

Table of Contents



Safety Warning	1
Main matched vehicle types	2
Service Manual of DK4A Diesel Engine Care and Maintenance	3
Service Manual of DK4A Diesel Engine Electric Control System	13
Service Manual of DK4A Diesel Engine Mechanical System	42
Service Manual of DK4A Diesel Engine Function Diagnosis and Fault Remedy	114
Afterword	129

Safety Warning

- ✓ The engine, whose operating range must not be changed at will and whose delivery pressure must not be regulated freely, must not be remodeled at pleasure.
- ✓ The engine in operation must not be adjusted or wiped.
- ✓ Running components of engine must not be approached by loose clothes and long hair or touched by hand.
- ✓ Upon the operation of engine, its exhaust system and supercharging system are very hot and must not be touched by body in order to avoid the scald.
- ✓ Do not open the coolant filler cap directly as the engine is very hot, with a view to avoid the scald by hot fluid stream.
- ✓ The engine at high temperature must not be stopped immediately; instead it should idle for at least 5 min.
- ✓ After being dismounted, both fuel injector and copper washers should be assembled in a one-to-one manner.
- ✓ The oil-water separator should be drained timely in accordance with instructions.
- ✓ The engine, together with components such as wires across the vehicle, fuel pipes and rubber hoses, must not get close to exhaust pipe, supercharger and rotational parts.



Main matched vehicle types

SUV



light-duty bus



Cross-country vehicle



Pickup



MPV



light-duty truck



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Service Manual of DK4A Diesel Engine

Care and Maintenance

Notes for Engine Repair

1. Issue of prevention against invasion by foreign bodies

- (a) The invasion of foreign bodies such as dust, gravel and metal grains into engine may invite the problem.
 - (1) Thoroughly clear the sand and soil on the exterior of engine.
 - (2) Disassembled parts should be covered by plastic film to prevent the intrusion of dust.

2. Issue of protection of components from scuffing

- (a) The injury of fitting surface or rotating section on a component may lead to the oil leakage or burnout.
 - (1) Instead of a screwdriver, a plastic hammer should act gently on the fitting surface of a component to be disassembled.
 - (2) Fixation of a component on a jaw vice, if required, should be done through an aluminum sheet, rather than being accomplished directly.

3. Issue of component cleaning

- (a) Every component, prior to the assembling, should be cleaned fully and then dried in air while being spread with appointed grease.
- (b) Components, for which the alkaline chemical is forbidden to be used, include aluminum ones and rubber ones (cylinder cover gasket etc.).
- (c) Components, for which the cleaning oil is forbidden to be used, are rubber ones (cylinder cover gasket etc.).

4. Issue of assembling position and direction

- (a) Assemble every part as per the pre-assembly position and direction.
- (b) If there is a requirement that pre-assembly position and direction be clearly marked out, it must be strictly followed;
- (c) Take care not to change the assembling position and direction of every dismantled part being arranged and realigned in the disassembling order;
- (d) This must be followed for parts marked with assembling position and direction.

5. For an engine in maintenance, its components that have been dismantled must be placed on a work support prior to the maintenance.

6. Those dismantled components must be arranged and realigned in the disassembling order.

7. A sliding or rotating section must be spread with engine oil.

8. Nonreusable parts, such as washers and gaskets, must be renewed.

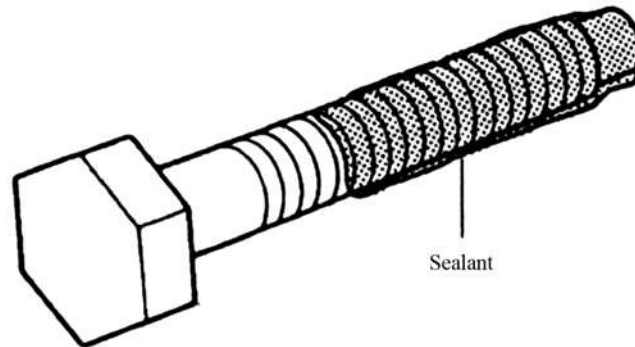
9. Basic notes

- (a) Pre-coated bolt
 - (1) A pre-coated bolt is one whose thread has been coated with sealant.
 - (2) Such a bolt being retightened or loosened or turned must be pre-coated with appointed sealant.

Note: the torque being calibrated must not be below the lower limit of allowable tightening torque.



- (3) In the reuse of a pre-coated part (bolt etc.), the bolt thread, together with the inside of tap hole, must be cleared of old sealant at first, later degreased with gasoline, dried with compressed air, and then spread with appointed sealant, finally tightened under a required torque.
- (4) Depending on the applied sealant, sometimes the bolt must be laid up for specified period to allow the hardening of sealant.



10. Dismounting of components in fuel system

(a) Site of dismounting the components in fuel system

- (1) The disassembly should be done on a airy site where there are no spark-generating devices such as electric welder, grinder, motor and furnace etc.;
- (2) Please do not operate in a pit or its neighborhood which might have been full of gaseous fuel.

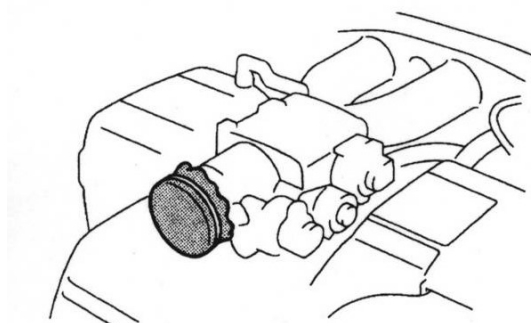
(b) Dismount the components in fuel system

- (1) Extinguishers must be prepared prior to the formal operation;
- (2) In order to prevent the generation of static electricity, the site ground must be sprinkled with enough water when the fuel changeover switch, vehicle and fuel tank are being grounded;
- (3) Please do not use the electric apparatuses such as electric pump and working light, as they may spark or become very hot;
- (4) Please do not use those tools which may spark in the operation;
- (5) Rags with fuel must be handled separately.



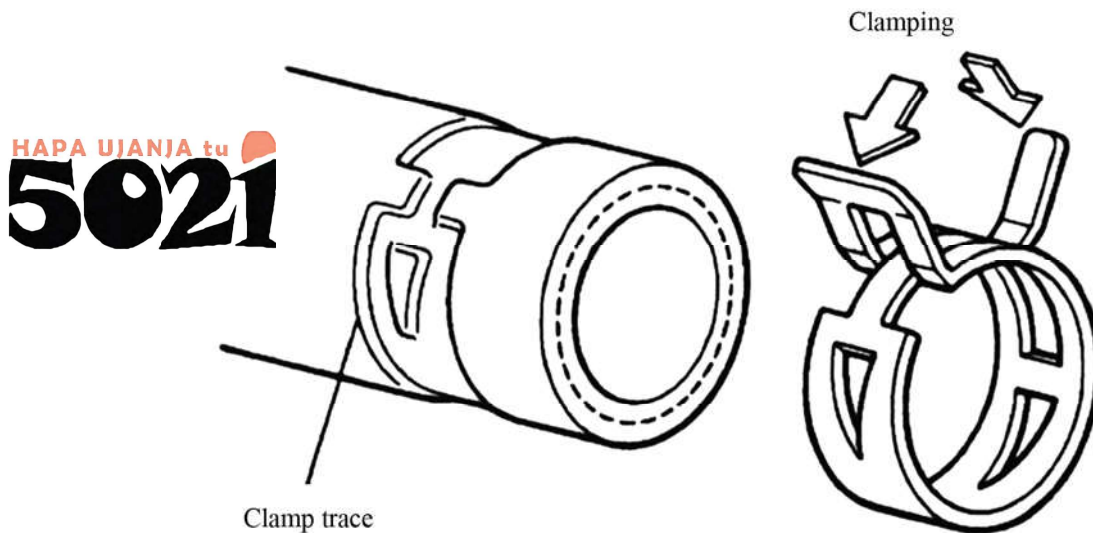
11. Dismounting of components in engine intake system

- (a) The intrusion of metal grains into intake channels will endanger the engine and turbocharger etc.;
- (b) During this dismounting course, parts in intake system that have been taken down must be plugged with clean rags or adhesive tapes, so does the opening on engine side;
- (c) It must be made sure that no metal or gravel has invaded the intake components being installed.



12. Handling of hose clamps

- (a) Make sure of the insertion depth of hose and the position of hose clamps before removing the hose so that these clamps can be totally restored in due course;
- (b) Those deformed or loosened clamps must be changed;
- (c) As the hose is being reused, its clamps must be placed where the original clamps are located;
- (d) A plate-spring clamp, upon its installation, must be tightened by applying force in the arrow direction.



13. Applicable fuel (recommended):

in summer: 0#

In winter: -10#

At -20°C : -20#

At -30°C : -35#

14. Applicable grease (recommended): API

CF-4(or higher) 20W-50

GB11122 CF-4(or higher) 20W-50

Note:

- (1) Make sure to use clean oil with required brand, which must never be replaced by normal oil in order to avoid the occurrence of accidental faults such as engine scuffing and shell sticking.
- (2) The oil into diesel engine must not contain impurities and water. The area near fuel tank filler should remain clean.
- (3) It is strictly forbidden to mix diesel fuel or oil of different brands and manufacturers. Mixture of both new and old oil is strictly prohibited in the replacement of oil for technical maintenance.
- (4) Change the oil filter timely, as regulated.

15. Choosing of coolant

- (1) The coolant should be anti-freeze and rust-proof to prevent water channel (jacket) from scaling, as the scale may result in such faults as high water temperature and engine scuffing.
- (2) As the antifreeze is harmful to human body, it should be stored in an original vessel to avoid the contact by some person.

- (3) In the absence of antifreeze, distilled water or clean soft water (boiled water, snow water, rainwater) may be used. But water from river, well or stream or tap water, which is hard and intended to be used, must be kept clean and softened by adding 2g trisodium phosphate (TSP) into 1L water.

Note:

- (1) In the use of a diesel engine, it is disallowed to add freely some coolant against the regulations in this manual just because of the insufficiency of coolant.
- (2) If the leakage of cooling system leads to the insufficiency of coolant, after the remedy of fault, the same brand of coolant should be added when the engine has become cool.
- (3) Do not use inferior coolant or confuse various brands of coolant, otherwise the lifespan of diesel engine may be seriously affected by corrosion and scaling etc.
- (4) It is strictly banned to use various kinds of unprocessed hard water. Otherwise, the consequent scaling may bring about such faults as high water temperature of engine and engine scuffing.



Technical Characteristics

1. Main technical parameters of generator and starter

Name	Item	Parameter
Generator	Nominal voltage	14V
	Rated current	80A
Starter	Voltage	12V
	Delivered power	2.7kW

Name of bolt or nut	Tightening torque	Name of bolt or nut	Tightening torque
Camshaft timing gear bolt	90 N·m~98N·m	Cylinder head bolt	First: 85 N·m Second: another 90°tightening Third: another 90°tightening
Bolt on main bearing cap	First: 50 N·m±5.0N·m Second: another 90°tightening		
Flywheel bolt	178N·m	Crankshaft pulley bolt	365N·m
Connecting-rod nut	First: 35 N·m±3.5 N·m Second: another 90°tightening		

Note: a special torque wrench must be used for tightening main bolts and nuts.

Specifications of main accessories

Accessory systems and their name		Type	Accessory systems and their name		Specifications
Lubrication system	Oil pump	Rotor type	Cooling system	Water pump	Centrifugal type
	Oil filter	Full flow		Thermostat	Wax type
Fuel supply system	Fuel filter	Full flow		Pre-heating system	Voltage of heater plug 12V
	High-pressure pump	Cylinder type			
	High-pressure pump	CPIH high-pressure pump	Electric EGR system	EGR system	
	Fuel injector	6 orifices			
Intake system	Supercharger	Exhaust turbocharging			

Operating of Diesel Engine

a. Pre-start preparation

- Check if various engine components are normal and correctly and securely connected, and if every rotating part is flexible;
- Supplement enough oil, fuel and cooling water as required, and observe if there is leakage;

Note: when the oil level is below the warning mark on dipstick, enough oil should be added timely lest a major accident might be caused.

- Check the looseness of water pump belts;
- Check the level of electrolyte inside the battery;
- Check the tightening of various connectors on electric devices such as battery, generator and starter;
- Any gas into fuel system must be got rid of prior to the start of diesel engine.

Air discharging method:

Firstly loosen the fuel supply pipe and pump the fuel with hand pump till no bubble exists. And then unscrew the screw cap at the outlet of fuel injection pump, drive this pump with starter until fuel is seen out of pump outlet.

b. Starting of fuel engine

In any case, the engine must be started under zero loads (in neutral position)

- Switch on the power supply with key to observe if every electric instrument can indicate normally.
- Start the engine.
- Place the switch in the starting position, where the engine should have been started within 15s. If not, a second starting attempt should be made after a 2s interval. If three consecutive starting attempts are in vain, the root cause should be investigated. No further attempt should be made before the remedy of fault. Upon the successful start of engine, the button of switch should be released immediately to allow the complete disengagement between starter gear and flywheel toothed ring lest the starter is damaged due to reverse driving.
- The engine should idle for 3—5 minutes after being started. Meanwhile, the indication of oil pressure gauge and the cooling water circulation should be checked. **Immediately running the just-started engine at a high speed is strictly banned.**

c. Coldstart of fuel engine

In a cold environment, the engine will be hard to be started. The lower the temperature is, the more difficult the start becomes. At $< -15^{\circ}\text{C}$ temperature, the difficulty in starting might be caused by the following aspects without coldstart assistance:

- As the environment temperature is low, the temperature of gas into cylinders is low, so is the compression end temperature inside the engine. As a result, the compression ignition temperature can't be reached to burst into combustion.
- In a cold environment, the diesel fuel has higher viscosity and inferior atomization quality, which make the ignition very difficult.
- Low environmental temperature may contribute to higher oil viscosity, greater starting resistance torque, lower starting speed, more air leakage in compression, higher heat transfer rate of working medium to the surroundings, as well as lower compression end temperature. Thus the ignition becomes difficult.
- Low environmental temperature may increase the internal resistance of battery and weaken its charging and



discharging capabilities, thus reducing the starting torque to cause the difficulty in starting. Solutions to such a coldstart difficulty include:

- Introduction of proper diesel fuel.
- Introduction of proper engine oil.
- Selection of correct starter and battery.
- Preheating of diesel engine. The coolant may be replaced by boiled water to preheat the engine. Supply the radiator with a proper amount of boiled water, which shouldn't be let out until the water jacket has become cold. Add new hot water to start the engine and drain it when the engine gets warm, and then add the rustproof antifreeze.

d. In-service inspection

- Check if there is knocking, looseness or other unusual sound.
- Check if there is some abnormal burning odor sent out by an overheated electric device.
- Check if there is leakage in fuel, cooling and lubrication systems.
- Check if the readings (indications) for oil pressure, coolant temperature, electric current, fuel level and others are normal.
- The above cases, if any, should be settled promptly.

e. Engine cutoff

- A diesel engine under heavy load, if expected to stop working, should at first lower its speed and load to a min. zero-load speed, at which the engine should run for 3~5 minutes before its cutoff. A sudden cutoff is disallowed for the engine with overhigh water temperature and overweight load.
- If the cooling water fails to be antifreeze in a $<5^{\circ}\text{C}$ environment, it should, after the engine cutoff, be totally drained out of engine so as to avoid the frost cracking of cylinder block.

5. Running-in of engine

New or just overhauled engine must at first experience a running-in process featuring gradual increase in load (originally small) prior to its usage. Through this process, a sound fit can be achieved between surfaces of moving parts to avoid abnormal wear and damage. To a large extent, the service life, working reliability and economy of engine depend on the running-in result in the initial operation stage of engine. Hence the user should follow strictly the running-in specifications.

(a) Running-in

- A new engine should complete a 2000 km running-in period on an automobile as per the running-in specifications (see the following table).
- An engine, whose pistons, piston rings, cylinder liners, main bearing shells and connection-rod bearing shells have been changed in an overhaul, should complete its running-in period in 1/3 of various road hauls by automobile, as listed on Table 4-1. The running-in process also allows the further check on assembling quality of every engine part for necessary adjustment.

Road haul(km)	Load on automobile	Engine speed(r/min)
0~300	Zero	Not more than 50% rated speed of relevant engine
>300~1000	Not more than 25% rated load	Not more than 50% rated speed of relevant engine
>1000~1500	Not more than 50% rated load	Not more than 50% rated speed of relevant engine
>1500~2000	Not more than 75% rated load	Not more than the rated top speed of engine

(b) Notes for running-in

- Make sure that in the running-in process, attention should be paid to observe and listen for the working conditions of various engine systems, and a check should be given on oil leakage, water leakage, air leakage, oil pressure, coolant temperature, engine speed and exhaust color. A fault or abnormality, if any, should be removed at first and then followed by further running-in.
- A running-in vehicle should run on a level-1 or level-2 road, rather than on an inferior road (in particular on a beach). Full-speed or overloaded running is strictly banned.

(c) Technical maintenance after the running-in

Upon the completion of running-in, the engine should be checked, cleaned and adjusted once for the removal of metal powder deposited in the lubricant and the adjustment of unreasonable clearances. Main contents involved in this period include:

- Drain the oil in lubrication system, clean the lubrication system, change the oil filter, and renew oil into specified brand;
- Check and adjust clearances of intake and exhaust valves, as listed below (in cold state):
Intake-valve clearance:(0.2mm~0.3 mm) / exhaust-valve clearance:(0.35 mm~0.45 mm)
- Check the tightening of bolts on all points, and retighten the cylinder head bolts as required (in the case of oil/water/air leakage)

Note: only after the completion of running-in and maintenance according to technical requirements can the engine enter normal operation. Otherwise, the service life of engine will be shortened.

(d) Notes for operating a new vehicle

Abiding by the following rules in driving a new vehicle can not only lengthen the service life of vehicle, but save the diesel fuel.

- Maintain normal coolant temperature and regular oil pressure
- Keep the vehicle running at normal speed instead of a high speed
- It is disallowed to slam acceleration as the vehicle is being started
- Try to avoid sudden braking in the initial 300 km haul
- The vehicle shouldn't run at low speed when the shift lever of gearbox is pushed into a high gear
- Do not drive the vehicle at high or low speed for a long time, but shift gears in due time according to the driving conditions
- Carry out the technical maintenance as required when the running-in haul for a new vehicle amounts to 2000km



6. Technical maintenance of diesel engine

Periodic maintenance can keep the engine in a long-time, satisfactory, technical state, so our customers must follow the specifications for careful technical maintenance, during which special attention should be paid to component cleaning. The dismantled parts in the reinstallation should be washed up and correctly installed, and then the engine should be started for a check on its running state.

(a) Technical maintenance period

All items of scheduled technical maintenance fall into 2 categories – daily maintenance and periodic maintenance based on the law that the deteriorating degree of technical state varies with component. The following engine operating time or road haul has been suggested by assuming the automobile runs on a level-1 or level-2 road. Given a tougher environment, both the period and haul should be cut by a half.

- Daily maintenance: generally at the end of every 8~10h shift.

- Periodic maintenance: after every accumulated 100h runtime of engine or every 5,000 km road haul of automobile; after every accumulated 200h runtime of engine or every 10,000km road haul of automobile; and after every accumulated 1,600h runtime of engine or every 80,000km road haul of automobile.

(b) Contents of technical maintenance

In order to ensure the normal running of engine, the following process should be abided by for technical maintenance.

- Daily technical maintenance

(1) Check the level of fuel, coolant and oil, and add as required if necessary.

Note: Only in the engine miss can various fluid levels be correctly checked.

Note: Never fuel the fuel tank when the engine is running. On a vehicle working in a sweltering climate, the tank must not be topped up; otherwise the fuel will overflow due to expansion. Once overflowing, the spill must be wiped off immediately.

(2) Clear the dust on battery and the spilled electrolyte to ensure the vent holes are unhindered. The battery in normal use hardly needs any maintenance, but at high temperature, needing regular check on electrolyte level. The fluid level should be 10~15 mm above the polar plate and if insufficient, should be made up by distilled water.

(3) After the start of engine, check if there is fuel, water or air leakage (“three leakages”) and timely remove it if any.

(4) Check the fixedness of all accessories.

(5) Observe the running state of started engine and check the performance of instruments. Timely repair or change the damaged instruments.

(6) Keep the engine clean. In particular, the electric devices must not be contaminated by oil and the radiator must not be covered with foreign bodies.

Note: if the engine works in a dusty environment, its air filter should be disassembled daily and dusted.

(c) Periodic technical maintenance of engine

After every 100h running period of engine or every 5,000 km road haul of vehicle, in addition to the above maintenance contents, the following should also be included:

(1) Clean the cartridges of oil filter, air filter and fuel filter.

(2) Check the coolant and clean the radiator.

(3) Check the fixedness of engine.

(4) Check the looseness of water pump belt.

(5) Check and adjust the valve clearances if necessary.

After every 200h running period of engine or every 10,000 km road haul of vehicle, in addition to the above maintenance contents, the following should also be included:

(1) Change the sump oil and oil filter cartridge.

(2) Change the fuel filter cartridge.

(3) Check valve clearances and adjust them if necessary.

(4) Check the water pump performance and water seals.

(5) Check if electric devices and wires have been connected securely and replace those burned out.

(6) Clean out the furring in pipes of cooling system.

(7) Clean the crankcase ventilation system.



- (8) Check as required the performance of supercharger rotor and remove the pipe connecting air compressor and air filter to rotate the rotor. If the rotor runs smoothly and can rotate freely for more than one revolution, it should be considered as trouble-free. Otherwise, the supercharger should be disassembled for internal inspection.

Note: make sure that, in the inspection of rotor performance, the surroundings and external environment around the disassembly site are absolutely clean. No foreign bodies should fall into the supercharging system, or a serious consequence will be caused. Normally only a Supercharger Company or special service center is qualified for this disassembly. So the user must not disassemble and reassemble the supercharger assembly at his discretion.

- (9) Dismount the compressor housing as required to check if oil leaks from the compressor end. Meanwhile, clean the housing cavity and impeller surface of compressor. But take care never to damage the blades at the time of cleaning. This task should be carried out by a service man from supercharger manufacturer.

After every 1600h running period of engine or every 80,000 km road haul of vehicle, in addition to the above maintenance contents, the following should also be included:

- (1) Disassemble and wash the engine to remove the oil stains and furring. Clean all the lubrication pipes and oil channels.
- (2) Dismount the cylinder heads as required to polish the valves and to remove the carbon deposited in the combustion chamber.
- (3) Check the wear of piston ring, cylinder liner, connection-rod small end bushing and connection-rod bearing shell, which, if necessary, should be changed.
- (4) Check the wear of main bearing brass and thrust pieces.
- (5) Check the wear of engaging surface of drive mechanism and drive gears and measure their engaging clearances. If necessary, repair or change the troubled ones.
- (6) Check the oil pump. Check upon disassembly or measure the damaged parts for adjustment.
- (7) Check the cylinder gaskets and intake/exhaust pipe gaskets, and change those damaged or disabled.
- (8) Check the generator and starter. Clean all mechanical parts and bearings, which, if blow-dried, should be re-greased. Check the wear of starter gears and the flexibility of driveline.
- (9) Disassemble and check the supercharger assembly as required, and change the damaged or disabled parts:
 - Clean the intake connection pipe, compressor impeller and compressor housing, and get rid of deposited carbon in impeller and volute.
 - Check the movable parts in supercharger and dial the rotor with finger. The rotor rotating for several revolutions with the aid of inertia force can be regarded as running flexibly. If there is inflexibility in rotation or seizure or knocking, the rotor should be considered abnormal so that an adjustment or repair is needed.
 - Check the axial displacement of rotor shaft, which, if longer than 0.3 mm, indicates an oversize wear of supercharger thrust bearing and the replacement necessity for this bearing.
 - Check the radial clearance between compressor impeller and compressor housing by pushing down the impeller radially with finger. At this moment, this clearance should be at least 0.1 mm. If not, the floating bearing of supercharger should be changed.

Seasonal technical maintenance

- (1) Winter-oriented fuel and oil must be used and the water content in fuel should be paid attention to for the prevention against fuel freezing.

- (2) The cooling system had better be filled with antifreeze, or all the cooling water should be drained when water temperature drops to 40—50℃ upon the parking.
- (3) A vehicle in a frigid season or region shouldn't be parked in the open air.
- (4) Both oil and cooling water can be heated to support a coldstart.

Notes for technical maintenance

- The operator should, according to the regulations on technical maintenance, maintain the engine by item and quality, without cutting any item of maintenance or lengthening the maintenance period at will.
- The disassembly-based maintenance should prevent dust from intruding upon the engine.
- Some maintenance operation or adjustment, demanding and complicated, should be carried out by professional technician or sent to “Special Service Station of Mianyang Xinchun Power Machine Co., Ltd.”.

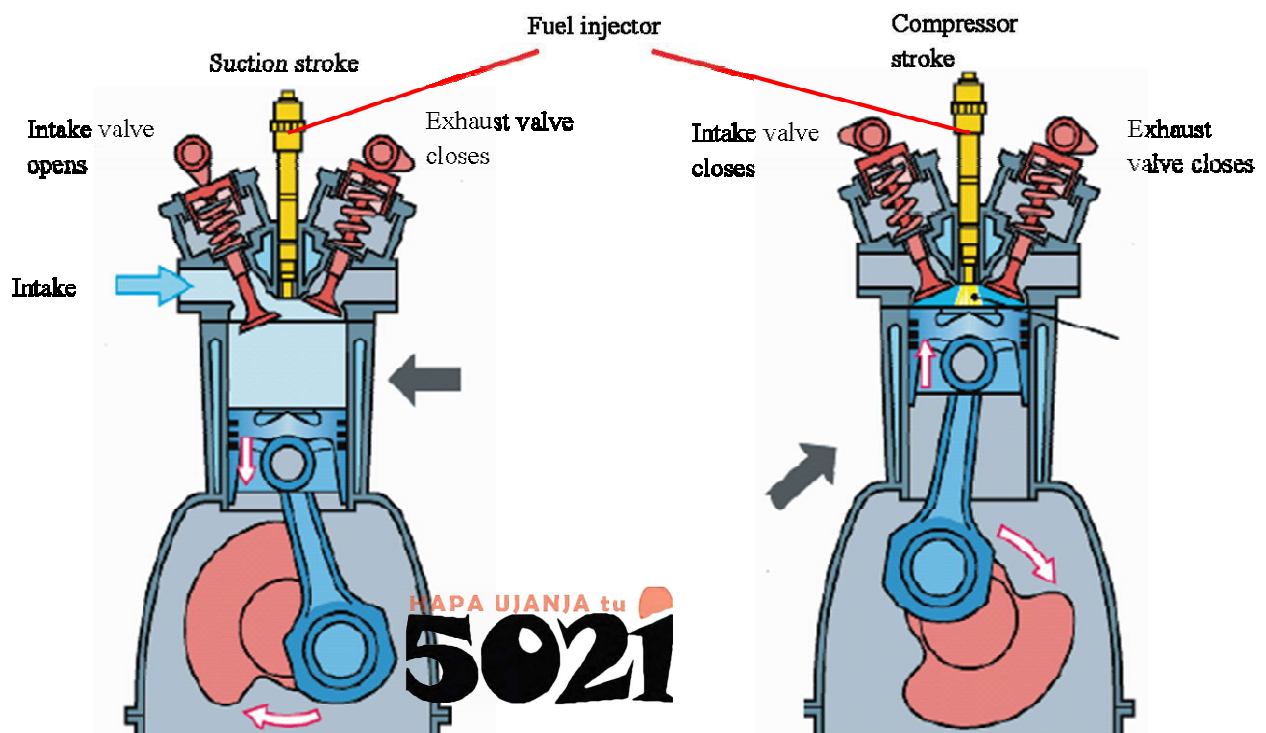


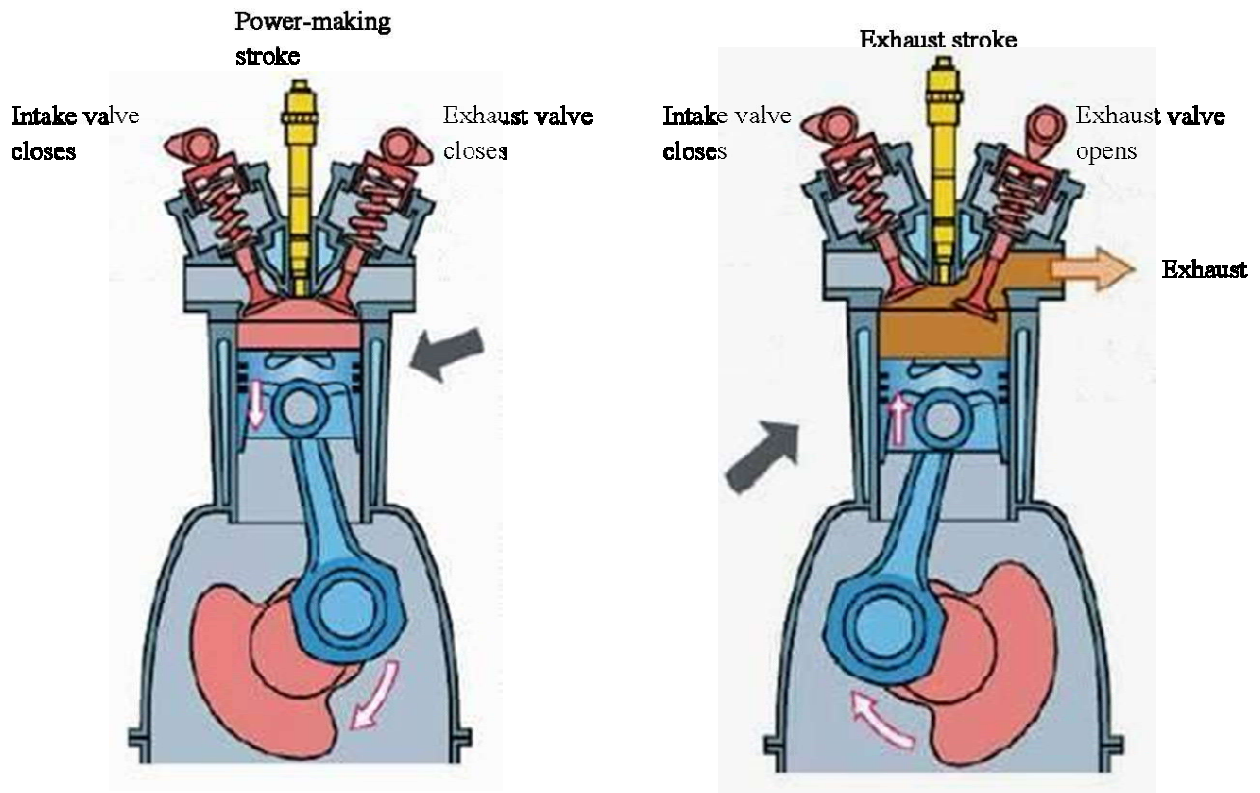
Service Manual of DK4A Diesel Engine

Electric Control System

1. Fundamentals of diesel engine	{	3.1	Core components	{	3.1.1	High-pressure pump
2. Overview of common-rail system					3.1.2	Fuel injector
3. Common-rail system components					3.1.3	Fuel rail
					3.1.4	ECU
	{	3.2	Other components	{	3.2.1	Crankshaft position sensor
					3.2.2	Phase sensor
					3.2.3	Airflow sensor
					3.2.4	Heater plug
					3.2.5	Heat-plug Control unit
					3.2.6	Fuel return pipe
					3.2.7	Fuel filter
					3.2.8	Water temperature sensor
					3.2.9	Accelerator pedal sensor
					3.2.10	High-pressure fuel pipe
3.2.11					EGR valve	
3.2.12					Turbocharger	

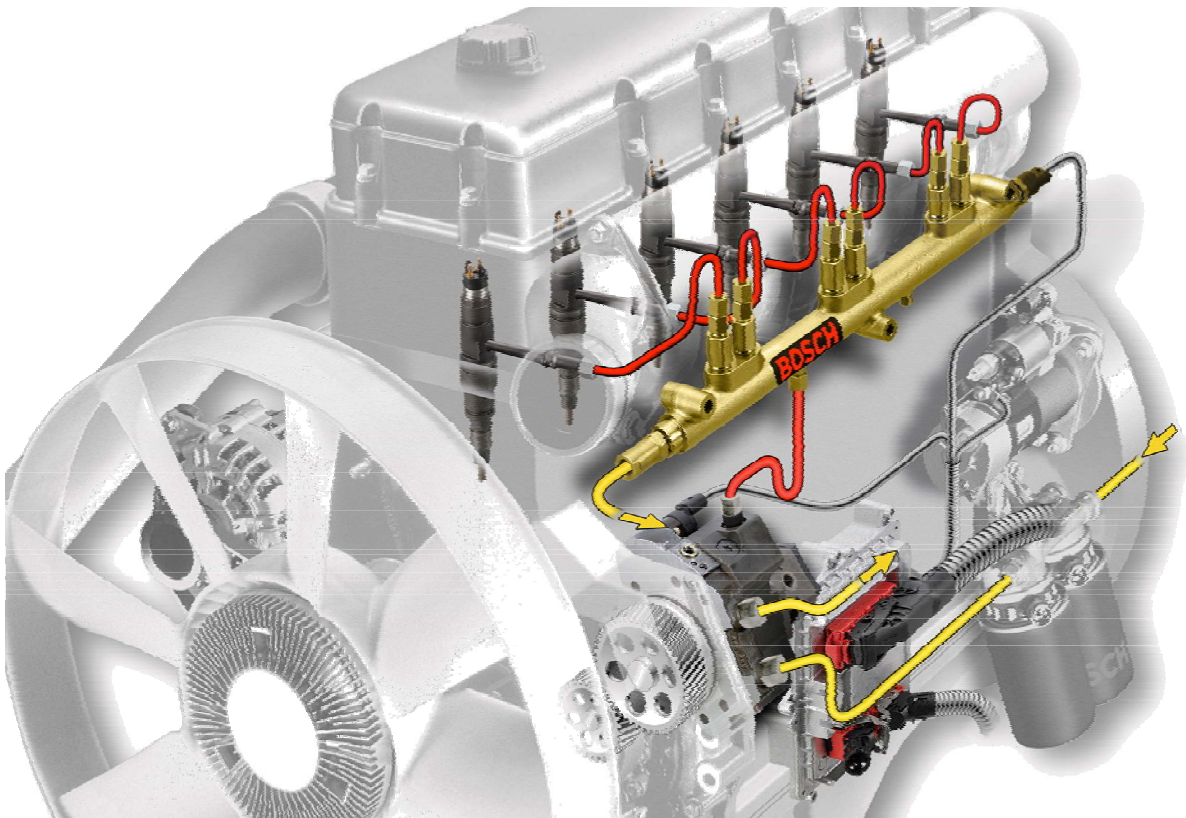
1. Fundamentals of Diesel Engine

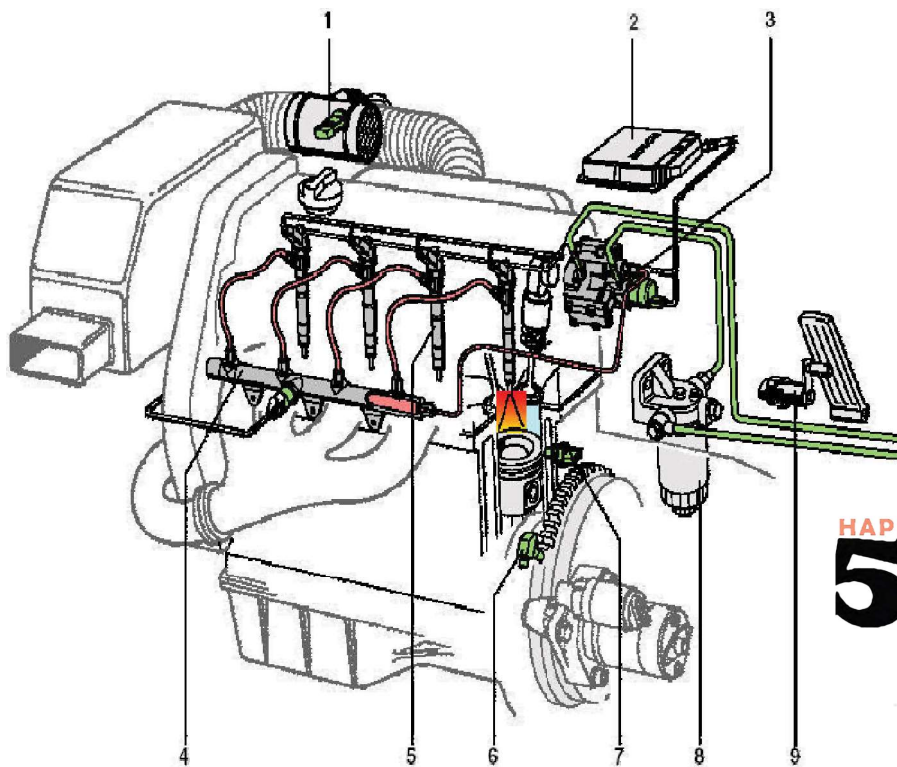




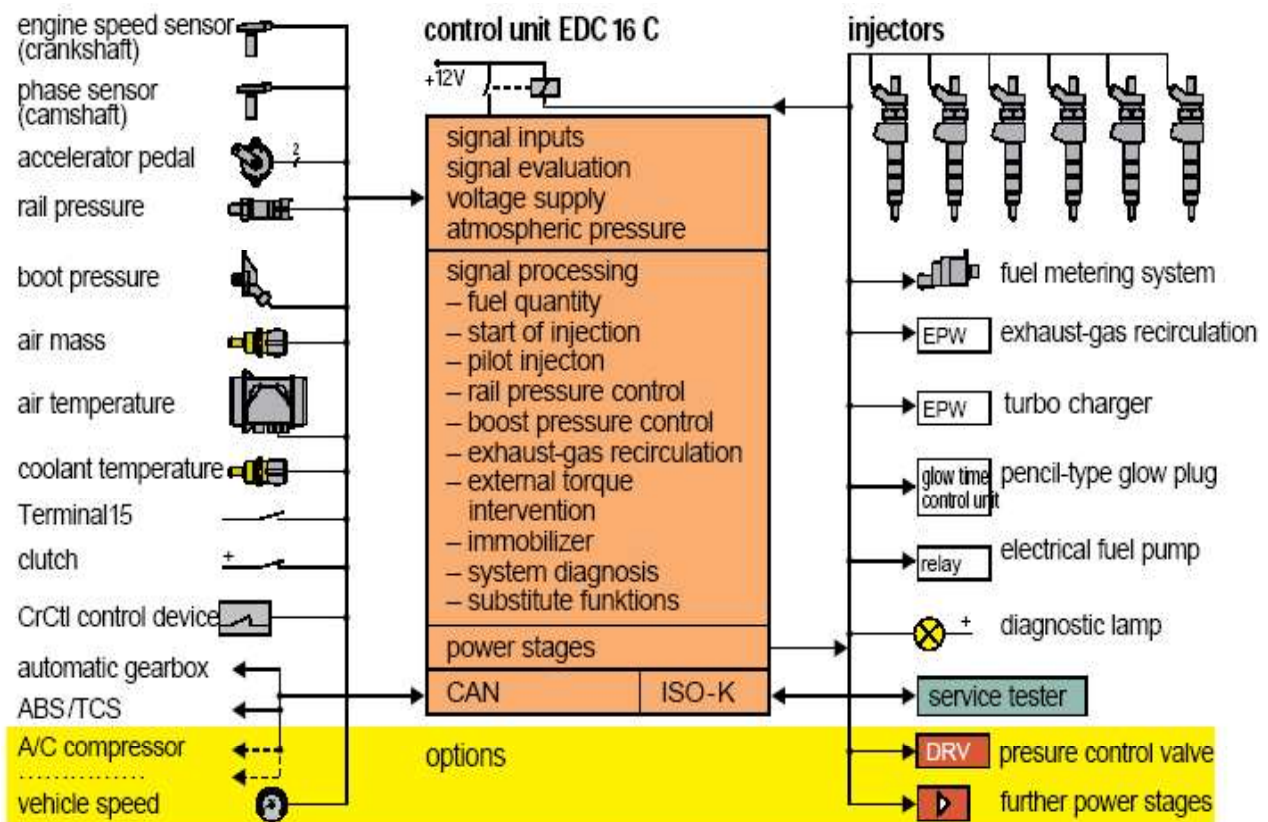
2. Overview of common-rail system

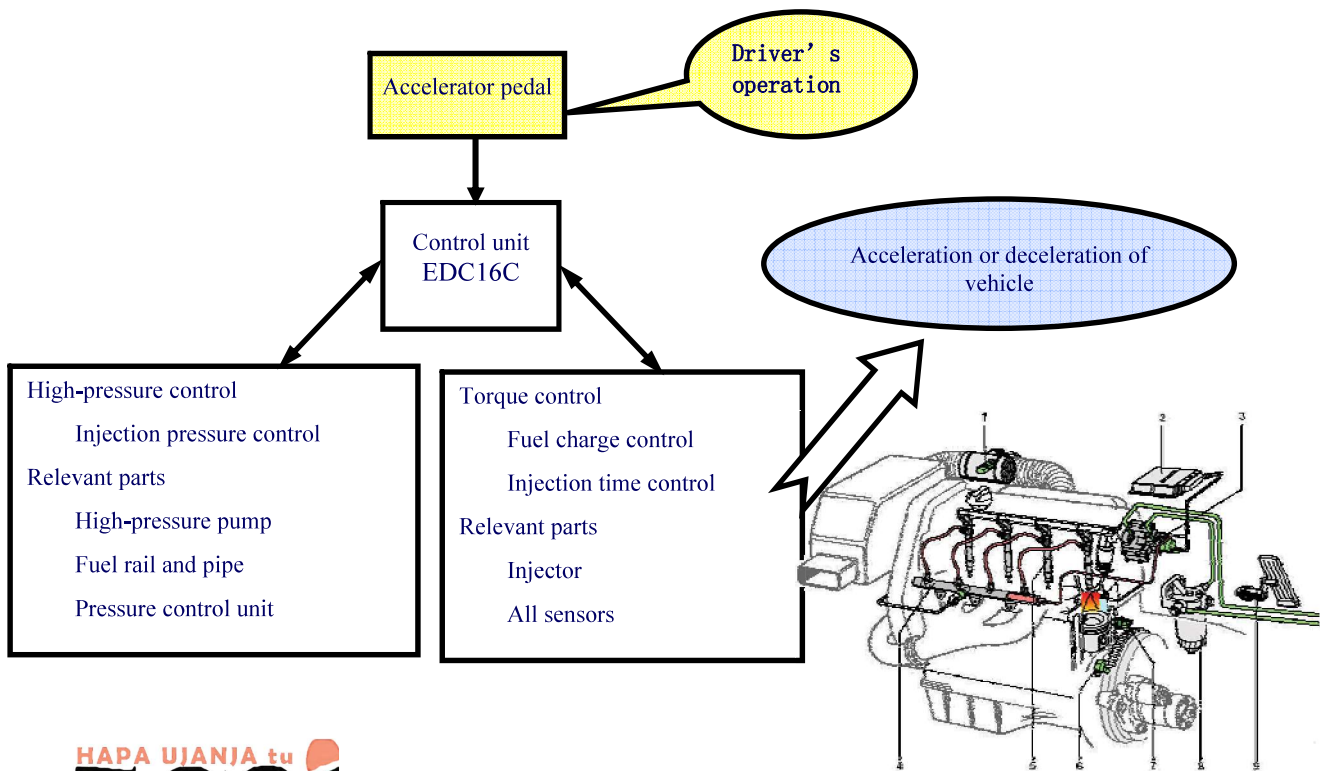
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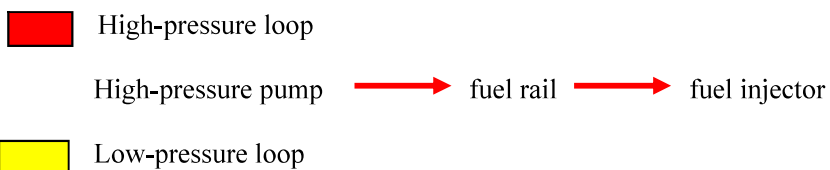
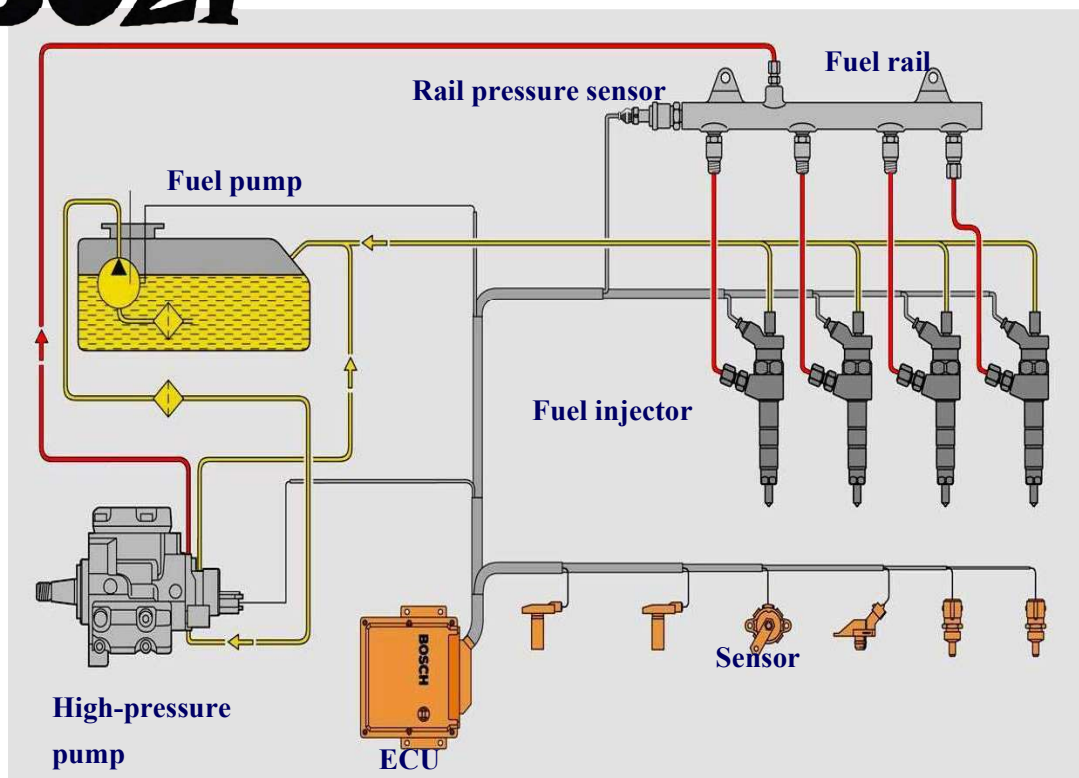


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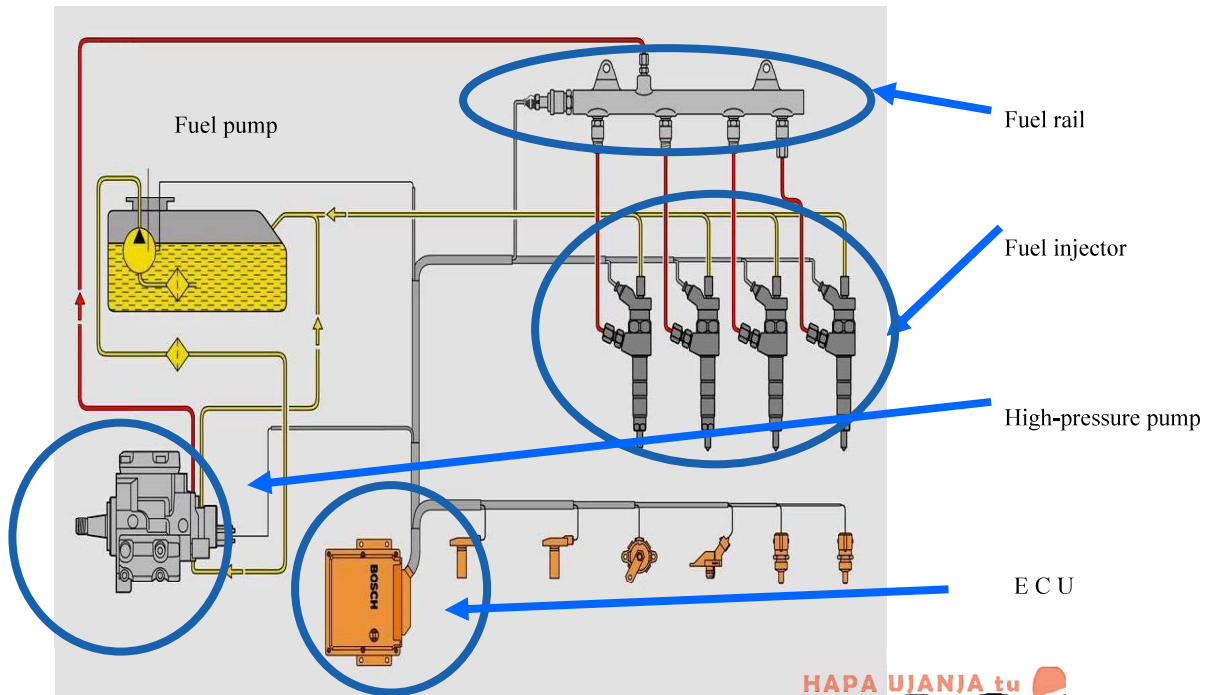


Fuel pump → high-pressure pump

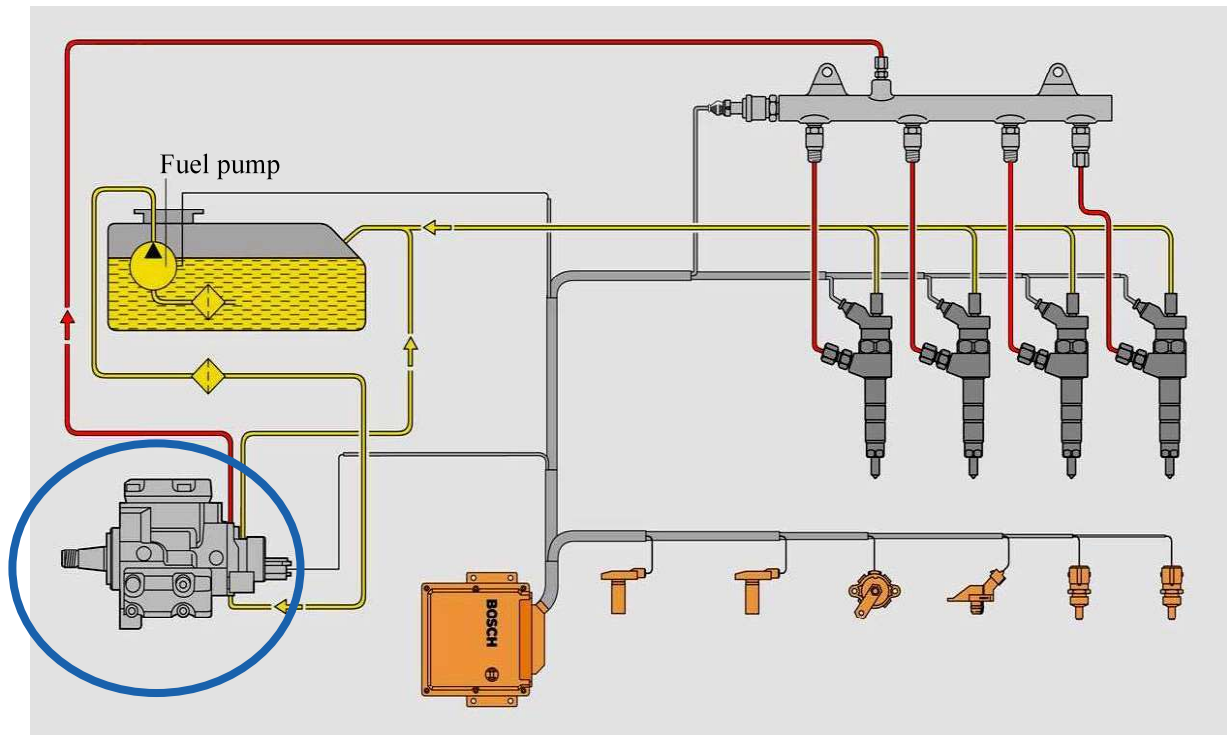
High-pressure pump → fuel tank

Fuel injector → fuel tank

3. Common-rail system components - core components



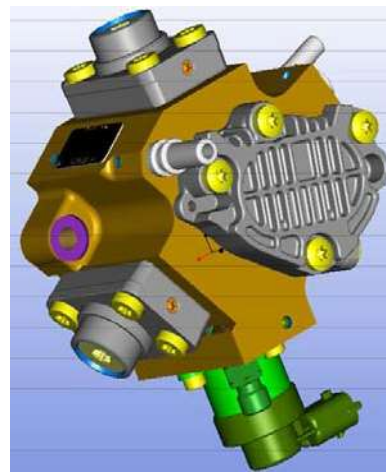
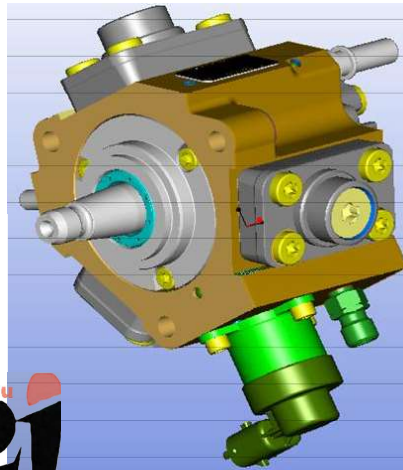
3.1.1 Core components – high-pressure pump



The common-rail high-pressure fuel pump CP1H, which has integrated the fuel feed pump, has 3 radial pistons. It is driven by gears and lubricated with diesel fuel. Its fuel delivery is metered by an inlet

metering valve inside and its compressed amount depends on the required rail pressure.

