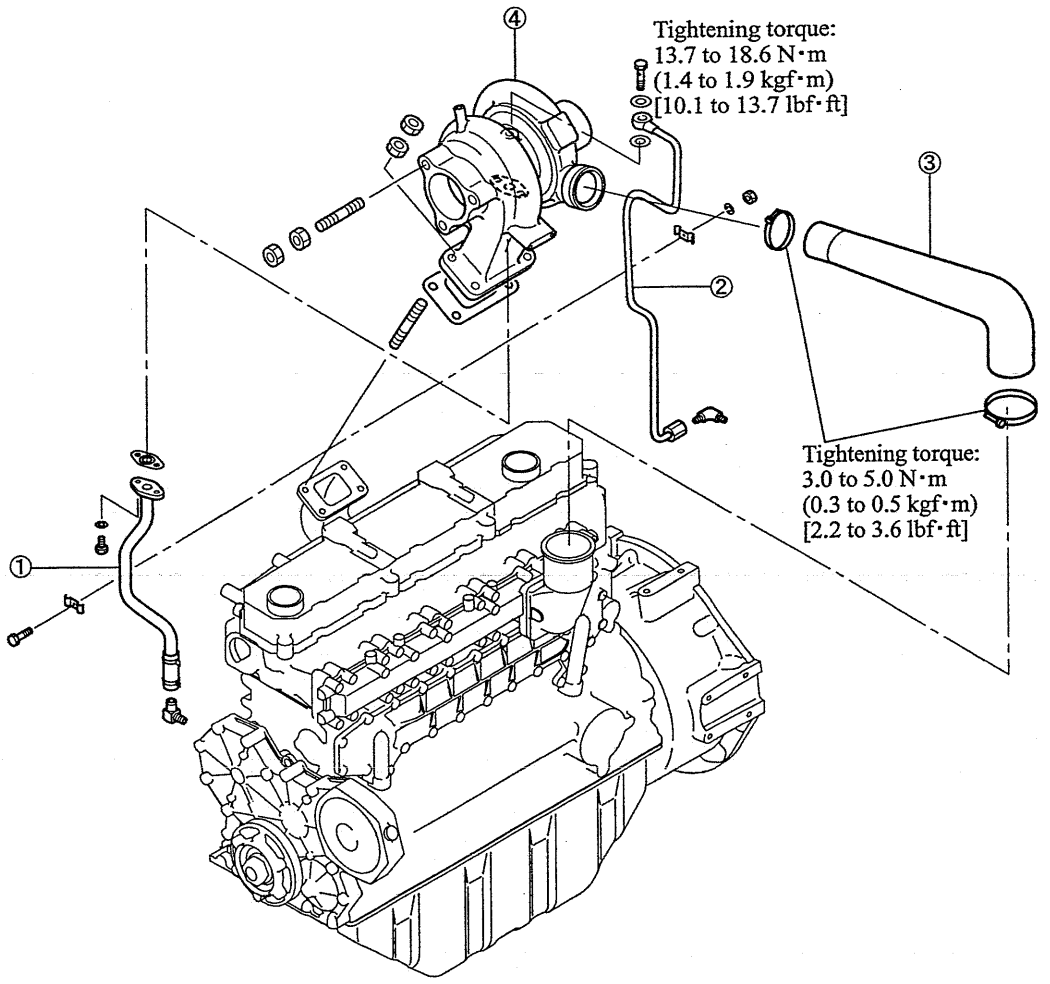
Removal of turbocharger (in-line fuel injection pump specification)

< Removal sequence >

① Oil pipe
② Oil pipe
③ Air hose
④ Turbocharger

3. Turbocharger

(In-line fuel injection pump specification)



Installation of turbocharger (in-line fuel injection pump specification)

< Installation sequence >

④→③→②→①