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Main parameters:

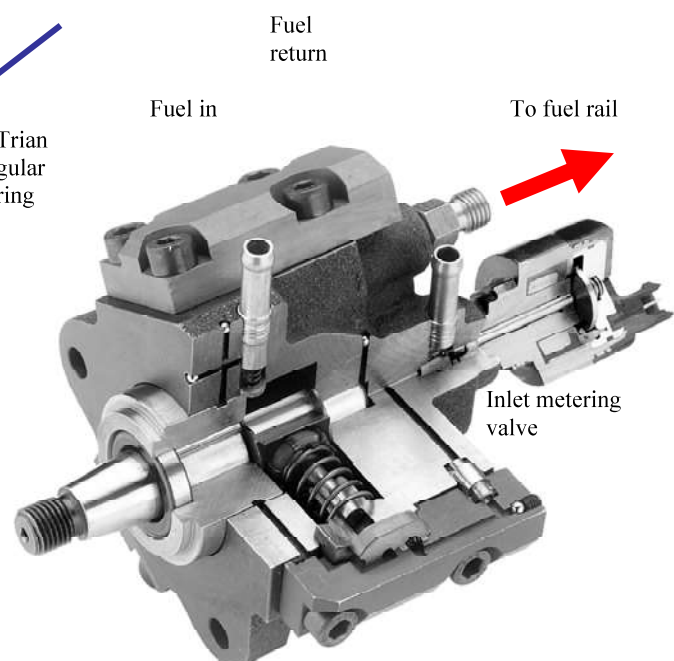
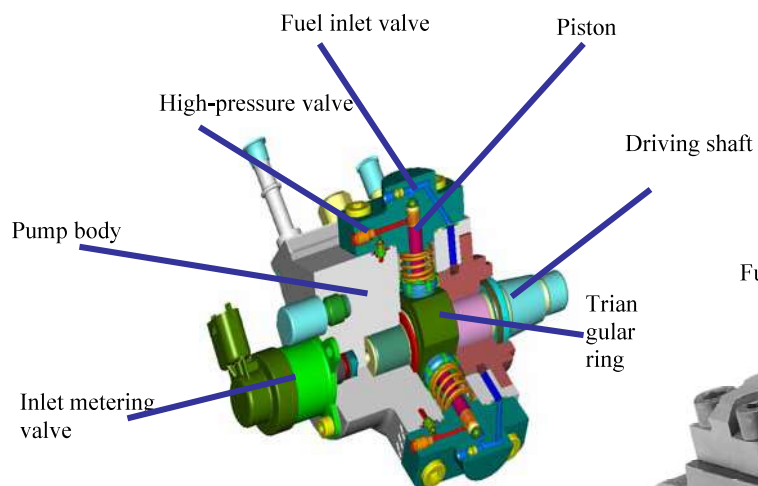
Material of pump body: cast iron

Max. pressure: 1450bar

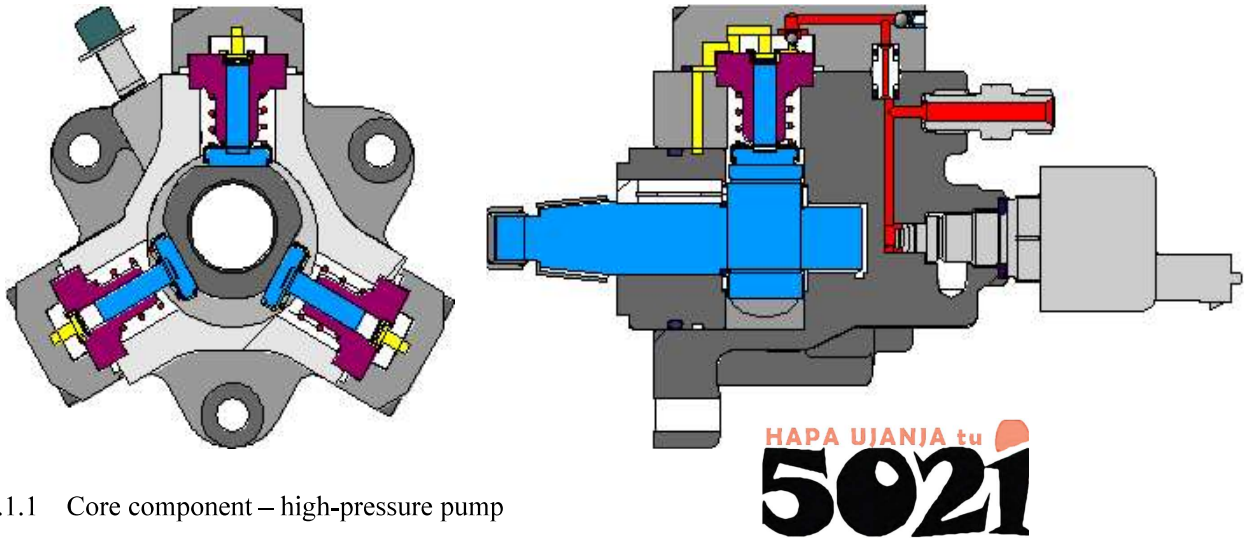
Max. fuel delivery: 843mm³/rev.

Rotational direction: clockwise

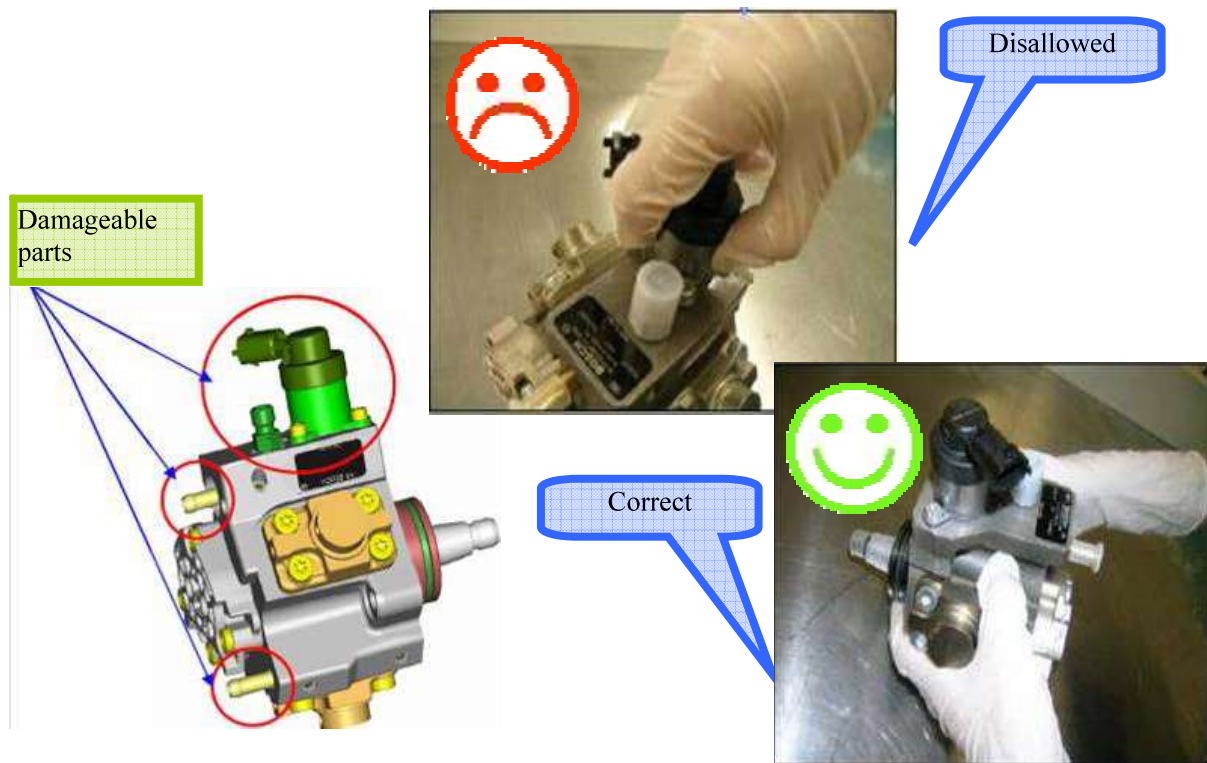
Gear ratio: 2/3



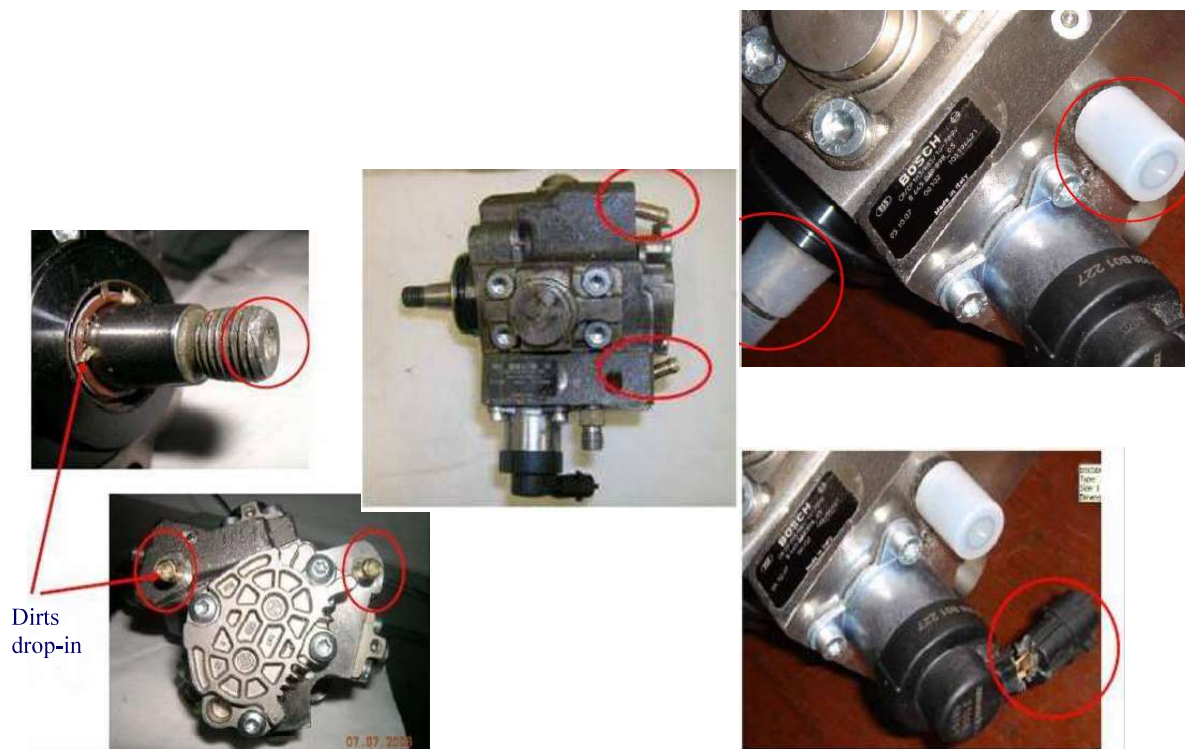
3.1 Core component – high-pressure pump



3.1.1 Core component – high-pressure pump



- The propeller shaft, together with all the fittings (fuel inlet fitting, fuel return fitting and high-pressure fitting) and inlet metering valve must be protected by protective caps. Such a cap is disallowed to be taken down before the installation of corresponding connection;
- Incorrect takedown and earlier unpacking might lead to inadvertent drop and breakage of high-pressure pump;

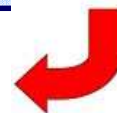
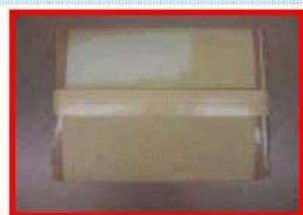


Correct packing method of high-pressure fuel pump

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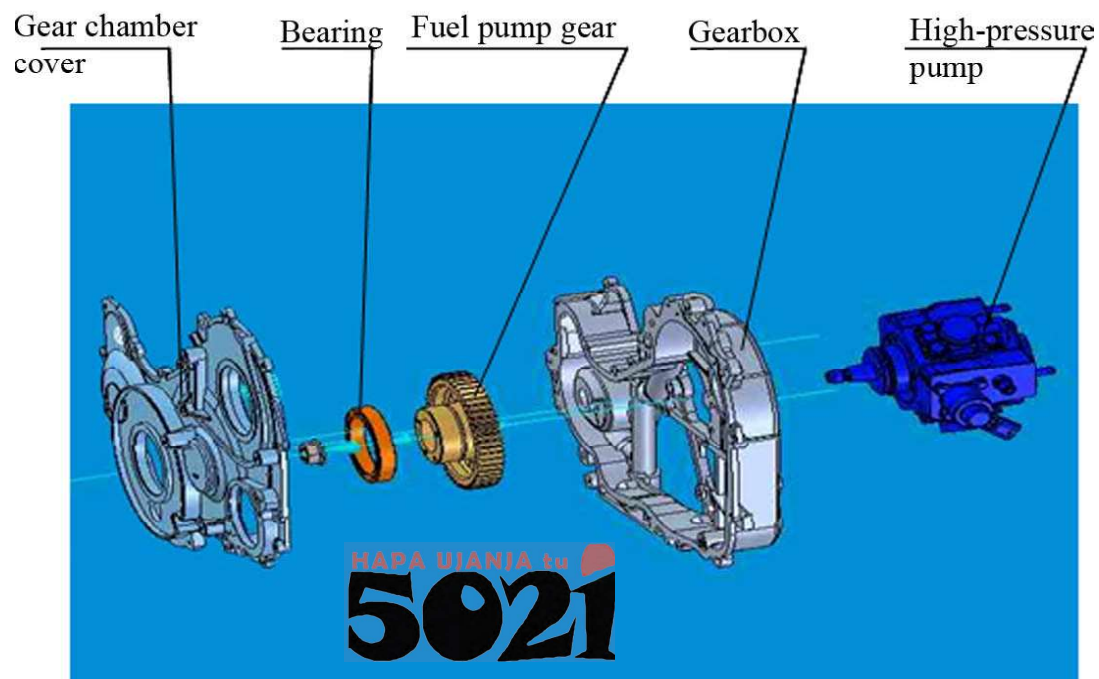
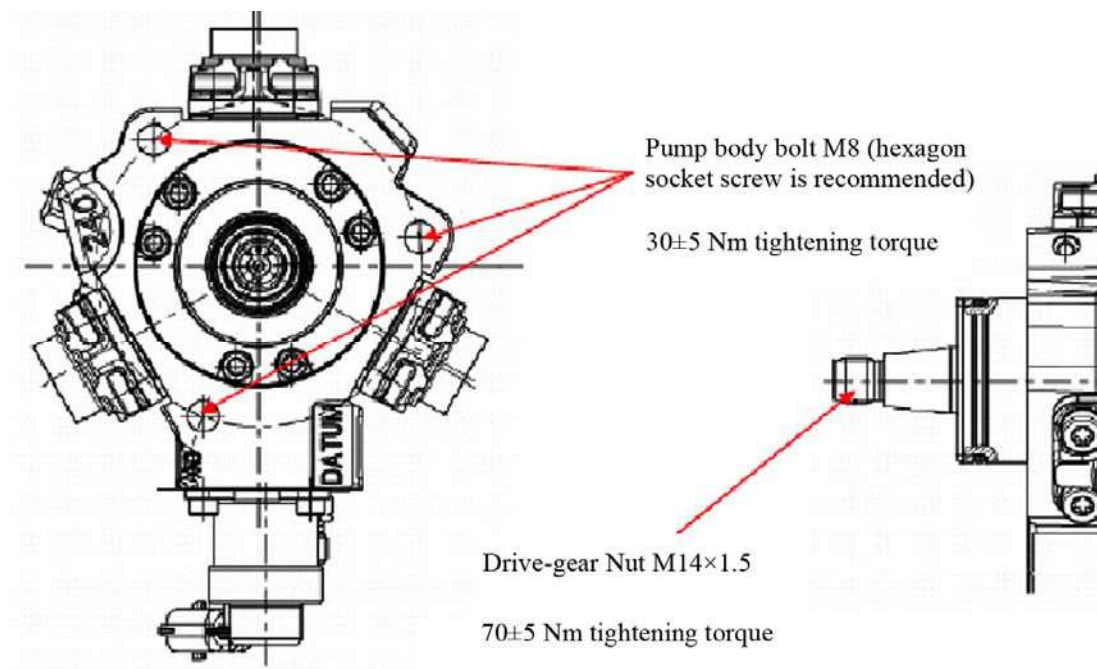
1. The high-pressure fuel pump should be packed into a clean plastic bag to prevent oil from leaking out.
2. All the surface of fuel pump should be enveloped by shockproof material to avoid the movement during the transportation period.



Correct installation of high-pressure pump

- The first step towards the pump installation is to take down the protective cap on shaft and clean the fuel on shaft surface with cleaning agent such as gasoline, alcohol, glycol or propane.
- Hold the pump with both hands in a right way and fit it into the engine flange while choosing a proper installation angle for fuel-flow control unit. In planting the pump, the shaft must be kept horizontal. To help the sealing ring into flange smoothly, rotate the pump body a little bit or spread the O-ring on pump flange with some grease.
- Fix the high-pressure fuel pump onto engine flange with the bolt tightening torque given out on the

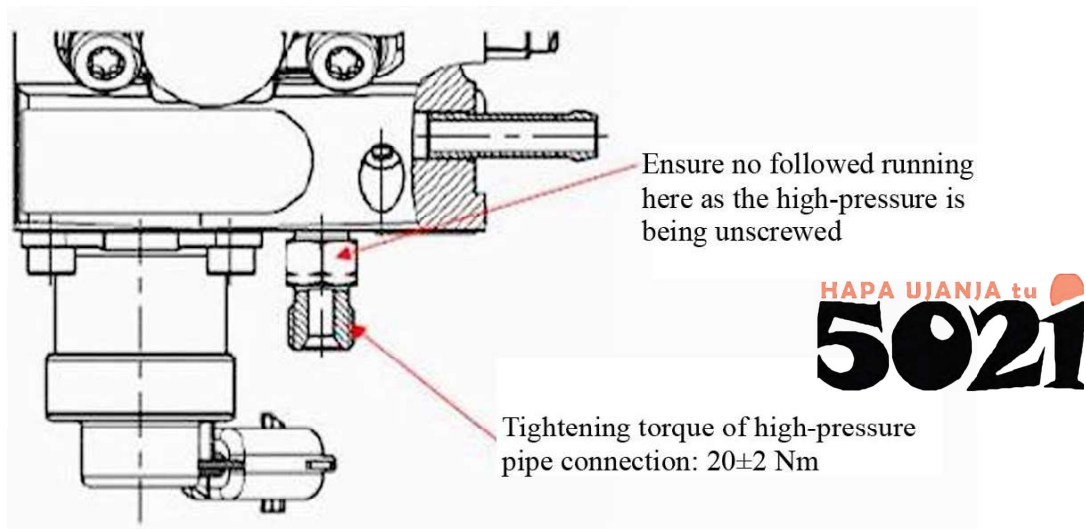
service manual.



Mounting and dismounting the high-pressure pump

- Take down the protective caps from high-pressure fuel pipe and high-pressure fitting. Tighten the high-pressure fitting with the torque required by service manual so that the fuel pipe is stressed only axially and the tight-coupling section between sealing surfaces of pipe and connection leaks.

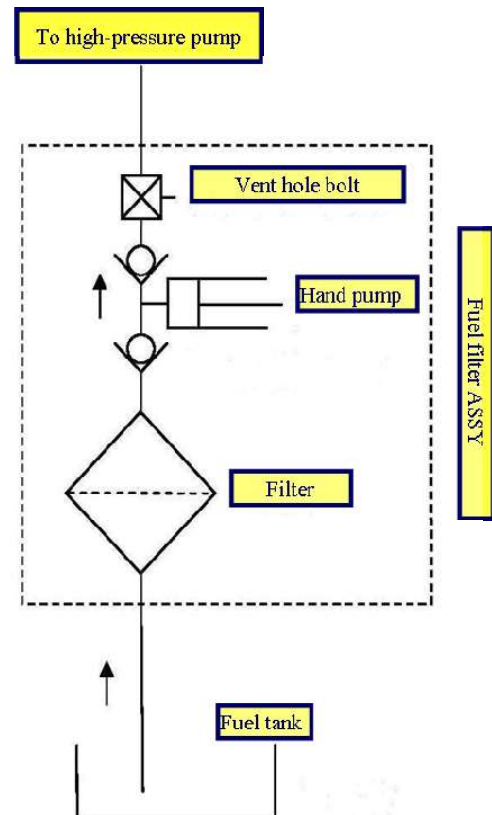
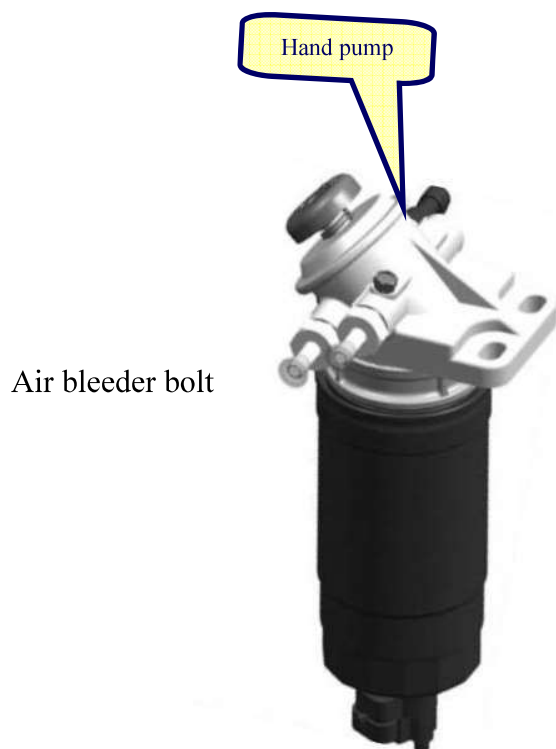
Note: When dismounting the high-pressure fitting is needed, a wrench must be used to keep the connection from becoming loose. If this connection has been loosened inadvertently, it is allowed to be retightened only once at most. Also this connection as well as spacer must be replaced. Otherwise a leakage might be caused easily.

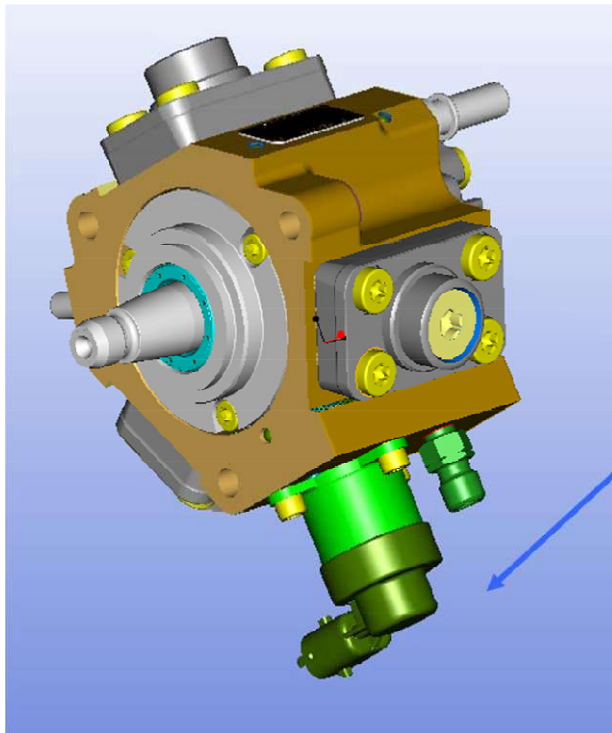


Fuel feeding of high-pressure pump

Dry-running is disallowed for a high-pressure fuel pump; otherwise there will be dry friction in the pump, leading to wear even damage on parts. Therefore for a pump in initial use or with air in its fuel channel, the following method must be followed to expel air and the fuel feeding pressure must not be higher than 4bar:

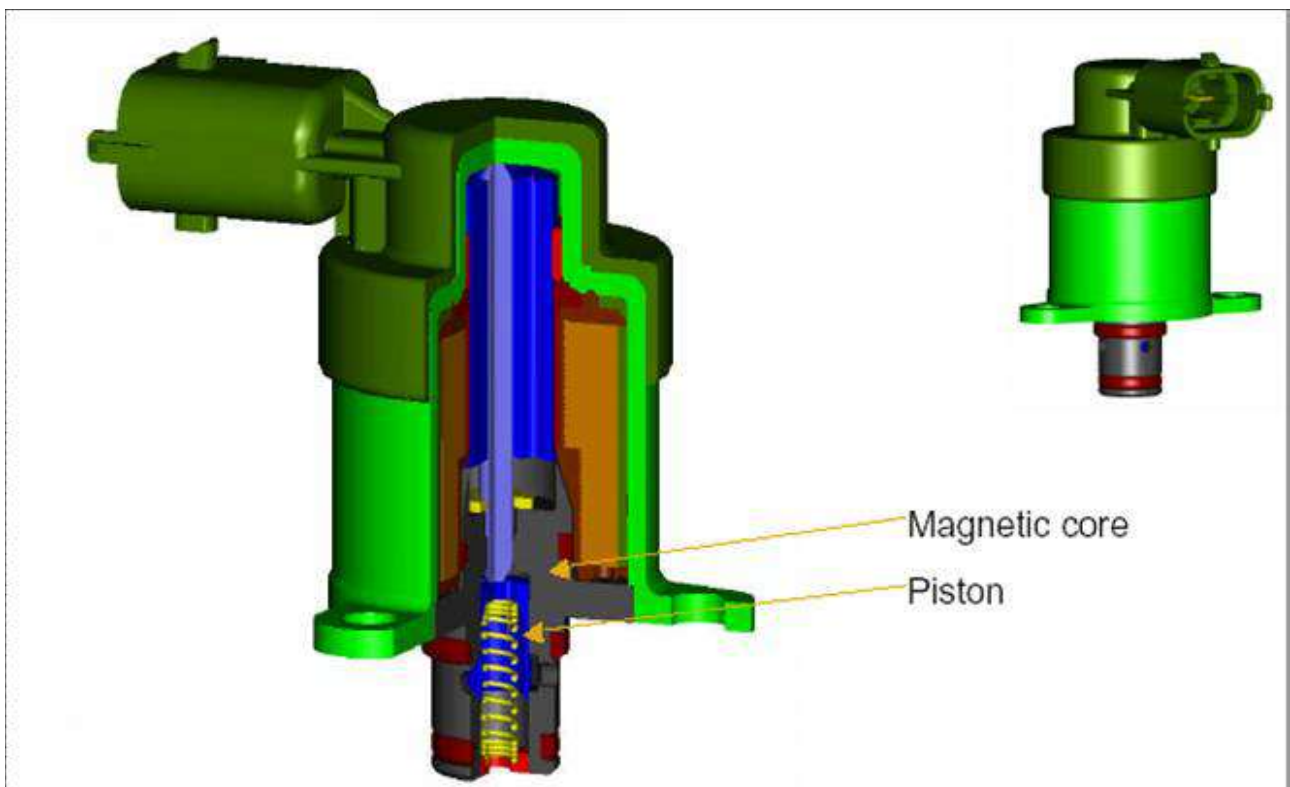
- Loosen the air bleeder bolt on fuel filter;
- Push down the hand pump on fuel filter until all the air has been vented and fuel is seen out of air-bleed hole;
- Tighten the air bleeder bolt;
- Repeat the above process if necessary.





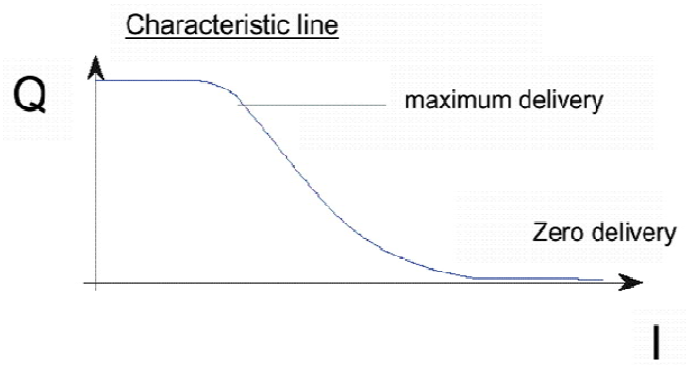
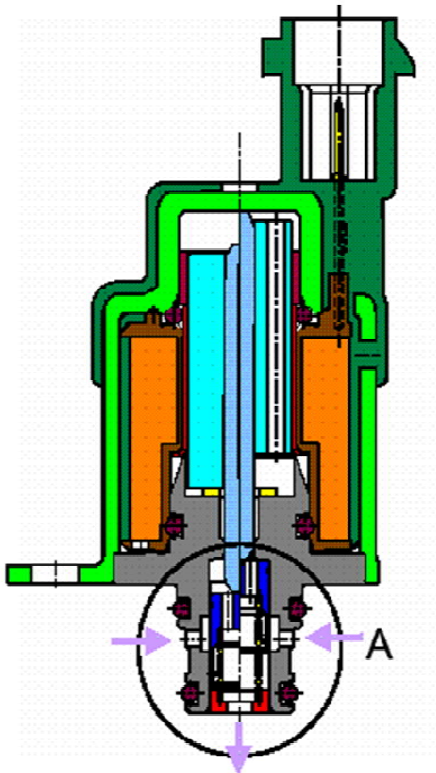
Inlet metering valve

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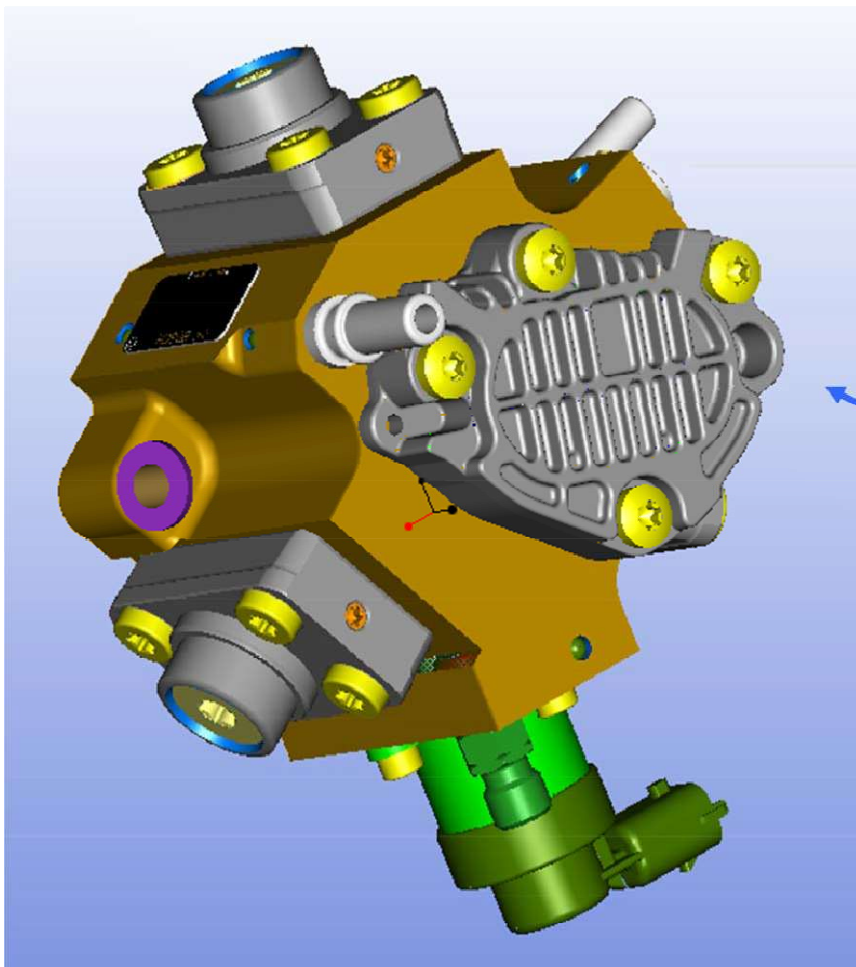
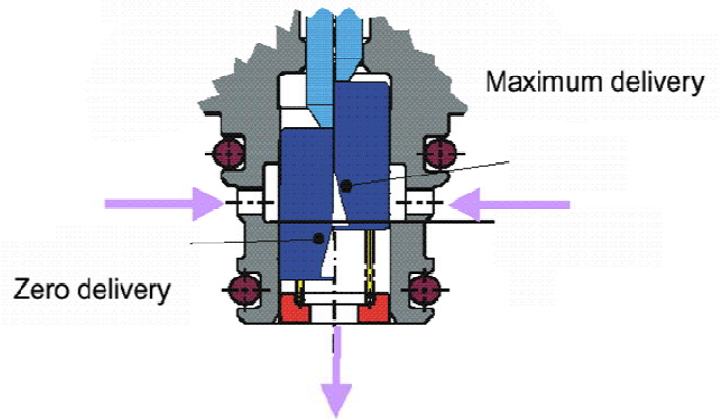


Magnetic core

Piston

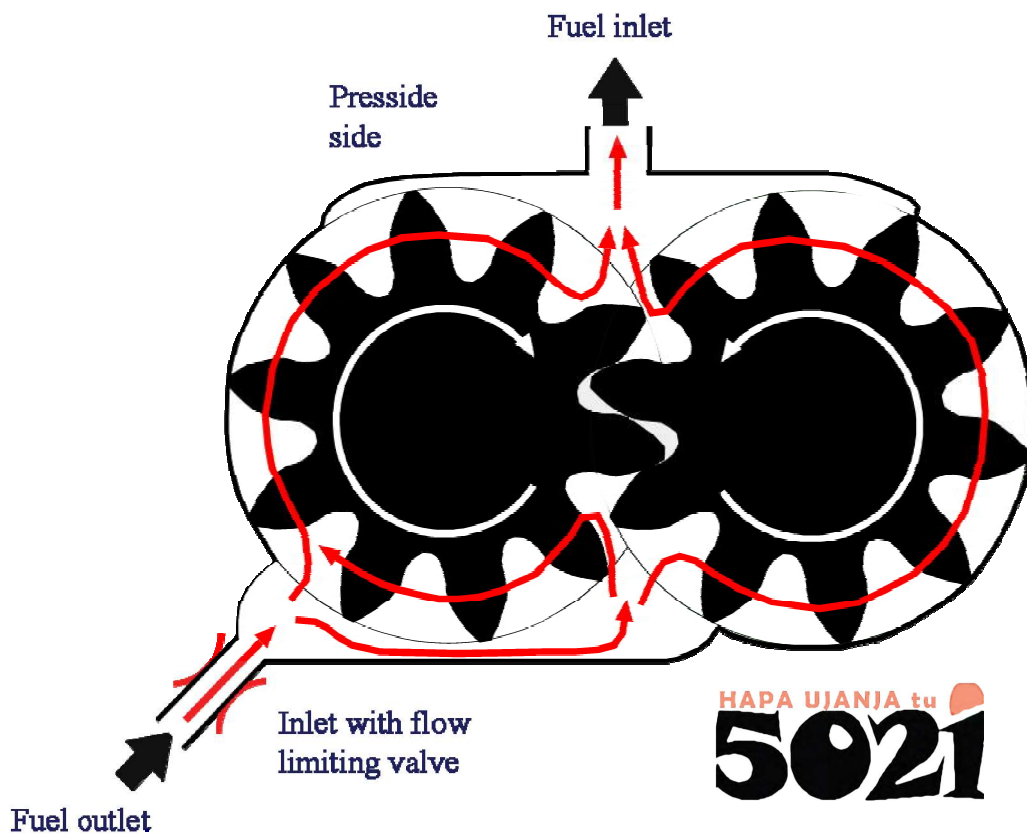


detail A:



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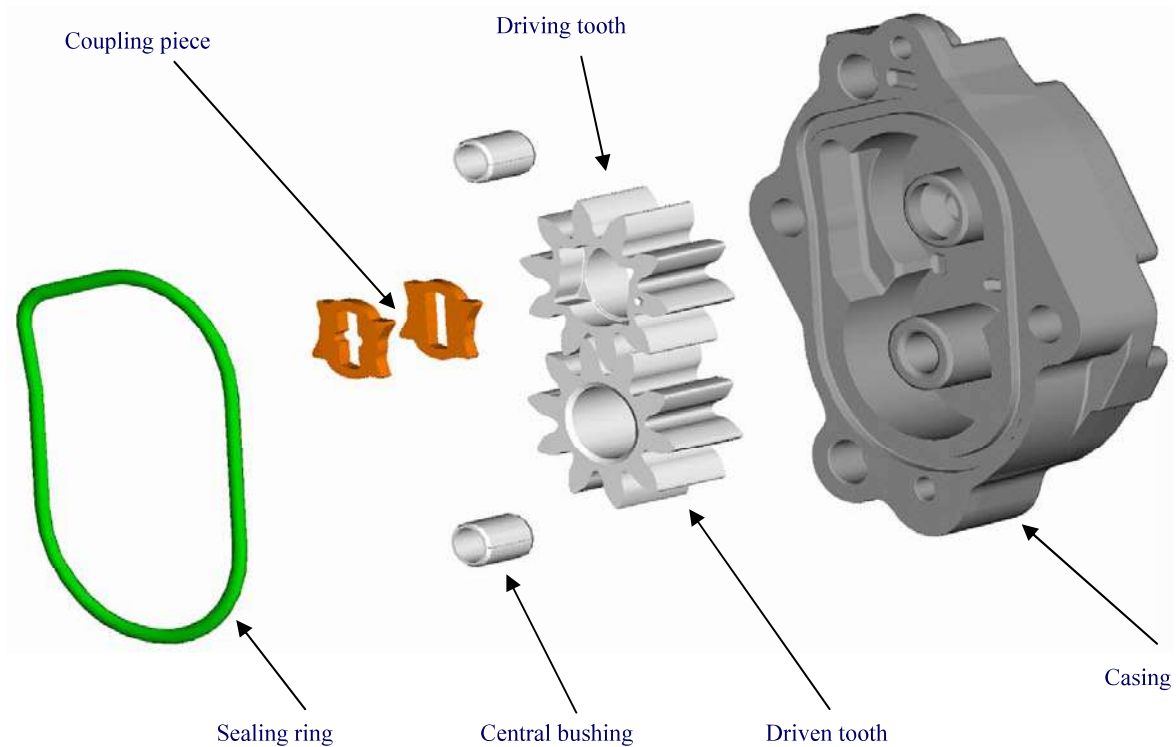
Gear pump

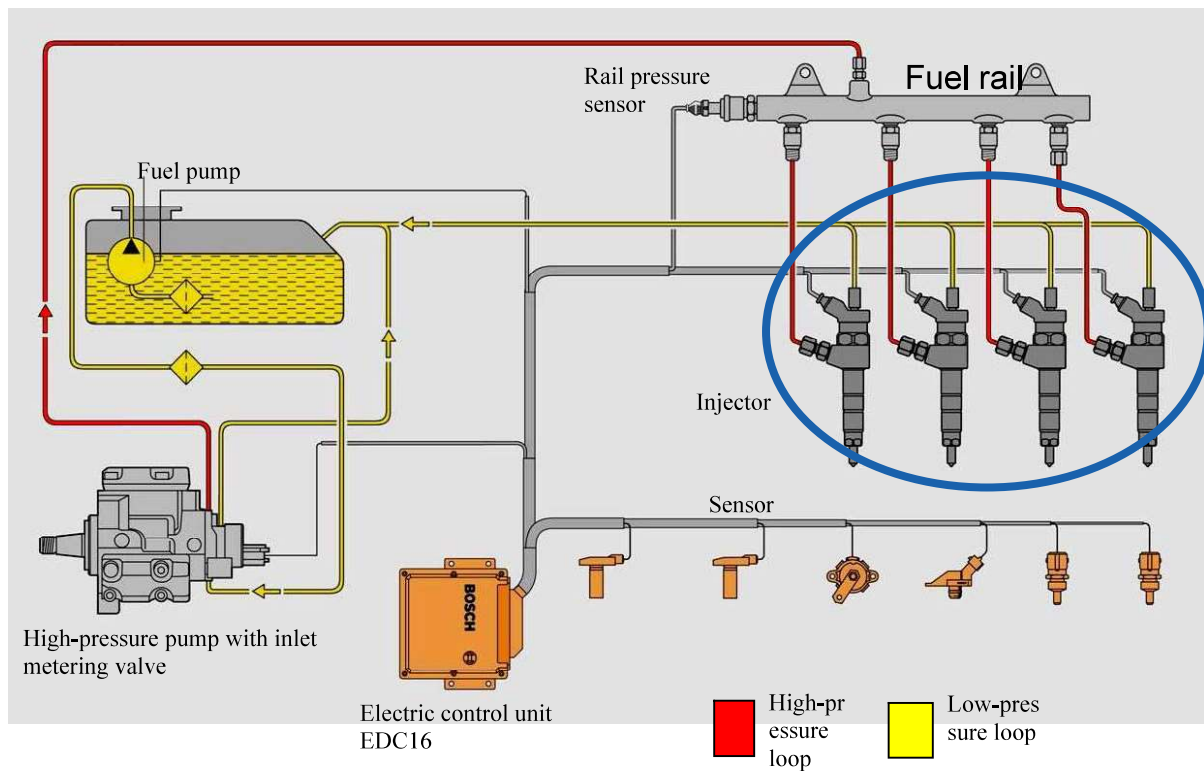


Pump body is made of cast aluminum and plated with nickel.

Flow rate = $5.5 \text{ cm}^3 / \text{rev}$.

PM (powder metallurgy) gears, one-piece formation.





3.1.2 Core component – fuel injector

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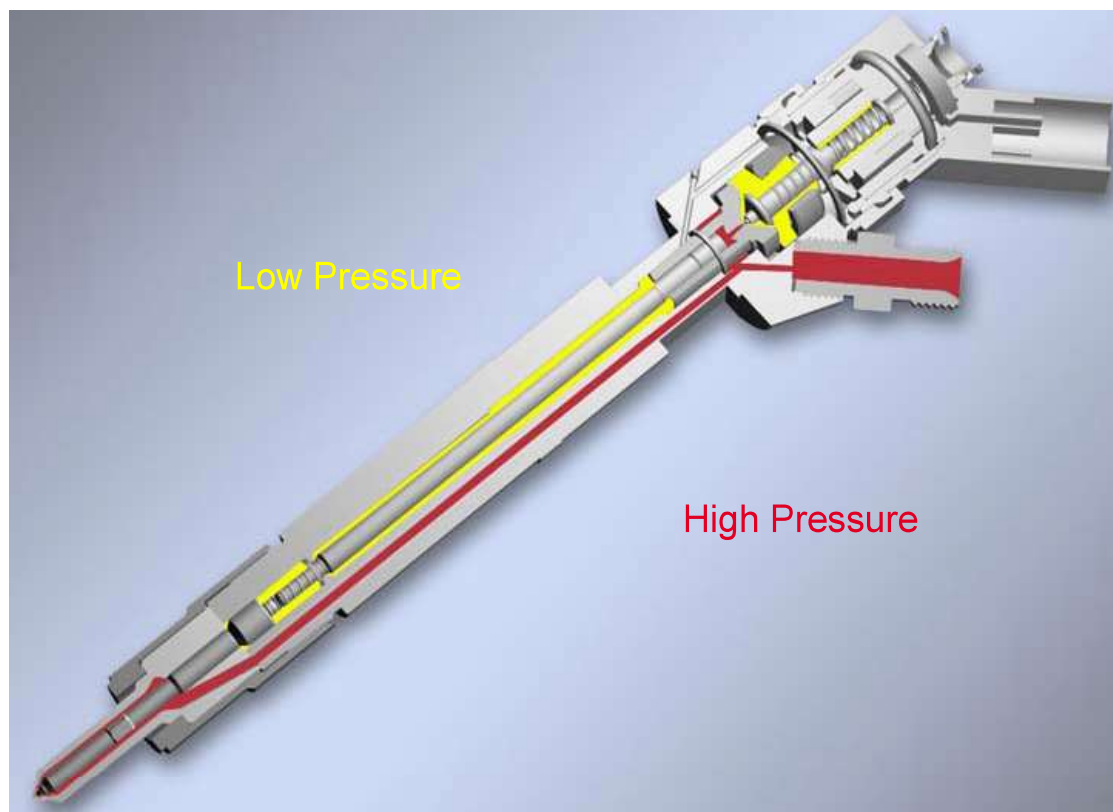
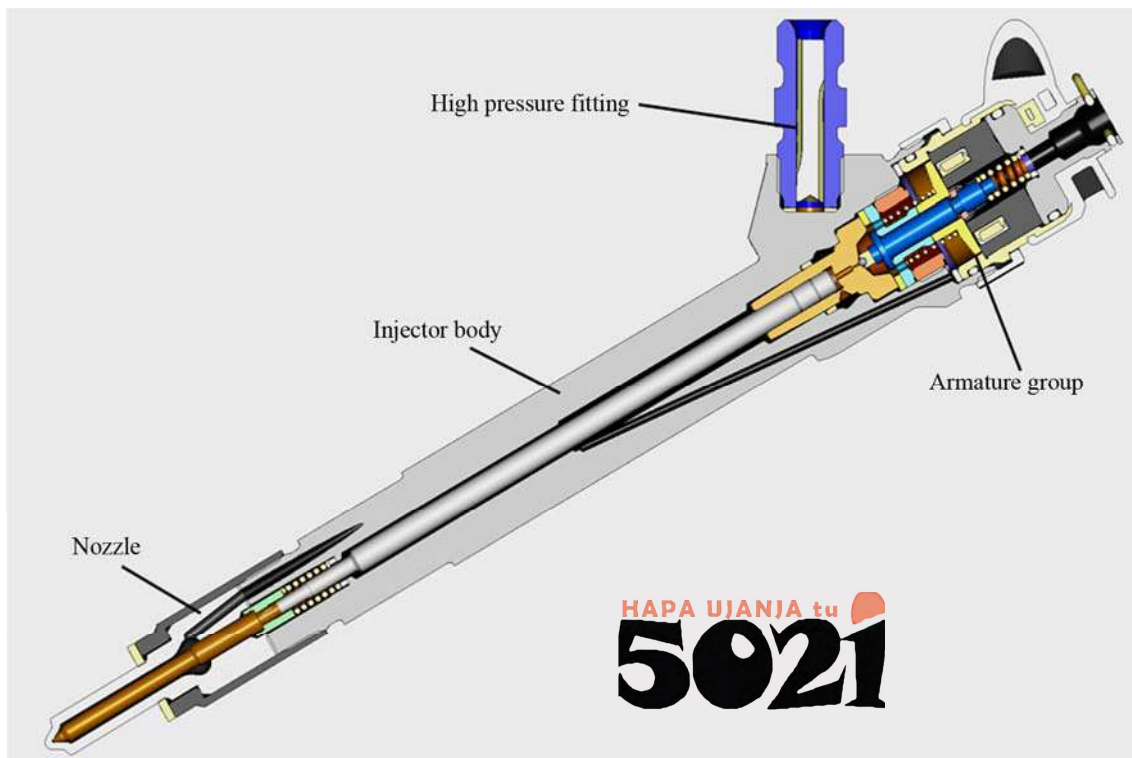


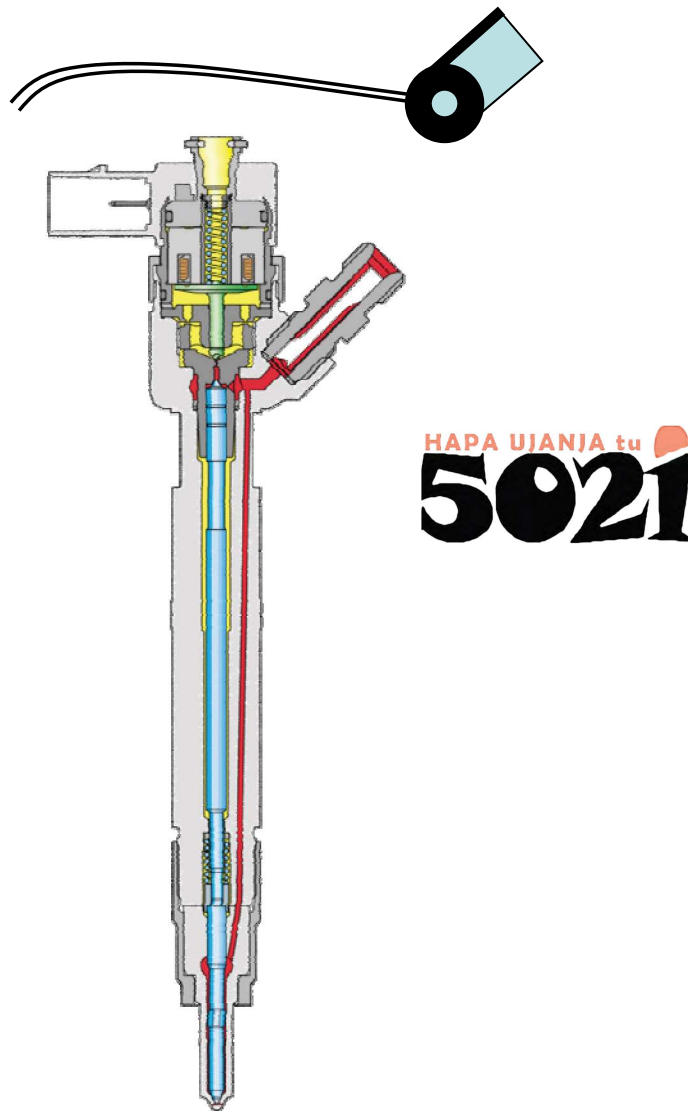
This injector, indirectly driven by solenoid valve, adopts P-type nozzle, spherical bearing surface, high-pressure orifice, as well as hydraulic coupling featuring low-pressure fuel return. It is fixed on engine through a special pressing plate.

Main parameters:

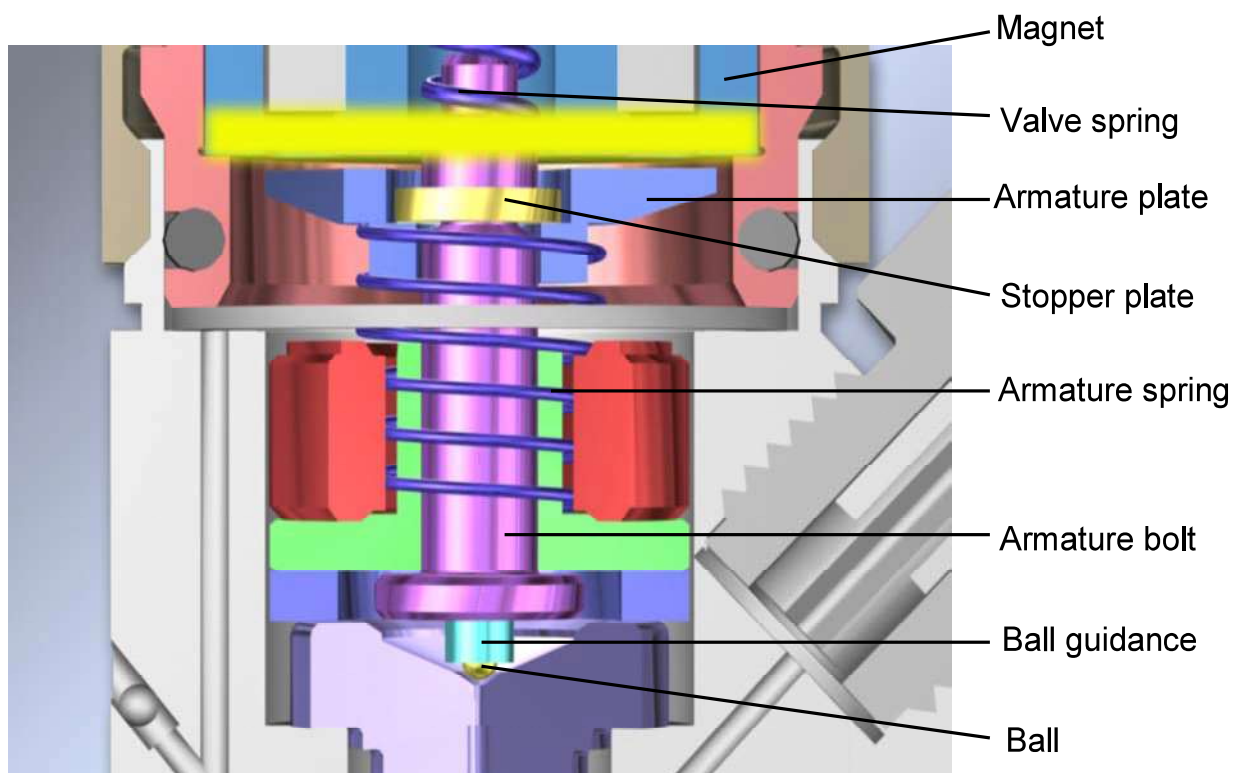
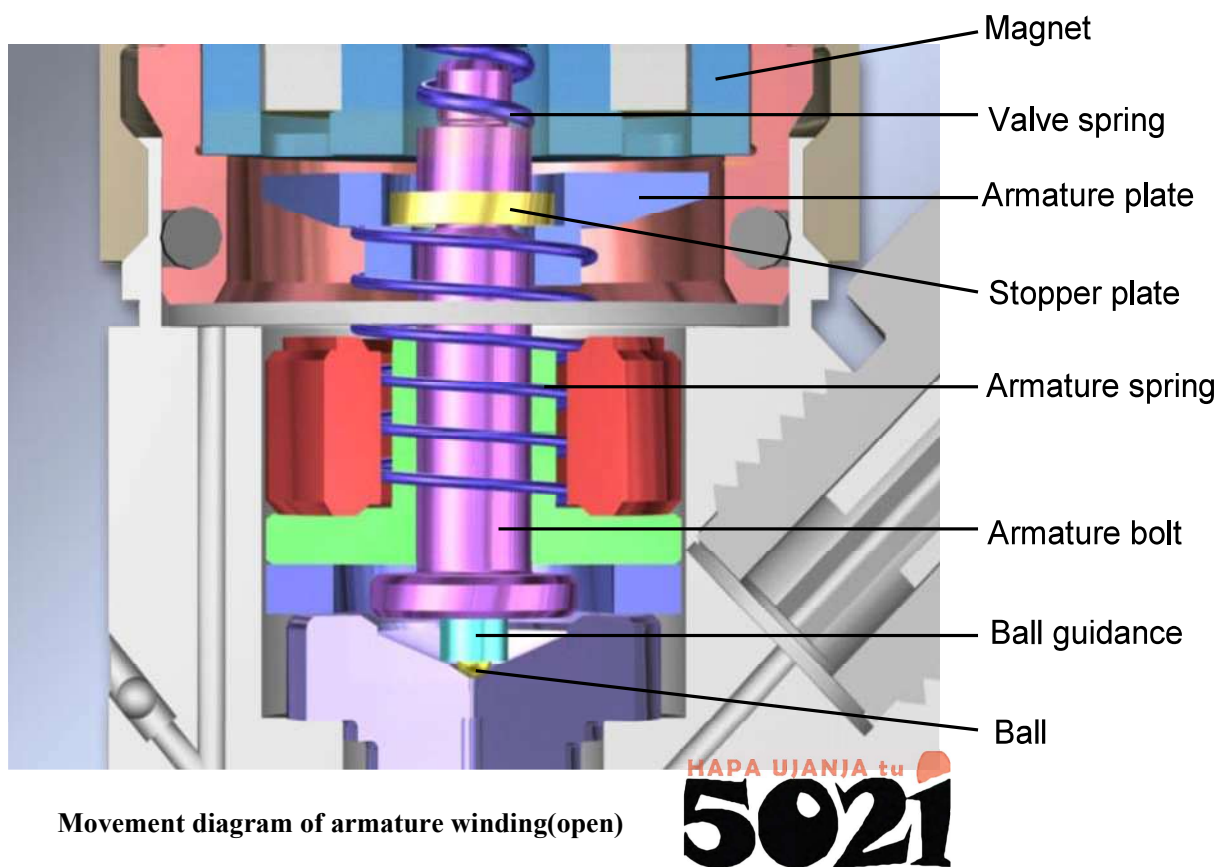
Pressure range: up to 1,450 bar

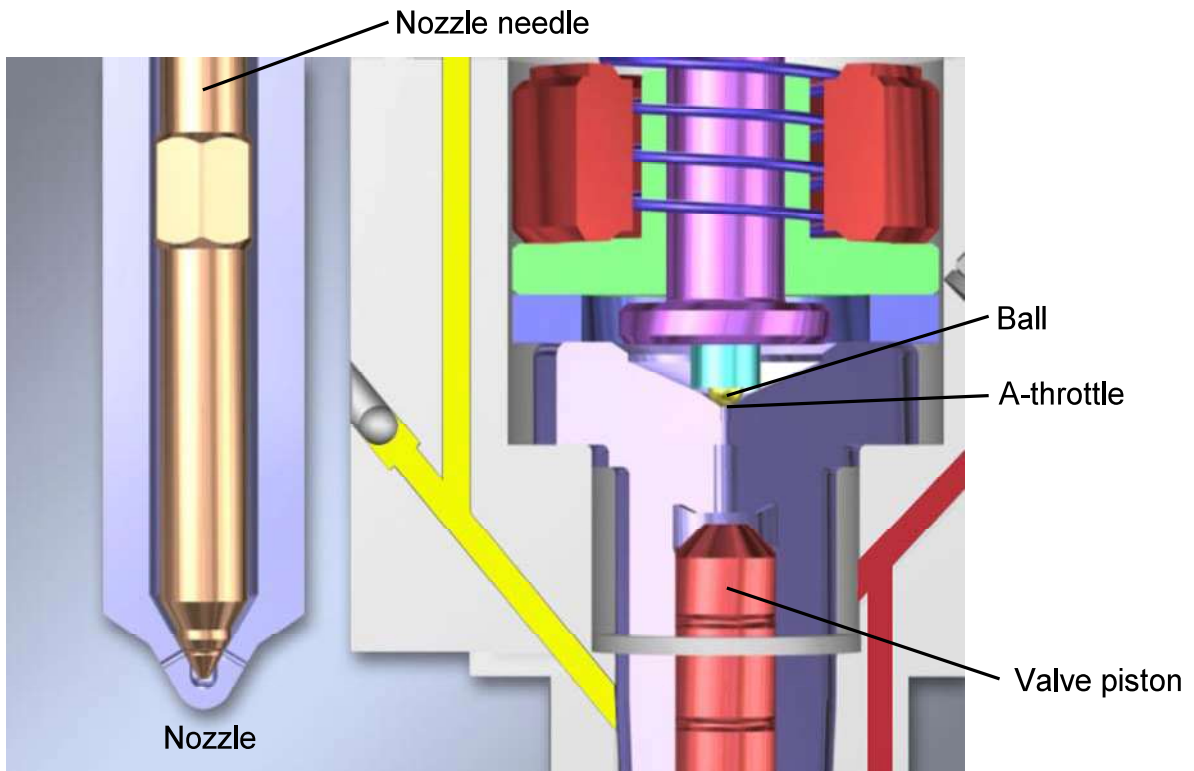
Nozzle: small-orifice type with single pin valve



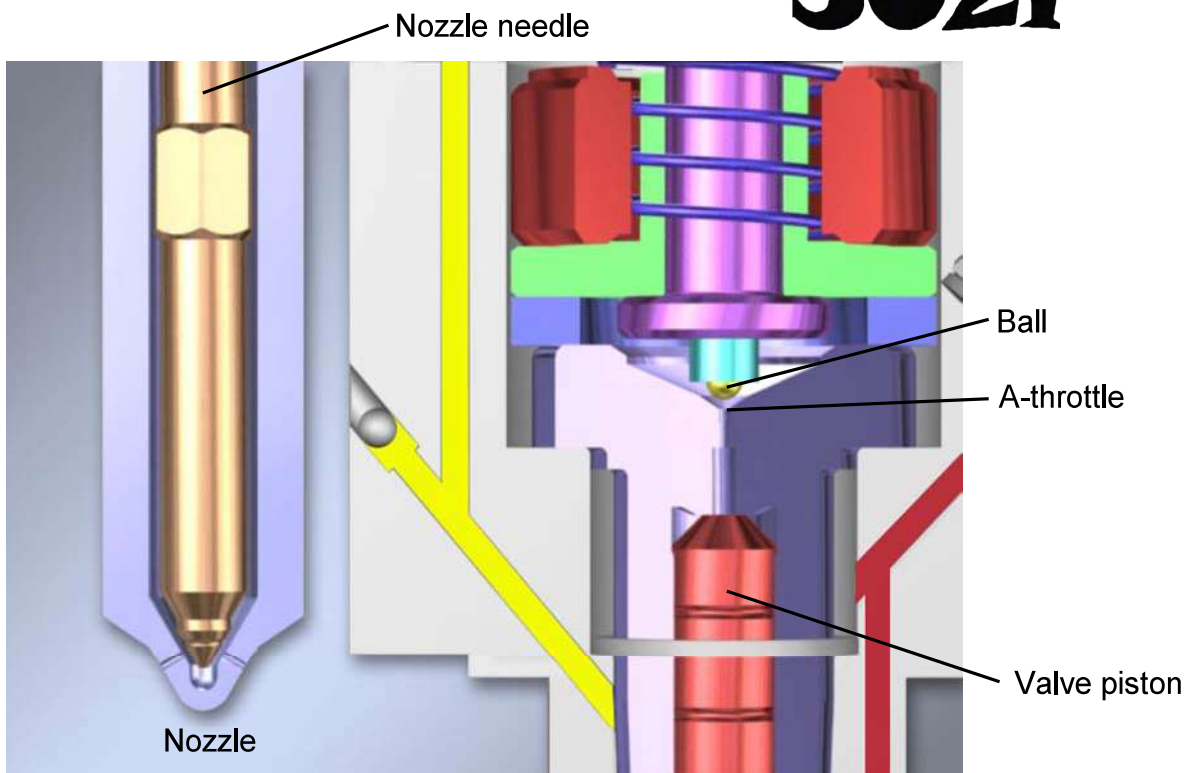


Movement diagram of armature winding (close)





Valve, piston, needle open position

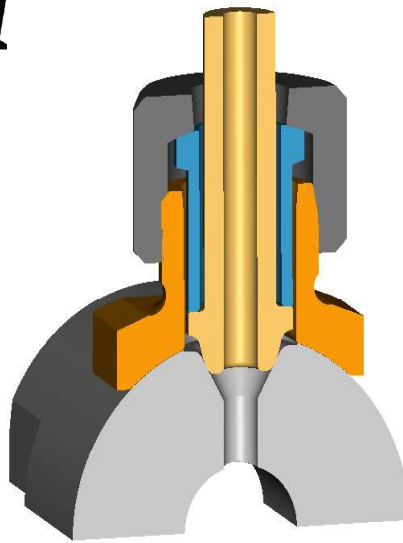


Sealing of fuel rail fitting



The rail fitting is sealed through the cone on rail and the head of high-pressure pipe.

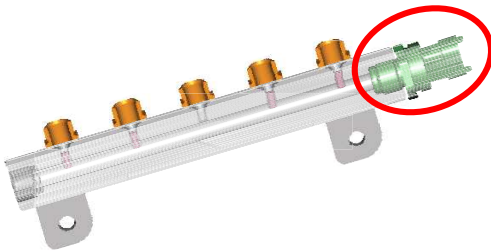
No high pressure should be borne by welded surface.



Hardness of fuel pipe head: $\leq HV250$

Welded surface:
With laser welding
technology

Rail pressure sensor



- The rail pressure sensor is integrated at the end of rail for inducing the transient pressure in rail.
- This sensor works by translating the pressure signal into electric signal through its component (semiconductor module), magnifying this signal and transmitting it to ECU.
- Position of rail pressure sensor: straight down with an allowable maximum 30° , disallowed to be in inverted suspension.

The common-rail 32-digit electric control unit (ECU), whose model is EDC16C39, can meet the Euro III emission standard now and probably Euro IV in the future through functional expansion.



Main parameters:

Rated voltage: 12V

Power consumption: normally 12.5~18W

Working temperature: $-40^{\circ}\text{C} \leq T \leq T_{\text{maximum environmental temperature}}$

In the flowing air: $T_{\text{maximum environmental temperature}} = 70^{\circ}\text{C}$

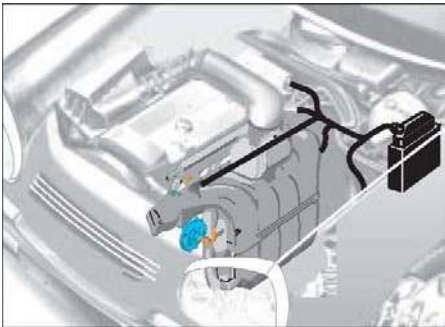
In the fixed air: $T_{\text{maximum environmental temperature}} = 85^{\circ}\text{C}$

Basic software functions:



- Split injection control (pre-jet, major jet and post-jet)
- Fuel amount control: low idle controller and balance among all cylinders
- Fuel injection regulation of injector
- Fuel amount limitation and engine-start fuel control
- Accelerator-pedal signal filtering and drivability pulse spectrum
- Exhaust gas recirculation
- Supercharging pressure control
- Intake throttle control
- Viable swirl control
- Preheating-time control of heater plug
- Fan and AC (air conditioner) control
- Trouble shooting function
- CAN interface
- Procedure updating

Installation of ECU



- The ECU must be installed in a dustproof and dry area, where a small amount of water is allowed to pass within a short period;
- Ensure water, oil and other fluid won't permeate into ECU seals and pressure compensation element through wires;
- It is disallowed to dip ECU into water;
- No elasticity is allowed where the ECU is installed;
- Don't dismount the ECU at discretion in the maintenance process;
- Dismounting the ECU, if really necessary, should be done more than 1 min. later after the unplugging of terminal post;
- Before welding, the ECU must be removed into a storage under full attention;
- No branching of ECU wire!

3.2.1 Other component – Crankshaft position sensor

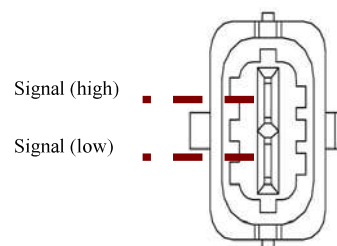


Function and principle:

- Engine speed & crankshaft position sensor (CPS) is a magnetoelectric sensor. Installed near the crankshaft, it works together with 58x ring gear on crankshaft. As the crankshaft rotates, crown and gullet of 58x ring gear pass through this sensor with different distances. Then this sensor senses the change in magnetic resistance. This alternating magnetic resistance generates an alternating output signal, with which the ECM can identify the rotational position and speed of crankshaft.
- Installation position: near the crankshaft. It must be press-mounted and must not be hammered.

Product features:

- Working temperature: $-40^{\circ}\text{C} \sim 120^{\circ}\text{C}$
- Working clearance: $0.5 \sim 1.5 \text{ mm}$
- Coil resistance: $860\Omega \pm 10\% (20^{\circ}\text{C})$
- Coil induction: $370\text{mH} \pm 60\text{mH} @ 1\text{kHz}$



3.2.2 Other component – phase sensor



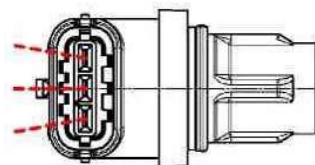
Function and principle:

- Camshaft position sensor is a Hall Effect sensor, which, near the camshaft, works together with signal wheel on camshaft. The signal wheel corresponds to a special position on engine. With this sensor, the ECU detects the digital voltage signal, through which the working cylinders of engine can be identified for one-to-one control.
- Installation position: near the crankshaft. It must be press-mounted and must not be hammered.

Product features:

- Working temperature : $-40 \sim +150^{\circ}\text{C}$;
- Working voltage: $4.7 \sim 18\text{ V}$;
- Working clearance: $0.2 \sim 1.8\text{ mm}$

Signal output (O)

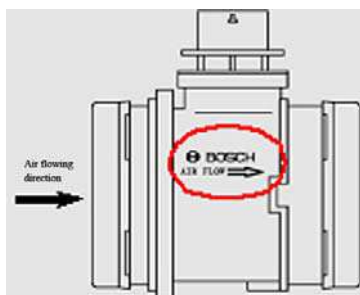


3.2.3 Other component – airflow sensor



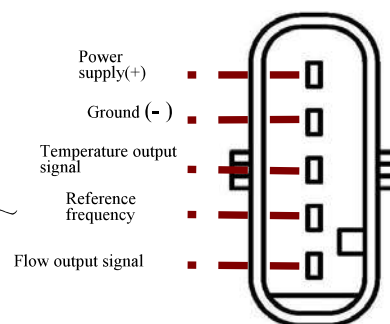
Function and principle:

- Airflow sensor is a hot-diaphragm airflow gauge installed on intake system. It has also a built-in temperature sensor that can measure the intake temperature. Through this signal, the ECU can judge the air flow into engine and the load on engine.
- Installation position: on the intake pipe. It should keep a certain distance from hot components such as turbocharger and exhaust manifold.
- This sensor must be installed in the same direction as that of intake air flow !



Product features:

- Rated flow rate: 640kg/h ;
- Working voltage: 14 V ;
- Temperature of sensor: $-40^{\circ}\text{C} \sim 120^{\circ}\text{C}$



3.2.4 Other component – heater plug



Function and principle:

- The heat plug is used for assisting the coldstart of diesel engine and improving the warming-up performance.
- Installation position: in the cylinder head. Ensure its glow end is correctly placed in the combustion chamber.



Product features:

- Rated voltage: 11V ;
- Power-on time before 850°C: 5s±1s;
- Temperature after 60s: 1050°C±50 °C。

3.2.5 Other component – heat-plug control unit

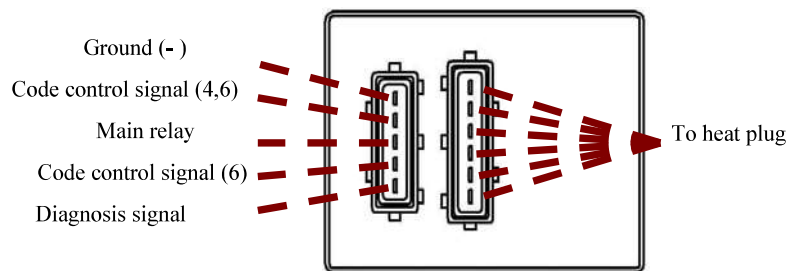


Function and principle:

- The heat-plug control unit is controlled by ECU. Through customized pin interfaces, it can separately be applied to engines with 4, 5 or 6 cylinders. It can also troubleshoot one or more heat plugs.
- Installation position: in a proper area of engine compartment, with pin interfaces horizontally downward.

Product features:

- Rated voltage: 12V ;
- Power consumption: 10 ~ 18W(when the heat plug is working) ;

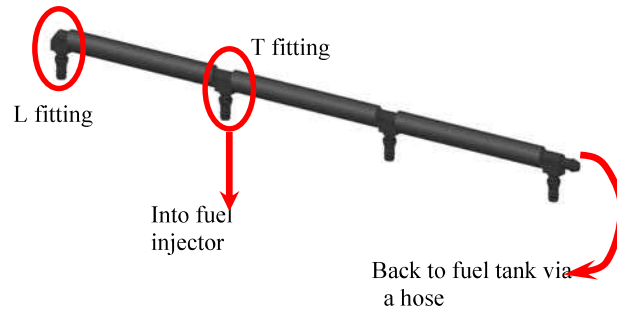


3.2.6 Other component – fuel return pipe

Function and principle:

The fuel return pipe collects the fuel returning from injector and send it back to fuel tank. It consists of L fittings, T fittings and steel-wire reinforced, rubber-covered hoses. Thereof, every fitting has a check inside to ensure the stable pressure of returning fuel.

Installation position: on the head of every cylinder injector.

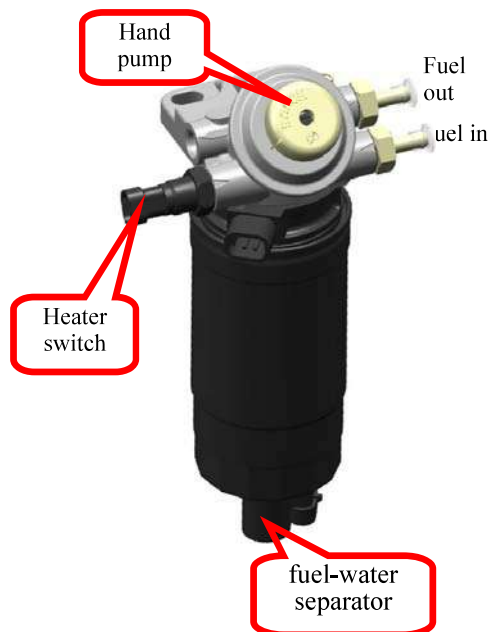


Product feature:

- System pressure: not more than 2 bar;
- Bending radius of pipeline: $\geq 30\text{mm}$;



3.2.7 Other component – fuel filter



Function and principle:

- In addition to filtering out the impurities in fuel, the fuel filter also integrates hand pump, fuel-water separator and fuel heater. The hand pump is used for expelling air out of pipes whenever there is an initial start or the vehicle has been laid up for a long time without being used. It timely reminds the driver of draining the separated water through the fuel-water separator indicator on dashboard. While the fuel heater can help improve the coldstart performance of vehicle.
- Installation position: in a correct area on vehicle body, straight up, 20° at most away from the vertical direction

Product features:

- Working temperature: $-40^\circ\text{C} \sim +120^\circ\text{C}$;
- Working pressure: $\leq 2.0\text{ bar}$;
- Replacement period: 30,000 km;

3.2.8 Other component – water temperature sensor

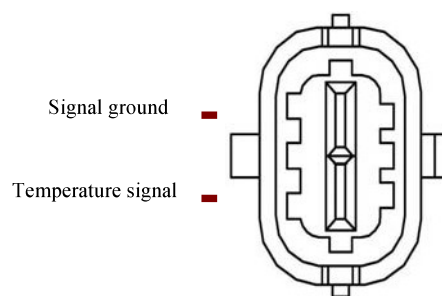
Function and principle:

- Coolant temperature sensor is used for detecting the working temperature of engine. The ECU will, according to different temperatures, provide the optimal control plan for engine;
- This sensor takes a thermistor with negative temperature coefficient as its sensing element;
- Installation position: this sensor is assembled on small circulation channel of engine coolant.



Product features:

- Working voltage: 5 ± 0.15 V;
- Working temperature: -40 °C ~ $+130$ °C



3.2.9 Other component – accelerator pedal sensor

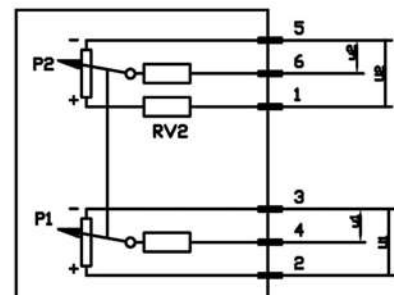
Function and principle:

Accelerator pedal sensor is mainly used for picking up the driver's requirements for vehicle and through the analyzing calculation of ECU, enabling the engine to supply the required power.



Product features:

- Working voltage: 5 ± 0.3 V;
- Working temperature: -40 °C ~ $+80$ °C;
- Pedal force: 500 ± 6 N;
- Pedal return force: > 5 N;



3.2.10 Other component – high-pressure fuel pipe

Installation of high-pressure fuel pipe

- ➔ Installation of high-pressure pipe between fuel rail and injector

- Fix the fuel injector onto engine with a final tightening torque exerted on presser bolts and tighten the rail on engine by hand ($3\pm 1\text{Nm}$) ;
 - Separately tighten the nuts on injector end and rail end of high-pressure pipe by hand ($3\pm 1\text{Nm}$) ;
 - Tighten the nut on injector end of high-pressure pipe with a final torque of $30\pm 3\text{Nm}$;
 - Screw the rail onto engine with a final $23\pm 2\text{Nm}$ torque;
 - Tighten the nut on rail end of high-pressure pipe with a final torque of $30\pm 3\text{Nm}$.
- Installation of high-pressure pipe between high-pressure pump and fuel rail
- Manually tighten the nuts on both ends of high-pressure fuel pipe ($3\pm 1\text{Nm}$) ;
 - Tighten the connection nuts on both ends of fuel pipe, fuel pump and fuel rail with a final $30\pm 3\text{Nm}$ torque.



Dismounting of high-pressure fuel pipe

- Dismounting of high-pressure pipe between fuel rail and injector
- Unscrew the nuts on high-pressure pipe between fuel rail and injector;
 - When the nut on injector end of this pipe is being unscrewed, the high-pressure fitting on injector must be fastened;
 - Take down the high-pressure pipe;
 - Release and pick off the pressing plate;
 - Take the injector out of cylinder head with a special remover;
 - Return all the protective caps onto injector and rail.
- Dismounting of high-pressure pipe between high-pressure pump and fuel rail
- Unscrew the nuts on high-pressure pipe between fuel rail and high-pressure pump;
 - In the effort to loosen the nut on pump end of this pipe, the high-pressure fitting on pump must be fastened with a wrench to avoid its follow-up;
 - Pick off the high-pressure pipe;
 - Return all the protective caps onto high-pressure pump and fuel pipe.



3.2.11 Other component – EGR valve

Function and principle:

- The EGR valve, which is on the intake pipe, is used for driving a certain amount of exhaust gas

into intake system for recycling.

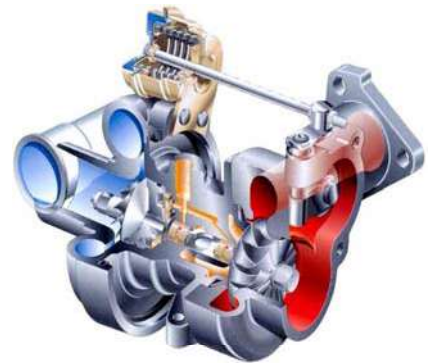
- The diaphragm of EGR valve is connected to a pivot on one end and to a spring on another end (it is just this spring that keep the valve normally closed). When the vacuum pressure (or air pressure) on diaphragm is greater than the spring force, the pivot will be pulled off its original position to open up the passage, through which the exhaust gas can enter the recycling system. The amount of recycled exhaust gas directly hinges on the intake amount.
- In nature, the EGR relies on worsen combustion to reduce the NO_x. As the NO_x can be produced under two conditions – high temperature and abundant oxygen, so by leading a certain amount of post-combustion exhaust gas into intake pipe via the control valve to join fresh air for in-cylinder combustion, such inert gas can slow down the combustion speed and lower the maximum combustion temperature and consequently reduce the amount of NO_x.



3.2.12 Other component – Turbocharger

Function and principle:

- The turbine of turbocharger is connected to exhaust pipe, so do compressor and intake pipe. As the turbine rotates coaxially with compressor impeller, the compressor can be towed by driving the turbine with exhaust gas, thus increasing the intake pressure and air charge.
- When the engine runs at a high speed and under a heavy load, overhigh turbocharger speed and supercharging pressure can be reduced by turning on the exhaust byway valve to bleed some exhaust gas, thus decreasing the turbocharger speed and controlling the compression ratio.



Essentials in operation:

- As the turbocharger adopts full-floating bearings with very high lubrication requirement, oil of supercharging diesel engine should be used as required.
- To ensure the lubrication of bearings, the engine should idle for several minutes upon the start to bring the lubricant up to a certain temperature and pressure. The same is true in stopping the engine, which means, instead of stalling suddenly, it should have its load gradually decreased and finally idle for several minutes before stalling.
- The relevant regulations should be abided by to regularly clean air filter and check the leakage of intake system.

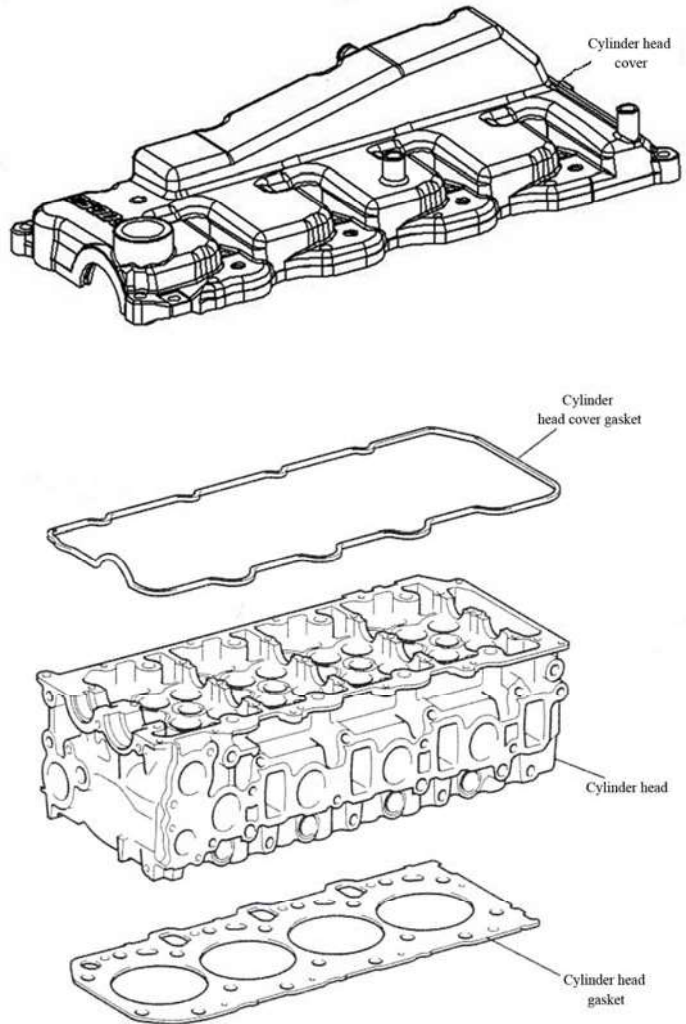
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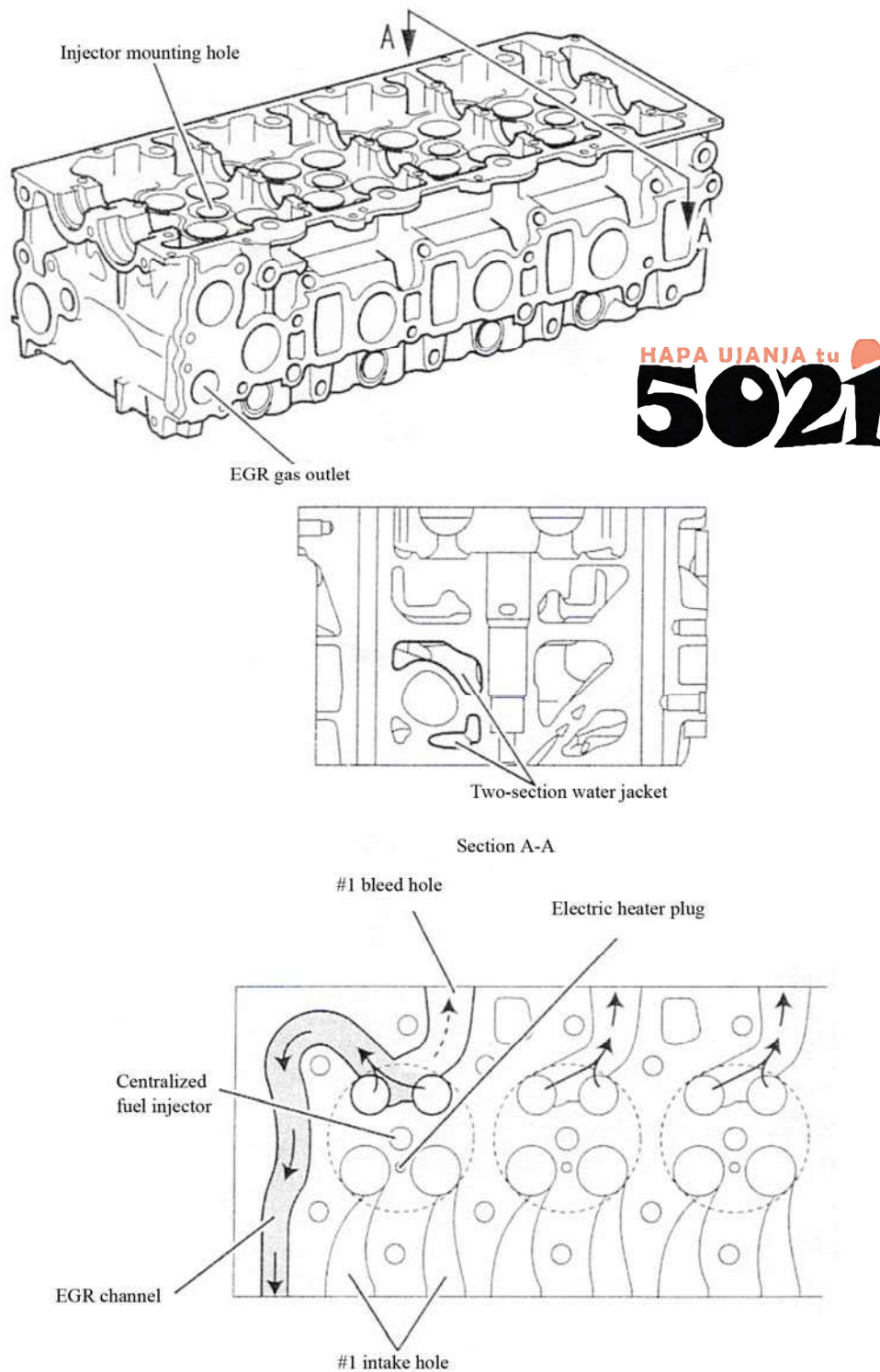
Service Manual of DK4A Diesel Engine

Mechanical System

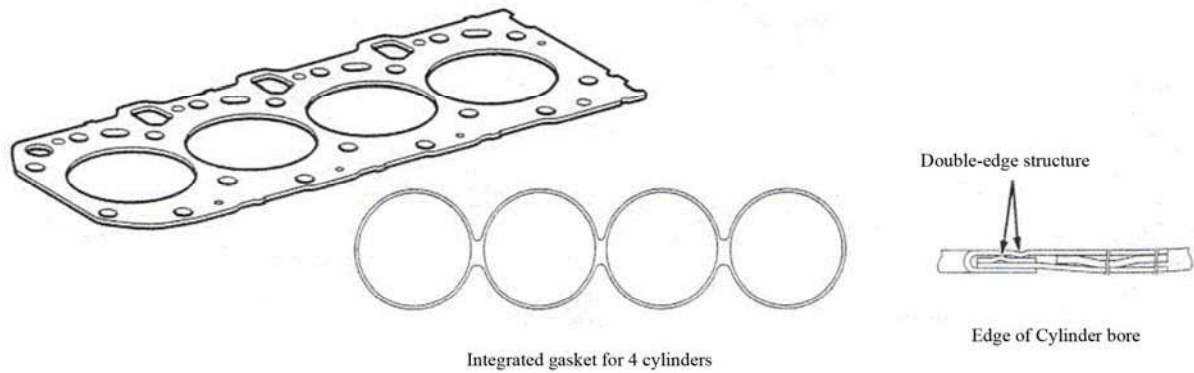
Cylinder head components

- Light and perfectly shockproof, the resin material adopted by cylinder head cover has not only reduced the engine weight, but ensured the strength of cylinder head cover. With the improvement in the shape of this cover, engine noise has been reduced. By installing a traverse baffle in the cover and extending the ventilation duct out of cover roof, the fuel cutout capability has also been enhanced. In addition, both traverse baffle and ventilation duct are made of resin, so the engine becomes lighter.
- The cylinder head gasket adopts heatproof and oil-proof ACM (acrylate rubber) to ensure its reliability.
- The cylinder head is made of light aluminum alloy with superior thermal conductivity. Also, adopting the DOHC and 4-valve structure and vertically aligning injectors at the center of cylinder head has endowed the engine with not only higher performance but better reliability, achieving the low-emission, downsizing target.
- The cylinder head gasket is formed by 4-layer steel pieces with superior sealing performance and heat resistance.
- **Cylinder head**
 - Independent intake holes are adopted. The introduction of two intake holes in different shapes has improved the eddy current in cylinders and facilitated the mixture between fuel and air.
 - The adoption of 2 layers (upper and lower) of water jacket has enhanced the cooling capacity and rigidity. On top of this, optimized casting method (reinforced casting) has also made the cylinder head more reliable.
 - An electric heater plug between intake valves has ensured the reliability and startability.
 - With the EGR channel designed in cylinder head, the EGR gas has been cooled more effectively and the cylinder head becomes smaller.



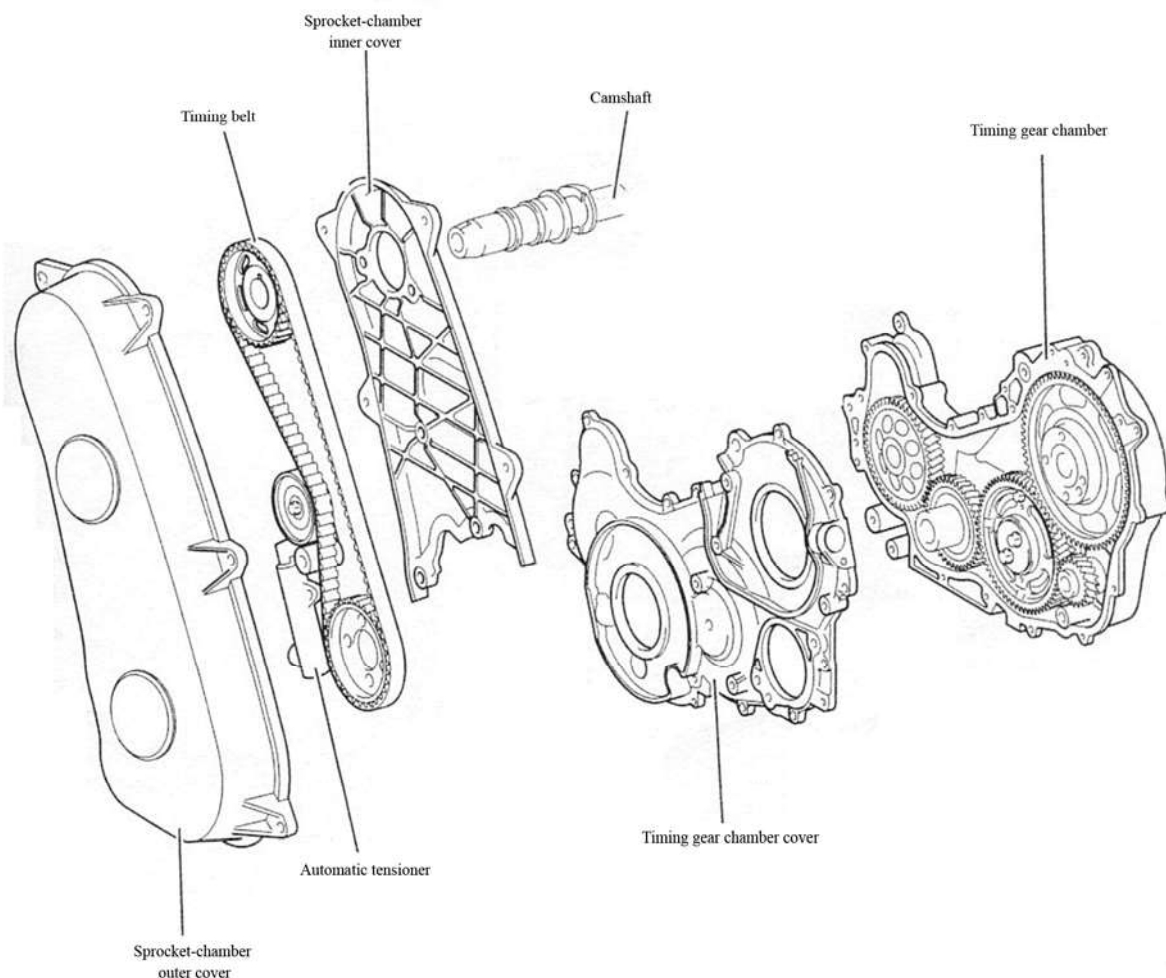


- The sealing capability has been enhanced by surrounding the cylinder bores on cylinder head gasket with an integrated independent gasket for #1-#4 cylinders.
- Cylinder bores adopt a double-edge structure, which can hold the elasticity of cylinder head gasket within a minimum threshold to ensure the sealability against the rising pressure of combusted air.



Camshaft timing system

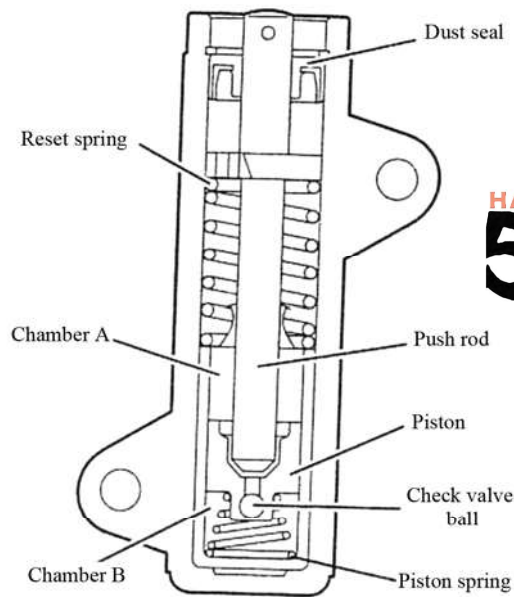
- The camshaft timing system is composed of timing gear system and toothed belt, making the engine shorter and the change of belt easier.
- High-strength material adopted by timing belt has created more reliability.
- Hydraulic automatic tensioner can keep the belt tension constant.
- Gear chamber and gear covers are made of aluminum alloy. On the timing gear chamber cover is a crankshaft position sensor.
- Both inner and outer covers of sprocket chamber are made of resin. Sealing gaskets around the outer cover of sprocket chamber has reduced the engine vibration and noise. The camshaft seal is installed on the cylinder head.



Camshaft timing system

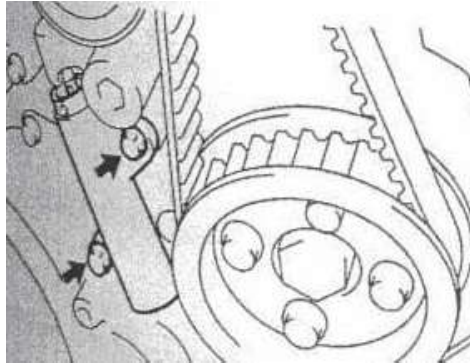
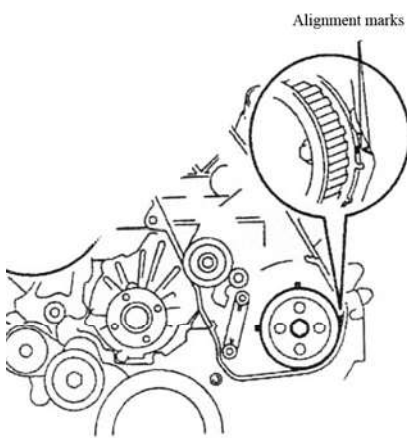
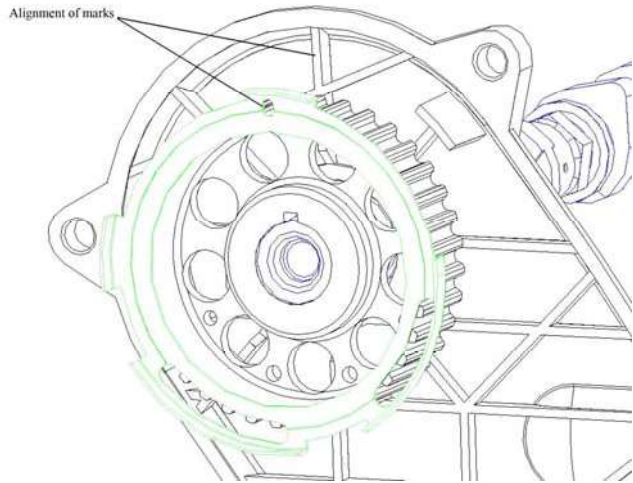
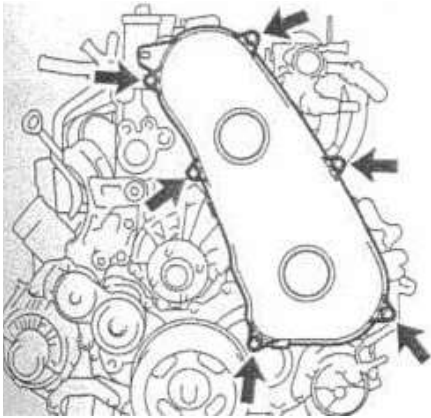
Oil-pressure tensioner

- The piston ring built in the tensioner pushes the idler pulley via a push rod to exert a certain tension force on belt. But forced by check valve ball, oil will enable the push rod to move towards the looser side of belt, thus keeping the tension on belt constant.
- Once the belt becomes loose, the push rod will be forced by piston spring to move up, and the oil in chamber A will burst through the check valve ball into chamber B, vice versa. If the engine speed drops, the tension on belt will increase so that the tensioner pulley will push the push rod. At this moment, the check valve ball cuts off the passage from chamber B to chamber A, so the chamber B will be highly stressed to prevent the invasion (into chamber B) by push rod. In this way, the belt tension can remain constant through the up-and-down continuous action of push rod.



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- Dismounting
 1. Dismount the outer cover of timing belt chamber.
 - (1) Dismount the phase sensor and its support.
 - (2) Remove the wire tube clamps.
 - (3) Unscrew 6 bolts to take down the outer cover of sprocket chamber.
 2. Dismount the timing belt
 - (1) Rotate the crankshaft clockwise until the marks on two toothed pulleys (sprockets) are aligned with each other.
 - (2) Evenly loosen 2 bolts to take down the tensioner.
 - (3) Dismount the timing belt and mark arrows according to its moving direction (its original moving direction should remain unchanged when the belt is being assembled)



- Installation

1. Prevent the valves and pistons against damage

To turn the camshaft in the absence of timing belt (dismounted), the crankshaft needs at first to be turned 90° anticlockwise.

Note:

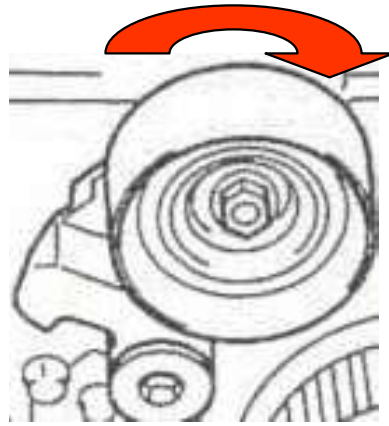
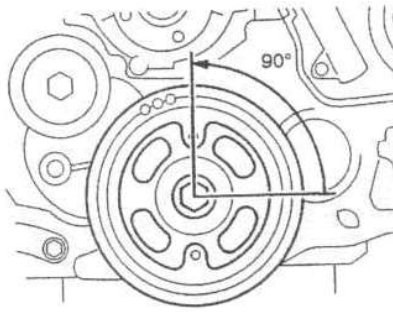
- Never turn the crankshaft when the timing belt has been removed, (The mutual interference between pistons and valves will invite the damage)
- In the installation of timing belt, the camshaft must firstly return to the alignment mark. Then rotate the crankshaft clockwise until it is aligned with alignment mark.

2. Check the timing belt tensioner (idler)

- (1) Turn the idler by hand to confirm it can rotate freely.
- (2) Confirm the sealing area has been lubricated evenly.

Note:

- Please repair the leaks when there are water beads and oil stains on the timing belt and every pulley.
- Every pulley to be installed must be wiped clean with rags until no oil stains can be found.
- Please don't dismount the timing belt idler, unless very necessary,



3. Install the timing belt

(1) Align the alignment marks of every pulley, as shown in the picture.

(2) Install the timing belt in the “driveshaft toothed pulley– camshaft toothed pulley –timing belt idler” sequence.

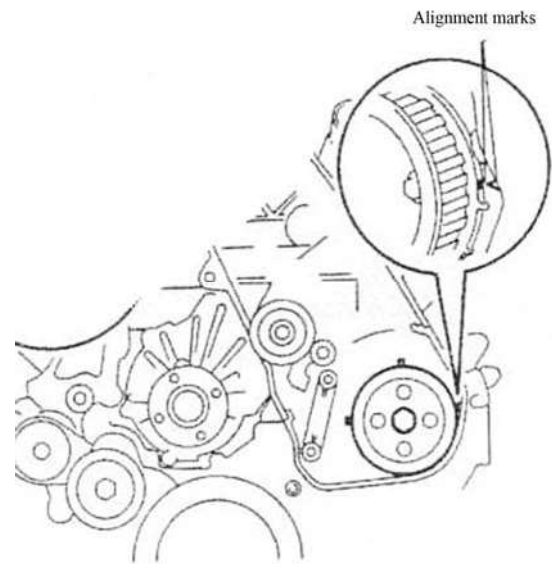
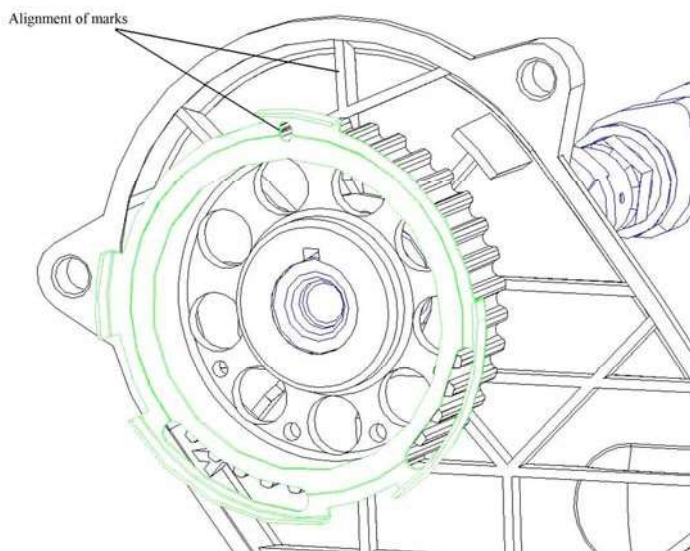
※ **Reference:** Install the timing belt and make the line on the back of belt aligned with the notch on every pulley.

(3) Fix the tensioner on a press and press the push rod downward.

※ **Note:**

① Please protect the tension rod top of tensioner from damage by using rags.

② Carry out the compression as the tension rod of tensioner faces up.



(4) Slowly press the tensioner push rods and after their alignment with cylinder bore, fix them with inner hexagon spanners (with a same 1.5 mm width on both sides) .

※ **Note:** The load on tension rods must not exceed 980N (100 kgf) (in a frigid region, the tensioner can be heated to a $<80^{\circ}\text{C}$ temperature to increase the press-mounting speed)

※ **Reference:** after the tension rods have been aligned with cylinder bores, press the pressing plate while aligning it with bores and inserting inner hexagon spanners.

(5) Install the tensioner with inserted inner hexagon spanners.

※ **Benchmark:** $T=13\text{N.m}$

※ **Note:** An inclining tensioner can't function normally. Please tighten every bolt evenly.

(6) Pull inner hexagon spanners out of tensioner.

(7) Turn the crankshaft for 2 rev. clockwise. Confirm all the alignment marks on all the toothed pulleys are aligned.

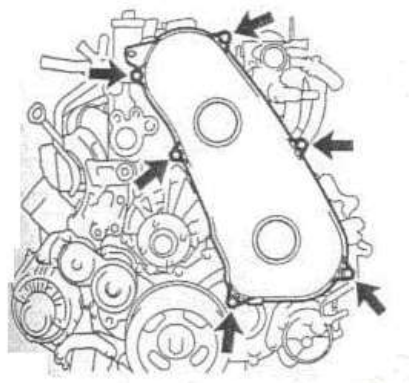
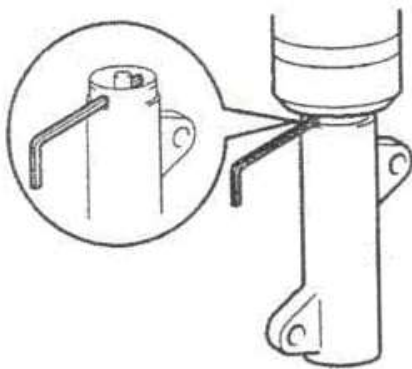
4. Install the outer cover of timing toothed-belt chamber

(1) Fix the outer cover of sprocket chamber with 6 bolts.

※ **Benchmark:** $T=6.0\text{N.m}$

(2) Install the phase sensor support.

(3) Connect the wires.



Cylinder head assembly

- Dismounting

1. Dismount the cylinder head cover.

(1) Loosen the presser bolts and presser-bolt washers of injector, and then dismount the injector presser plates for 4 cylinders.

(2) Take down the injectors and record the corresponding cylinder numbers of injectors.

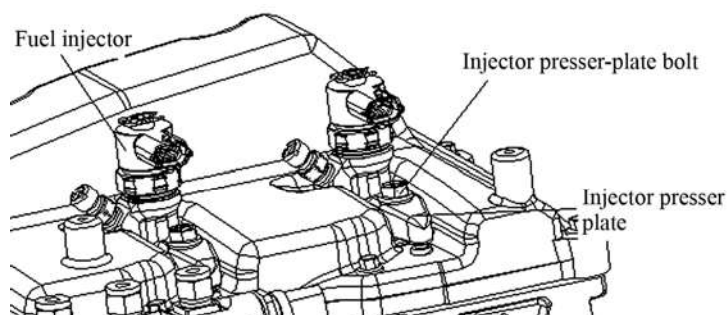
(3) Unscrew the bolts on cylinder head cover and take down the cover.

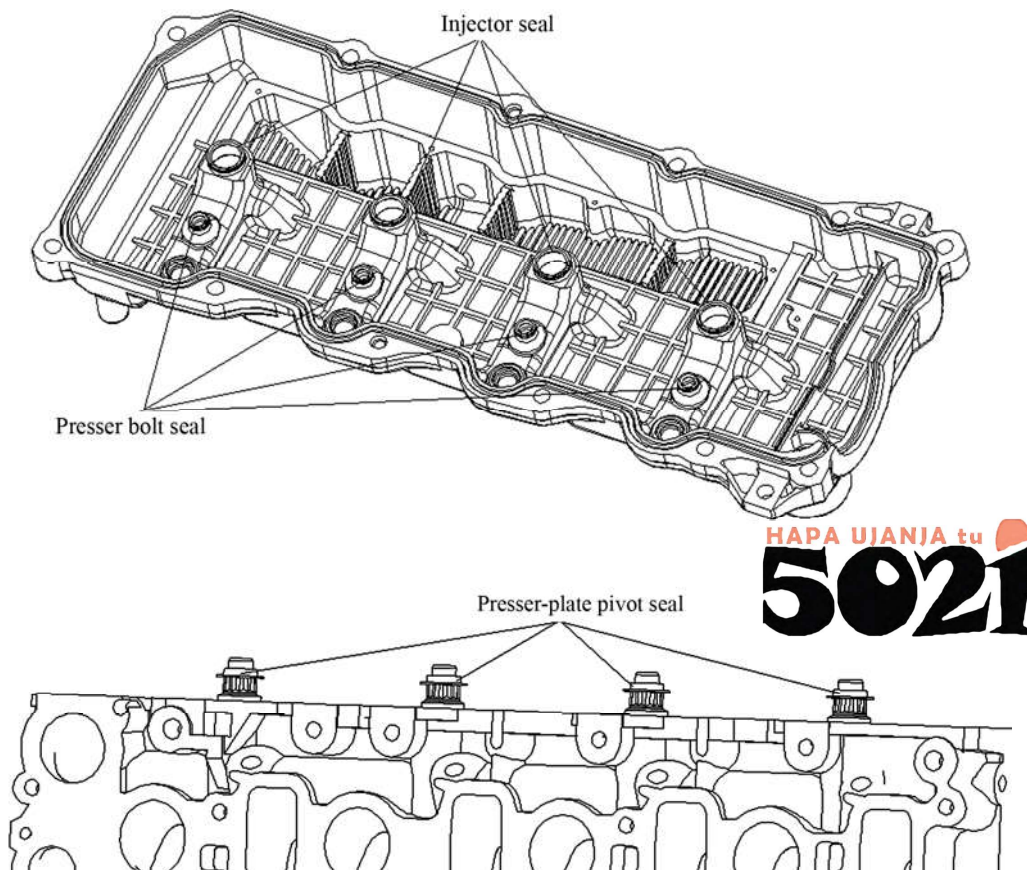
(4) Take down the injector seals and presser-bolt seals from cylinder head cover.

2. Take down the seals at the pivot of presser plates.

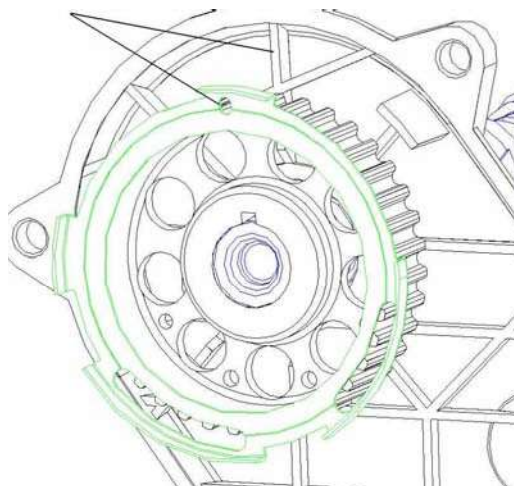
3. Dismount the timing toothed belt

(1) Remove the phase sensor.





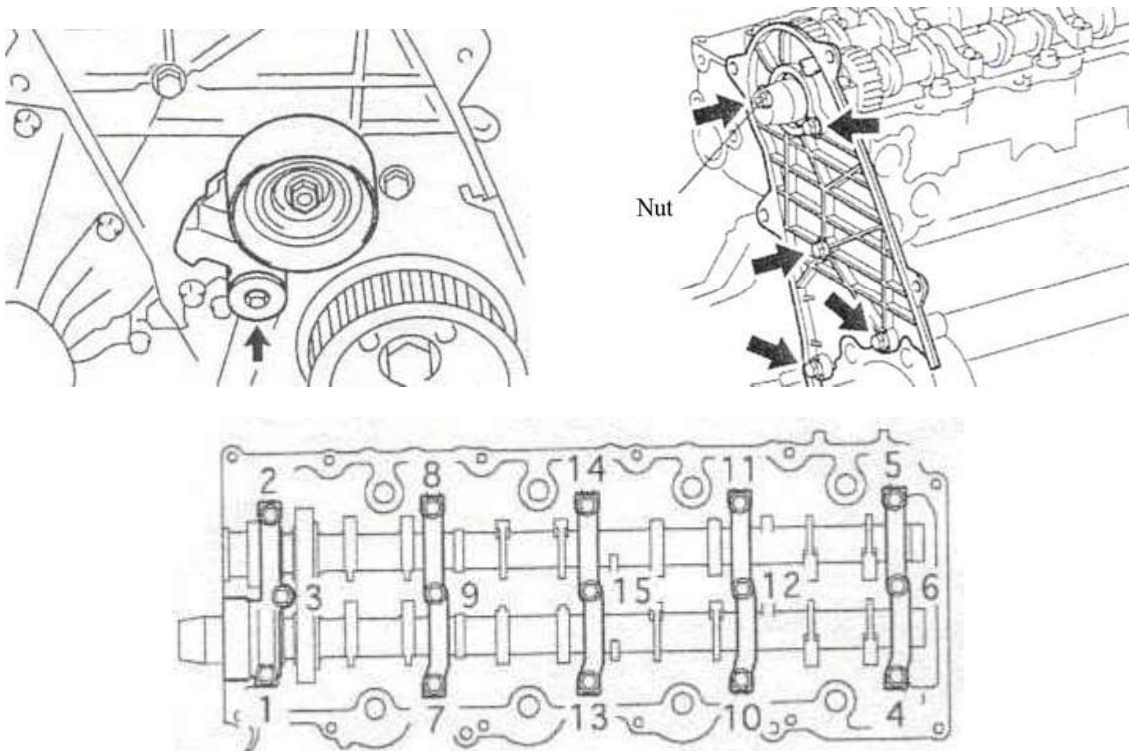
- (2) Take down the outer cover of timing belt chamber.
 - (3) Rotate the crankshaft to the compression TDC (top dead center) of cylinder 1.
 - (4) Take down the timing toothed belt
4. Dismount the timing toothed pulley (or sprocket)
- (1) Fasten the camshaft with a monkey spanner and loosen the bolts on camshaft timing sprocket.
 - (2) Loosen the bolts on camshaft timing pulley until there are 2~3 threads for bolts to completely exit the camshaft screws (don't let bolts completely out lest the sprocket being pulled out will drop).
 - (3) Draw the timing pulley with a special tool (tension tool) (no hammering! Very great engaging force exists in the cone fit between sprocket and camshaft, so hammering the sprocket will lead to its deformation or damage).



- (4) Dismantle the pulley key from camshaft.
5. Dismount the timing belt tightener (idler)

Unscrew the timing idler bolts with a hexagon spanner.
6. Dismantle the inner cover of timing belt chamber

Unscrew the fastening bolts and nuts, and then take down the inner cover of timing belt chamber.
7. Dismount the camshaft
 - (1) Evenly loosen the bolts and remove the cover of camshaft bearing shell in the sequence shown in the picture.



※ **Note:**

- ① Pry the camshaft with a right tool but without an oversize force.
 - ② Please don't damage the thrust surface of camshaft and cylinder head.
- (2) Remove the camshaft seal.
 - (3) Dismantle the intake camshaft and exhaust camshaft.
8. Dismantle the cylinder head
 - (1) Evenly loosen the cylinder head bolts for several times in the illustrated sequence, and take down the bolts and washers.
 - (2) Check the cylinder head bolts

Measure the illustrated position with vernier calipers.

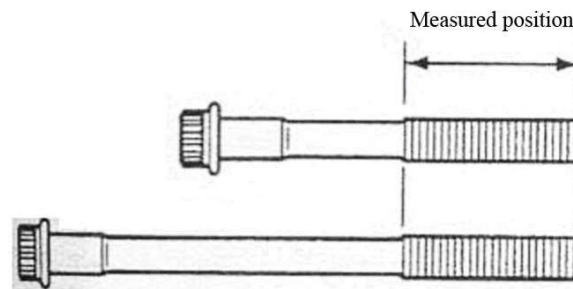
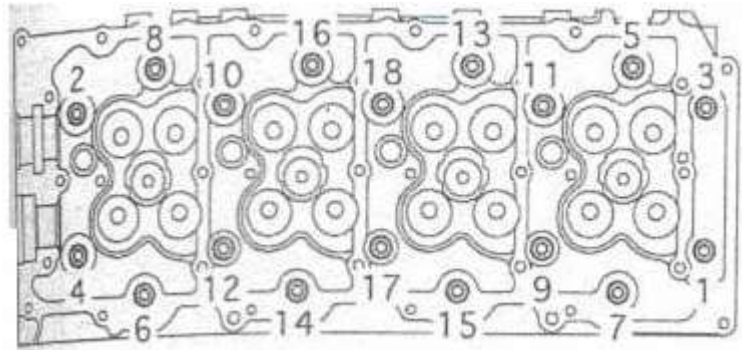
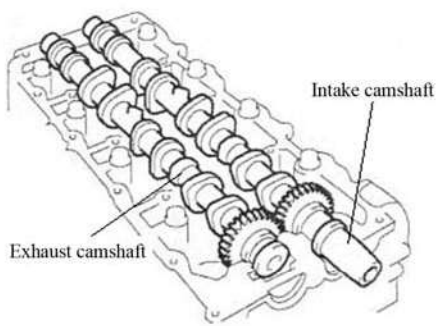
※ **Standard value:** $\phi 11.67 \sim 11.97\text{mm}$

※ **Limit value:** $\phi 11.60\text{mm}$

※ **Reference:** Make the measurement in multiple positions. Renew the product if the measured

values are below the limit.

9. Dismantle the cylinder head gasket



• Installation

1. Install the cylinder gaskets

(1) Measure the piston protrusion.

Measure the piston protrusion (the distance to the upper surface of cylinder block) with dial gauge and flat-seat probe.

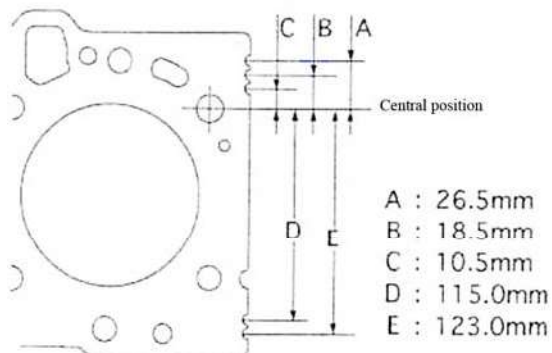
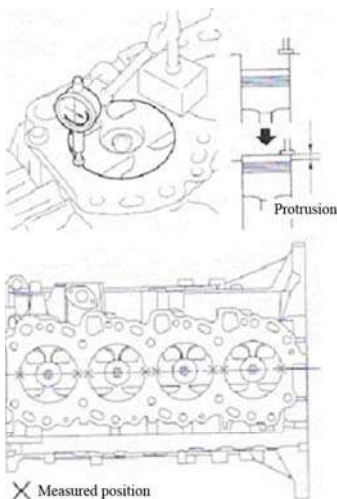
※ Note:

- ① The probe should be vertical to the upper surface of cylinder block.
- ② Choose one position respectively in front of and behind every piston. Measure two points for every cylinder (8 points in total).

(2) Choose cylinder gaskets based on the maximum piston protrusion.

※ Note:

- ① The thickness of a cylinder gasket should be identified according to the position of notch at the rear end of cylinder gasket.



- ② Choose cylinder gaskets according to all the protrusions.
- (3) Install the chosen gaskets onto cylinder blocks.

※ **Note:**

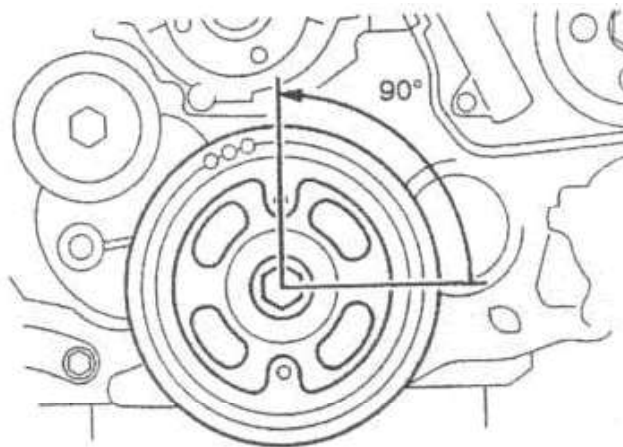
- ① Clean the lower surface of cylinder head and the upper surface of cylinder block.
- ② No foreign bodies into cylinder gaskets!

2. Install the cylinder head

※ **Note:**

- ① Confirm the pulley notch is just 90° ahead of the TDC before installing cylinder gaskets.
 - ② Tighten the cylinder head bolts in a plastic-range tightening method.
- (1) Fit washers onto cylinder head bolts and then insert them into cylinder head.

Selection code	Maximum piston protrusion δ (mm)
A	[0.005 $\leq$ δ $\leq$ 0.055)
B	[0.055 $\leq$ δ $\leq$ 0.105)
C	[0.105 $\leq$ δ $\leq$ 0.155)
D	[0.155 $\leq$ δ $\leq$ 0.205)
E	[0.205 $\leq$ δ $\leq$ 0.255)

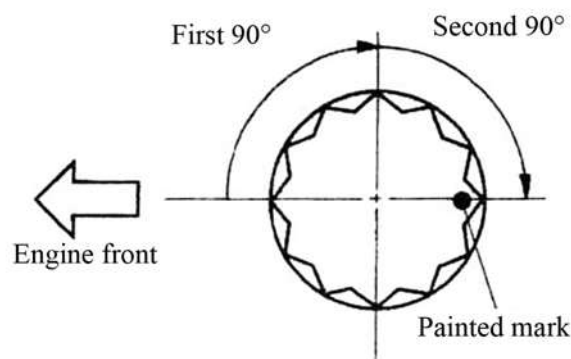
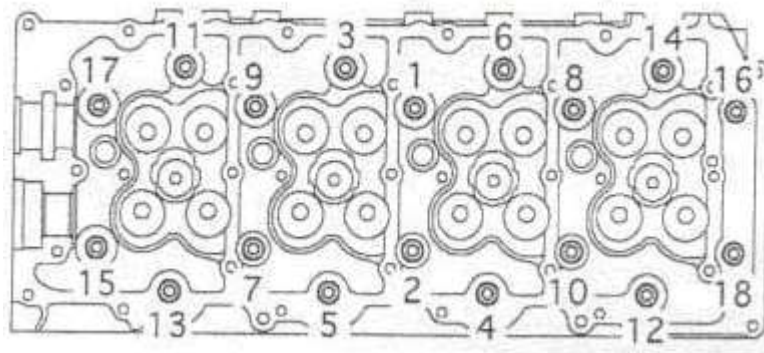


- (2) Pre-tighten the cylinder head bolts for several times in the illustrated sequence, and then tighten them with the required torque.

※ **Standard value:** T=85N.m

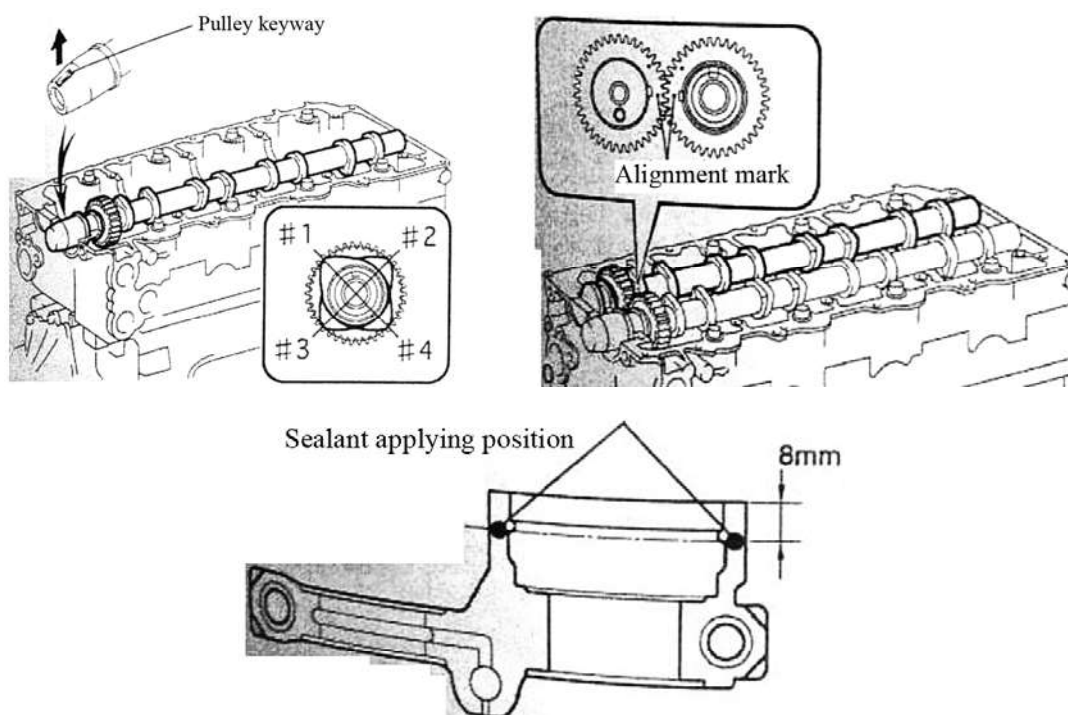
- (3) Mark the top of cylinder head bolts and keep these marks on the front side of engine.
- (4) Turn every cylinder head bolt for 90° .

- ※ **Note:** Tighten the cylinder head bolts in the tightening sequence.
- (5) Tighten every cylinder head bolt for another 90° .
- (6) Conform all the marks on all cylinder head bolts are on the rear side of engine.



3. Install the camshaft

- ※ **Note:** As the camshaft has a small thrust clearance (axial clearance), it should be installed horizontally lest the thrust surface will have such defect as damage, scratch or burr.
- (1) Check if the crankshaft is 90° ahead of TDC.
- (2) Let the keyway face up and fit the intake camshaft onto cylinder head.
- ※ **Note:** Apply the engine oil on the cam, thrust surface and gears of camshaft and the axle journal of cylinder head.
- (3) Let the gears on intake camshaft and exhaust camshaft engage, and then install the exhaust camshaft.
- ※ **Note:**
Apply the engine oil on the cam, thrust surface and gears of camshaft and the axle journal of cylinder head.
- (4) Spread the illustrated position with sealant and then install the camshaft onto cylinder head.



(5) Align the camshaft bearing shell covers and fit them onto cylinder head, as shown in the picture.

(6) Tighten the camshaft bearing shell covers in the illustrated sequence.

※ **Standard value:** $T=19\text{N.m}$

(7) Check and adjust the valve clearances.

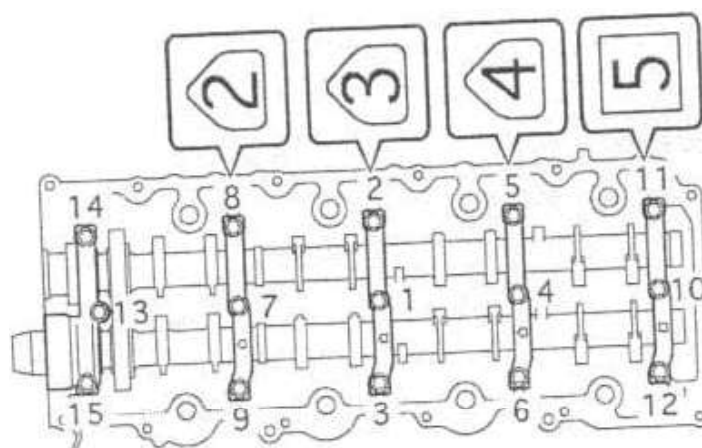
(a) Measure the valve clearances in the illustrated positions (in cold state).

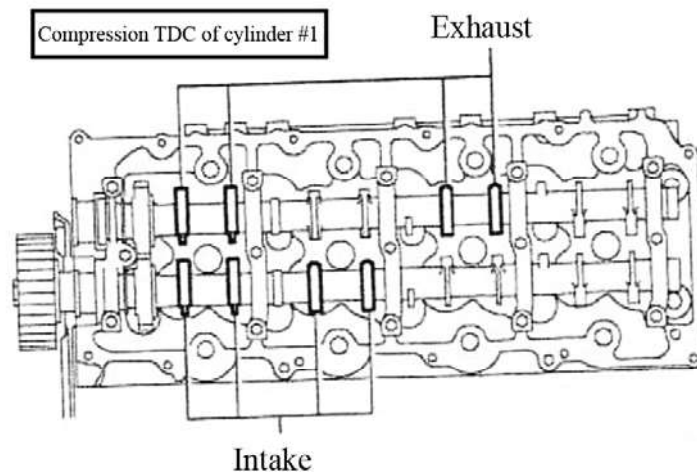
※ **Reference:** intake: $0.20\sim 0.30\text{mm}$

Exhaust: $0.35\sim 0.45\text{mm}$

※ **Note:** Valve clearances need to be measured when the valves are in cold state.

(b) Rotate the camshaft to measure and record the valve clearances of other cylinders.





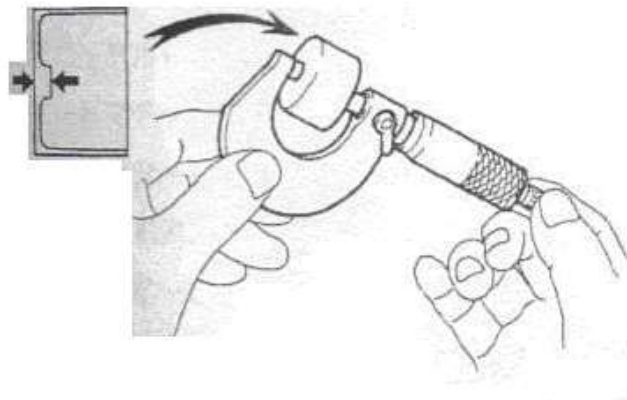
(c) Adjust the valve clearances

- ① Dismantle the camshaft and take down the valve tappets.
- ② Measure with dial gauge the thickness of valve tappets that have been just taken down.
- ③ Calculate the tappet thickness when valve clearances meet the Standard values.

※ **Standard values:** IN: $A=B+(C-0.25\text{mm})$

$$\text{EX: } A=B+(C-0.40\text{mm})$$

- ④ Choose the valve tappets.
- ⑤ Install the chosen valve tappets.
- ⑥ Reinstall the camshaft and check the valve clearances, which, if beyond the Standard value range, should be readjusted as per the above steps until the Standard values are met.



A	Valve tappet to be chosen
B	Thickness of just removed valve tappet
C	Valve clearance that has been measured

4. Install the camshaft seal

- (1) Apply a thin layer of MP grease on new seal lip.

※ **Note:** Pay attention not to let foreign bodies stay on the lip.

(2) Beat the seal in with special tooling

※ **Standard value:** 0.5mm~-1.5mm (to the end face of cylinder head end)

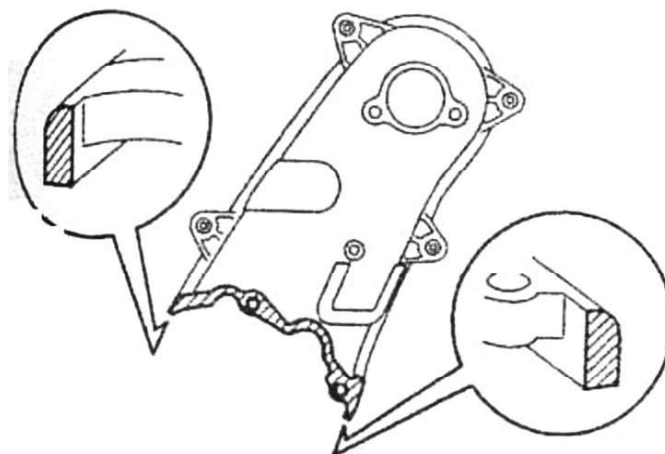
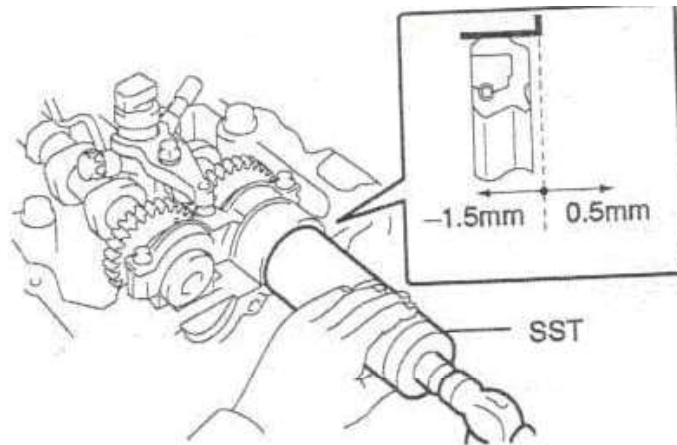
※ **Note:** The fuel seal can't be installed obliquely.

5. Install the inner cover of timing belt chamber

(1) Spread the illustrated position with sealant.

※ **Note:**

- ① Clean and degrease the mounting surface.
- ② Install this cover within 3 minutes after applying the sealant, and tighten it within 15 min.
- ③ Don't start the engine within 2h after this installation.



 Sealant applying position

(2) Fix the inner cover of sprocket chamber with 4 sets of bolt and nut.

※ **Standard value:** T=10N.m

6. Install the timing belt tightener (idler)

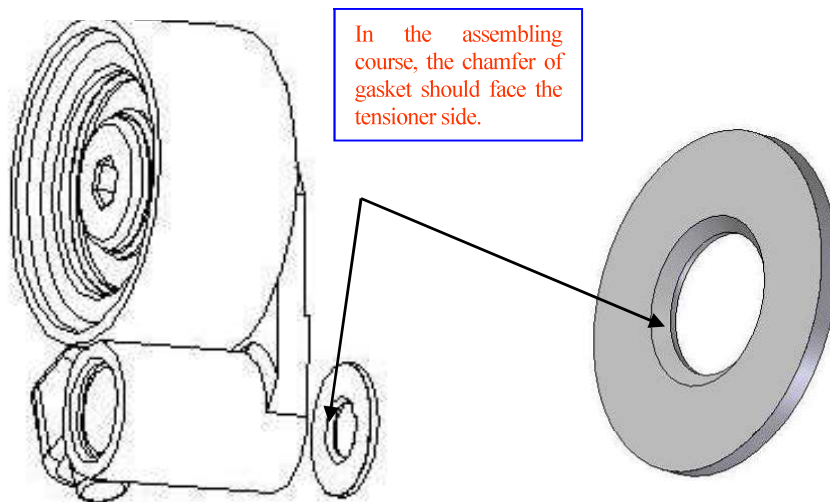
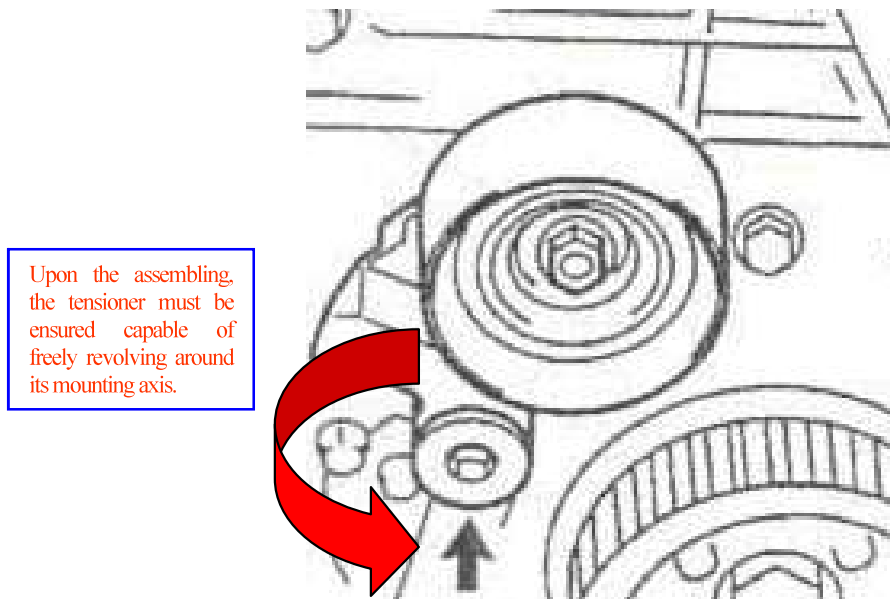
Mount the timing belt idler with hexagonal socket wrench.

※ **Standard value:** $T=35\text{N.m}$

7. Install the camshaft timing pulley

- (1) Fit the pulley key onto camshaft.
- (2) Mount the camshaft timing pulley.
- (3) Fasten the camshaft with monkey wrench, and then screw the mounting bolts of camshaft timing pulley. (Before tightening the bolts, the sprocket mounting surface must be checked to be 2mm above the camshaft end face).

※ **Standard value:** $T=90\sim 98\text{N.m}$



8. Install the timing belt

Note: after every 50,000km use, the timing belt must be renewed. The timing belt in installation must ensure its timing mark is aligned with that on sprocket.

9. Install the outer cover of timing belt chamber

10. Install the cylinder head cover

- (1) Mount the presser pivot seals on cylinder head bolts with a projection.

(2) Install the injector seals and presser bolt seals.

(3) Spread the illustrated position with sealant.

※ **Note:**

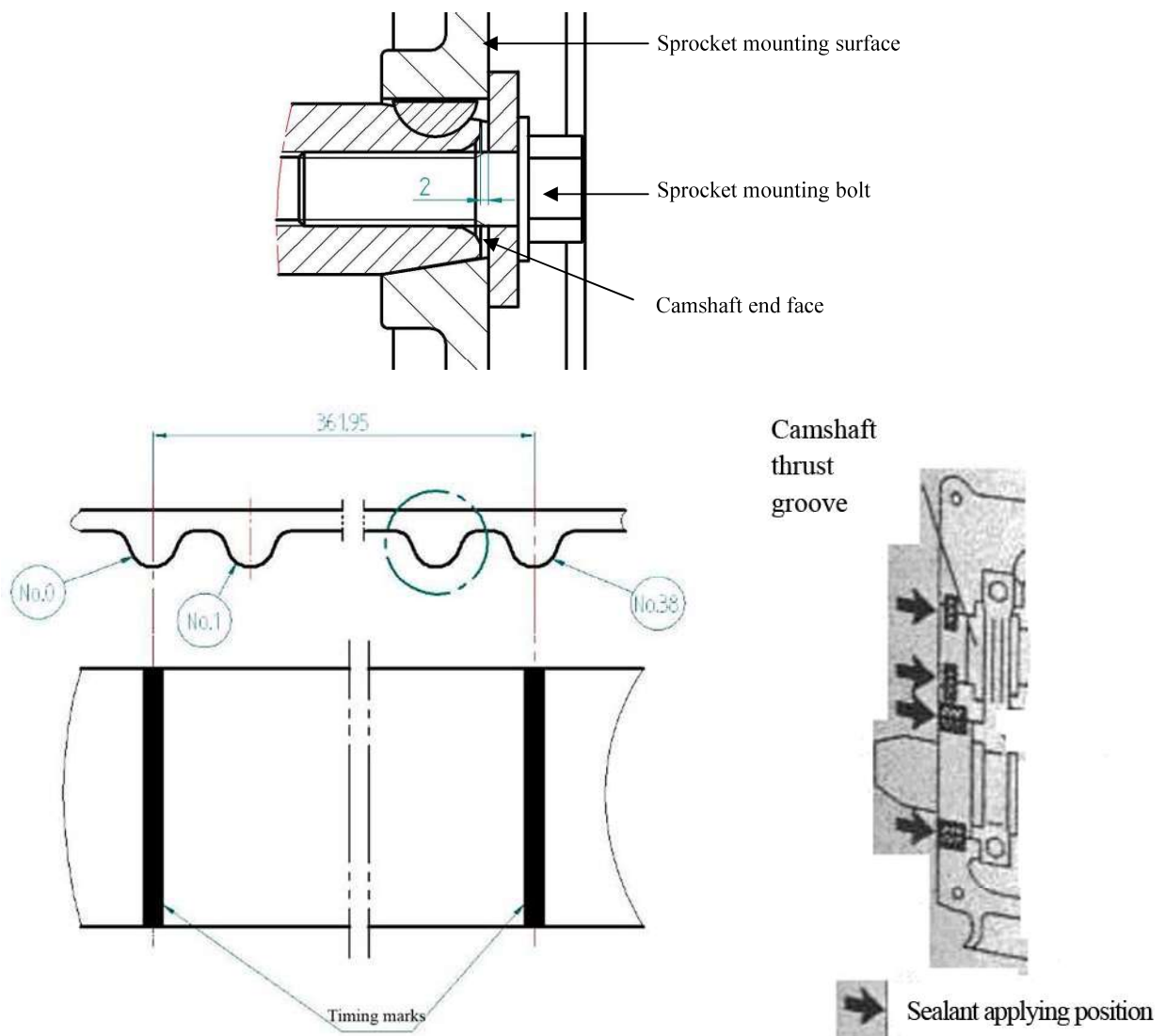
- ① Clean and degrease the mounting surface.
- ② Install this cover within 3 minutes after applying the sealant, and tighten it within 15 min.
- ③ Don't start the engine within 2h after this installation.

(4) Fix the cylinder head cover with 10 bolts and 2 nuts.

※ **Standard value:** $T=9.0\text{N.m}$

11. Install the fuel injector

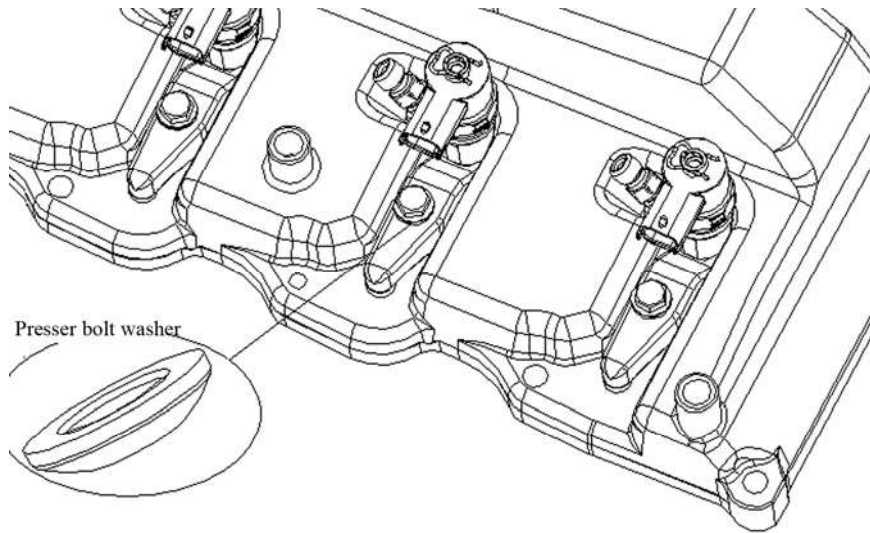
Check if the copper gasket of injectors is intact, and insert the numbered injectors into the corresponding cylinders.



12. Install the injector presser plate

13. Thread the presser bolt washers onto injector presser bolts, install these bolts and tighten them.

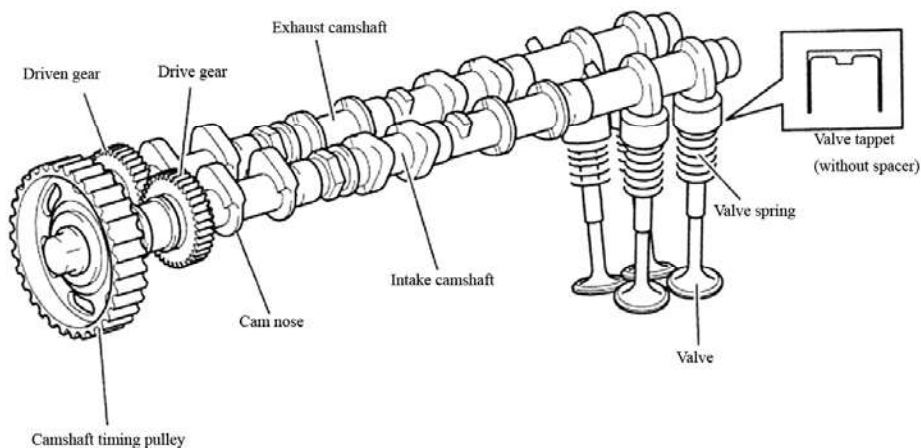
※ **Standard value:** $=30 \pm 3\text{N.m}$



Intake and exhaust systems

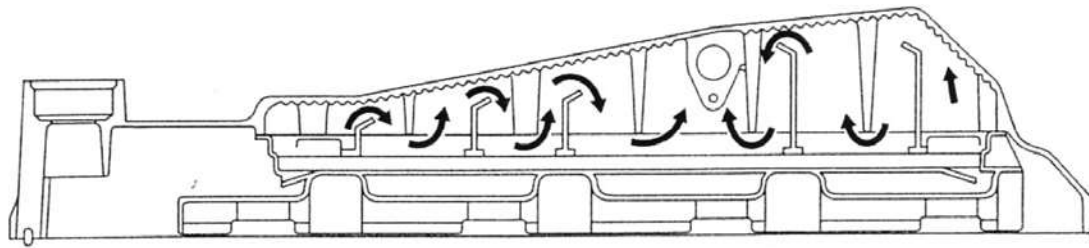
I Valve-related items

- Adopt the DOHC4 valve structure, in which the intake camshaft drives the exhaust camshaft through gears.
- Camshafts are made of alloy cast iron. By reducing the thickness of cam nose and shortening the camshaft diameter has the engine become lighter.
- 4 Valves are made of heatproof steel and oppositely aligned. In addition, a high-speed, low-consumption target has been achieved with smaller diameter of valve stems, lighter valves and lower inertia.
- Valve tappets have no spacers, thus decreasing the quantity of components and reducing the engine weight.

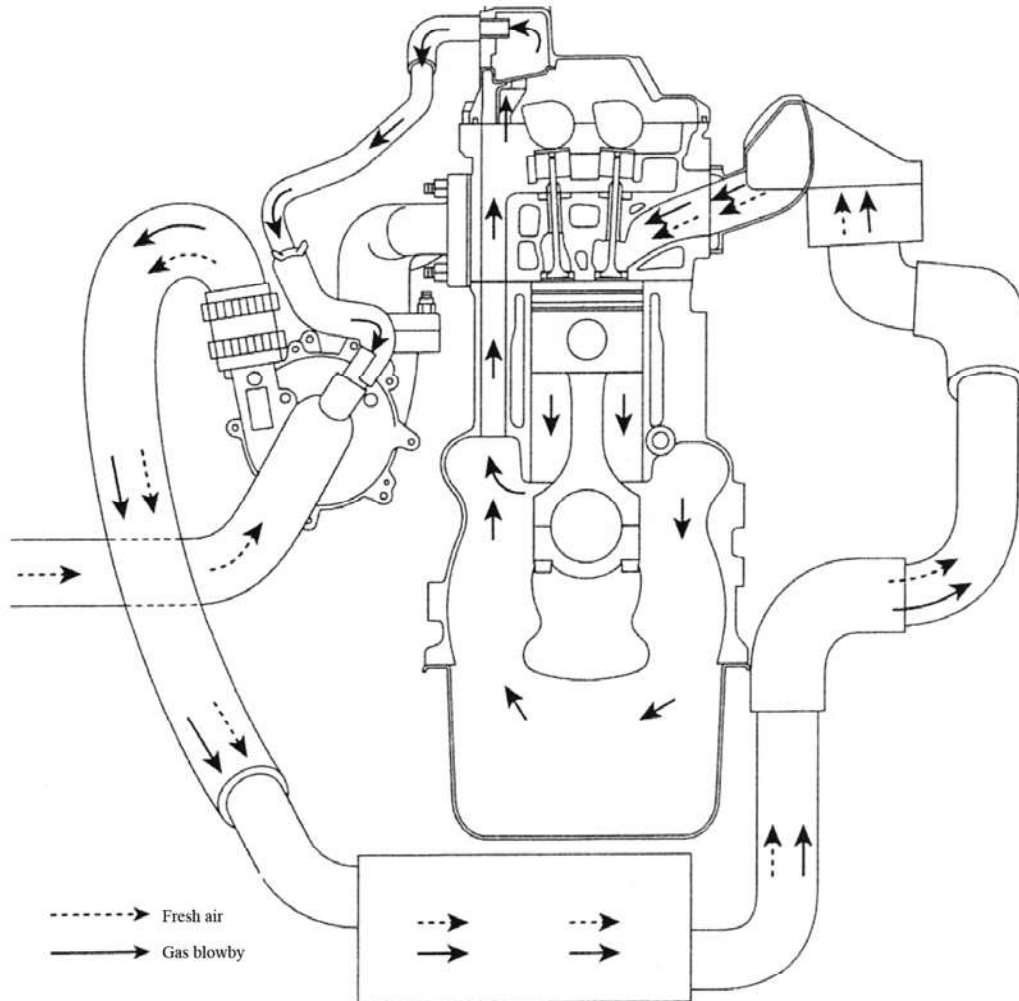


Crankcase ventilator

- Lead the gas blowby containing a large amount of hydrocarbon into take system, where it can combust once again to improve the exhausting performance.
- By designing the blowby passage into a loop and extending the ventilation duct out of the top of cylinder head cover have both the oil content in blowby and the oil consumption been reduced , thus achieving the low-emission target.
- The gas blowby in crankcase, via the ventilation duct at the top of cylinder head cover, is restored to the intake side of turbocharger.



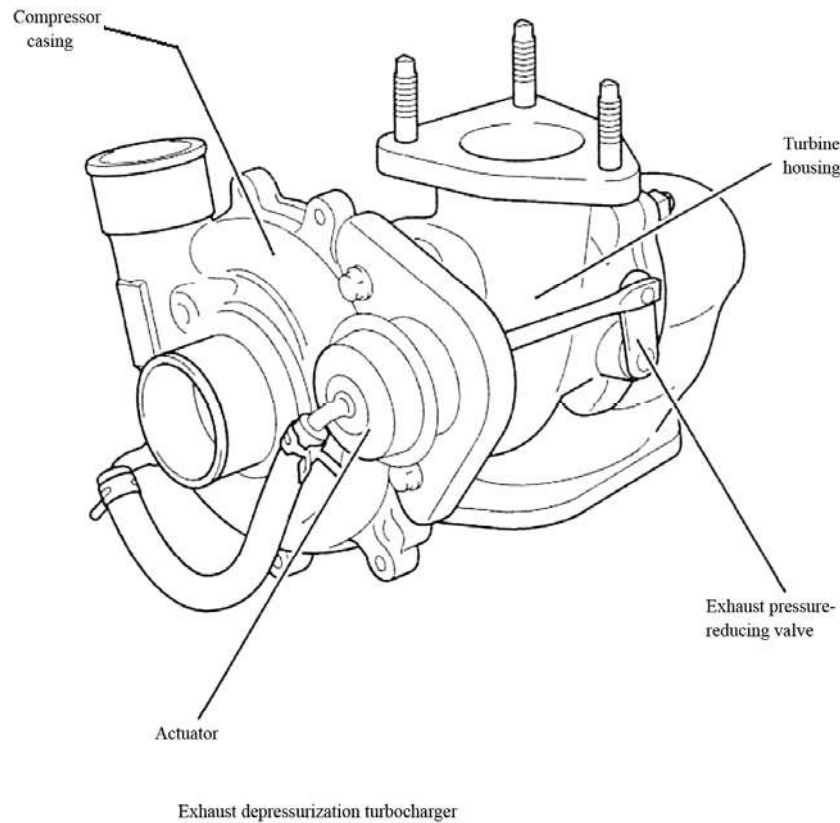
Sectional view of cylinder head cover (blowby passage) ← 窜漏气体



Air flowing diagram

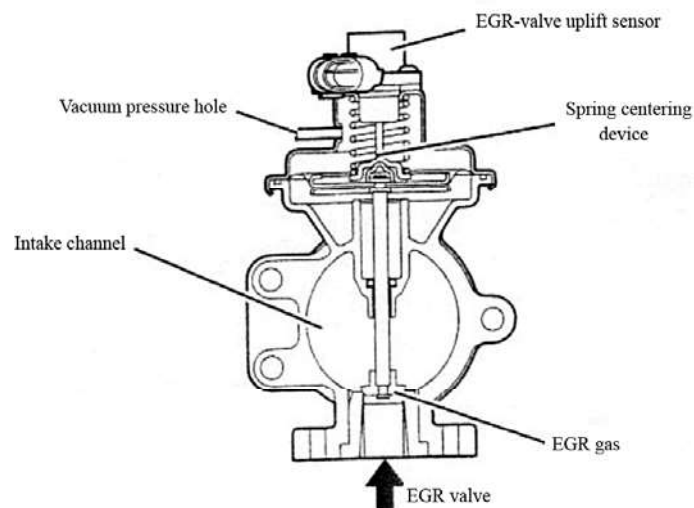
Turbocharger

- The turbocharger is an exhaust depressurization type. Once the supercharging pressure goes beyond the set value, the actuator on exhaust pressure-reducing valve begins to take action. It releases the exhaust pressure through the byway and lowers the supercharger speed in order to keep the supercharging pressure rising continuously. The maximum supercharging pressure depends on the spring force of exhaust pressure-reducing valve.
- Lighter rotor, together with improved air inlet shape and blade shape has not only contributed to quicker response and stronger supercharging performance, but fully ensured the engine reliability.
- The compressor casing is cooled by air, while the exhaust temperature is brought down through intercooler.



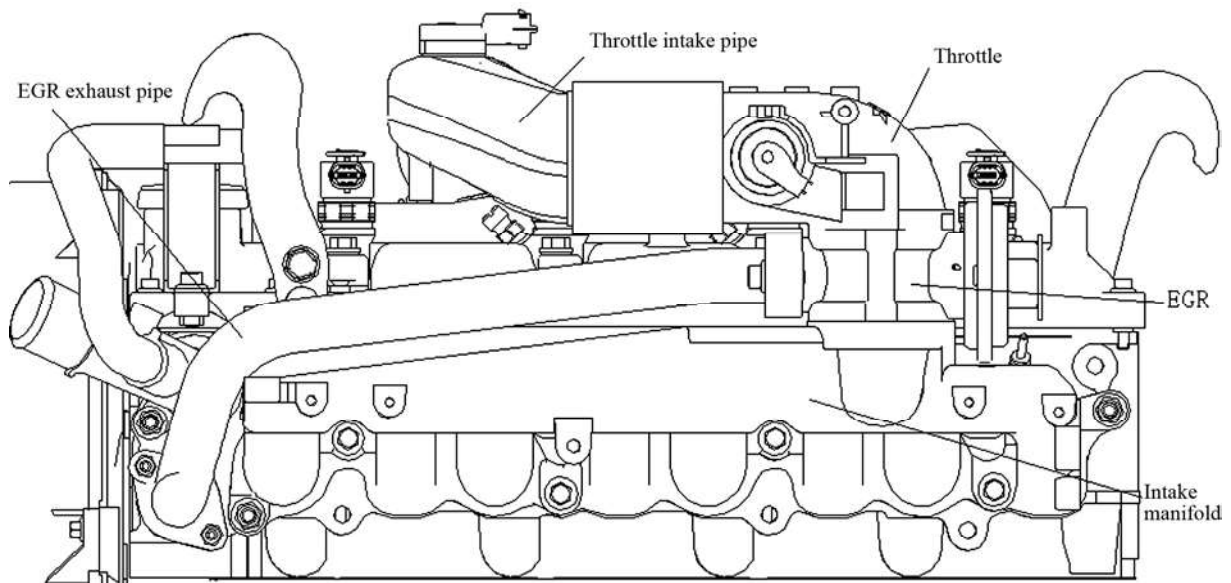
EGR valve

- An electric EGR system has been adopted to reduce the emission.
- Install the EGR valve on intake channel, cool it with air, and with the aid of a large-capacity multi-pipe EGR cooler, achieve a large amount of EGR gas.
- Through the EGR channel designed inside the cylinder head, the end gas can be recycled directly on the intake side, so the EGR gas can be cooled more effectively and the engine becomes smaller.
- EGR-valve uplift sensor has been used. It can closely monitor the actual uplift of EGR valve so as to accurately control the EGR.
- The use of spring centering device has reduced the lag on both “on” and “off” sides of EGR valve, thus improving the EGR regulating accuracy .



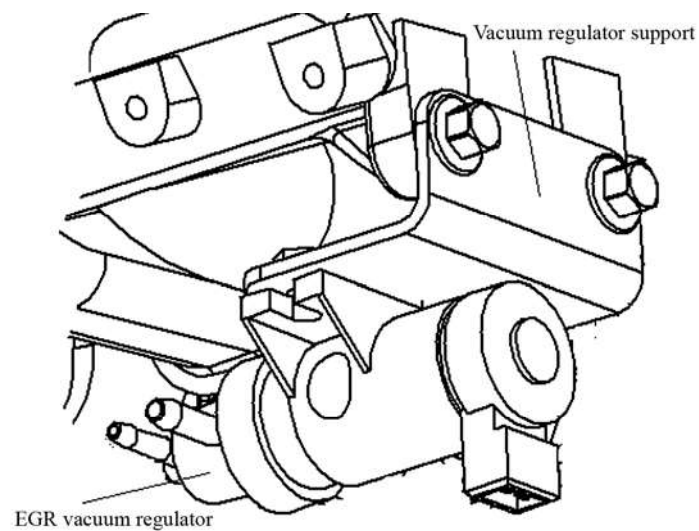
- Dismounting

1. Dismantle the throttle intake pipe.

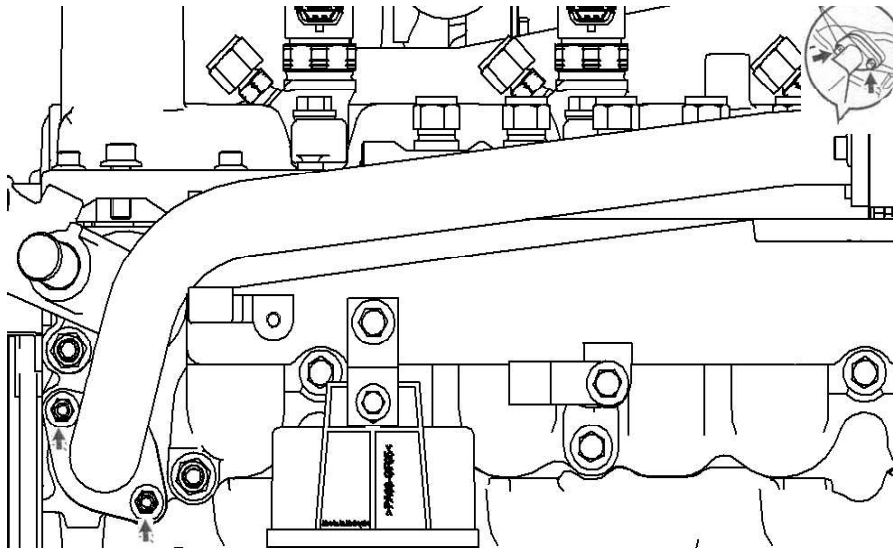


2. Take down the throttle body.

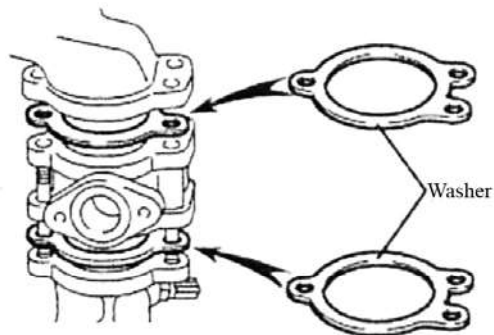
3. Remove the EGR vacuum regulator and vacuum regulator support.



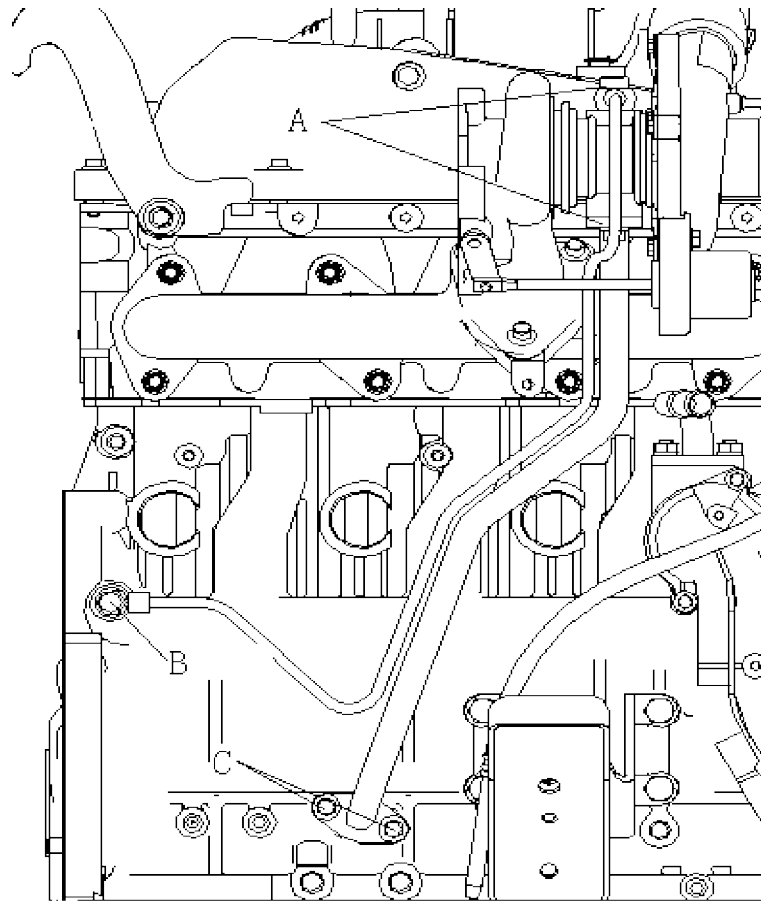
4. Unscrew two bolts and two nuts to remove the EGR exhaust pipe.



5. Remove the EGR valve and two washers from intake manifold.
6. Unscrew 4 bolts and 2 nuts to take down the intake manifold and intake manifold gaskets.



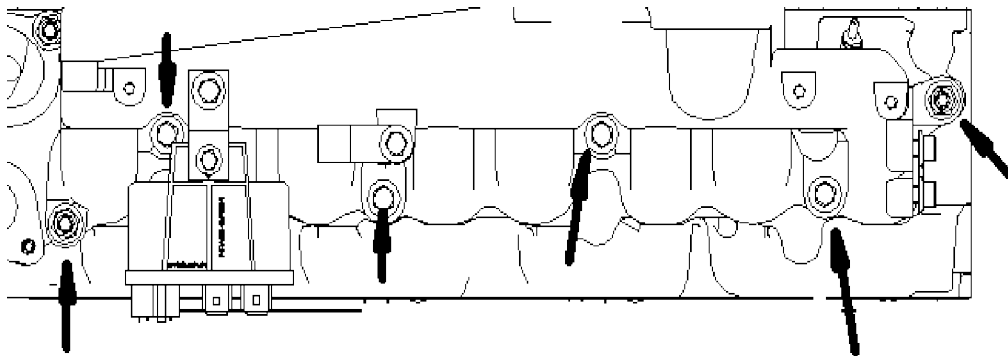
7. Remove the fuel inlet pipe and return pipe from turbocharger.
 - (1) Take down the screw plugs on fuel inlet pipe (see A and B in the picture), and remove the fuel inlet pipe from turbocharger.
 - (2) Take down 4 nuts (see A and C in the picture), and remove the fuel return pipe from turbocharger.
8. Take down 3 nuts and then the turbocharger.
9. Take down 8 nuts and then the exhaust pipe as well as exhaust pipe gaskets.



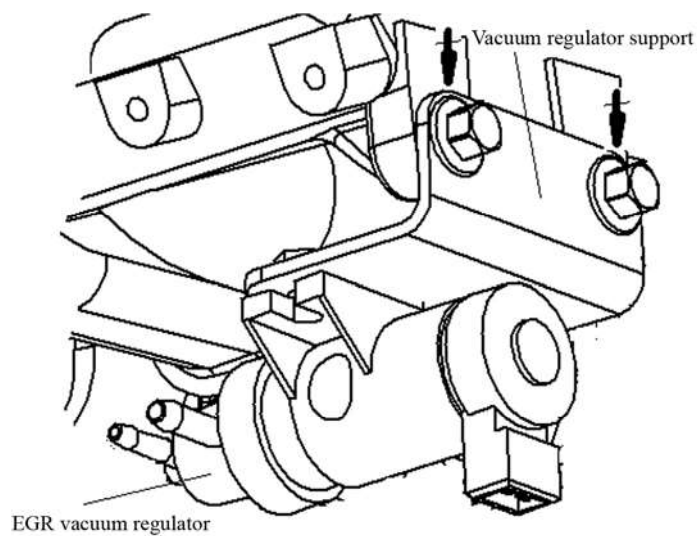
- Installation

1. Install the intake manifold gaskets.

※ **Note:** Clean the mounting surface between cylinder head and intake manifold.

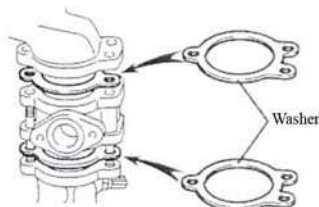


2. Install the intake manifold, and tighten 4 bolts and 2 nuts.
3. Install the vacuum regulator and vacuum regulator support.



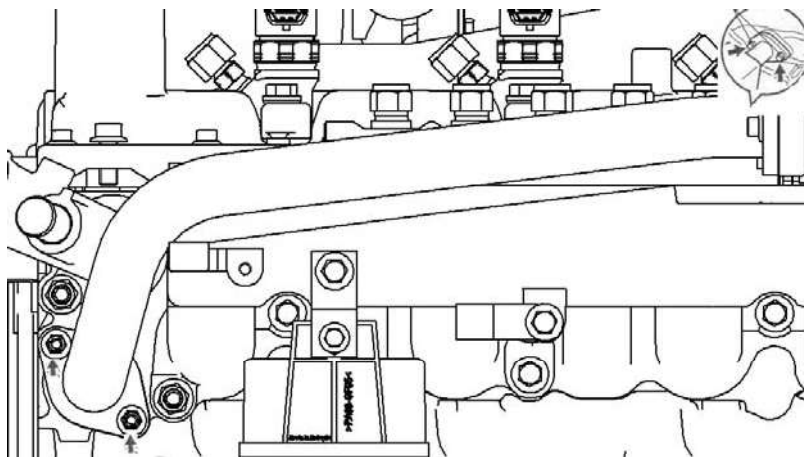
4. Install the EGR valve and throttle body.

- (1) Temporarily fix the EGR, with 2 washers installed (as shown in the picture).
- (2) Fasten the throttle body with 3 bolts.



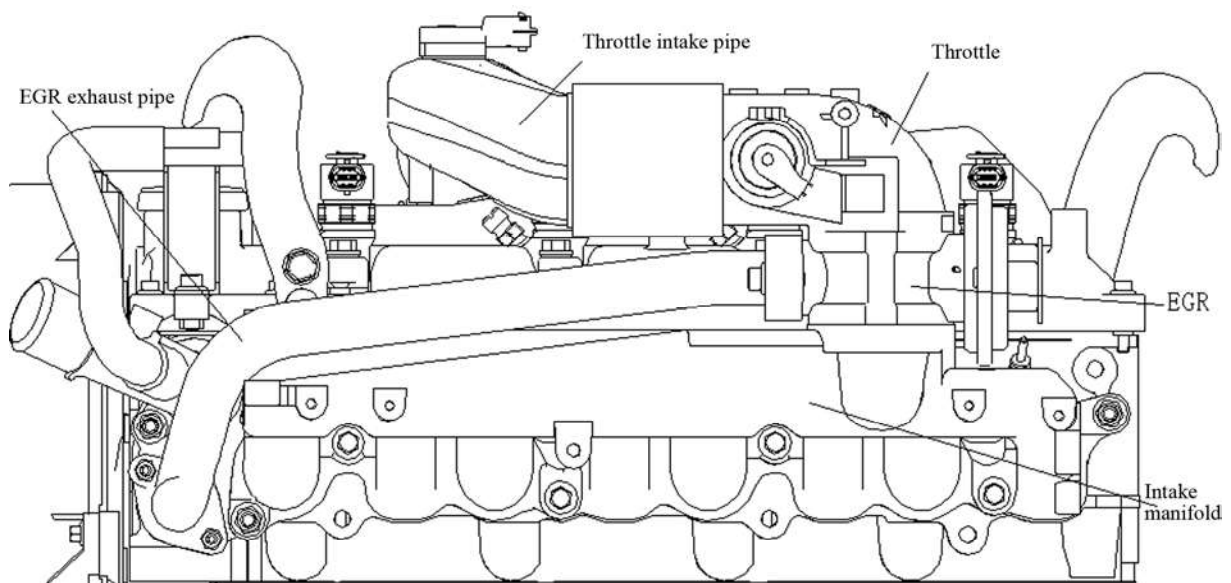
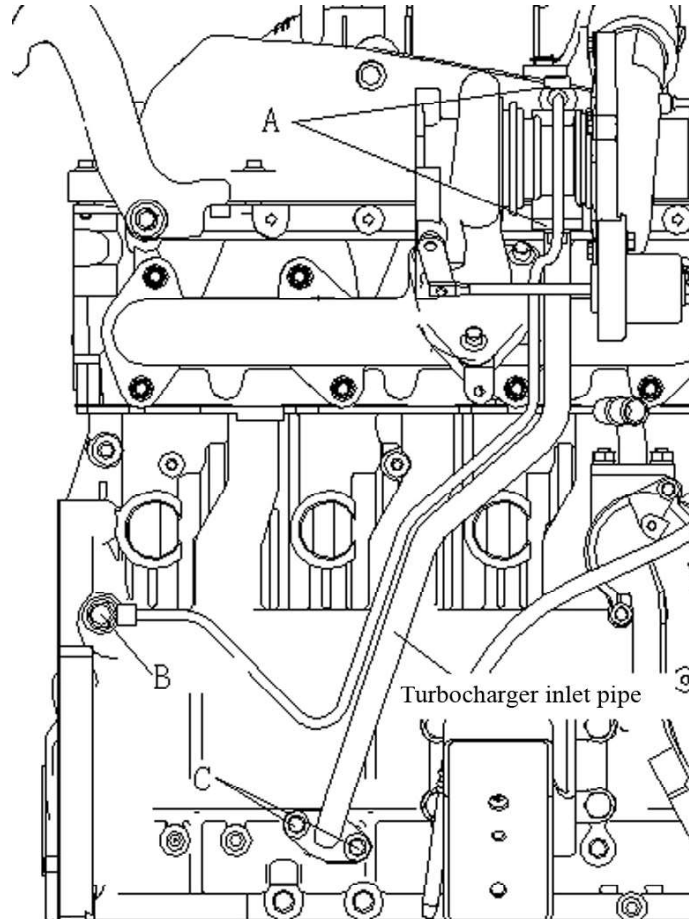
5. Install the EGR exhaust pipe.

- (1) At first install the cylinder-head end with gaskets and nuts - without tightening them for the time being.
 - (2) Put on the gaskets to mount the EGR end with bolts.
 - (3) Tighten the nuts and bolts on both ends.
6. Put on the exhaust manifold gaskets and install the exhaust manifold.
7. Fit the turbocharger return pipe onto turbocharger.
8. Put on the turbocharger gaskets to install the turbocharger.



9. Install the fuel inlet pipe and return pipe of turbocharger.

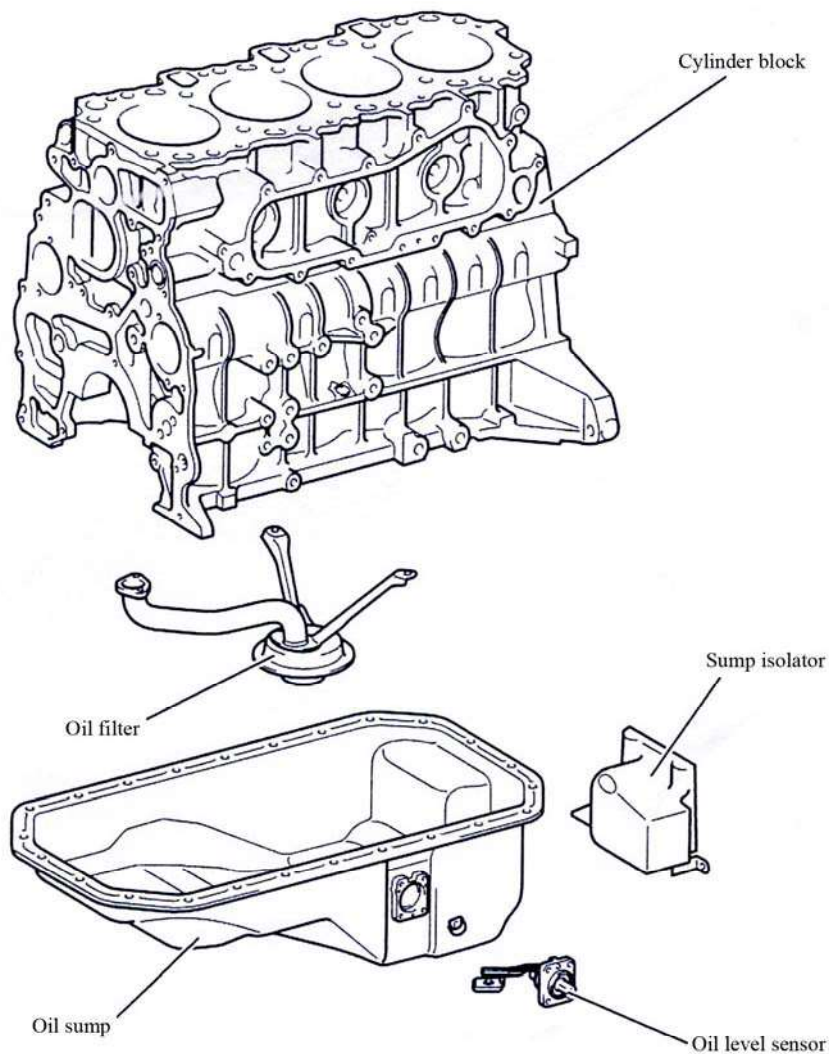
- (1) Tighten 2 nuts as shown in C.
 - (2) Put on the nuts at both ends of fuel inlet pipe (see A and B) and mount the turbocharger inlet pipe.
10. Install the throttle intake pipe.



- The cylinder block is made of alloy cast iron with high rigidity and has no sleeve.
- The oil sump formed by rustproof steel sheets has increased the loading capacity of vehicle

through its oil storage newly set at the rear end of engine. Meanwhile, it has changed the position of filter suction port lest air will be sucked in due to the change in oil level as the vehicle is uphill or downhill or takes a turn.

- There is a oil level sensor on one side of sump, which can notify the driver of oil level drop.
- Liquid spacer with superior leak-tightness has been used between sump outer edge and cylinder block.
- Sump isolator has been adopted between sump and transmission as shock absorber to reduce the noise of standing waves.

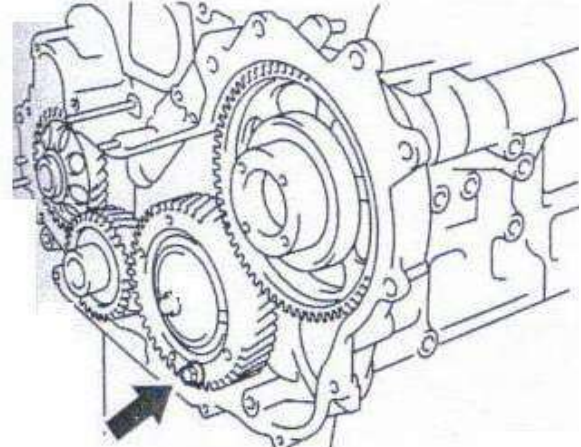
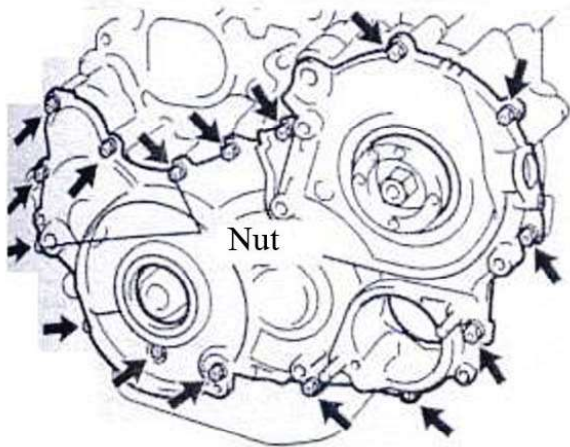


Pinion unit

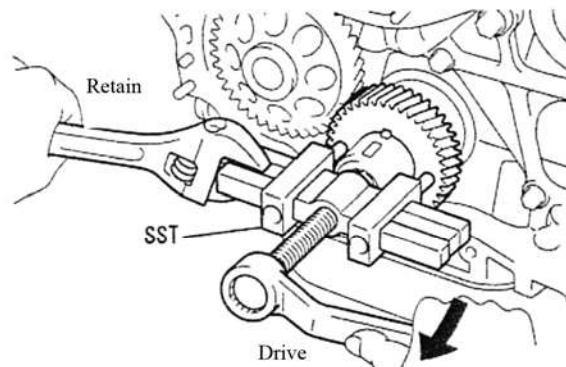
- Dismounting

This system is dismantled as follows:

- Dismounting
 1. Dismount the front-end pinion unit and timing belt system.
 2. Dismount the water pump, unscrew bolts and nuts, and take down the pump and washers.
 3. Remove the sprocket chamber cover.
 4. Install the locking bolts (M6) onto idler and compress them.



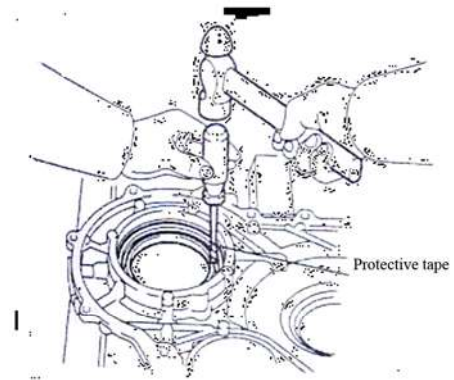
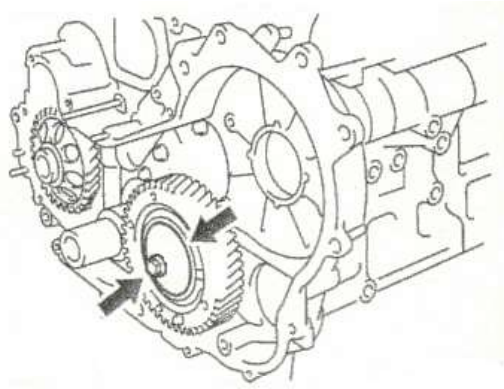
5. Dismount the fuel pump pinions and fuel pump (feed pump) assembly.
6. Dismount the crankshaft timing gears.
 - (1) Temporarily install the pulley bolts on crankshaft.
 - (2) Remove the crankshaft timing gears with right tools.
 - (3) Unscrew the pulley bolts from crankshaft.
7. Take down the idler thrust pieces.
8. Take down the idler set.



※ **Note:** Confirm no deviation has been found on primary and secondary idler gear pairs (compressed by M6 bolts).

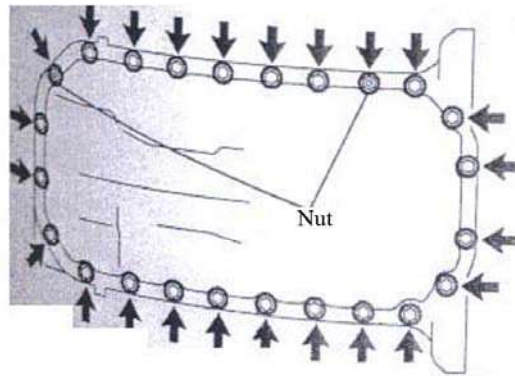
9. Take down the idler shaft.
10. Take down the sprocket chamber seal.

Hammer out the seal with a taped, slotted screwdriver and a hammer.



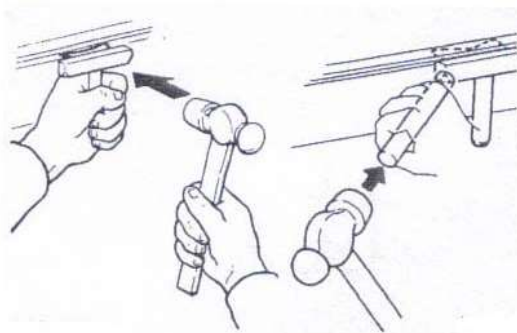
11. Dismantle the oil sump.

- (1) Dismount bolts and nuts.
- (2) Remove the sump with a prying knife.



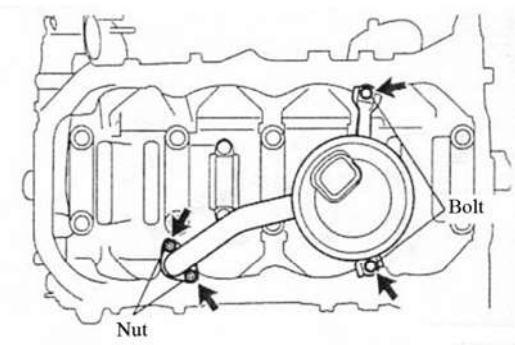
※ Note:

- ① Don't deform the sump.
- ② Don't tip the sump where oil has not been drained totally.



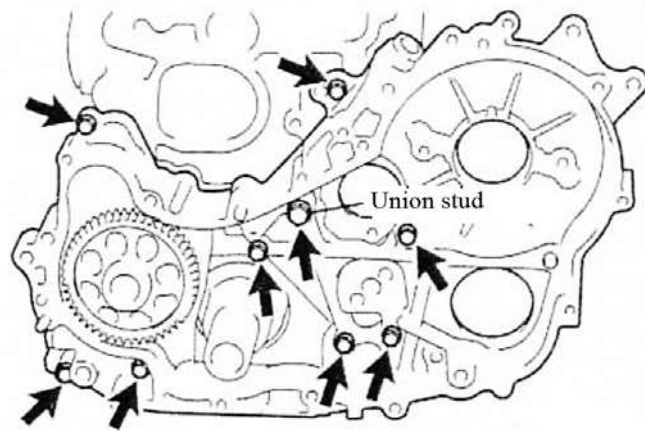
12. Dismount the oil strainer.

Screw out bolts and nuts, and take down the filter and filter base.



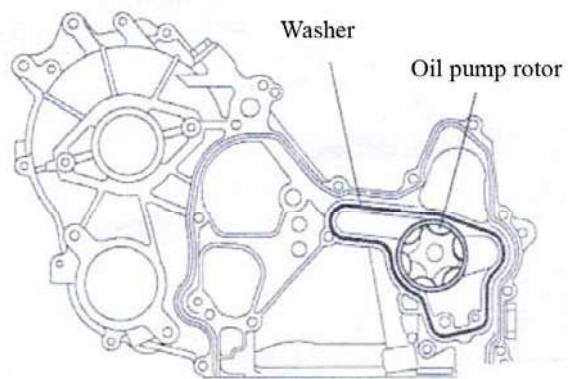
13. Dismount the timing gear chamber.

- (1) Screw out bolts and union studs to dismount the timing gear chamber.
- (2) Pry the illustrated position with a slotted screwdriver to take down the timing gear chamber.

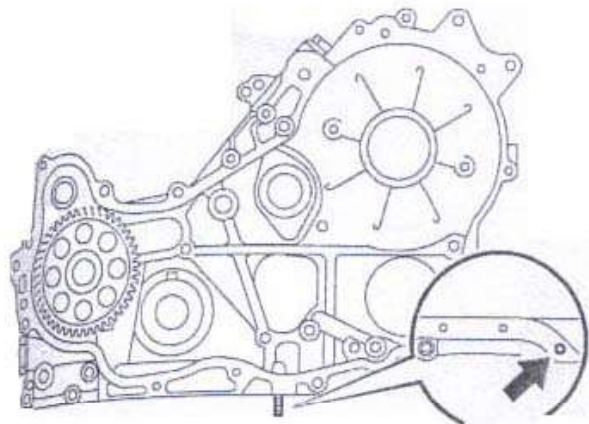


※ **Note:** Don't let the oil pump rotor inside the timing gear chamber slip.

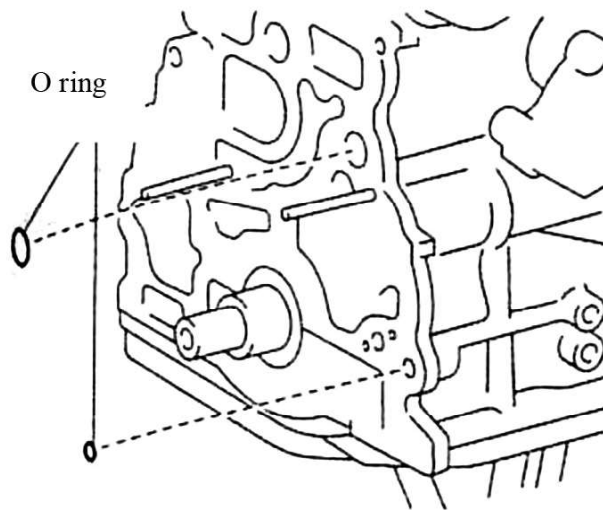
- (3) Take down the oil pump rotor and washers.



- (4) Dismount the bolts.



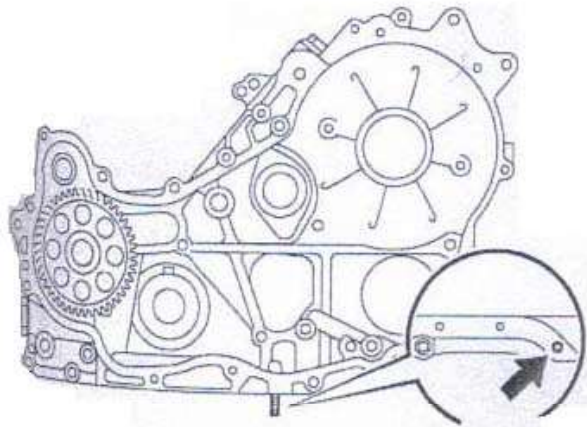
- (5) Remove two O rings from cylinder block.



- Installation

1. Install the timing gear chamber.

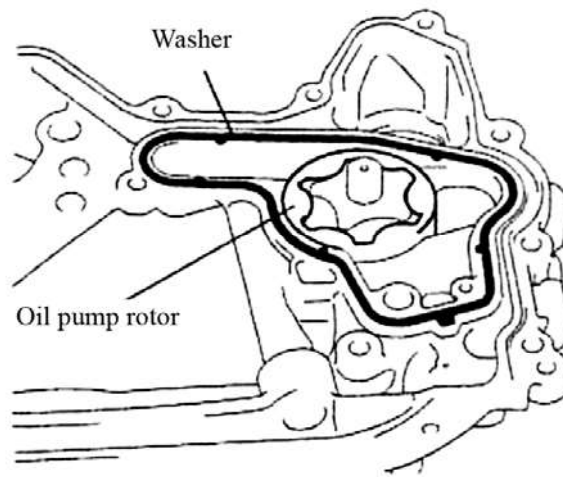
- (1) Fit two new O rings on timing gear chamber.
- (2) Install the studs in the illustrated positions (in the replacement of studs).



※ Standard value: $T=8.0\text{N.m}\{82\text{kgf.cm}\}$

- (3) Cleaning and degreasing.

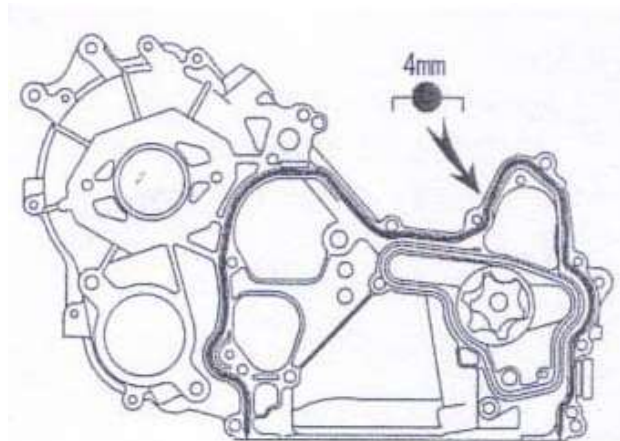
- ① Clean and degrease the mounting surface.
- ② Clean and degrease the bolts and bolt holes.
- (4) Install the oil pump rotor on timing gear chamber.
- (5) Put new pump washers on timing gear chamber.
- (6) Spread the illustrated position with sealant (in a 4 mm or so diameter).



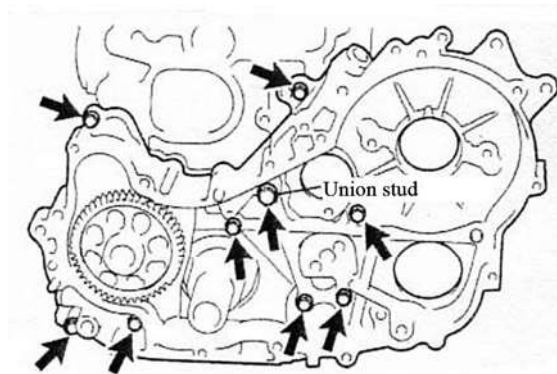
(7) Install the timing gear chamber with 8 bolts and union studs.

※ **Standard value:** $T=13\text{N.m}\{133\text{kgf.cm}\}$ (bolt)

$T=16\text{N.m}\{163\text{kgf.cm}\}$ (union stud)



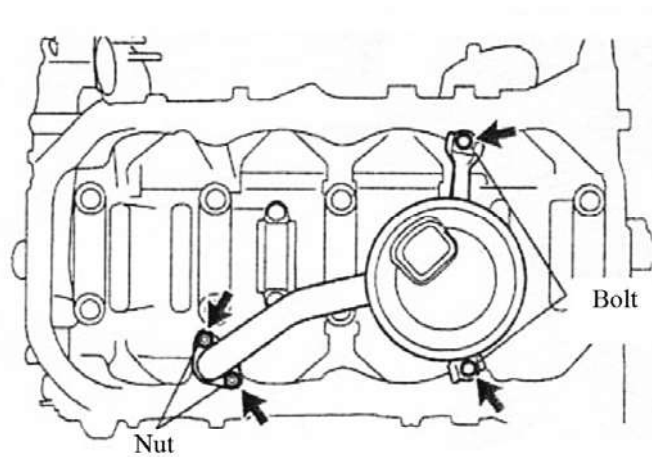
(8) Remove the screw plug to inject 50cc oil.



2. Install the oil strainer.

Renew the washers and mount the oil filter with bolts and nuts.

※ **Standard value:** $T=8.0\text{N.m}\{82\text{kgf.cm}\}$



3. Install the oil sump.

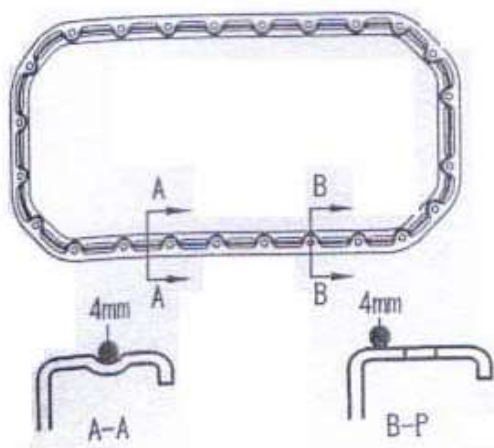
(1) Cleaning and degreasing.

- ① Clean and degrease the mounting surface.
- ② Clean and degrease the bolts and bolt holes.

(2) Spread the illustrated position with sealant (in a 4 mm or so diameter) and mount the sump.

(3) Tighten the bolts and nuts.

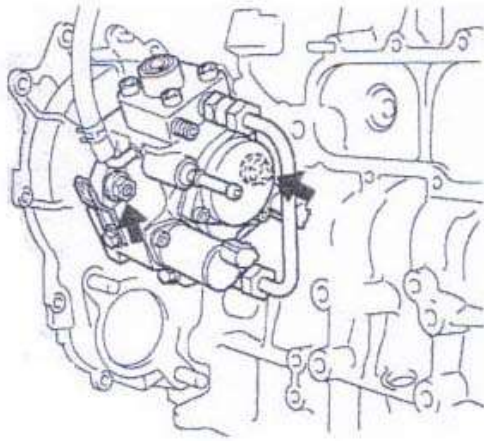
※ **Standard value:** $T=16\text{N.m}\{163\text{kgf.cm}\}$



4. Install the fuel pump gears.

(1) Mount the fuel pump (feed pump) assembly.

※ **Standard value:** $T=30\text{N.m}\{305\text{kgf.cm}\}$

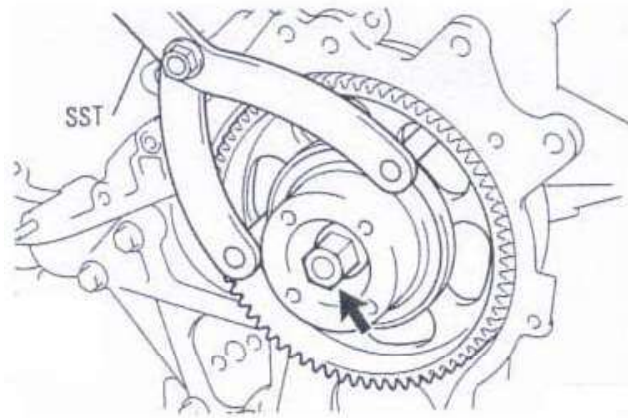


(2) Mount the fuel pump gears.

(3) Renew O rings, and put on the nuts.

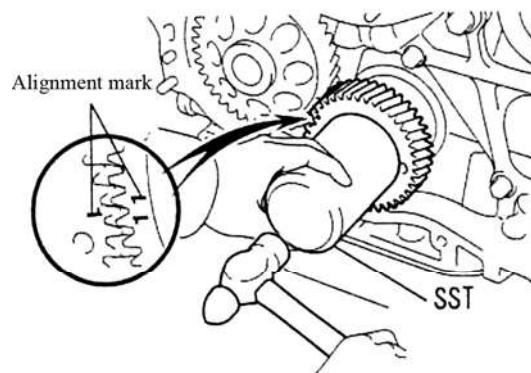
(4) Tighten the nuts with a right tool.

※ Standard value: $T=70\text{N.m}\{714\text{kgf.cm}\}$



5. Install the camshaft timing gear.

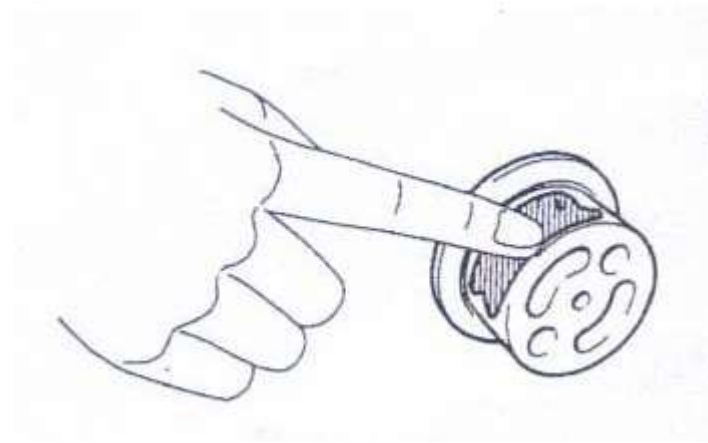
As illustrated, align the camshaft timing gear with oil pump gear and then mount the crankshaft timing gear with some tool and hammer.



6. Install the idler shaft.

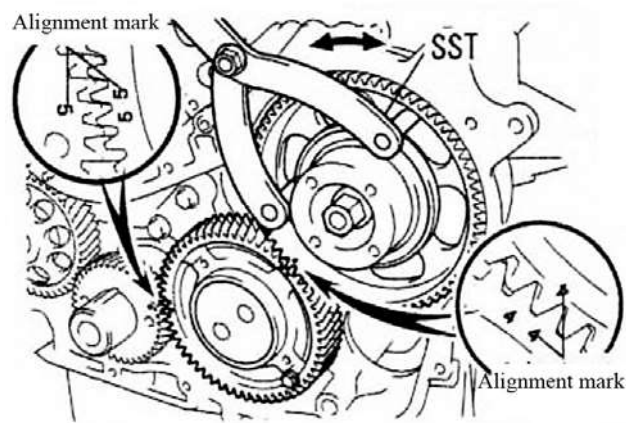
(1) Spread this shaft with oil.

(2) Install it.



7. Install the idler set.

- (1) After the alignment between fuel pump gear and crankshaft timing gear, mount the idler set with tools.



(2) Operating principle of idler gear pairs

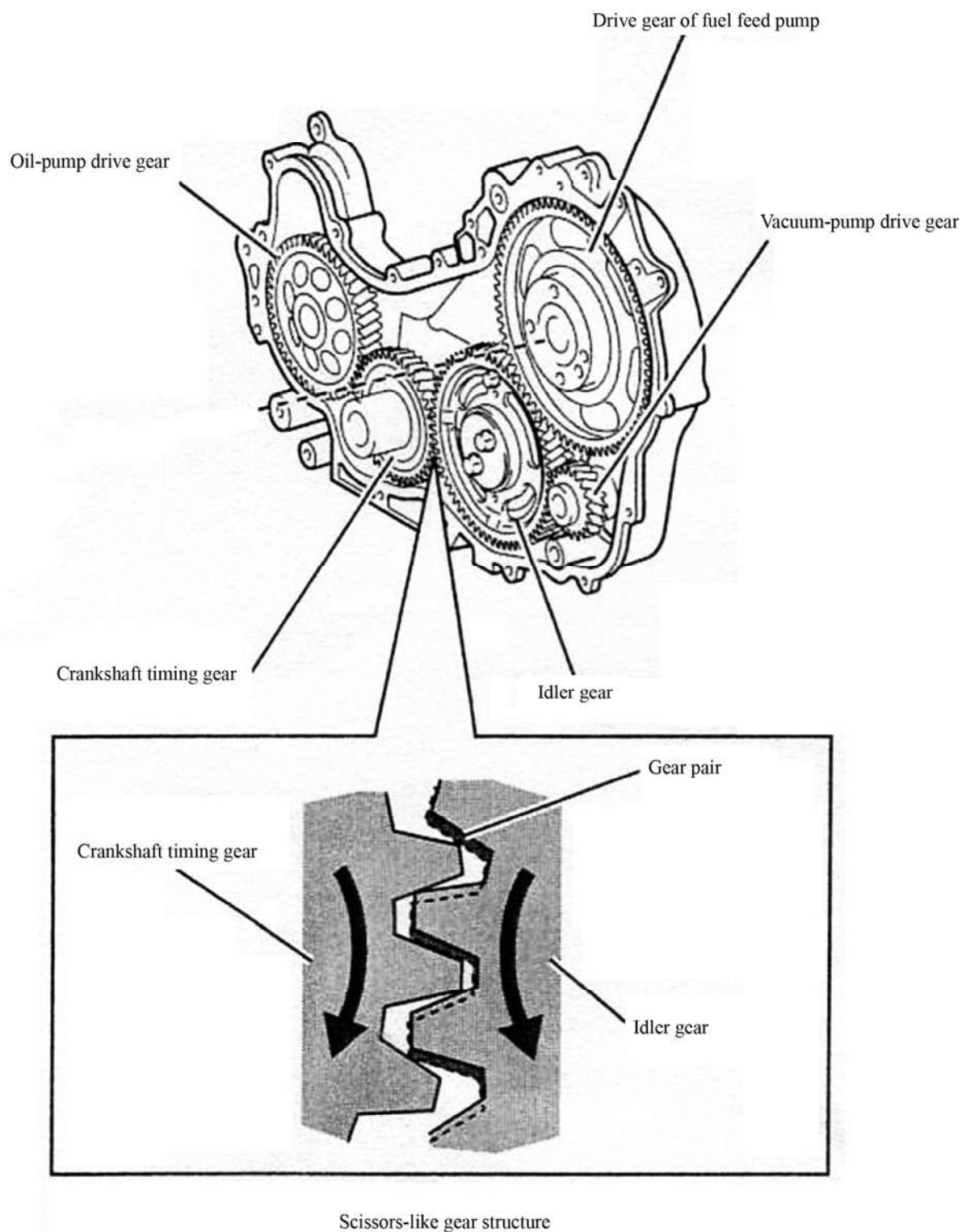
Structure: backlash-free gear driving

This structure consists of primary and secondary gears, between which there is a torsion spring with two ends against two pins respectively fastened on primary and secondary gears. Because of torsions spring, the tooth flanks of primary and secondary gears are staggered from each other by a small angle into scissors shape.

Features:

At a lower temperature, there is a bigger backlash between the driving and driven gears of twin overhead camshaft (DOHC). At this moment, under the force of torsion spring, flanks of backlash-free primary and secondary gears are staggered from each other by a small angle to offset the backlash between the driving and driven gears, vice versa.

Merits: reducing the engine noise.



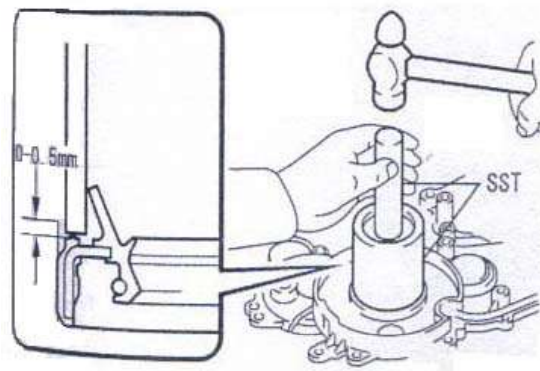
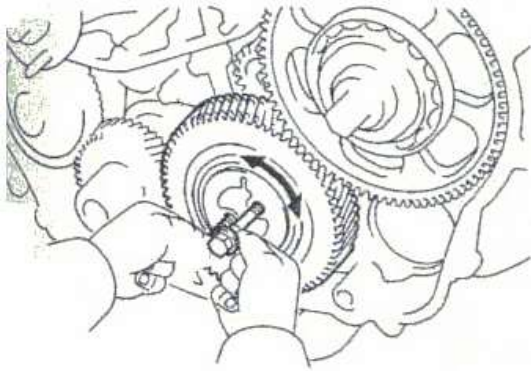
8. Install the idler thrust piece.

(1) Position the locking bolts of idler thrust piece into the mounting holes.

※ **Reference:** Let the cross recess of thrust piece face the read end.

(2) Mount the idler thrust piece with bolts.

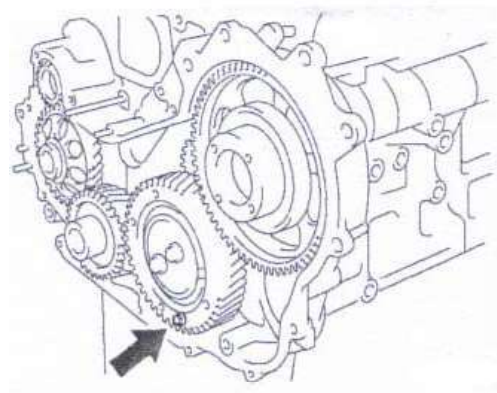
※ **Standard value:** $T=75\text{N.m}\{765\text{kgf.cm}\}$



9. Install the fuel seal.

11. Install the timing gear chamber.

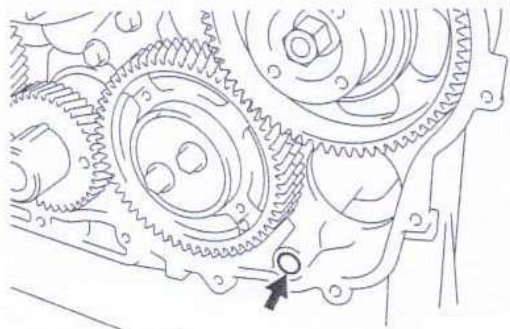
(1) Unscrew the locking bolts from idler.



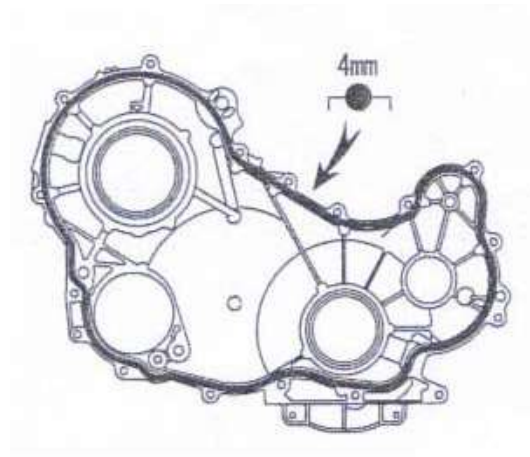
(2) Install new O ring in the illustrated position.

(3) Cleaning and degreasing.

- ① Clean and degrease the mounting surface.
- ② Clean and degrease the bolts and bolt holes.

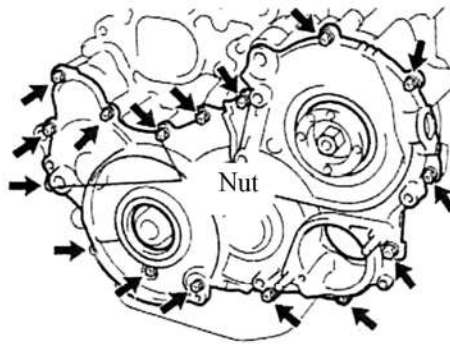


(4) Spread the illustrated position with sealant (in an about 4 mm diameter) and mount the timing gear chamber.



(5) Tighten the bolts and nuts.

Standard value: $T=13\text{N.m}\{133\text{kgf.cm}\}$

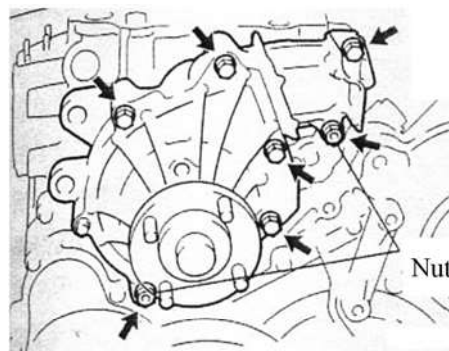


12. Install the water pump assembly.

(1) Mount new pump washers on cylinder block.

(2) Mount the water pump assembly with bolts and nuts.

※ [Standard value](#): $T=13\text{N.m}\{133\text{kgf.cm}\}$



13. Install the sprocket chamber inner cover and other components.

II Cylinder block assembly

- Dismounting

1. Check the connection rod.

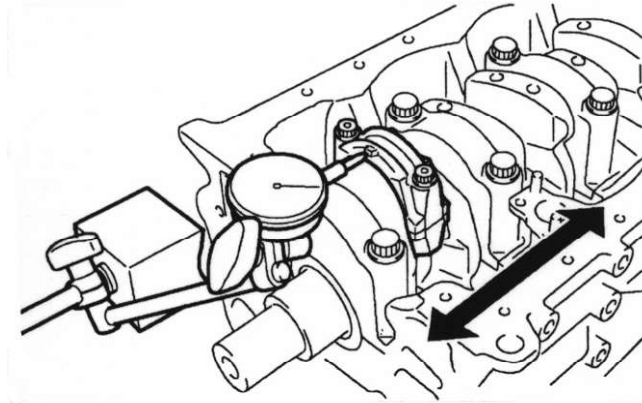
Key: Check its axial clearance.

Inspection means: measure the axial clearance with dial gauge.

Standard value: 0.10~0.30mm

Limit value: 40mm

Reference: The connection rod as well as crankshaft must be changed if the above clearance is beyond the limit.

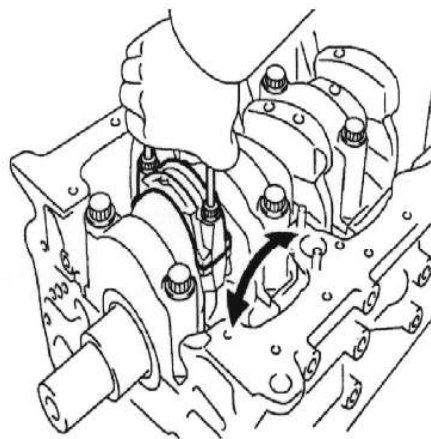


2. Check the connection-rod bearing shell.

Key: Check the oil film clearance.

Inspection steps:

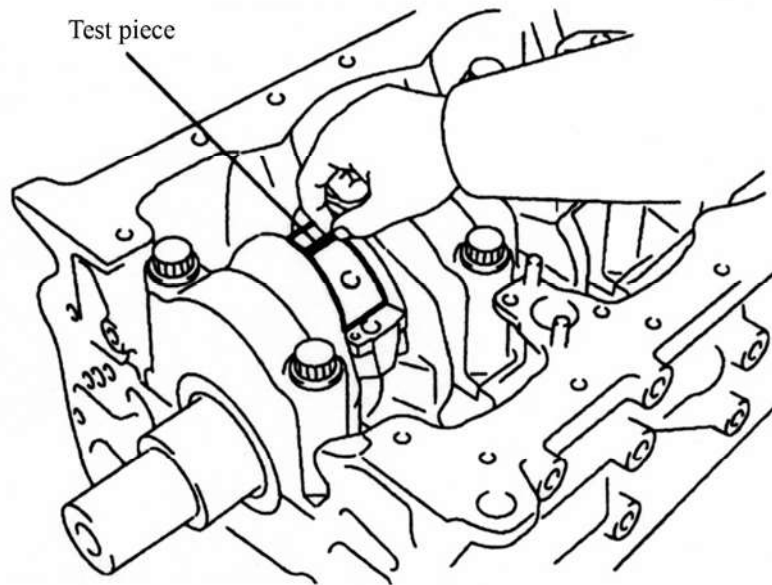
- (1) Unscrew the connection-rod bolts with socket wrench.
- (2) Slide the connection-rod cover back and forth while removing it and connection-rod bearing shell with 2 main bearing bolts.



- (3) Clean both inside and outside of connection-rod bearing shell and crankshaft pin.

※ **Note:** Confirm if there is any damage and scuffing or not.

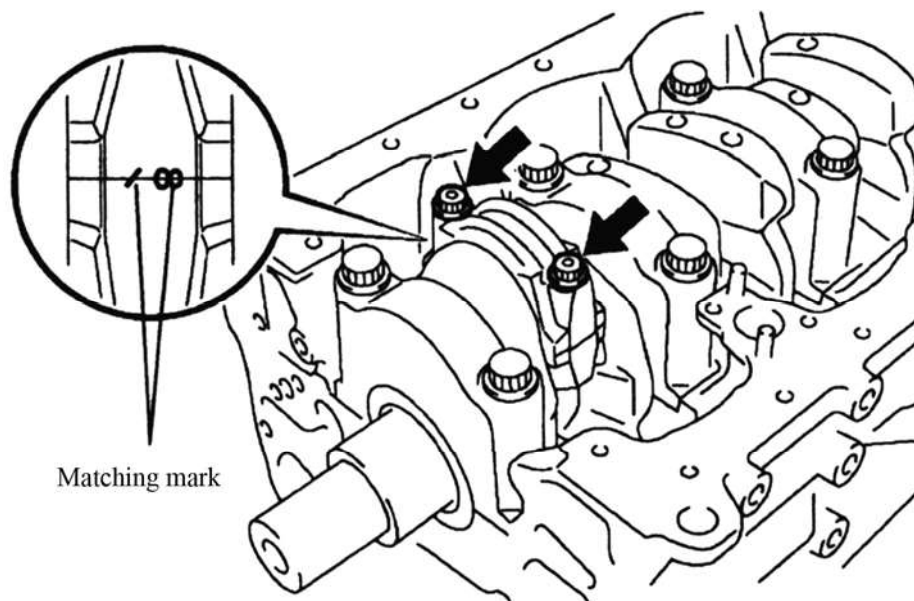
- (4) Set the test piece in the crankshaft rotating direction and mount the connection-rod cover.



(5) Apply a small amount of engine oil on the threads and root of connection-rod bolts.

(6) Tighten the connection-rod bolts with socket wrench.

※ **Standard value:** $T=35\text{N}\cdot\text{m}\{355\text{kgf}\cdot\text{cm}\}$



(7) Make a colored mark on the top of connection-rod bolts and keep it facing the engine front.

(8) Tighten every bolt by another 90° based on the colored mark.

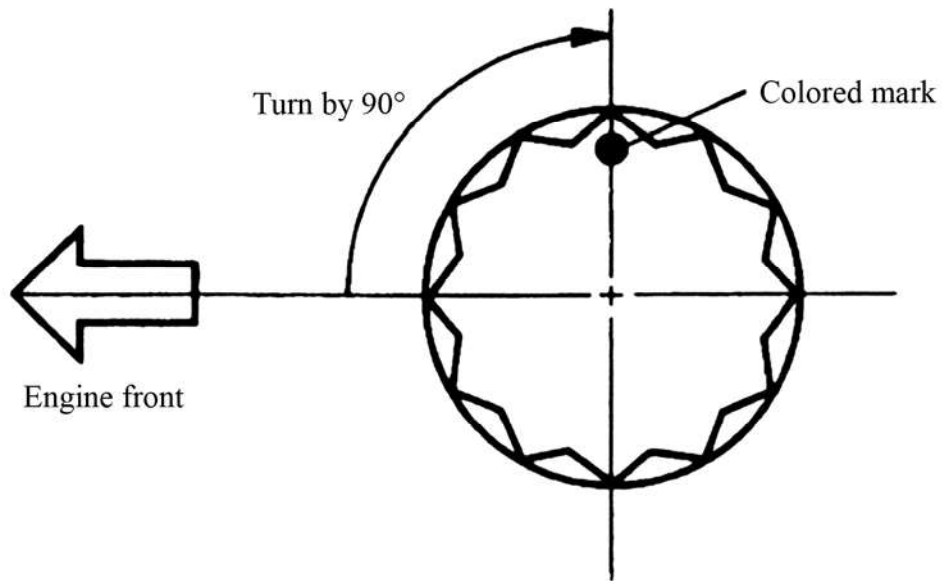
(9) Confirm every mark faces the same direction.

(10) Measure the widest area of test piece after removing the connection-rod cover.

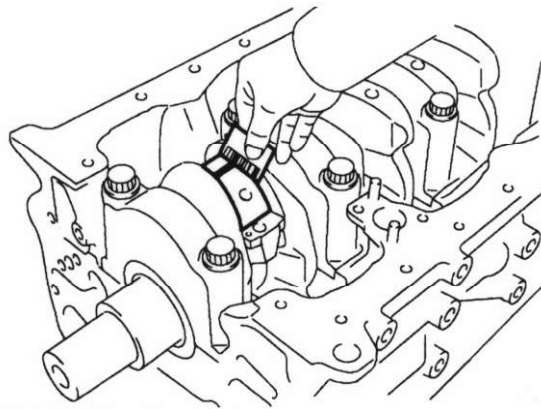
※ **Standard value:** $0.036\sim0.054\text{mm}$

※ **Limit value:** 0.1mm

※ **Note:** The test piece must be removed upon the inspection.



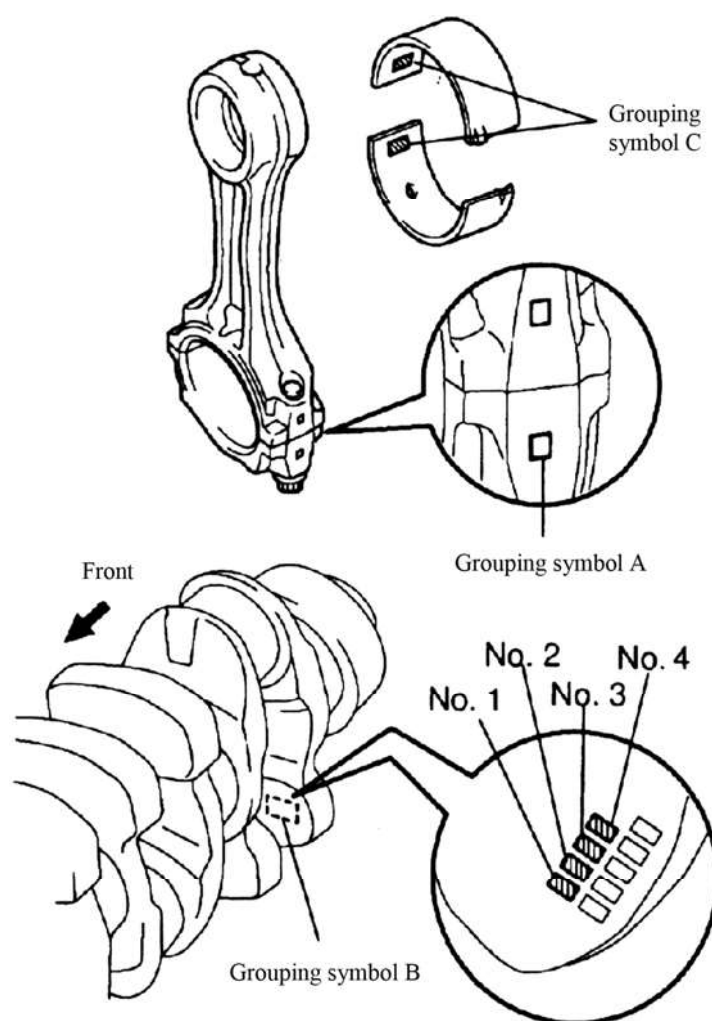
Reference: The connection-rod bearing shell must be changed if the above measured value is beyond the limit.



Method of choosing the connection-rod bearing shell

Chosen shell (symbol "C") = connection-rod cover (symbol "A") + crankshaft (symbol "B")

E.g.: if the symbol of connection-rod cover is 1 and that of crankshaft is 2, the chosen shell should have a symbol of 3 ($1+2=3$).



	Chosen group								
connection-rod cover (“A”)	1			2			3		
crankshaft (“B”)	1	2	3	1	2	3	1	2	3
Chosen shell (“C”)	2	3	4	3	4	5	4	5	6

3. Dismount the connection rod.

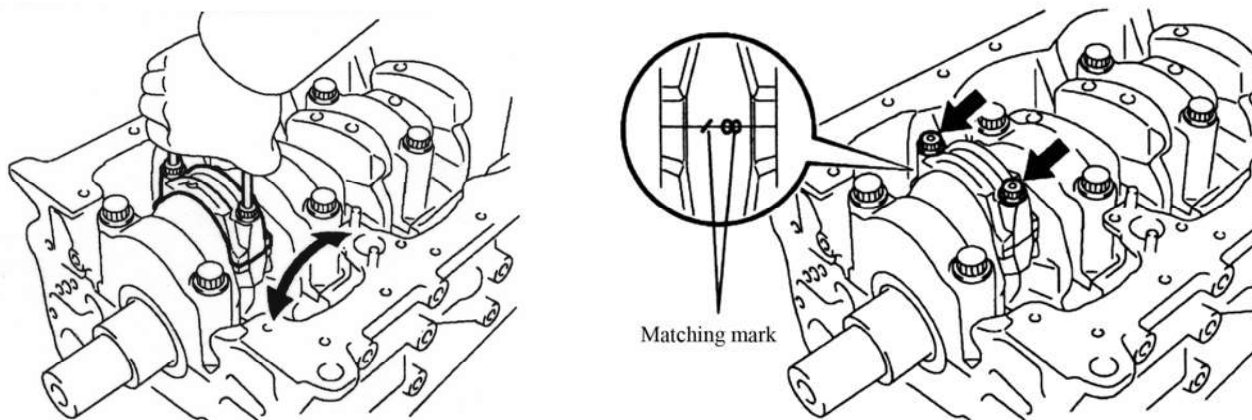
- ① Screw out 2 connection-rod bolts with socket wrench.

Reference: Confirm the matching marks on connection rod and its cover.

- ② Slide a connection-rod cover back and forth while mounting it and connection-rod bearing shell with 2 connection-rod bolts.
- ③ Remove the connection rod with piston from cylinder block.

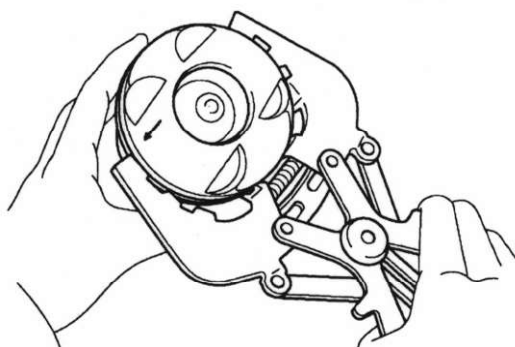
※ **Note:** Connection-rod matching.

- ④ Remove the connection-rod bearing shell from connection rod.



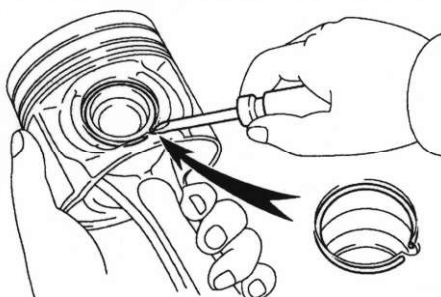
4. Dismount the piston ring.

- ① Remove the 1st and 2nd gas rings with special tools.
- ② Take down the oil ring by hand.



5. Check the piston and piston pin.

- ① Remove the locking ring of piston pin hole with a thin, slotted screwdriver.
- ② Use a piston heater to heat the connection rod with piston to about 80°C.
- ③ Remove the piston pin and piston from connection rod (with piston).



※ **Reference:** Those dismantled components must be separately placed according to their mounting position.

6. Check the crankshaft.

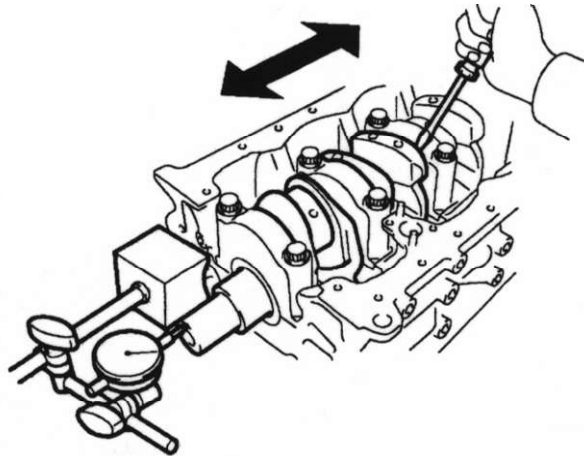
Key: Check its axial clearance.

Inspection tool: dial gauge

Standard value: 0.040~0.240mm

※ Limit value: 0.30mm

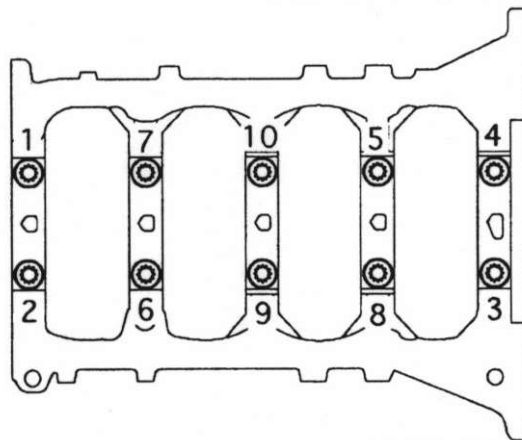
Reference: The crankshaft thrust washer or crankshaft must be replaced if this clearance goes beyond the limit.



7. Dismount the crankshaft.

- ① Evenly loosen 10 main bearing cap bolts in 2~3 steps in the illustrated sequence and remove them.
- ② Remove the main bearing cap, main bearing shell and crankshaft thrust washer and then crankshaft.

Reference: Those dismantled components must be separately placed according to their mounting position.

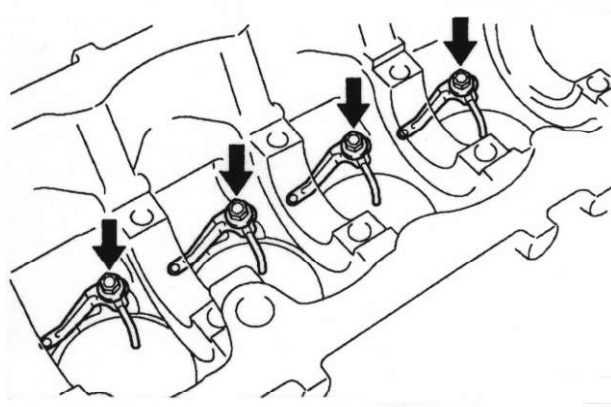


8. Dismount the injection nozzle.

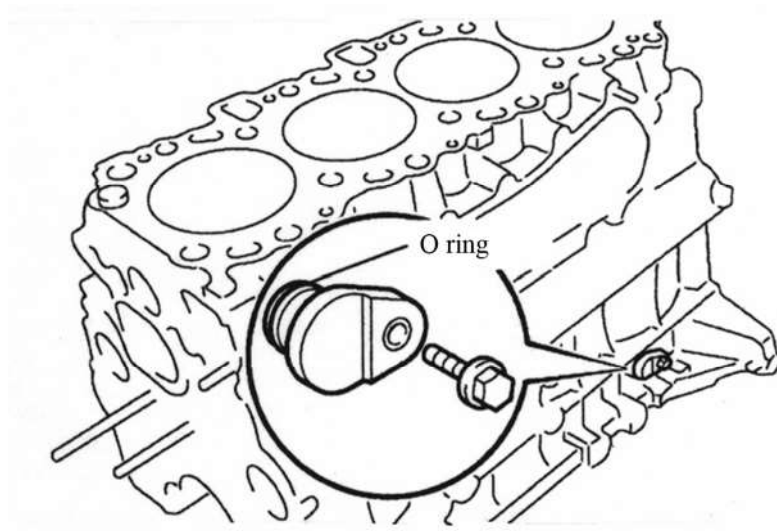
- ① Dismount the oil check valve.
- ② Remove the injection nozzle.

9. Dismount the screw plug.

- ① Unscrew the bolts.
- ② Remove the screw plug.



10. Dismount the hose fitting of geared water pump.
11. Dismount the studs.
12. Dismount the cover of cylinder head pin.
13. Dismount the location pin of timing gear cover.
14. Dismount the location pin of rear oil seal seat of engine.
15. Dismount the location pin of rear cover.
16. Dismount the screw plug.

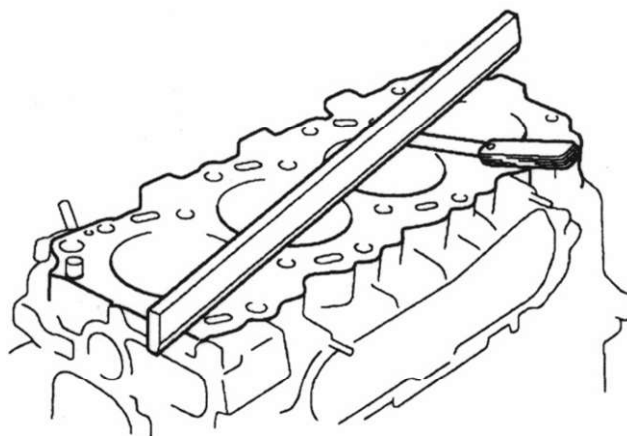


17. Check the cylinder block.
 - (1) Check the deformation of cylinder block.

Inspection tools: Ruler and feeler gauge.

Inspection method: Measure the surface deformation with ruler and feeler gauge, as shown in the right-hand picture.

※ Limit value: 0.10mm

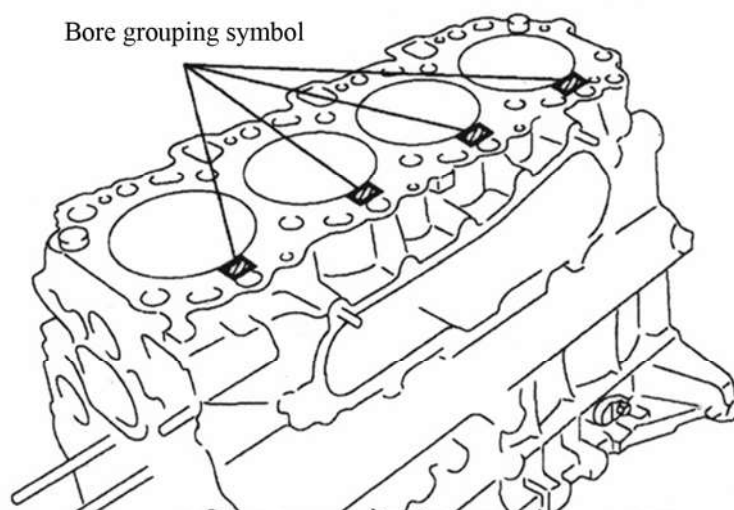


(2) Check the diameter of cylinder bore.

Inspection tool: bore dial indicator.

※ Standard value: 92.00~92.03mm

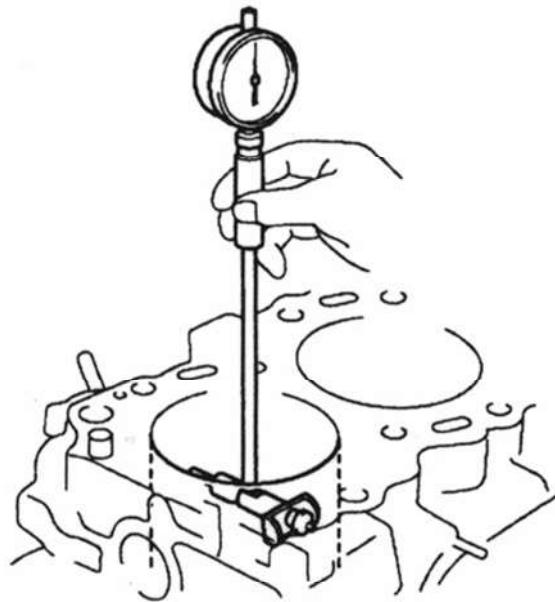
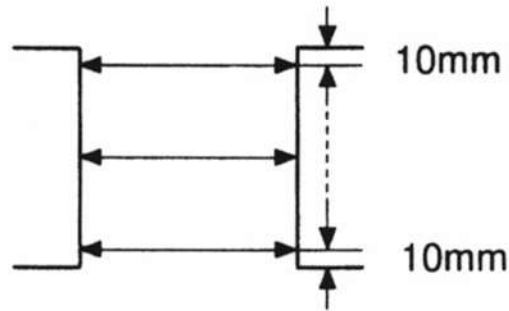
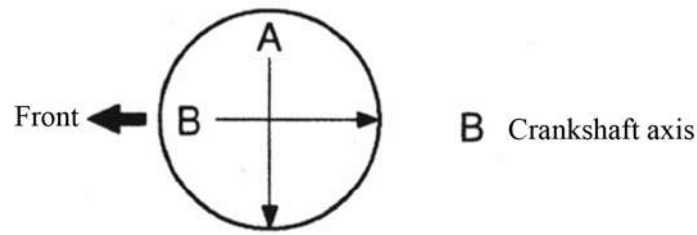
※ Limit value: 92.23mm



Reference:

The cylinder block must be replaced or bored when the diameter of cylinder bore is beyond the limit;
Bore grouping number is engraved on the upper surface of cylinder block.

Symbol of chosen bore	Cylinder bore [mm]
1	92.00-92.01
2	92.01-92.02
3	92.02-92.03



18. Check the piston with piston pin.

Key:

(1) Check the outer diameter (OD) of piston.

Inspection tool: micrometer

Inspected position: 63.63mm to the upper surface of piston

※ Standard value: 91.92~91.95mm

※ Limit value: 91.89mm

※ Note: The replacement of piston, if necessary, should concur with that of piston ring.

※ Reference: On the upper surface of piston is the engraved symbol of piston OD.

(2) Check the piston clearance.

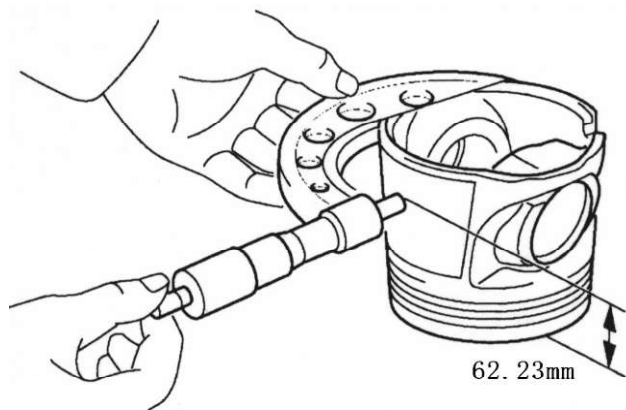
① Checking method

Calculate the piston clearance based on the min. cylinder bore and piston OD.

※ **Standard value:** 0.07～0.09mm

※ **Limit value:** 0.14mm

※ **Note:** The minimum cylinder bore should be measured in the anti-thrust direction of cylinder.



Symbol of chosen piston OD	Piston ID [mm]
1	91.92～91.93
2	91.93～91.94
3	91.94～91.95

Reference: If the piston clearance is beyond the limit, an O/S piston must not be used until the cylinder block has been changed or bored.

Precision-bored size = (O/S piston size) + (piston clearance) - (honed size 0.02mm)

O/S type	Piston OD [mm]	Cylinder ID [mm]
O/S (0.50)	92.42-92.45	92.50-92.53
O/S (0.75)	92.67-92.70	92.75-92.78
O/S (1.00)	92.92-92.95	93.00-93.03

② Calculate the ellipticity and conicity.

After the cylinder block has been bored, the cylinder bore must be measured with a bore dial indicator so as to work out the ellipticity and conicity.

Limit: 0.02mm for both ellipticity and conicity

Reference:

- Ellipticity.....A-B or a-b
- Conicity.....A-B or a-b

Recheck the piston clearance.

(3) Check the piston pin.

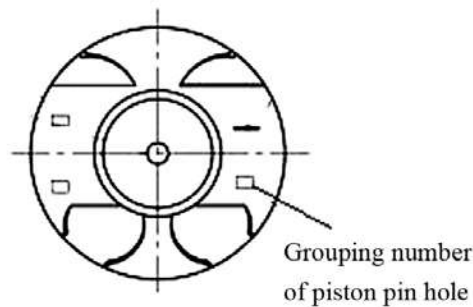
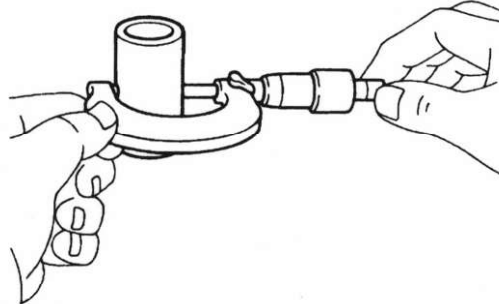
① Check the OD of piston pin.

Inspection tool: micrometer.

※ **Standard value:** 34.000~34.008mm

※ **Note:** As there is no symbol on a piston pin, much care should be taken not to confuse it with other piston pins.

Reference: On the upper surface of a piston is the diameter symbol of piston pin hole engraved.

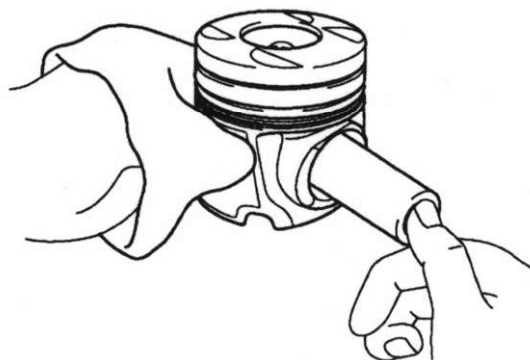


② Heat the piston with a piston heater to about 80°C.

※ **Note:** Choose the piston pin of same number according to the grouping number of piston-pin hole diameter.

③ Apply a small amount of engine oil on piston pin and insert it into piston, confirming with thumb it has been in place.

※ **Note:** Don't make bold to change the matching combinations among pistons and piston pins.



19. Check the piston rings.

(1) Check the clearance between piston rings and grooves, namely lateral clearance.

Checking method:

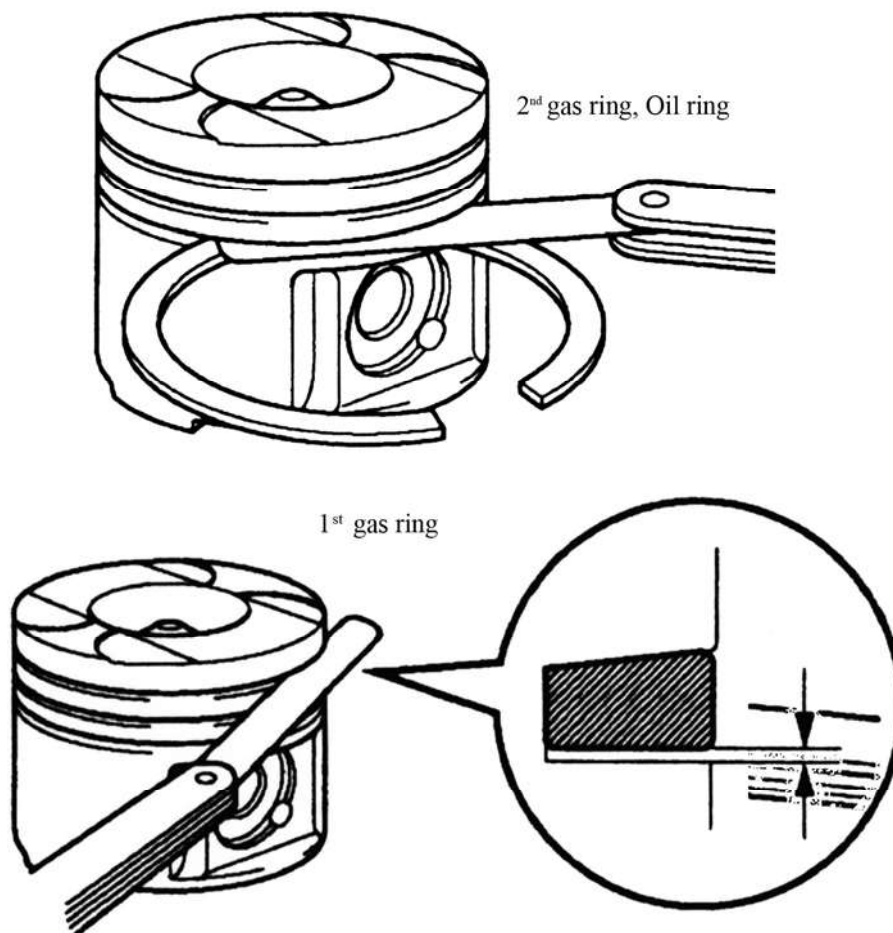
① At first install the rings on pistons making sure the piston side shares the same plane with

piston ring side.

- ② Measure the clearance between piston ring and groove around the piston with a feeler gauge.

Standard values:

	1st gas ring	2nd gas ring	Oil ring
Lateral	0.065~0.105	0.050~0.090	0.030~0.075



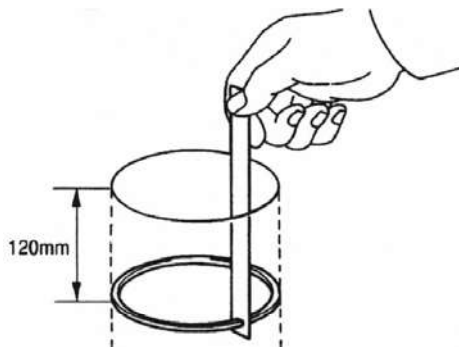
- (2) Check the piston ring gap.

Checking method:

- ① Press the piston ring with piston until it is 120mm away from the upper surface of cylinder block.
- ② Measure the piston ring gap with a feeler gauge.

Standard values:

	1st gas ring	2nd gas ring	Oil ring
Gap	0.065~0.105	0.050~0.090	0.030~0.075
Limit	0.85	1.07	0.77



20. Check the connection rod.

Key: Check the radial clearance of connection-rod small end.

(1) Measure the inner diameter (ID) of connection-rod small end bushing with a gauge.

Standard values:

Symbol “1” of connection-rod small end: 34.016~34.020mm

Symbol “2” of connection-rod small end: 34.020~34.024mm

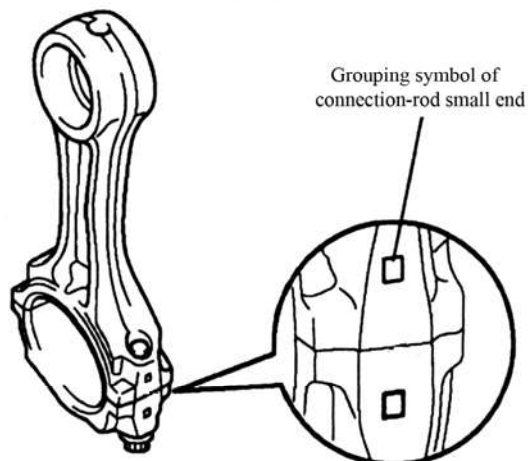
(2) Calculate the radial clearance.

Calculate the radial clearance based on the ID of connection-rod small end bushing and OD of piston pin.

Standard value: 0.012~0.020mm

Limit value: 0.08mm

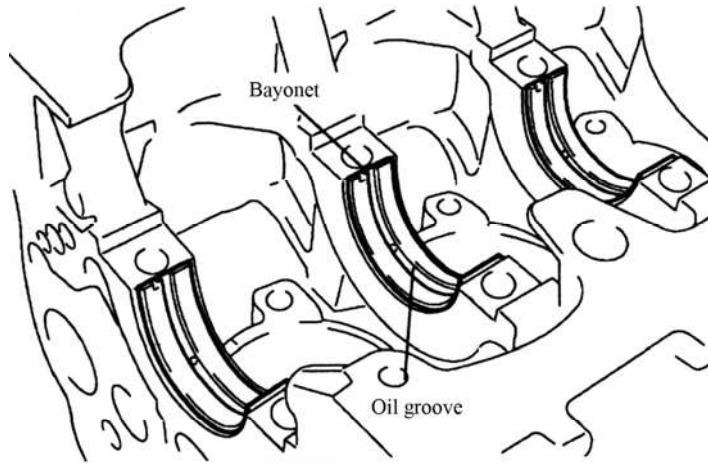
Reference: The connection-rod bushing, or piston and piston ring must be changed when the radial clearance is beyond the limit.



21. Check the radial clearance of crankshaft

- (1) Align the oil hole and block tongue, and mount the main bearing shell with oil groove onto cylinder block.

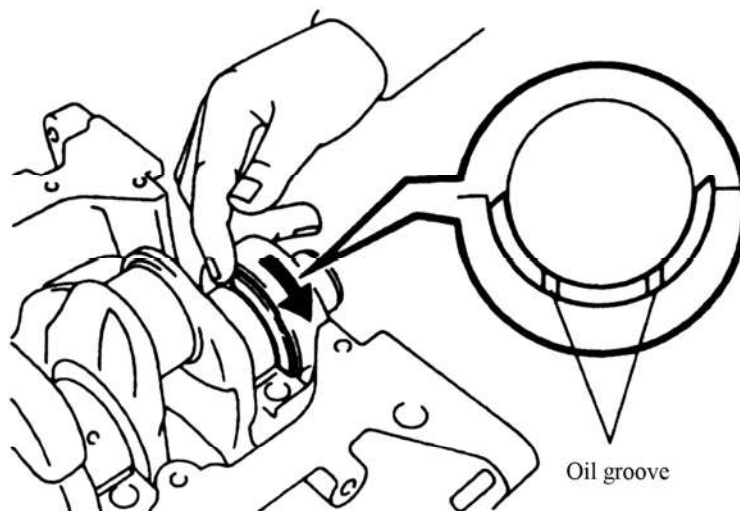
※ **Note:** Don't apply engine oil on the mounting surface and back of crankshaft bearing shell.



- (2) Place the crankshaft on cylinder block.

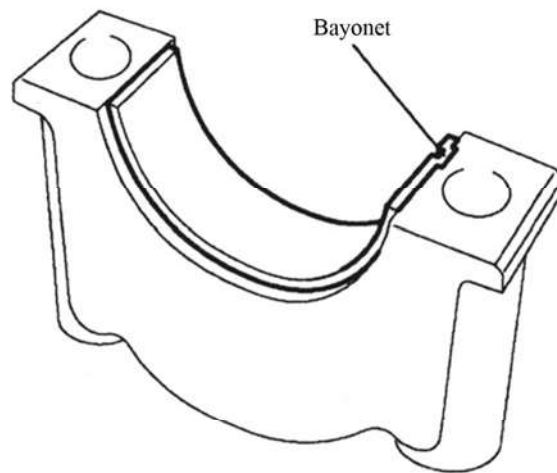
- (3) Crankshaft thrust pieces, after being spread with engine oil, should have their oil groove positioned outward, and then be mounted in front of and behind the 5# main journal.

※ **Reference:** Push the crankshaft back and forth. Only when the mounting clearance of crankshaft thrust pieces has increased can the crankshaft be mounted.



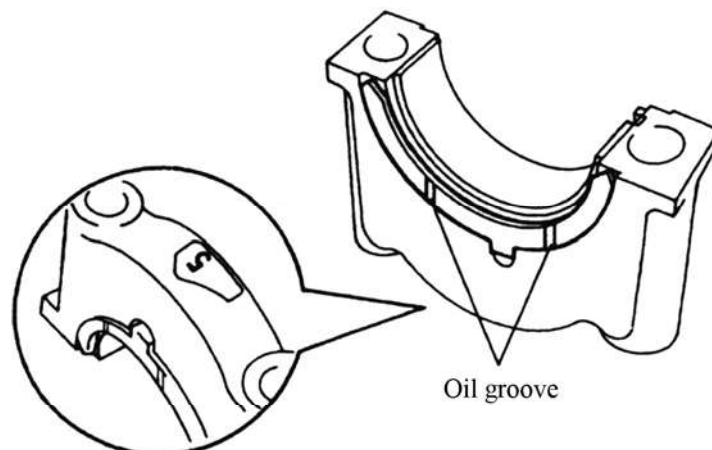
- (4) With block tongue aligned, mount the main bearing shell on main bearing cap.

※ **Note:** Don't apply engine oil on the mounting surface and back of crankshaft bearing shell.



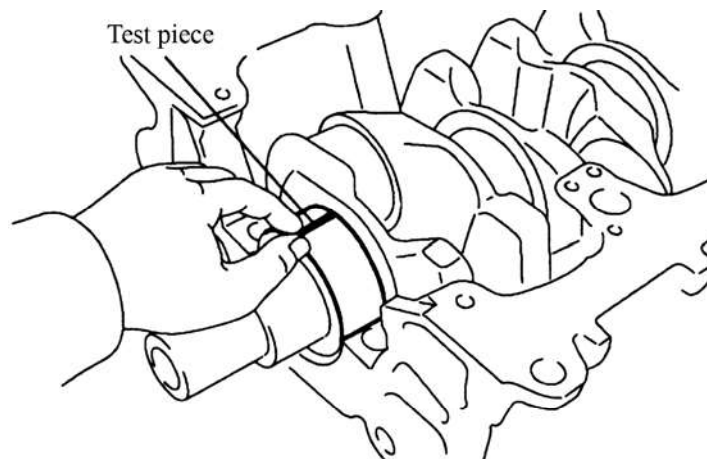
- (5) Crankshaft thrust pieces, after being spread with engine oil, should have their oil groove positioned outward, and then be mounted in front of and behind the 5# main bearing cap.
- (6) Set the test piece in the crankshaft journal direction.

※ **Note:** Don't turn the crankshaft until the measurement of radial clearance has been completed.

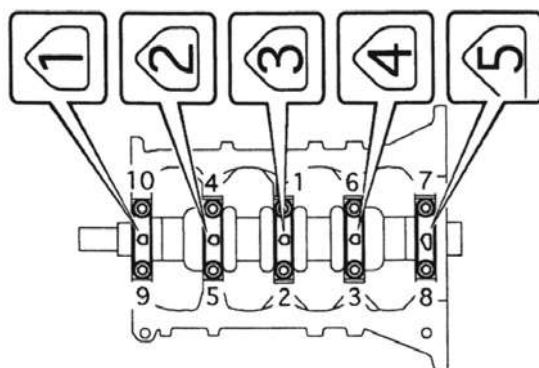


- (7) Mount the main shell cap on cylinder block after determining its front-side mark and number, as shown in this picture.
- (8) Apply a small amount of engine oil on the threads and root of main bearing cap bolts, and then evenly tighten them in for 2~3 times in the illustrated order.

※ **Standard value:** $T=50\text{N.m}\{510\text{kgf.cm}\}$



- (9) Make a colored mark on the top of main shell cap bolts and keep it facing the engine front.
- (10) Tighten every bolt by another 90° based on the colored mark.
- (11) Confirm every mark faces the same direction.



- (12) Remove the main shell cap and then measure the widest area of test piece.

※ **Standard value:** 0.030~0.048mm

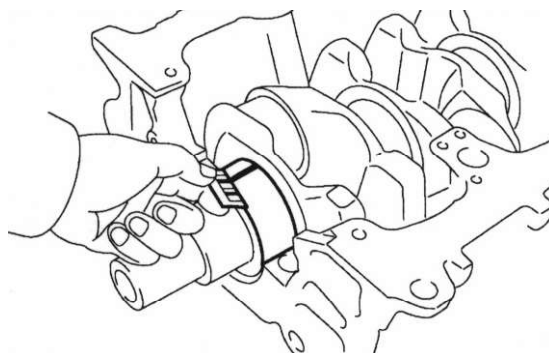
※ **Limit value:** 0.10mm

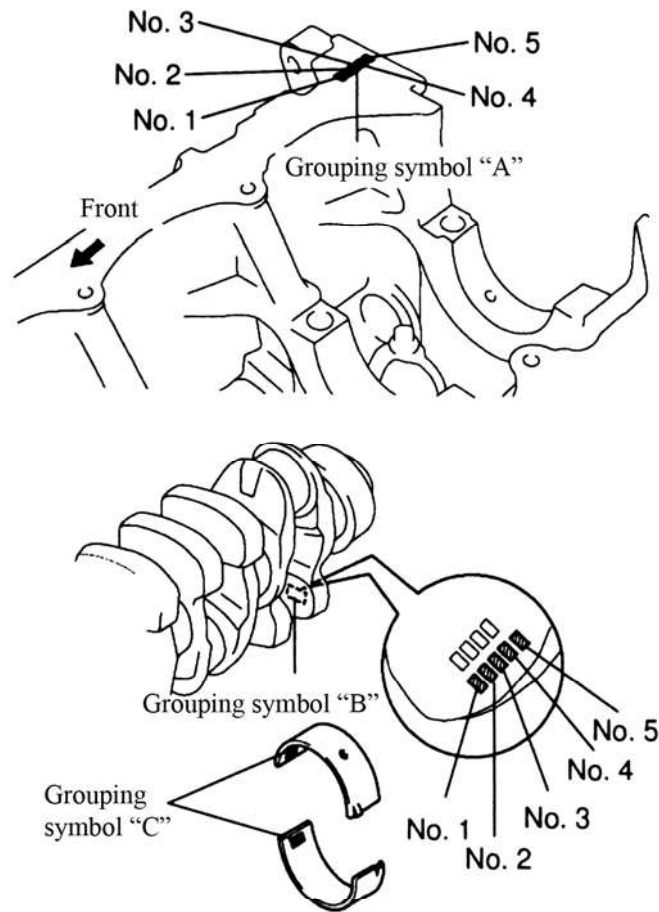
※ **Note:** The test piece must be dismantled upon the completion of this inspection.

Reference: The main bearing shell must be changed when the above measured value is beyond the limit.

Method of choosing main bearing shell

	Chosen number								
Cylinder block (“A”)	1			2			3		
Crankshaft (“B”)	1	2	3	1	2	3	1	2	3
Chosen shell (“C”)	2	3	4	3	4	5	4	5	6



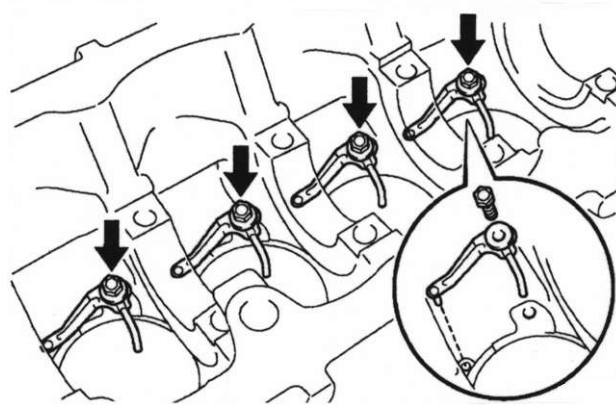


- Installation:

1. Install the fuel injection nozzle

Align the location pin on the nozzle side with pin hole on the cylinder block side, and then install the nozzle.

※ Standard value: $T=26\text{N.m}\{265\text{kgf.cm}\}$

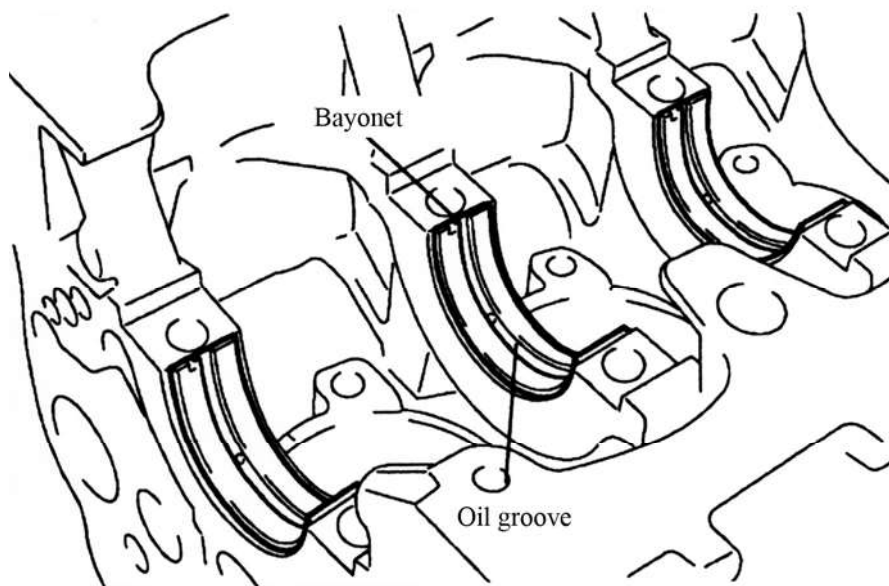


2. Install the crankshaft

- ① Align the oil hole and block tongue, and mount the main bearing shell with oil groove onto cylinder block.

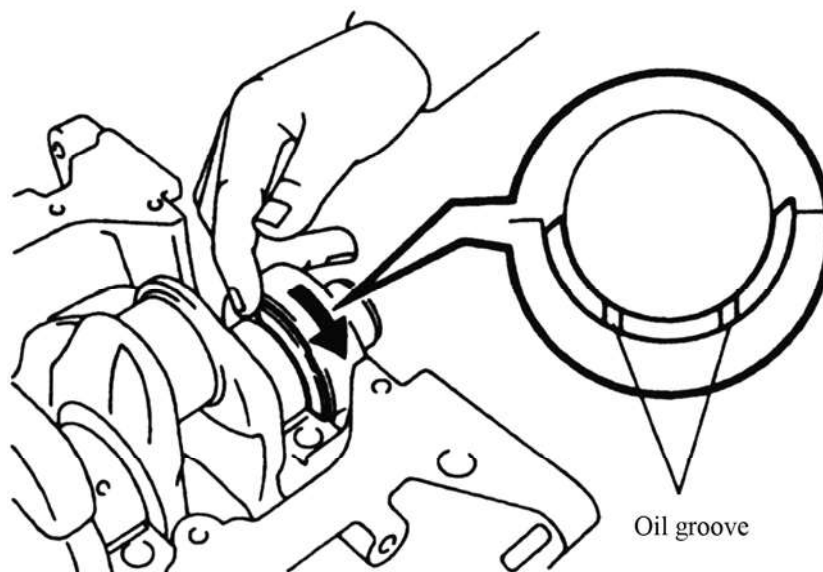
※ Note: Don't apply engine oil on the mounting surface and back of main bearing shell.

- ② Place the crankshaft on cylinder block.



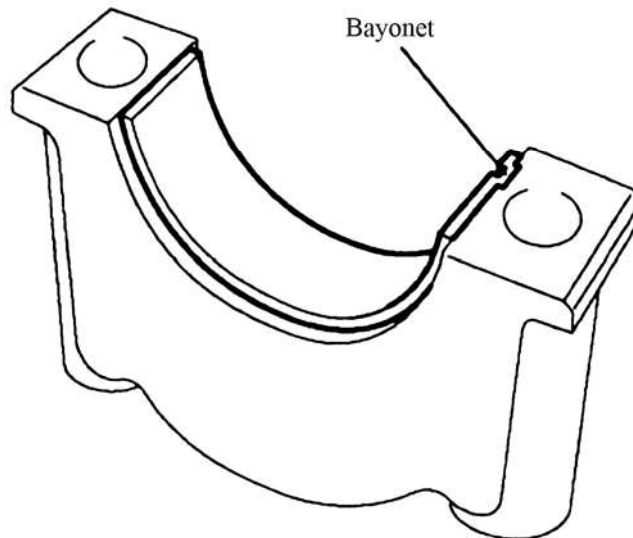
③ Crankshaft thrust washers, after being spread with engine oil, should have their oil groove positioned outward, and then be mounted in front of and behind the 5# bearing journal.

※ **Reference:** Push the crankshaft back and forth. Only when the mounting clearance of crankshaft thrust washers has increased can the crankshaft be mounted.

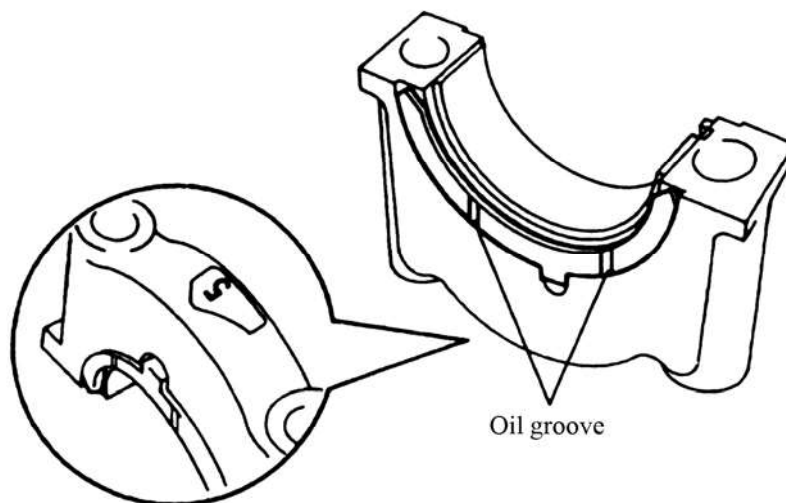


④ With block tongue aligned, mount the main bearing shell on main shell cap.

※ **Note:** Don't apply engine oil on the mounting surface and back of main bearing shell.



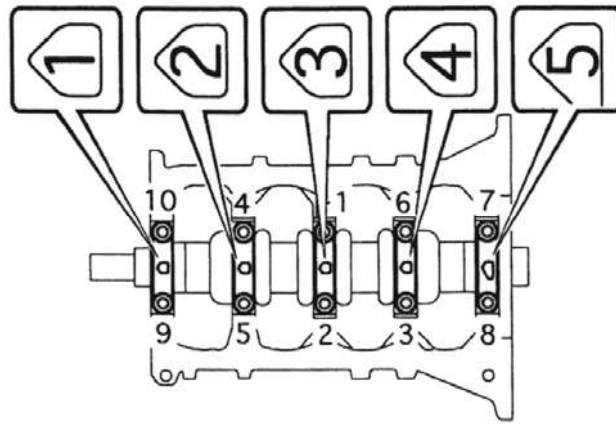
- ⑤ Crankshaft thrust washers, after being spread with engine oil, should have their oil groove positioned outward, and then be mounted in front of and behind the 5# main shell cap.



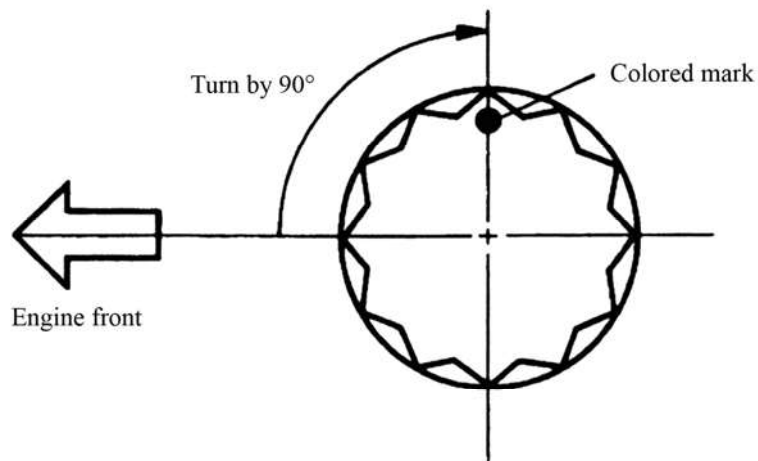
- ⑥ Mount the main shell cap on cylinder block after having determined its front-side mark and number, as shown in this picture.
- ⑦ Apply a small amount of engine oil on the threads and root of main bearing cap bolts, and then evenly tighten them for 2~3 times in the illustrated order.

※ **Standard value:** $T=50\text{N}\cdot\text{m}\{510\text{kgf}\cdot\text{cm}\}$

※ **Note:** Tighten the mounting bolts of main shell cap in a plastic-range tightening method.

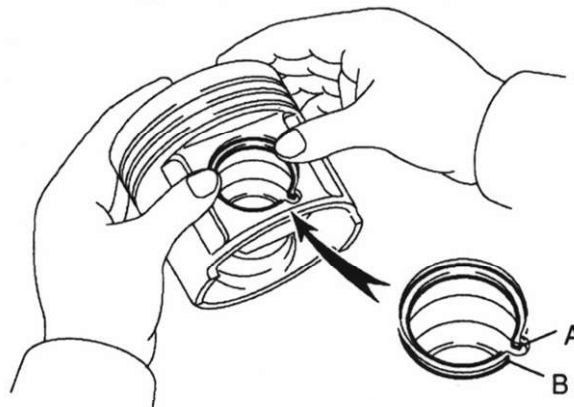


- ⑧ Make a colored mark on the top of connection rod bolts and keep it facing the engine front.
- ⑨ Tighten every bolt by another 90° based on the colored mark.
- ⑩ Confirm every mark are in the same direction.



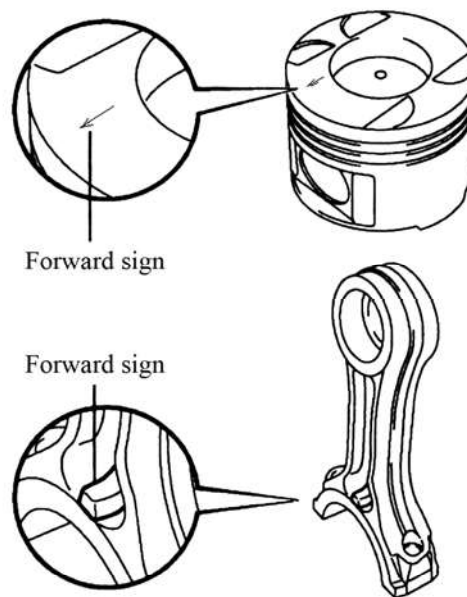
3. Install the piston with piston pin

- ① Mount new locking ring into piston pin hole on one side of piston.
- ※ **Note:** A locking ring in installation must have its end A or B aligned with the notch on the related piston.
- ② Heat the piston to about 80°C with a piston-specific heater.



- ③ Align the mark on the front side of piston with that on the front side of connection rod.
- ④ After pressing the piston pin in with thumb, mount the connection rod on screw plug.

- ⑤ Put on new pin hole ring.



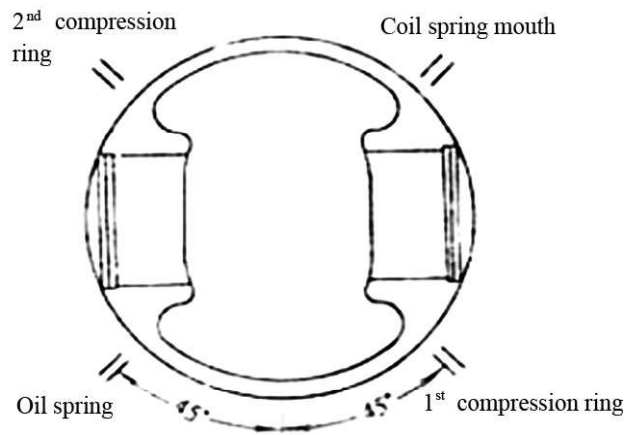
4. Install piston rings.

- ① Mount the expansion ring on piston.
- ② Mount the oil ring with a specific tool.
- ③ Place the expansion ring and oil ring as shown in the picture.
- ④ Mount the 1st and 2nd piston rings with a specific tool, with their marked face up.
- ⑤ Place the 1st and 2nd piston rings, oil ring and support spring.

Reference:

Number of piston ring	Assembling mark
1 st piston ring	A1or1N
2 nd piston ring	A2orCYPR

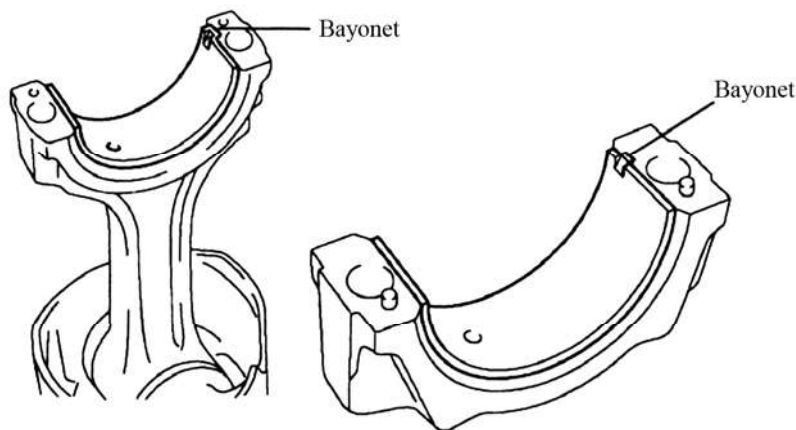




5. Install the connection rod

- ① Mount the connection-rod bearing shell, whose block tongue and oil hole have been aligned, on connection rod and connection-rod cap.

※ **Note:** Don't apply engine oil on the mounting surface and back of connection-rod bearing shell.



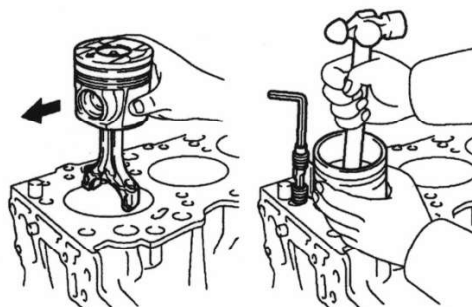
- ② Apply engine oil on cylinder inner wall, piston exterior and connection-rod shell surface.
- ③ Confirm the gap position of piston rings.
- ④ Upon the identification of marks on front side of piston and connection-rod, mount the piston and connection rod with a piston-ring compressor.

※ **Note:** The cylinder inner wall and crank pin must not be damaged in the installation.

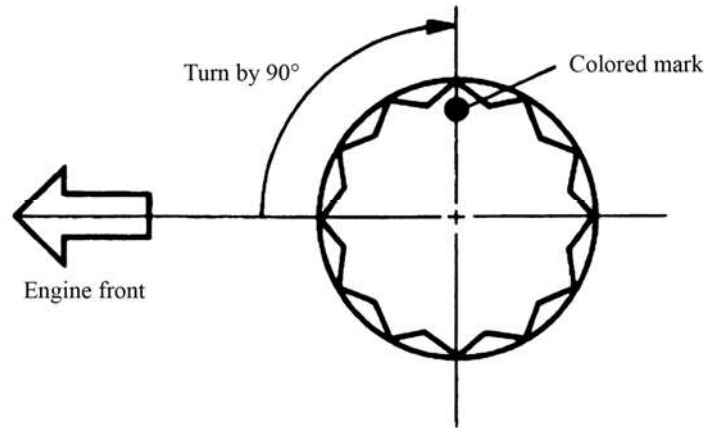
- ⑤ Apply a small amount of engine oil on the threads and root of connection-rod bolts. (8) Tighten connection-rod bolts with socket spanner.

※ **Standard value:** $T=35\text{N.m}\{355\text{kgf.cm}\}$

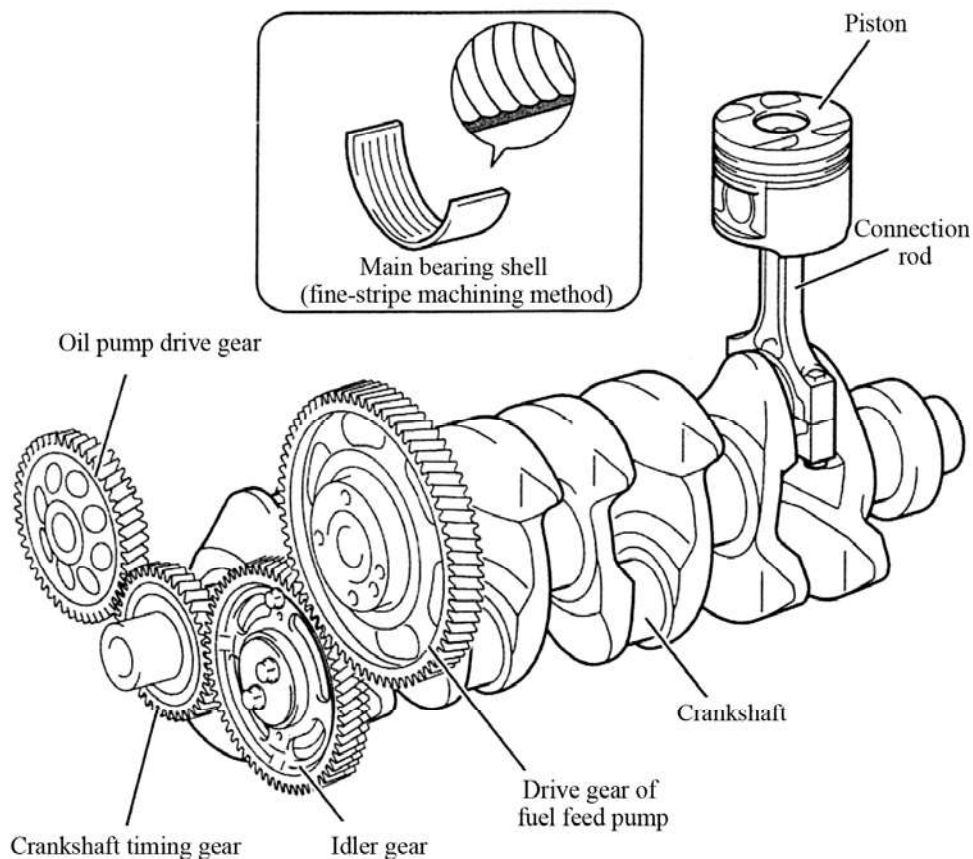
※ **Note:** Tighten connection-rod bolts in a plastic-range tightening method.



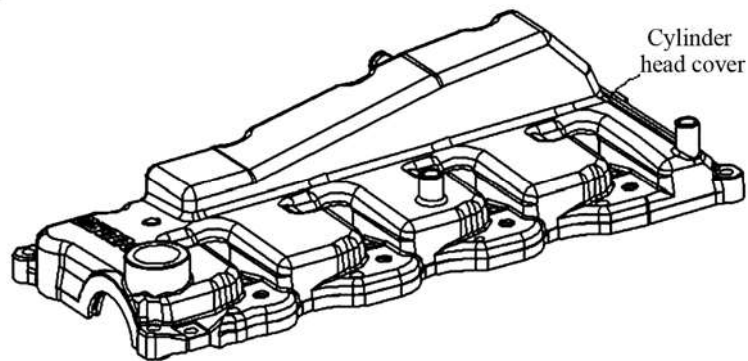
- ⑥ Make a colored mark on the top of connection rod bolts and keep it facing the engine front.
- ⑦ Tighten every bolt by another 90° based on the colored mark
- ⑧ Confirm every mark are in the same direction.
- ⑨ Confirm the crankshaft rotates normally.
- ⑩ Identify the thrust clearance of connection rod.



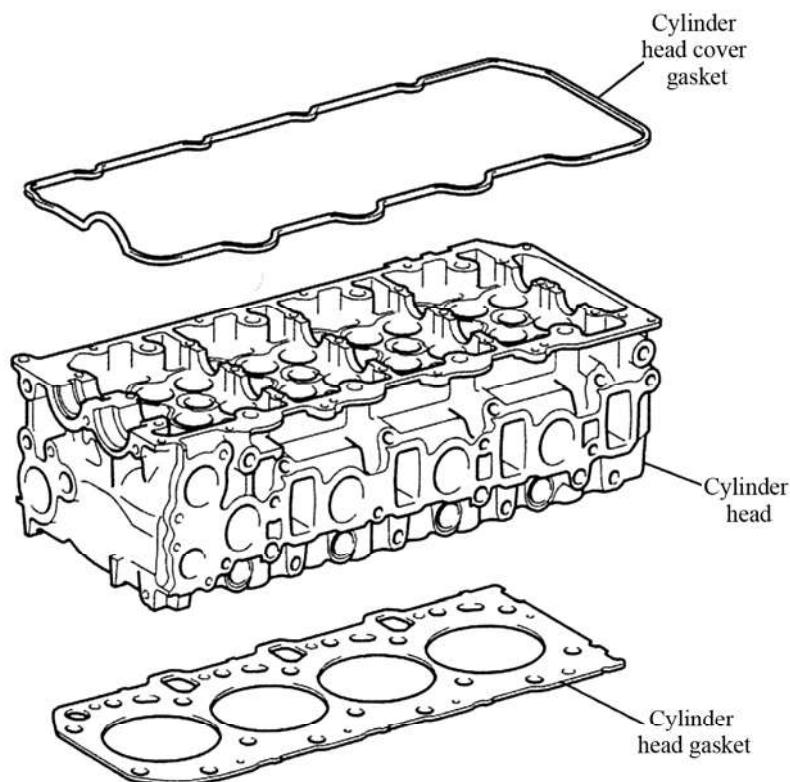
III Items related to piston and crankshaft



- Light and perfectly shockproof, the resin material adopted by cylinder head cover has not only reduced the engine weight, but ensured the strength of cylinder head cover. With the improvement in the shape of this cover, engine noise has been reduced. By installing a traverse baffle in the cover and extending the ventilation duct out of cover roof, the fuel cutout capability has also been enhanced. In addition, both traverse baffle and ventilation duct are made of resin, so the engine becomes lighter.



- Improvement has been made in the diameter of PVC tubes to prevent water inside the tubes from freezing at a low temperature.
- The cylinder head gasket adopts heatproof and oil-proof ACM (acrylate rubber) to ensure its reliability.
- The cylinder head is made of light aluminum alloy with superior thermal conductivity. Also, adopting the DOHC and 4-valve structure and vertically aligning injectors at the center of cylinder head has endowed the engine with not only higher performance but better reliability, achieving the low-emission, downsizing target.
- The cylinder head gasket is formed by 4-layer steel pieces with superior sealing performance and heat resistance.



1. Piston and piston rings

➤ Piston

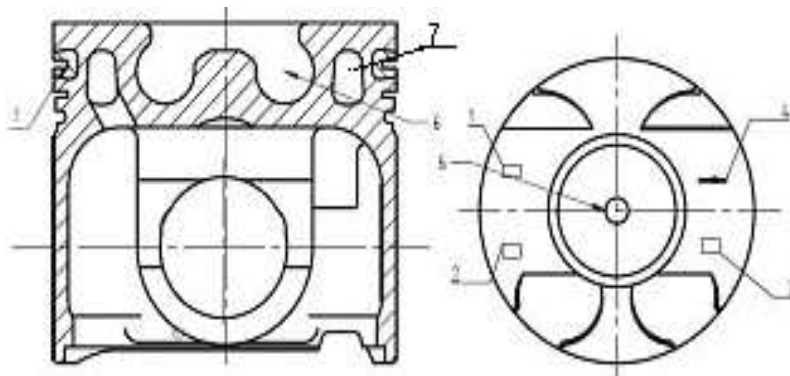
- Material: light, heat-resistant, eutectic Al-Si alloy casting, whose exterior is tin-plated to improve the running-in performance.
- Structure: as shown in right-hand picture.

- Main characteristics:

- ① The inside of piston ring groove is designed with cooling oil channel, through which oil out of injection nozzle cools the piston, solving the problem that the temperature of piston top increases with power output. As a result, the abrasion resistance of piston is enhanced.
- ② An reentrant round ω shape suiting the direct injection system has been adopted for combustion chamber to improve the combustion efficiency, thus achieving the target of high output, low fuel consumption and low emission.

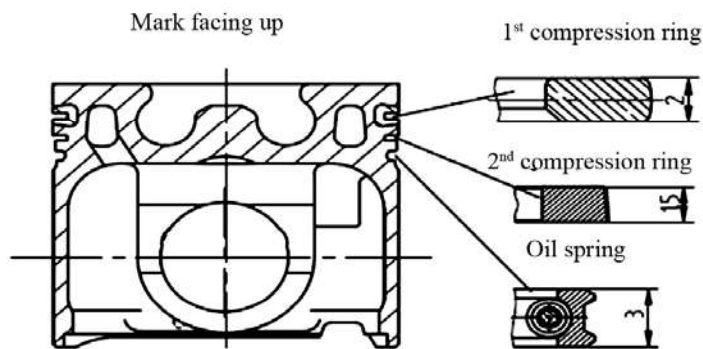
➤ Piston rings

- The 1st gas ring adopts alloy steel to ensure the wear resistance of piston.
- The 2nd gas ring reduces the piston ring tension and friction to achieve low fuel consumption.
- Oil ring adopts coil spring scraping oil effectively.



1.Piston weight grouping mark 2.Piston skirt diameter grouping mark 3.Piston pin hole grouping mark

4. Print direction mark 5.Insert ring 6.Reentrant quadrangle combustion chamber;7.Cooling oil channel Piston structure



2. Crankshaft

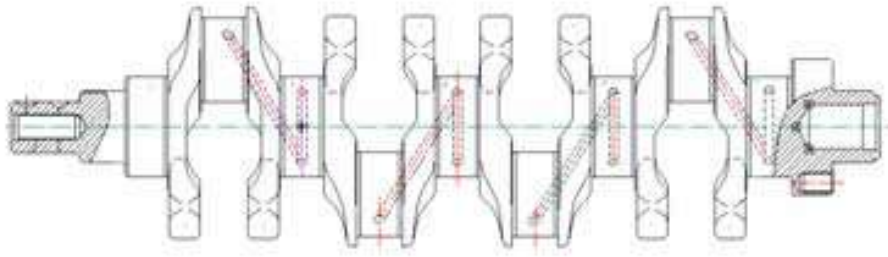
The crankshaft is cast, consisting of 5 journals and 8 balance weights. The Considering the environmental factor in addition to more strength and less weight, superior alloy steel is therefore chosen. On top of this, improvement has been made in the weight balance of running crankshaft, and vibration and noise has been reduced.

For the structure of crankshaft, see this picture.

3. Flywheel

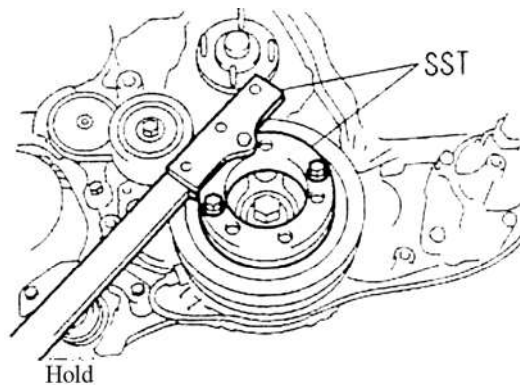
The flywheel is a cast round disc at the rear of crankshaft. It has 3 outward grooves on the friction surface for taking away a large amount of grindings and heat produced by the friction between clutch disc and

flywheel, whose lifespan can therefore be lengthened. On the rim of flywheel is a toothed ring assisting the starter in starting the engine.



Dismounting

- ① Fasten the crankshaft with tools.
- ② Take down 8 bolts and then remove the flywheel.
- ③ Dismount the rear partition.



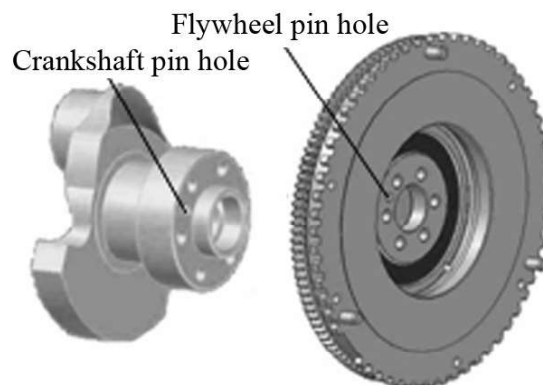
Install the flywheel

- ① Mount the rear partition with bolts.

※ Standard value: $T=8.0\text{N.m}$ (82kgf.cm)

- ② Fasten the crankshaft with tools.

Apply sealant on the thread 2~3 pitch away from the top of locking bolt.



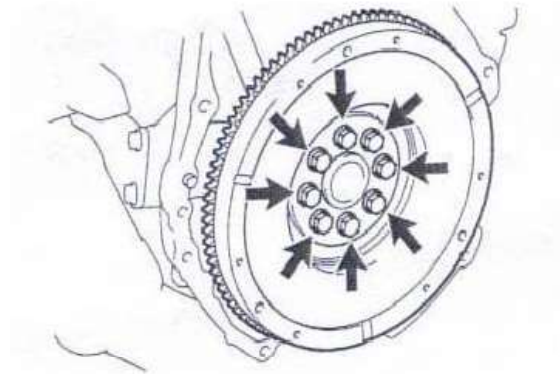
※ Note:

- a. Clean and degrease the bolts and bolt holes.
 - b. The engine must not be started within 1h after this installation.
- ③ Align the pin hole on flywheel with pin hole or pin on crankshaft flywheel mounting surface.

④ Fix the flywheel with 8 bolts.

※ **Note:** Evenly tighten the bolts on opposite sides and in the diagonal lines.

※ **Standard value:** $T=178 \pm 18 \text{N.m}$ {1815kgf.cm}



Lubrication system

- This lubrication is characterized by full pressure feed and full filtering.
- On the front end of oil filter is an efficient oil cooler targeting the cooling performance gain.
- The use of oil jet, by cooling and lubricating the pistons more effectively, has made the engine more durable and reliable.

1. Structure of lubrication system

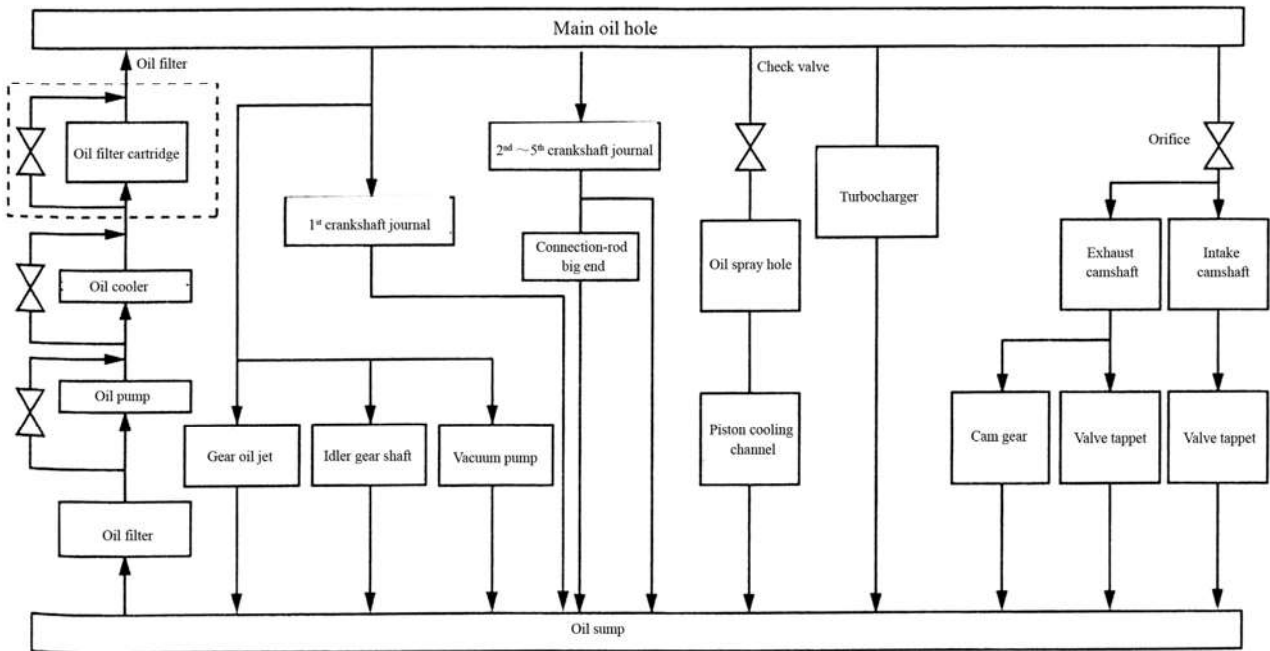
Lubrication mode: combination of pressure lubrication and splash lubrication.

Lubrication system: including oil sump, oil strainer, oil pump, oil filter, oil intercooler, cylinder-block main oil channel, piston cooling injector, and oil pressure sensor and oil pressure gauge. (See the “Lubrication system diagram”).

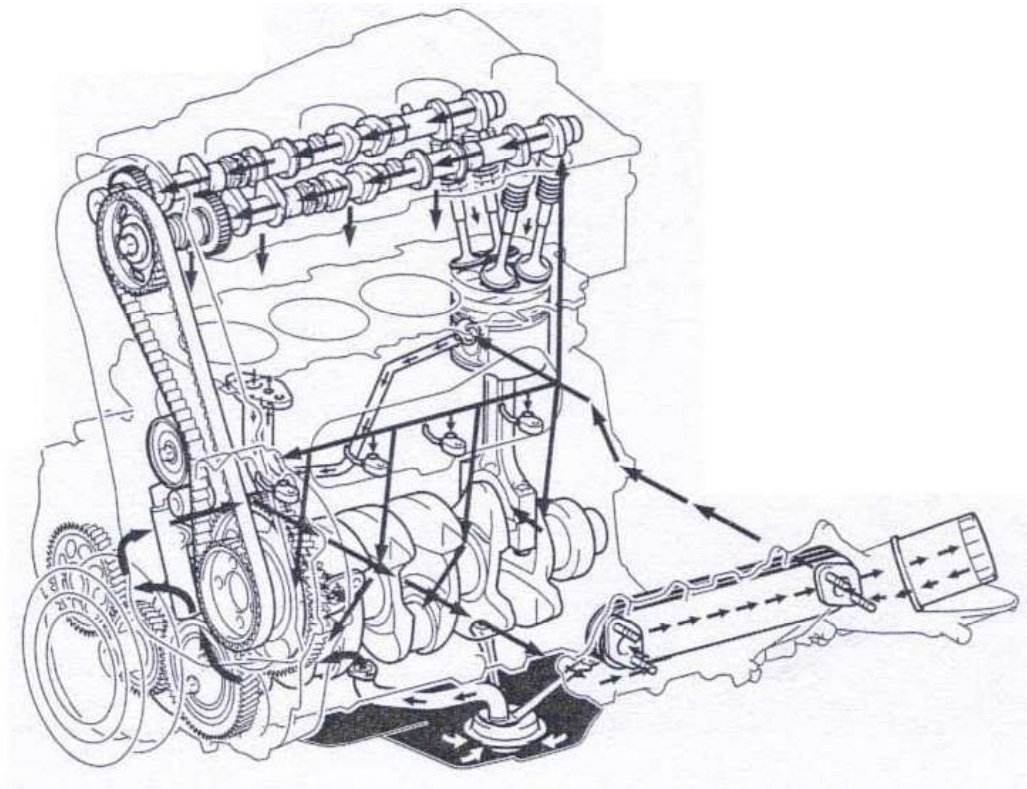
Pressure lubrication: targeting supercharger, main bearing, connection-rod bearing and camshaft bearing etc. (See the “Oil-way diagram of lubrication system”)

E.g.: The supercharger adopts pressure lubrication, which is to ensure enough lubrication and cooling of rotor and bearings in their normal operation. Lubricant for supercharger recirculates from main oil channel of cylinder block, via oil inlet pipe into supercharger, then through oil return pipe back to oil pan.

Splash lubrication: targeting piston, piston ring, piston pin, cylinder sleeve, camshaft and oil pump gear etc.



Lubrication system



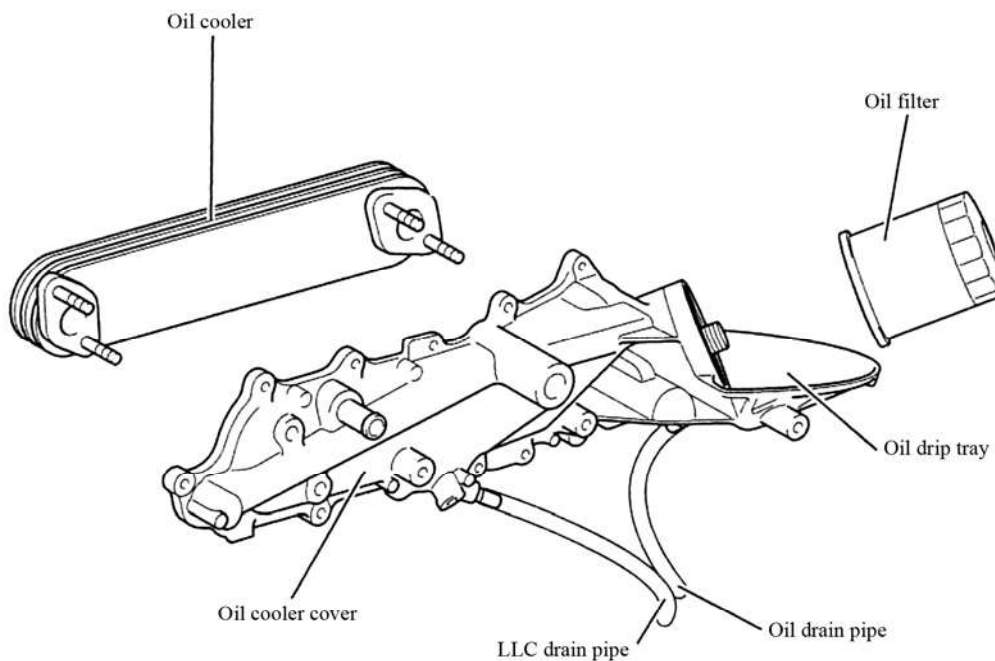
Oil-way diagram of lubrication system

2. Oil filter

Structure:

An oil filter consists of filter bracket assembly, spin-on cartridge and sealing ring. Inside the filter is a safety valve, along with a pressure limiting valve forcing excessive oil back to sump.

Type: full-flow type.



- ※ **Suggestion:** For a new vehicle, the 2,000 km running-in haul should end up with the replacement of oil filter, and thereafter, every 8,000 km should be ended with the replacement of both oil and oil filter.
- ※ **Note:** Unclean oil will exacerbate the wear of parts and might even block the oil way, so oil filter should be maintained periodically according to technical requirements.
- ※ **Note:** No leakage is allowed on the faying surface between oil filter housing and base. Nor should damage on parts is allowed.

Specifications of oil filter

Type	Full flow
Filtering mode	With filter paper
Filtering capacity [cm ³]	90
OD*height [mm]	φ76.3*84.4

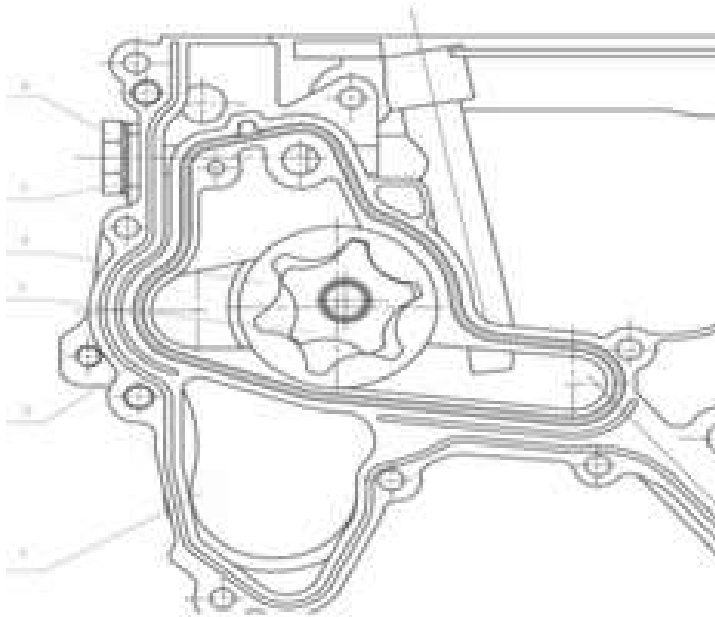
3. Oil pump

- It is a gear pump (see the right-hand picture) fixed on gear chamber and driven by helical gear on camshaft.
- Merits:
 - ① Small volume

This small pump adopts 5 blades and 6 cycloidal teeth. It is driven by crankshaft timing gear through pump driving gear. In addition, the integration of pump driving gear and timing gear chamber has cut the engine size to achieve the engine downsizing.
 - ② Low friction

Internal depressurization has been introduced to regulate the oil feeding resistance and reduce the friction.
- Technial requirements of installation
 - ① The assembled pump should rotate flexibly and stably, without any seizure.

- ② No oil leakage is allowed on the frying surface.
- ③ The opening pressure of pressure regulating valve is $480 \pm 49\text{kPa}$.



Oil pump

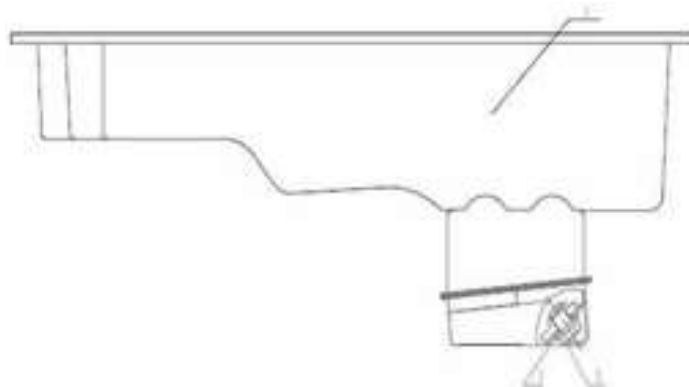
- | | | | |
|--|---|---------------------|---------------------|
| 1. Gear chamber | 2. Oil pump sealing surface | 3. Pump inner rotor | 4. Pump outer rotor |
| 5. Pressure regulating valve screw-plug washer | 6. Screw plug for pressure regulating valve | | |

4. Oil sump

- It functions as a closed crankcase to collect and store the lubricant.
- Upon the installation, oil sump should be checked for leakage in the operation of hot engine. If there is leakage, the relevant nuts and bolts should be tightened. If the leakage still exists, oil sump should be dismantled for a check.

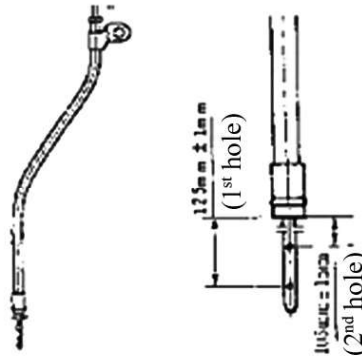
5. Dipstick

- Dipstick is a tool checking the oil level in lubrication system.
- On the dipstick are upper (7.5L) and lower (5.5L) marks machined for oil level check.



Oil sump

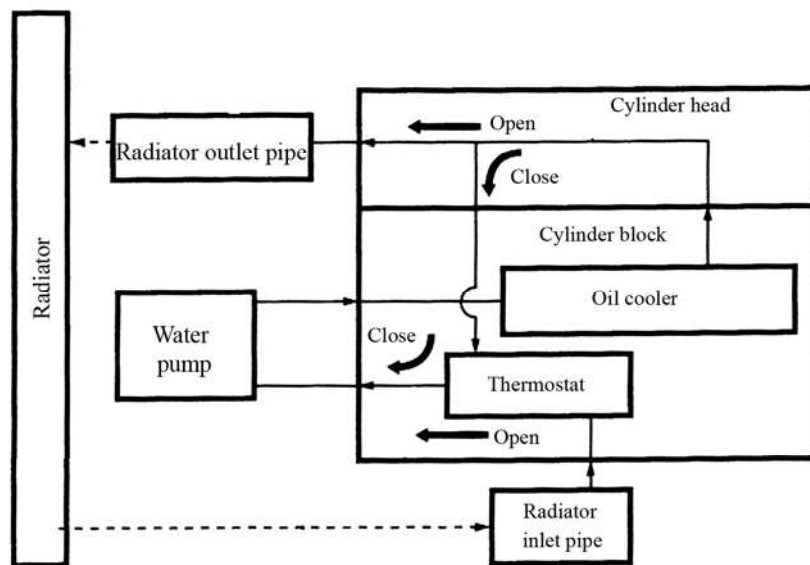
- | | | |
|-------------|-------------------|--------------------------|
| 1. Oil sump | 2. Oil drain bolt | 3. Oil drain bolt washer |
|-------------|-------------------|--------------------------|



Dipstick

Cooling system

- Water-cooled forced recirculation has been adopted for cooling purpose here. A thermostat with bypass valve has been arranged where the water inlet is located.
- As a double-layer (upper and lower) structure, the water jacket in cylinder head has higher cooling power towards lower part of cylinder head.
- Newly developed downflow all-aluminum radiator has been adopted.



Water pump

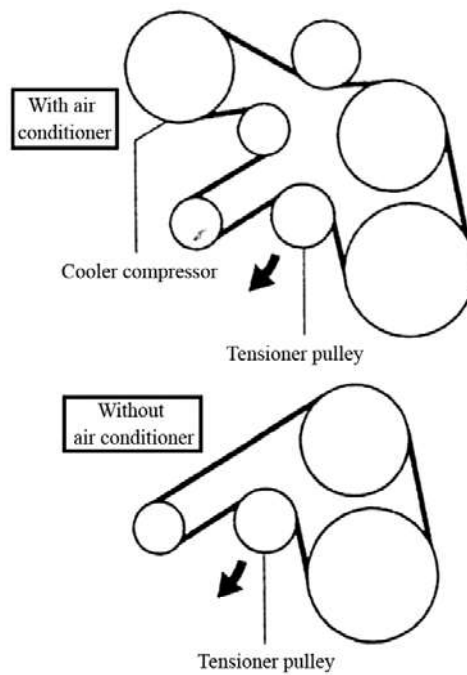
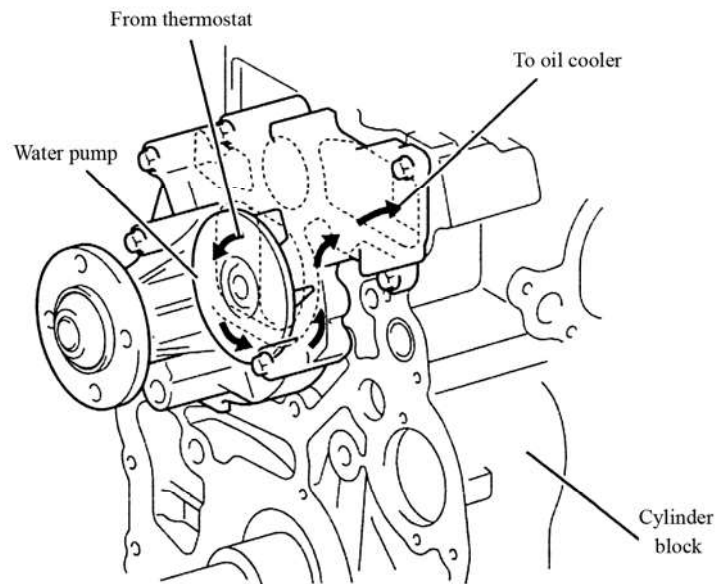
- Water pump casing is made of light aluminum alloy.
- The volute shape is optimized and the pump volume is reduced.

Pump specifications

Rotor diameter [mm]	75
Bearing diameter [mm]	30
Number of blades	6
Displacement [L/min] (at 5000r/min)	180

➤ Dismounting

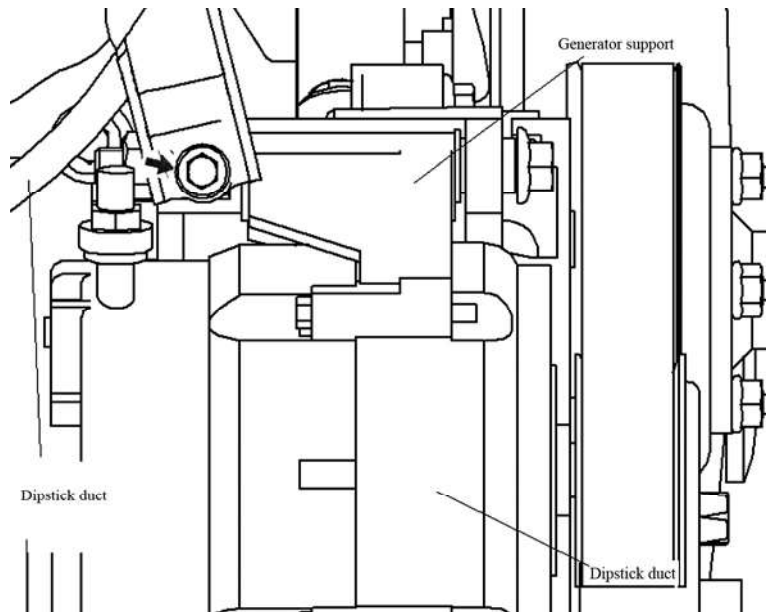
1. Turn on the drain plug to let out the coolant.
2. Remove the integrated belt.



3. Unscrew the dipstick holding bolts.
4. Dismantle the generator and its support.
5. Dismantle the air conditioner compressor and its support.
6. Unscrew 4 nuts and take down the fan and fan pulley.
7. Remove the phase sensor.
8. Dismount the outer cover of timing belt chamber and the timing belt.
9. Dismount the camshaft timing pulley.

10. Dismount the timing belt idler.

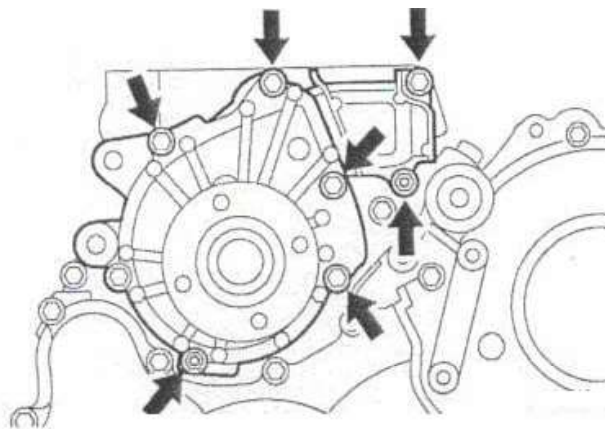
11. Dismount the inner cover of timing belt chamber.



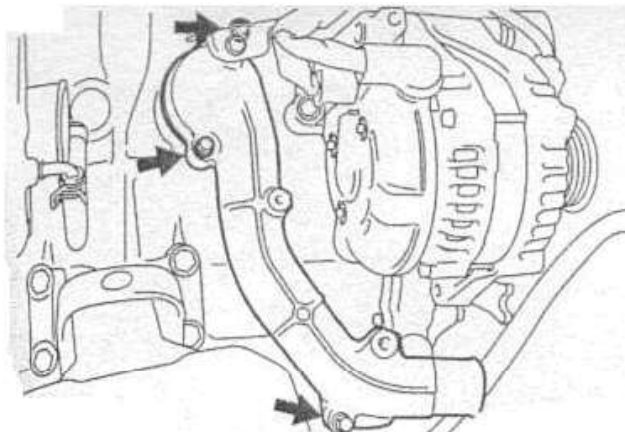
12. Dismount the water pump assembly.

(1) Check if there is coolant out of drain plug.

(2) Turn the pulley to confirm it is free from abnormal noise and seizure.



13. Dismount the water inlet pipe.



13. Take out the thermostat.

(1) Soak the thermostat into water and heat it slowly.

(2) Check the temperature as the valve begins to open.

※ **Standard value:** 80~84°C

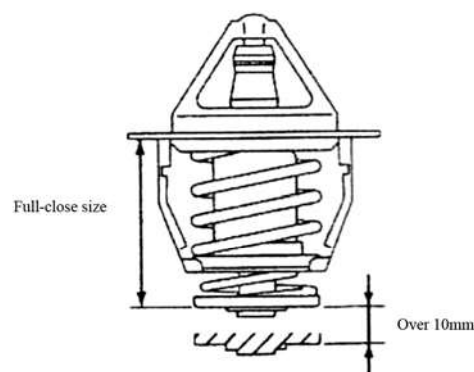
(3) Check the uplift of valve.

※ **Standard value:** Uplift: over 10mm

Full-open temperature: 95°C

(4) Check if the valve is fully closed when the thermostat is at low temperature (below 40°C).

※ **Reference:** If the valve isn't fully closed, the thermostat must be changed.



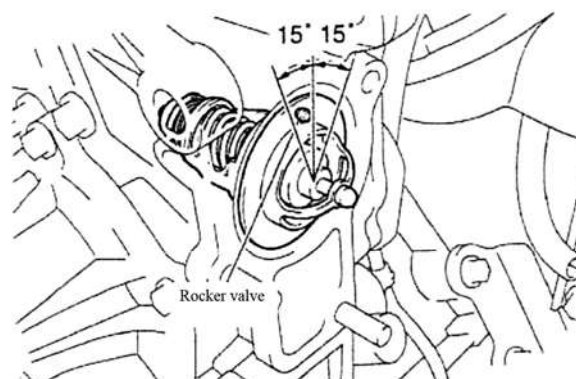
➤ Installation

1. Install the thermostat.

(1) Mount the washers on thermostat.

(2) Mount the thermostat as shown in the picture by keeping its rocker valve up.

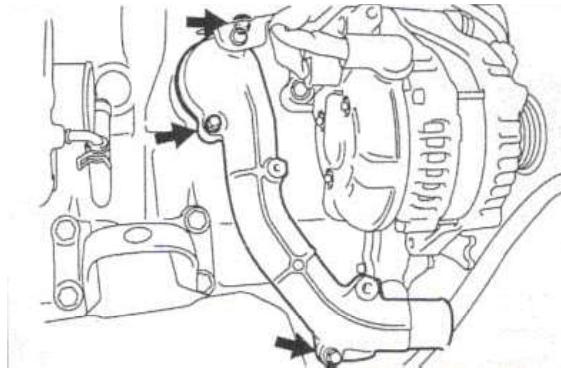
※ **Reference:** Keep it within $\pm 15^\circ$ right above the rocker valve.



2. Install the water inlet pipe.

Fix this pipe with 3 bolts.

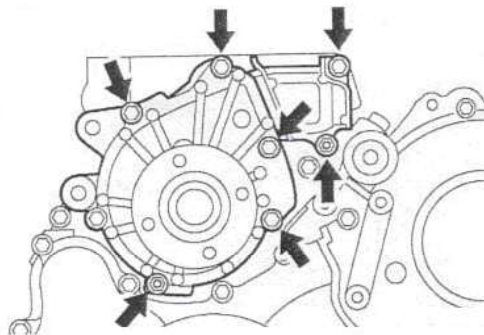
※ **Standard value:** T=13N.m



3. Install the water pump assembly.

Renew the washers and fix the water pump assembly with 5 bolts and 2 nuts.

※ Standard value: $T=13\text{N.m}$



4. Install the inner cover of timing belt chamber.

5. Install the timing belt idler.

6. Install the camshaft timing pulley.

7. Install the timing belt, outer cover of timing belt chamber, as well as phase sensor.

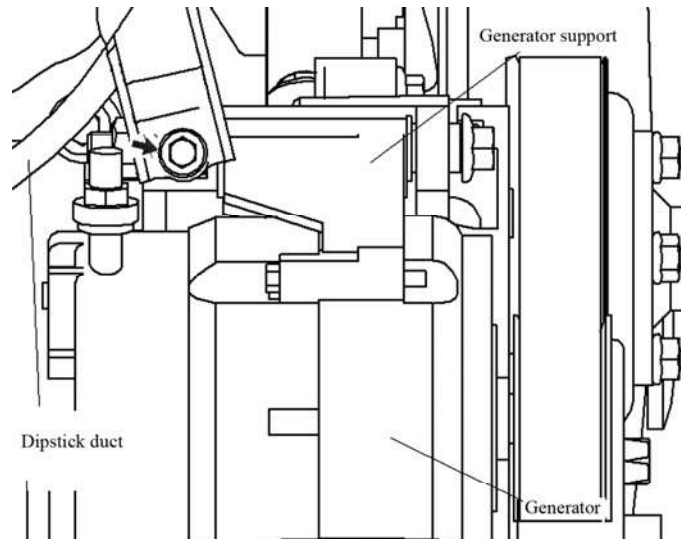
8. Install the water pump pulley, silicon oil clutch and fan.

9. Install the AC (air conditioner) compressor support and AC.

10. Install the generator support and generator.

11. Fix the dipstick duct.

12. Install the integrated belt.



Service Manual of DK4A Diesel Engine

Function Diagnosis and Fault Remedy

Brief Introduction of Basic Control by Electric Control System

Control of operating state

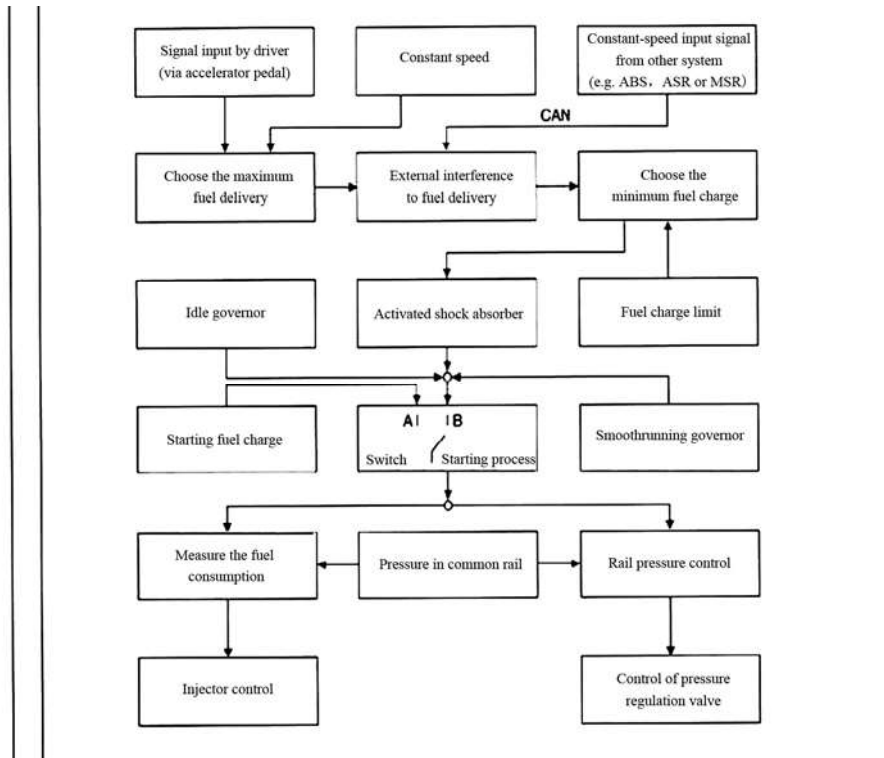
To enable an optimal combustion process for engine under every working condition, the ECU is required to work out reasonable fuel delivery in every case. In this process, various parameters must be taken into consideration.

For the calculation of fuel delivery in ECU, refer to the following chart:

Control of operating state

To enable an optimal combustion process for engine under every working condition, the ECU is required to work out reasonable fuel delivery in every case. In this process, various parameters must be taken into consideration.

For the calculation of fuel delivery in ECU, refer to the following chart:



Starting fuel charge

In terms of starting, the fuel charge is function of temperature and crankshaft speed. It is the accumulated fuel charge from the moment when the starting switch is turned to “start” position (position A in the previous picture where fuel is transiently injected) to the moment when engine reaches the required minimum speed. It is immune to driver.

The vehicle will undergo such standardization tests as plateau test, high-temperature test and high cold test to ensure the engine can be normally started in various environments so that the vehicle can be driven even in a formidable environment.

Starting pre-heat

In case of starting the engine at $<75^{\circ}\text{C}$ water temperature, the heater plug should pre-work for a period to ensure a smooth start as the ignition switch is switched on. This pre-working state is demonstrated by 0~12s illumination of heater plug. The lower the water temperature is, the longer the pre-heating period becomes. If water temperature is lower than 40°C during and after the start, the heater plug will also work for 0~180s based on water temperature, and the increase in its pre-working time will be in proportion to the decrease in water temperature as well to ensure normal start and stable operation of engine.

Transport condition

When the vehicle is running normally (see the previous picture in which the start switch is in the position B), the fuel charge can be calculated based on accelerator pedal device (accelerator pedal sensor) and engine speed. The transmission diagram should be utilized for this calculation concern so as to match the driver's input to engine O/P (output) power optimally.

Idle speed control

With the idle speed controlled, fuel consumption will mostly depend on engine efficiency and idle speed. As the fuel consumption of vehicle hinges on its working condition in a heavy traffic, it is obvious that the idle speed should at best be minimized. But the idle speed must be set under whatever condition so that engine speed won't drop too much under a load to make the engine almost stall or stall.

E.g. when electrical system is being loaded, when AC is on, when automatic gear shift is busy, or when power steering device is operating – there is a load on engine.

To achieve the required idle speed, the idle speed controller will change the fuel charge until actual engine speed is just the required idle speed. Here, this speed, together with speed governing characteristics is subject to the influence from specific gear and engine temperature (coolant temperature sensor). In addition to external load torque, internal friction torque must also be considered and offset through idle speed control. Minor and quite stable in the service life of vehicle, these changes are closely related to temperature.

Take the PALADIN as an example: after starting the engine at $<5^{\circ}\text{C}$ water temperature, this system will govern the engine speed for 2s preheating period, in which engine speed will exceed the 800rpm target idle speed. The lower the water temperature is, the higher the speed of started engine will be – but lower than 1000rpm. As the vehicle runs, the idle speed at every gear is unexceptionally 200rpm.

If the AC is switched on during as engine idles, the AC compressor will start working within 2s, meanwhile the target idle speed will rise to 810rpm to weaken the influence from compressor operation.

The idle speed controller can unexceptionally stabilize the idle speed at the target point whenever the steering wheel is turned, the headlamps are turned on or other loading function is activated.

Note: for different vehicle types, both target idle speed and AC idle speed may vary slightly due to the influence from factors such as load, driveline and noise, and are subject to adjustment and calibration as the case may be.

Smoothrunning control

Mechanical tolerances and aging will lead to the torque deviation among engine cylinders, which will further cause rough running of engine during its running particularly idling period. Smoothrunning governor can calculate the speed change based on every combustion process for mutual comparison and regulate the fuel delivery of every cylinder as per the measured speed difference, enabling every cylinder to make the same contribution to engine torque. But it functions only when engine runs at a much lower speed.

Control on fuel charge limit

There is a series of reason to demonstrate why the fuel amount required by driver or physically realizable to the utmost extent can't be injected, including:

- Excessive pollutant emission
- Excessive carbon black emission

- Mechanical overload caused by oversize torque or engine speed
- Thermal overload due to overhigh temperature of condensing agent, oil or turbocharger

This fuel charge limit is the result of various inputs, such as air intake, engine speed and coolant temperature.

Take the PALADIN as an example: for a standard electric fan, its opening temperature is 90°C and closing temperature is 88°C; While for a high-speed fan, its opening temperature is 95°C and closing temperature is 90°C. If air temperature or load is so high that electric fan can't control water temperature ($\geq 105^\circ\text{C}$), engine will be overheated. At this moment, the system will automatically regulate the fuel charge to limit the engine output so as to hold the temperature within a safe range. Thus there will be a little drop in power – from the perspective of engine protection, this is necessary. If water temperature is higher than 95 °C in engine stalling, the fan will also go on working for 10~120s to bring down water temperature.

The same is true with AC, which will activate its protective function by shutting off when water temperature is above 105°C, to reduce the load on engine. However, when water temperature drops to 102°C, the AC will automatically start to work.

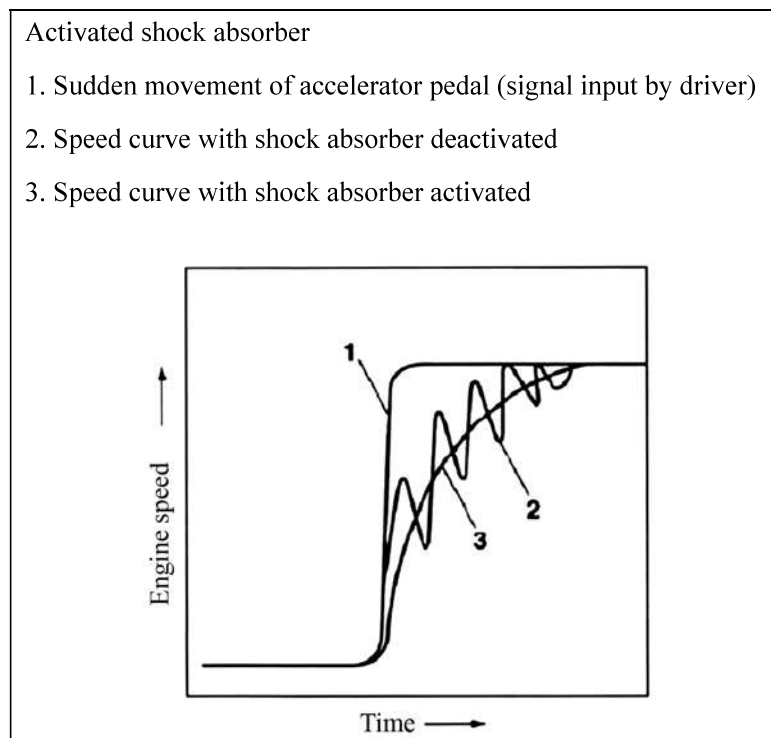
Standardizing the protective function of supercharger and oxidation catalytic converter through high-temperature and plateau tests is also based on such a principle – the system will automatic regulate the fuel charge to limit the supercharger speed within 180,000 rev./min under various working conditions and keep the exhaust temperature within 700°C (sometimes over 700°C temporarily but below 750°C).

Also, the temperature threshold for various protective functions will vary with vehicle type, radiation system and engine compartment structure, but for a common purpose – to ensure safe, steady running of both vehicle and engine.

Activated shockproof control

Suddenly stepping or releasing the accelerator pedal will result in rapid change in fuel charge and later engine torque. With such a sudden change in load, elastic engine base and driveline will jerk so violently that engine speed fluctuates (see the following picture).

This periodic fluctuation in engine speed can be weakened by activating the shock absorber, which will contribute to the same speed fluctuation frequency to change the fuel charge. The higher the engine speed, the less the fuel charge; vice versa – this has effectively cushioned the oscillation.



Engine stalling

A diesel engine will run in the principle of automatic ignition, which means it can only rely on fuel cutoff to stop running.

An engine with electric control unit can be stopped by meeting the “zero fuel charge” requirement specified by ECU. Also, the system has been supplied with a series of additional fuel cutoff approaches ready for motion.

Integrated troubleshooting function

Sensor monitoring

An integrated troubleshooting system can monitor if sensors have been fully powered and if their signal is real (e.g. the temperature is $-40^{\circ}\text{C} \sim 150^{\circ}\text{C}$). If applicable, an important signal should be provided with a redundant signal, that is to say, in the case of a fault, the redundant signal can be turned to for continuous operation.

Monitoring module

In addition to microprocessor, there is a Monitoring module in ECU. This module and ECU can monitor each other. If something is wrong, either of them can independently cut off the fuel injection.

Fault identification

Only within the sensor monitoring range can the fault identification function be utilized. If the presence time of a fault is longer than the preset identification time, this signal channel will be judged as in a trouble. In this case, this fault, along with its environmental conditions (such as coolant temperature and engine speed etc.) will be stored in the fault memory of ECU.

In case of a lot of faults, it is necessary to reset the “normalizing” state. In this regard, the signal channel must be confirmed integral within a specified period.

Fault handling

The output signal of a signal beyond the allowable range can be converted into a set value. This procedure is also applied to the following input signals:

- Battery voltage
- Temperature of coolant, air and lubricant
- Supercharging air pressure
- Atmospheric pressure and air intake

In addition, if something is wrong with the signal of accelerator pedal sensor or braking signal, the redundant value of accelerator pedal sensor can be applied.

Take the PALADIN as an example: if water temperature sensor gets into trouble, the system will adopt the redundant water temperature value, which is -25°C prior to engine start to ensure the success in starting and is 90°C after the start to ensure the smooth running. Meanwhile, electric fan controller will also take 105°C as the default water temperature. The fan will go on working to ensure water temperature in engine won't become overhigh without being monitored. Except the engine speed sensor, most of sensors are provided with their redundant value to ensure the vehicle, once in trouble, can be driven to a service station for repair.

System lamps

Trouble lamp:

After switching on the ignition switch without starting the engine, the trouble lamp will light up for 1s self-check and then go out. If there is a trouble in the system, this lamp will light up again to remind the driver of repair. If the lamp is lightened in engine running, the driver should stop the vehicle immediately for a check.

OBD lamp:

After switching on the ignition switch without starting the engine, the trouble lamp will shine constantly. But after the engine is started, it will go out. If emission from a running engine goes beyond the standard just because of a fire, the OBD lamp will light up to remind the driver of checking the engine.

2.5L-TDI engine with BOSCH common-rail injection system

Troubleshooting

1. Introduction of Main Functions of Troubleshooter
2. Failure Code List
3. Common Failure Modes

Main Functions of Troubleshooter

Troubleshooting functions			
Read the failure code			
Read the failure code			
Read the data stream			
Action test			
Read the freeze frame			
Read the version information			
Injection nozzle matching			
Engine test			
Page up		Page down	
Front page of troubleshooter	Backward	Print	Help
Start			14:48

Main Functions of Troubleshooter

Failure codes			
P0110 Time-cycle reference signal - error is found in signal range			
P2264 Water-level sensor(contained) in fuel works normally			
P2135 Accelerator pedal 2 doesn't match APP1; Accelerator pedal 1 doesn't match APP2			
P0633 No programming error is found in burglar alarm			
P0193 Fuel rail pressure and voltage are above the upper limit			
P0251 Metering unit PWM – power level: the metering unit output is turned on and loaded			
P0118 Voltage of coolant temperature sensor is above the upper limit			
Page up		Page down	
Front page of troubleshooter	Backward	Print	Help
Start			14:49

Clear the failure codes	
Cleared	
Confirm	Print
Start	14:49

Main Functions of Troubleshooter

Choosing the data stream			
Engine speed			
Fuel rail pressure			
Controlled state of AC compressor			
Current fuel charge			
Airflow deviation			
EGR (exhaust gas recirculation) valve ratio			
Ignition switch state			
State of pre-heating lamp			
Page up		Page down	
Front page of troubleshooter		Backward	Print
Start			

Data stream			
Engine speed	0 rpm		
Fuel rail pressure	0 hpa		
Controlled state of AC compressor	Off		
Page up	Page down	Record	Drawing-1
Front page of troubleshooter	Backward	Print	Help
Start			 14:51

Main Functions of Troubleshooter

Action test			
AC compressor signal test			
EGR actuator test			
Power-on time correction test			
Power-on time test on roller test stand			
Test for pre-heating lamp signal			
Test for pre-heating control			
OBD lamp signal test			
Test of metering unit actuator			
Page up		Page down	
Front page of troubleshooter	Backward	Print	Help
Start			 14: 52

Action test	
Completed	
Confirm	Print
Start	    15:02

Main Functions of Troubleshooter

Failure codes			
P0110 Time-cycle reference signal - error is found in signal range			
P2264 Water-level sensor(contained) in fuel works normally			
P2135 Accelerator pedal 2 doesn't match APP1; Accelerator pedal 1 doesn't match APP2			
Page up		Page down	
Front page of troubleshooter	Backward	Print	Help
Start			15:03

Data stream			
Ratio between current torque and maximum torque		0.00 %	
Linear environmental temperature		38.94 °C	
Engine speed		179 rpm	
Original vehicle speed		0 km/h	
Original airflow per unit time		14.89 kg/h	
Rail pressure		369600.00 hpa	
Original atmospheric pressure		1000.00 hpa	
Page up	Page down	Record	Drawing-1
Front page of troubleshooter	Backward	Print	Help
Start			15:03

Main Functions of Troubleshooter

Engine matching system																																																									
Please enter the first 7-digit IOA code																																																									
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Start	15:08																																																								

Main Functions of Troubleshooter

Failure codes			
Compression test 1			
Fuel-charge correction output of every cylinder			
Speed of every cylinder without FBC			
High-pressure test of fuel rail			
Acceleration test			
Compression test 2			
Page up		Page down	
Front page of troubleshooter	Backward	Print	Help
Start			15:08

Compression test	
Cylinder 1: 0r./min Cylinder 2: 0r./min Cylinder 3: 0r./min Cylinder 4: 0r./min	
Confirm	Print
Start	15:09

Failure Code List

Failure code	Failure description	Type	Fault ty
P0647	Fault path of air condition power stage 空调电源的故障途径	Bit0	Short Circuit Battery
P0646		Bit1	Short Circuit Ground
P0645		Bit2	No Load
P0645		Bit3	Excess Temperature
P0531	Fault path 1 for air condition pressure 空调压力的故障1	Bit0	Period Max error = SRC-High
P0531		Bit1	Period Min error = SRC-Low
P0533		Bit2	Duty Cycle Min error
P0532		Bit3	Duty Cycle Max error
P0531	Fault path 2 for air condition pressure 空调压力的故障2	Bit0	entering the Special Operation sector
P0530		Bit1	PresDSMDeb1Type
P2518	Fault path for analog air condition pressure 类似空调压力的故障	Bit0	Voltage above upper limit
P2517		Bit1	Voltage below lower limit
P2519	Fault path of air condition power stage 空调电源的故障	Bit2	CAN Msg. TimeOut error
P2519		Bit3	Non-Plausible CAN Msg. Value
P060B	Error status of ADC monitoring 模拟数字转换监测的错误状态	Bit0	SRC-High error of ADC reference voltage
P060B		Bit1	SRC-Low error of ADC reference voltage
P060B		Bit2	Test impulse error
P060B		Bit3	ADC queue error
P1100	error path for checking the drift factors out of the range in the low-idle mode 流量记忆速模式中检查偏移因子的输出范围错误		
P1100			
P1100	error path for checking the drift factors out of range in the load mode 流量记忆负载模式中检查偏移因子的输出范围错误		drift limit
P1100			drift limit
P1101	Intake Air Temperature sensor 流量记的进气温度传感器	Bit0	Voltage above upper limit
P1101		Bit1	Voltage below lower limit
P1102	error path for signal range check of duty cycle of air temperature signal 流量记空气温度信号的占空比信号范围检查错误		
P1102			
P0104	error path for plausibility check of offset drift of airmass 空气流量真实性检查的故障		ss ADC raw value > threshold high
P0104			ss ADC raw value < threshold low

P0048			Bit0	Short Circuit Battery
P0047	fault path for BPA power stage	进气压力传感器电源错误	Bit1	Short Circuit Ground
P0045			Bit2	No Load
P0046			Bit3	Excess Temperature
P0069	Error path for Plausibility Check	进气压力传感器真实性检查错误	Bit3	Not plausible with atmospheric pressure sensor
P0238			Bit0	Voltage above upper limit
P0237	Error path for Boost pressure sensor	进气压力传感器故障	Bit1	Voltage below lower limit
P0235			Bit2	CAN signal defect
P12FF	Error path for Boost pressure sensor SRCPhy range error	进气压力传感器信号范围错误		Voltage above upper Physical range
P12FF				Voltage below lower Physical range
P0563	battery voltage fault	电池故障	Bit0	Voltage above upper limit
P0562			Bit1	Voltage below lower limit
P0571	Error path for brake signal	刹车信号故障	Bit2	brake signal is defective
P0504			Bit3	brake signals not plausible
P0596			Bit0	Short Circuit Battery
P0595	Error Path for Cruise control Lamp powerstage	巡航控制灯的电源故障	Bit1	Short Circuit Ground
P0594			Bit2	No Load
P0118			Bit0	Voltage above upper limit
P0117	error path of coolant temperature sensor	冷却水温度传感器故障	Bit1	Voltage below lower limit
P0115			Bit2	Can Msg. value defect
P1103			Bit3	plausibility defect between OTS and CTS
P1601			Bit0	Short circuit to battery
P1602	error path of coolant temperature output	冷却水温度输出故障	Bit1	Short circuit to ground
P1603			Bit2	No load
P1604			Bit3	Excess temp.
P12FF	Error path for Coolant Temperature	冷却水温度错误	Bit0	Voltage above upper Physical range
P12FF			Bit1	Voltage below lower Physical range

P0048			Bit0	Short Circuit Battery
P0047	fault path for BPA power stage	进气压力传感器电源错误	Bit1	Short Circuit Ground
P0045			Bit2	No Load
P0046			Bit3	Excess Temperature
P0069	Error path for Plausibility Check	进气压力传感器真实性检查错误	Bit3	Not plausible with atmospheric pressure sensor
P0238			Bit0	Voltage above upper limit
P0237	Error path for Boost pressure sensor	进气压力传感器故障	Bit1	Voltage below lower limit
P0235			Bit2	CAN signal defect
P12FF	Error path for Boost pressure sensor SRCPhy range error	进气压力传感器信号范围错误		Voltage above upper Physical range
P12FF				Voltage below lower Physical range
P0563	battery voltage fault	电池故障	Bit0	Voltage above upper limit
P0562			Bit1	Voltage below lower limit
P0571	Error path for brake signal	刹车信号故障	Bit2	brake signal is defective
P0504			Bit3	brake signals not plausible
P0596			Bit0	Short Circuit Battery
P0595	Error Path for Cruise control Lamp powerstage	巡航控制灯的电源故障	Bit1	Short Circuit Ground
P0594			Bit2	No Load
P0118			Bit0	Voltage above upper limit
P0117	error path of coolant temperature sensor	冷却水温度传感器故障	Bit1	Voltage below lower limit
P0115			Bit2	Can Msg. value defect
P1103			Bit3	plausibility defect between OTS and CTS
P1601			Bit0	Short circuit to battery
P1602	error path of coolant temperature output	冷却水温度输出故障	Bit1	Short circuit to ground
P1603			Bit2	No load
P1604			Bit3	Excess temp.
P12FF	Error path for Coolant Temperature	冷却水温度错误	Bit0	Voltage above upper Physical range
P12FF			Bit1	Voltage below lower Physical range

P0128	Coolant temperature sensor absolute test	冷却水温度传感器绝对测试	Bit3	Minimum temperature not reached within time limit
P0116	Coolant temperature sensor dynamic test	冷却水温度传感器动态测试	Bit3	Minimum temperature raise not reached within time limit
P0301	error path for Misfire cylinder 1	1缸失火故障	Bit0	number of recognized misfire events above limit
P0302	error path for Misfire cylinder 2	2缸失火故障	Bit0	number of recognized misfire events above limit
P0303	error path for Misfire cylinder 3	3缸失火故障	Bit0	number of recognized misfire events above limit
P0304	error path for Misfire cylinder 4	4缸失火故障	Bit0	number of recognized misfire events above limit
P0305	error path for Misfire cylinder 5	5缸失火故障	Bit0	number of recognized misfire events above limit
P0306	error path for Misfire cylinder 6	6缸失火故障	Bit0	number of recognized misfire events above limit
P1301	error path for Misfire cylinder 1	1缸失火故障	Bit0	Average number of misfire events above limit
P1301	error path for Misfire cylinder 2	2缸失火故障	Bit0	Average number of misfire events above limit
P1301	error path for Misfire cylinder 3	3缸失火故障	Bit0	Average number of misfire events above limit
P1301	error path for Misfire cylinder 4	4缸失火故障	Bit0	Average number of misfire events above limit
P1301	error path for Misfire cylinder 5	5缸失火故障	Bit0	Average number of misfire events above limit
P1301	error path for Misfire cylinder 6	6缸失火故障	Bit0	Average number of misfire events above limit
P0300	error path for misfire in multiple cylinders	复合气缸失火故障	Bit0	number of recognized misfire events above limit
P0856	physical plausibility DCS	阻力矩的物理真实性	Bit0	physical unplausibility of DCS-demand
P1109			Bit0	degradation level 0
P110A	Error path/status for Performance limitation logic	性能限制逻辑的错误/故障	Bit1	degradation level 1
P110B			Bit2	degradation level 2
P110C			Bit3	degradation level 3
P161F	faultpath for compression test	压缩测试的故障	Bit0	fault path for compression test
P0704	diagnostic fault path signals errors of main clutch signal	主离合器信号的信号诊断故障		CAN clutch signal is not defined
P0704				clutch signal is not plausible
P0575	Error path for cruise control plausibility	巡航控制的真实性错误	Bit3	cruise control raw key status not plausible
P1605			Bit0	Short Circuit Battery
P1606	Error path for the Tachometer signal	转速表信号错误	Bit1	Short Circuit Ground
P1607			Bit2	No Load

P0073			Bit0	Voltage above upper limit
P0072	error path of environment air temperature sensor	环境温度传感器故障	Bit1	Voltage below lower limit
P0071			Bit2	Signal error, only in case of CAN
P12FF	Error path for Intake Air sensor SRCPhy range error	进气温度传感器信号范围检查错误		Voltage above upper Physical range
P12FF				Voltage below lower Physical range
P2530	fault path 1 for Engine Compartment Stop Button	发动机舱停止按钮故障1		Button is Stucked
P062F	error path for incompatible data value in EEPROM	存储器中对立数据的错误		Error in any element
P0490			Bit0	Short Circuit Battery
P0489	fault path for EGR power stage	EGR电源故障	Bit1	Short Circuit Ground
P0404			Bit2	No Load
P0403			Bit3	Excess Temperature
P245D			Bit0	Short Circuit Battery
P245C	fault path of EGRCD-cooling bypass valve	EGR旁通冷却阀故障	Bit1	Short Circuit Ground
P245A			Bit2	No Load
P245B			Bit3	Excess Temperature
P0406	error path of exhaust gas recirculator valve position sensor	EGR阀位置传感器故障		Voltage above upper limit
P0405				Voltage below lower limit
P1200	Errorpath for filtered energizing time of Cylinder 1	1缸喷嘴加电时间错误	Bit0	above upper limit of filtered energizing time
P1201			Bit1	below lower limit of filtered energizing time
P1202	Errorpath for filtered energizing time of Cylinder 2	2缸喷嘴加电时间错误	Bit0	above upper limit of filtered energizing time
P1203			Bit1	below lower limit of filtered energizing time
P1204	Errorpath for filtered energizing time of Cylinder 3	3缸喷嘴加电时间错误	Bit0	above upper limit of filtered energizing time
P1205			Bit1	below lower limit of filtered energizing time
P1206	Errorpath for filtered energizing time of Cylinder 4	4缸喷嘴加电时间错误		above upper limit of filtered energizing time
P1207				below lower limit of filtered energizing time
P1208	Errorpath for filtered energizing time of Cylinder 5	5缸喷嘴加电时间错误	0	above upper limit of filtered energizing time
P1209			1	below lower limit of filtered energizing time
P120A	Errorpath for filtered energizing time of Cylinder 6	6缸喷嘴加电时间错误		above upper limit of filtered energizing time
P120B				below lower limit of filtered energizing time
P120C	Errorpath for energizing time calibration injection of Cylinder 1	1缸标准喷射的喷嘴加电时间错误		limit of energizing time
P120D				limit of energizing time
P120E	Errorpath for energizing time calibration injection of Cylinder 2	2缸标准喷射的喷嘴加电时间错误		er limit of energizing time
P120F				er limit of energizing time
P1210	Errorpath for energizing time calibration injection of Cylinder 3	3缸标准喷射的喷嘴加电时间错误		er limit of energizing time
P1211				er limit of energizing time
P1212	Errorpath for energizing time calibration injection of Cylinder 4	4缸标准喷射的喷嘴加电时间错误		er limit of energizing time
P1213				er limit of energizing time
P1214	Errorpath for energizing time calibration injection of Cylinder 5	5缸标准喷射的喷嘴加电时间错误		it of energizing time
P1215				it of energizing time
P1216	Errorpath for energizing time calibration injection of Cylinder 6	6缸标准喷射的喷嘴加电时间错误		pper limit of energizing time
P1217				wer limit of energizing time
P0478			Bit0	Short Circuit Battery
P0477	fault path for EVCD power stage	排气阀电源故障	Bit1	Short Circuit Ground
P0475			Bit2	No Load
P0476			Bit3	Excess Temperature
P1621			Bit0	Short Circuit Battery
P1622	fault path for Eng power stage	发动机电源故障	Bit1	Short Circuit Ground
P1623			Bit2	No Load
P1624			Bit3	Excess Temperature
P1112	Fault path for non plausibility between coolant and second temperature at engine start, after a min. cool down time	两次冷却水温度差值的真实性错误	Bit3	difference between coolant and second temperatures exce
P0340	error path of camshaft failure	相位传感器故障	Bit0	no camshaft signal
P0341			Bit1	wrong camshaft signal
P0335	error path of crankshaft failure	曲轴位置传感器故障	Bit0	no crankshaft signal
P0336			Bit1	wrong crankshaft signal
P0016	error path of offset between camshaft and crankshaft	相位和曲轴位置偏差的错误		offset between camshaft and crankshaft
P1625			Bit0	Short Circuit Battery
P1626	Error Path for Exhaust barke Lamp powerstage	排气阀灯电源错误	t1	Short Circuit Ground
P1627			t2	No Load
P1628			Bit3	Excess Temperature
0	Error Path for Exhaust brake monitor	排气阀的检测故障	Bit0	Short Circuit Battery
P1007	fault FMTC_trq2qBas_MAP contains non strictly monotonous q curves	扭矩转换曲线精确分布的故障		
P0183	Fuel Temperature sensor	燃油温度传感器	Bit0	Voltage above upper limit
P0182			Bit1	Voltage below lower limit
P12FF	Error path for Fuel temp sensor SRCPhy range error	燃油温度传感器测量范围错误		Voltage above upper Physical range
P12FF				Voltage below lower Physical range
P0692			Bit0	Short Circuit Battery
P0691	fault path of fan control for PWM type relay	脉宽式冷却风扇继电器故障	Bit1	Short Circuit Ground
P0480			Bit2	No Load
P0483			Bit3	Excess Temperature
P0694			Bit0	Short circuit to battery
P0693	fault path of fan control for digital power stage 2	高速冷却风扇数字电源故障2	t1	Short circuit to ground
P0481			t2	No load
P0484			Bit3	Excess temperature
P2267	water level in fuel sensor	油水传感器	Bit0	max error incase of water
P2264			Bit2	sensor not working normally
U0404	physical plausibility TSC	电子档位控制物理真实性	Bit0	physical unplausibility of TSC-demand
P0384			Bit0	Short Circuit Battery
P0383	Error path for the glow control relay actuator	预热塞控制继电器故障	Bit1	Short Circuit Ground
P0670			Bit2	No Load
P0670			Bit3	Excess Temperature
P1608			Bit0	Short Circuit Battery
P1609	Error path for the glow display lamp	预热指示灯故障	Bit1	Short Circuit Ground
P160A			Bit2	No Load
P160B			Bit3	Excess Temperature

P0380	Errors of Glow control unit	预热控制单元错误	Bit0	failure of a glow plug, Relay failure, Short circuit in glow plu
P0382			Bit1	Short circuit in glow plug, over-current, Relay got stuck
P060A	error state communication - SPI	通讯状态错误	Bit0	communication error of CJ940
P062F			Bit1	error during last read operation
P062F	error state of EEPROM	存储器状态错误	Bit2	error during last write operation
P062F			Bit3	default value used
P1630	error path for Recovery which is locked	锁住校正的错误	Bit3	a recovery has occurred
P1631	error path for Recovery which is suppressed	抑制校正的错误	Bit3	a recovery has occurred
P060B	error path for Recovery which is visible	可见校正的错误	Bit3	a recovery has occurred
P1637	error state supply voltage CJ940 upper limit	支持电压超过上限	Bit0	internal supply voltage upper limit
P1638	error state supply voltage CJ940 lower limit	支持电压超过下限	Bit1	internal supply voltage lower limit
P160C	HpTst 油轨高压测试		Bit0	HpTst deactivates rail pressure monitoring
P0098			Bit0	Voltage above upper limit
P0097	error path of air temperature sensor	空气温度传感器故障	Bit1	Voltage below lower limit
P12FF				Voltage above upper Physical range
P12FF	Error path for Intake Air sensor SRCPhy range error	进气温度传感器信号测试范围的错		Voltage below lower Physical range
P0513	Used to indicate when security function is not through	防盗器中当安全功能没有通过时显		indicates that the recieved pattern and the transmitted patte
U0167	Error in EEPROM when accessing the ImmoCil blk	当通过防盗器灯错误存储		Maximum fault
P0633	Fault path for Immo Not programmed	防盗器不执行的故障	Bit0	fault for Immo Not programmed
U0426	Fault path for Wrong Response from ICM	防盗器相应错误	Bit0	fault for Wrong Response from ICM
P0513	Fault path for Immo Not in default Security level	防盗器默认的安全级别错误		fault for Immo Not in default Security level
U0167	Fault path for ICM communication time out	防盗器通讯超时错误	Bit0	fault for ICM communication time out
P0611			Bit0	Number of injections limited by charge balance
P0611	Fault path of injection limitation	喷油限值故障	Bit1	Number of injections limited by quantity balance
P0611			Bit2	Number of injections limited by software
P1223			Bit0	short circuit
P1224				short circuit on Low Side to ground
P1225	faultpath bank1-specific errors -> stop engine	喷嘴控制单元1故障-特殊错误-停机		depending on application
P1226			Bit3	not-classifiable error
P1227			Bit0	depending on application
P1228				depending on application
P1229	faultpath bank1 specific warnings -> stop engine	喷嘴控制单元1故障-特殊警告-停机		open load
P122A			Bit3	depending on application
P122B			Bit0	short circuit
P122C				short circuit on Low Side to ground
P122D	faultpath bank2-specific errors -> stop engine	喷嘴控制单元2故障-特殊错误-停机		depending on application
P122E			Bit3	not-classifiable error
P122F			Bit0	depending on application
P1230				depending on application
P1231	faultpath bank2-specific warnings -> stop engine	喷嘴控制单元2故障-特殊警告-停机		open load
P1232			Bit3	depending on application
P062B			Bit0	CY33X internal reset / clockloss / undervoltage
P062B			Bit1	CY33X is unlocked / CY33X init error
P062B	faultpath Chip-specific errors -> stop engine	喷嘴芯片A故障-特殊错误-停机		CY33X is in Testmode
P062B			Bit3	CY33X SPI communication error /checksum/readback
P062B			Bit0	CY33X internal parity error
P062B			Bit1	CY33X internal program flow error
P062B	faultpath Chip-specific errors -> stop engine	喷嘴芯片B故障-特殊错误-停机	Bit2	CY33X check of inv. YSEL during ON failed
P062B			Bit3	CY33X ON timeout for at least 1 cylinder
P0262			Bit0	short circuit on Low Side to battery
P0263	faultpath cylinder1-specific errors -> stop engine	1缸喷嘴故障-特殊错误-停机	1	depending on application
P0261			2	short circuit Low Side to High Side
P0263			Bit3	not-classifiable error
P123F			Bit0	depending on application
P1240			Bit1	depending on application
P0205	faultpath cylinder5-specific warnings	5缸喷嘴故障-特殊警告	Bit2	open load
P1241			Bit3	depending on application
P0277			Bit0	short circuit on Low Side to battery
P0278				depending on application
P0276	faultpath cylinder6-specific errors -> stop engine	6缸喷嘴故障-特殊错误-停机		short circuit Low Side to High Side
P0278			Bit3	not-classifiable error
P1242			Bit0	depending on application
P1243			Bit1	depending on application
P0206	faultpath cylinder6-specific warnings	6缸喷嘴故障-特殊警告	Bit2	open load
P1244			Bit3	depending on application
P0650			Bit0	Short Circuit Battery
P0650	Power Stage fault status for MIL	MIL灯电源故障	Bit1	Short Circuit Ground
P0650			Bit2	No Load
P0650			Bit3	Excess Temperature
P0687			Bit0	main relay does not open in time
P0686	error path for main relay	主继电器错误	Bit1	main relay opens too early
P0251				open load of metering unit output
P0252	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-开路		excess temperature of metering unit powerstage
P0254	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-对电池短路		short circuit to battery of metering unit output
P0253	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-对地短路		short circuit to ground of metering unit output
P025D				signal range check high error of metering unit AD-channel
P025C	error path of metering unit AD-channel	轨压脉宽控制单元模拟信号转换错误		signal range check low error of metering unit AD-channel
P060C	the fault path contains the supervision of the communication between Watchdog of CY310 and the controller. The path is used to handle the reversible Shut-down of the system using the engine coordinator	系统管理错误-关闭系统	Bit3	Set, if error-counter of Watchdog or controller are not plausible
U1001	Error path for BCM in Confirmed Absent state	BCM错误	Bit0	BCM Confirmed Absent
U1002	Error path for BSM in Confirmed Absent state	BSM错误	Bit0	BSM Confirmed Absent
U1003	error path for bus off state	CAN线路错误	Bit0	CAN Confirmed BusOff
U0100	Error path for ECM in Confirmed mute state	ECM错误	Bit0	ECM Confirmed Mute
U0101	Error path for TCM in Confirmed Absent state	TCM错误	Bit0	TCM Confirmed Absent

P123F			Bit0	depending on application
P1240	faultpath cylinder5-specific warnings	5缸喷嘴故障-特殊警告	Bit1	depending on application
P0205			Bit2	open load
P1241			Bit3	depending on application
P0277			Bit0	short circuit on Low Side to battery
P0278	faultpath cylinder6-specific errors -> stop engine	6缸喷嘴故障-特殊错误-停机	Bit1	depending on application
P0276			Bit2	short circuit Low Side to High Side
P0278			Bit3	not-classifiable error
P1242			Bit0	depending on application
P1243	faultpath cylinder6-specific warnings	6缸喷嘴故障-特殊警告	Bit1	depending on application
P0206			Bit2	open load
P1244			Bit3	depending on application
P0650			Bit0	Short Circuit Battery
P0650	Power Stage fault status for MIL	MIL灯电源故障	Bit1	Short Circuit Ground
P0650			Bit2	No Load
P0650			Bit3	Excess Temperature
P0687	error path for main relay	主继电器错误	Bit0	main relay does not open in time
P0686			Bit1	main relay opens too early
P0251	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-开路	Bit2	open load of metering unit output
P0252			Bit3	excess temperature of metering unit powerstage
P0254	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-对电池短路	Bit0	short circuit to battery of metering unit output
P0253	error path of metering unit PWM-powerstage	轨压脉宽控制单元电源错误-对地短路	Bit1	short circuit to ground of metering unit output
P025D	error path of metering unit AD-channel	轨压脉宽控制单元模拟信号转换错误	Bit2	signal range check high error of metering unit AD-channel
P025C			Bit3	signal range check low error of metering unit AD-channel
P060C	the fault path contains the supervision of the communication between Watchdog of CY310 and the controller. The path is used to handle the reversible Shut-down of the system using the engine coordinator	系统管理错误-关闭系统	Bit3	Set, if error-counter of Watchdog or controller are not plausible
U1001	Error path for BCM in Confirmed Absent state	BCM错误	Bit0	BCM Confirmed Absent
U1002	Error path for BSM in Confirmed Absent state	BSM错误	Bit0	BSM Confirmed Absent
U1003	error path for bus off state	CAN线路错误	Bit0	CAN Confirmed BusOff
U0100	Error path for ECM in Confirmed mute state	ECM错误	Bit0	ECM Confirmed Mute
U0101	Error path for TCM in Confirmed Absent state	TCM错误	Bit0	TCM Confirmed Absent
U1001	Error path for BCM in Confirmed Absent state	BCM错误	Bit0	BCM Confirmed Absent
U1002	Error path for BSM in Confirmed Absent state	BSM错误	Bit0	BSM Confirmed Absent
U1003	error path for bus off state	CAN线路错误	Bit0	CAN Confirmed BusOff
U0100	Error path for ECM in Confirmed mute state	ECM错误	Bit0	ECM Confirmed Mute
U0101	Error path for TCM in Confirmed Absent state	TCM错误	Bit0	TCM Confirmed Absent
P0523			Bit0	Voltage above upper limit
P0522	error path of oil pressure sensor	机油压力传感器故障	Bit1	Voltage below lower limit
P0520			Bit2	Hardware signal error
P0521			Bit3	Plausibility check - oil pressure too high
P0524	error path for oil pressure too low error	机油压力太低故障	Bit3	Plausibility check - oil pressure too low
P0198			Bit0	Voltage above upper limit
P0197	error path of oil temperature sensor	机油温度传感器故障	Bit1	Voltage below lower limit
P0195			Bit2	signal error for CAN
P100D			Bit3	Plausibility error between OTS and CTS
P1613	Fault path for overrun monitoring	减速监测故障	Bit0	Erroneous time exceeds limit of overrun monitoring
P1614	Fault path for redundant engine speed calculation in overrun monitoring	减速监测中其余的发动机速度计算故障	Bit0	error in engine speed check
P0299	Permanent governor deviation in PCR	压力传感器压力加载标准中的持续控制差异超过上限	Bit0	positive governor deviation above limit
P0234	Permanent governor deviation in PCR	压力传感器压力加载标准中的持续控制差异超过下限	Bit0	negative governor deviation below limit
P0629			Bit0	Short Circuit Battery
P0628	error path of power stage pre-supply pump	预加压泵电源错误	Bit1	Short Circuit Ground
P0627			Bit2	No Load
P062A			Bit3	Excess Temperature
P0193	error path of rail pressure	油轨轨压错误	Bit0	Voltage above upper limit
P0192			Bit1	Voltage below lower limit
P0191	error path RPS offset monitoring	轨压传感器监测错误	Bit0	RPS raw value is above maximum offset
P0194			Bit1	RPS raw value is below minimum offset
P1011	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	maximum positive deviation of rail pressure exceeded
P1012	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	maximum positive deviation of rail pressure exceeded concern
P1013	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	maximum negative rail pressure deviation with metering unit or
P0087	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	minimum rail pressure exceeded
P0088	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	maximum rail pressure exceeded
P1014	faults for checks in MeUn controlled mode	轨压控制模式中的检查故障	Bit0	setpoint of metering unit in overrun mode not plausible
P1615	faultpath for runup test	失火察觉中加速测试故障	Bit3	is set to deactivate misfire detection during runup test
P1616			Bit1	Watch dog switch off path defect
P1617	Fault path for test of redundant shut off paths during initialization	初始化中测试其余关闭途径故障	Bit0	Voltage monitoring upper limit shut off path defect
P1618			Bit3	Voltage monitoring lower limit shut off path defect
P0643	sensor supply voltage 1	供电电源传感器1	Bit0	Voltage above upper limit
P0642			Bit1	Voltage below lower limit
P0653	sensor supply voltage 2	供电电源传感器2	Bit0	Voltage above upper limit
P0652			Bit1	Voltage below lower limit
P0699	sensor supply voltage 3	供电电源传感器3	Bit0	Voltage above upper limit
P0698			Bit1	Voltage below lower limit
P1641	faultpath for shut off test	关闭测试故障	Bit0	Indicate the shut off test is taken by diagnostic tester
P0617			Bit0	Short Circuit Battery
P0616			Bit1	Short Circuit Ground
P0615	Error path starter power stage	起机电源错误	Bit2	No Load
P0615			Bit3	Excess Temperature
P1619			Bit0	Short Circuit Battery
P161A	Power Stage fault status for System lamp	故障灯电源错误	Bit1	Short Circuit Ground
P161B			Bit2	No Load
P161C			Bit3	Excess Temperature
P2533	error path for terminal 15 - contains plausibility error [Sig] of T15	点火开关故障	Bit0	No Terminal 15 signals detected
P0607	TPU monitoring	计数控制单元监测	Bit0	Deviation between TPU and system time
P2142			Bit0	Short Circuit Battery

P2141	fault path for T/A power stage	节气阀电源错误	Bit1	Short Circuit Ground
P0487			Bit2	No Load
P0488			Bit3	Excess Temperature
P0638	error path of Thr/Vlv regular mode	节气阀正常模式错误	Bit0	maximum failures
P1629	error path of Thr/Vlv state line	节气阀状态错误	Bit0	maximum failures
P0662			Bit0	Short circuit to battery
P0661	fault path for VSA power stage	可变涡轮增压电源错误	Bit1	Short circuit to ground
P0660			Bit2	No load
P1620			Bit3	Power stage excess temperature
P0503			Bit0	exceeding of the maximum vehicle speed
P0500	fault path 1 for vehicle speed sensing	车速传感器故障1-HW	Bit2	HW signal for vehicle speed not valid
P0501			Bit3	vehicle speed not plausible with injection mass and engine spe
P2157	fault path 2 for vehicle speed sensing	车速传感器故障2-CAN	Bit2	CAN signal for vehicle speed not valid
P161D	Error path for dataset variant coding. Npl=Requested variant could not be set, Sig=variant		Bit2	Signal fault
P161E	dataset defect	数据变量码故障	Bit3	Not plausible fault
P0607	the fault path contains the supervision of the SPI-Handler	SPI管理故障		Set, if SPI-communication failed

Common Failure Modes

Failure symptom	Checked position
Absence of crankshaft rotation	1. Battery
	2. Starter
	3. Starter relay
Unsatisfactory high-speed idling	1. Replacement of fuel filter
	2. Fuel injector
	3. Engine control unit
	4. Components of fuel feed pump
	5. Fuel pressure sensor
	6. Fuel quality
	7. Engine water temperature sensor
	8. Fuel piping (the pipe between fuel tank and feed pump is jammed)
Overhigh idle speed	1. A/C signal loop
	2. Fuel injector
	3. Engine control computer
	4. Fuel feed pump
	5. Fuel pressure sensor
	6. Engine water temperature
	7. Accelerator pedal components

Failure symptom	Checked position
Too low idle speed	1. A/C signal circuit
	2. Fuel injector
	3. EGR system
	4. Compressor
	5. Valve clearance
	6. Fuel piping
	7. Engine control computer
	8. Fuel feed pump
	9. Fuel pressure sensor
	10. Engine throttle body
Unstable idle speed	1. Fuel injector
	2. Fuel piping
	3. EGR system
	4. Compressor
	5. Valve clearance
	6. Engine control computer
	7. Fuel feed pump
	8. Fuel pressure sensor
	9. Engine throttle body
	10. Fuel properties
	11. Air conditioner system
	12. Power steering system
	13. AC (alternating current) generator
White smoke emission	1. EGR system
	2. Fuel injector

Failure symptom	Checked position
	3. Replacement of fuel filter
	4. Engine control computer
	5. Fuel feed pump
	6. Fuel pressure sensor
	7. Engine throttle body
	8. Fuel properties
	9. Compressor
	10. Turbocharger
Black smoke emission	1. Analysis on the cause of black smoke
Abnormal starting and engine stalling	1. Analysis on the cause of abnormal starting and engine stalling
Power deficiency	1. Analysis on the cause of power deficiency, engine trembling and engine speed fluctuation
Unstable idle speed and violent vibration	1. Analysis on the cause of unstable idle speed and violent vibration
Knocking and abnormal sound	1. Analysis on the cause of knocking and abnormal sound
Engine speed fluctuation	1. Fuel injector
	2. ECU power circuit
	3. Compressor
	4. Fuel piping
	5. Valve clearance
	6. Engine control computer
	7. Fuel feed pump
	8. Fuel pressure sensor
	9. Engine throttle body
	10. Air conditioner system
	11. Power steering system