DENSO

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ECD Service Dealer Only

Diesel Injection Pump

No. E-03-02

SERVICE MANUAL

Common Rail System for ISUZU 6HK1/6SD1 Type Engine

Operation

June, 2003

DENSO CORPORATION

00400018

GENERAL

The common rail system was designed for electronic control of injection quantity, injection timing and injection pressure to obtain optimal operational control.

Features

- Lower exhaust gas and higher output due to high pressure injection in all usage ranges.
- Reduction in noise and exhaust gas due to injection rate control.
- Improved performance due to increased flexibility in the injection timing setting.
- Independent control of injection pressure in response to engine speed and load.

Main Elements

Manufacturer	Vehicle Model	Engine Model	Cylinder Configuration	Total Displacement (cc)
ISUZU	Forward	6HK1	Straight 6	7,800
		6SD1		9,800
		6WG1		15,600

1. Outline

1.1 System Outline

This system also provides the following functions:

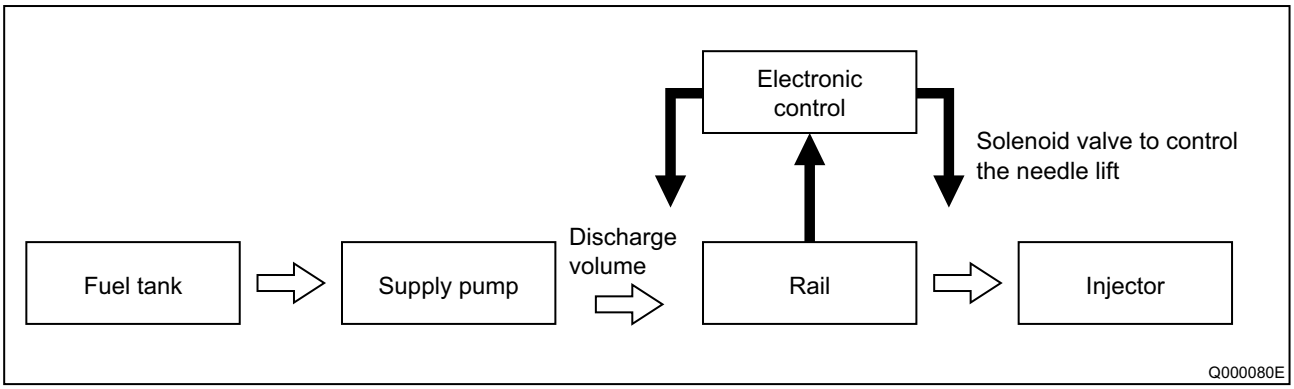
- A self-diagnosis and alarm function using computer to diagnose the system's major components and alert the driver in the event of a problem.
- A fail-safe function to stop the engine, depending upon the location of the problem.
- A backup function to change the fuel regulation method, thus enabling the vehicle to continue operation.

1.2 System Configuration

Divided by function, the system can be classified according to the fuel system and the control system.

[1] Fuel System

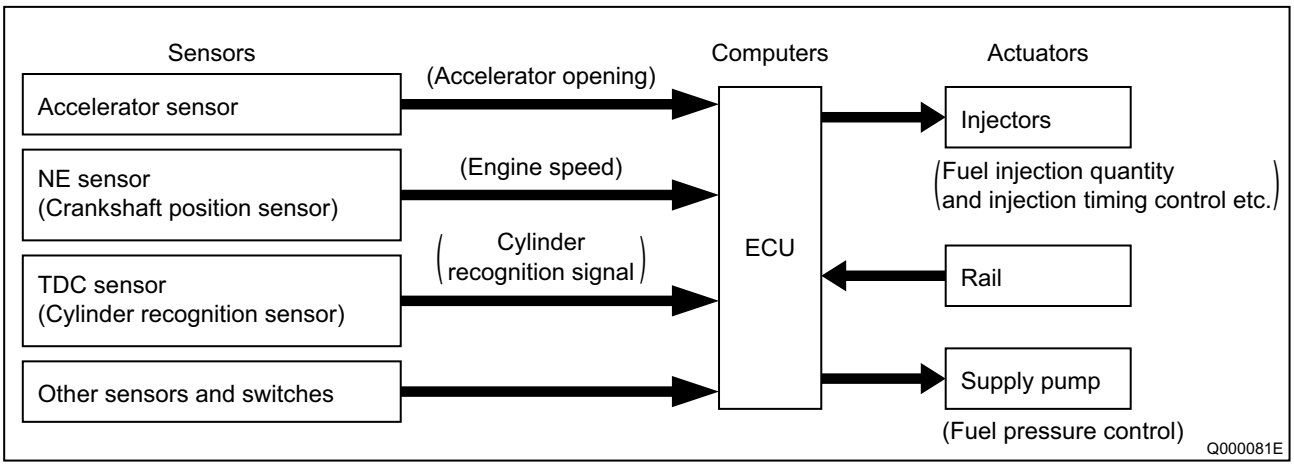
High-pressure fuel that is generated by the supply pump is distributed to the cylinders using a rail. Electromagnetic valves in the injectors then open and close the nozzle needle valve to control the start and end of fuel injection.



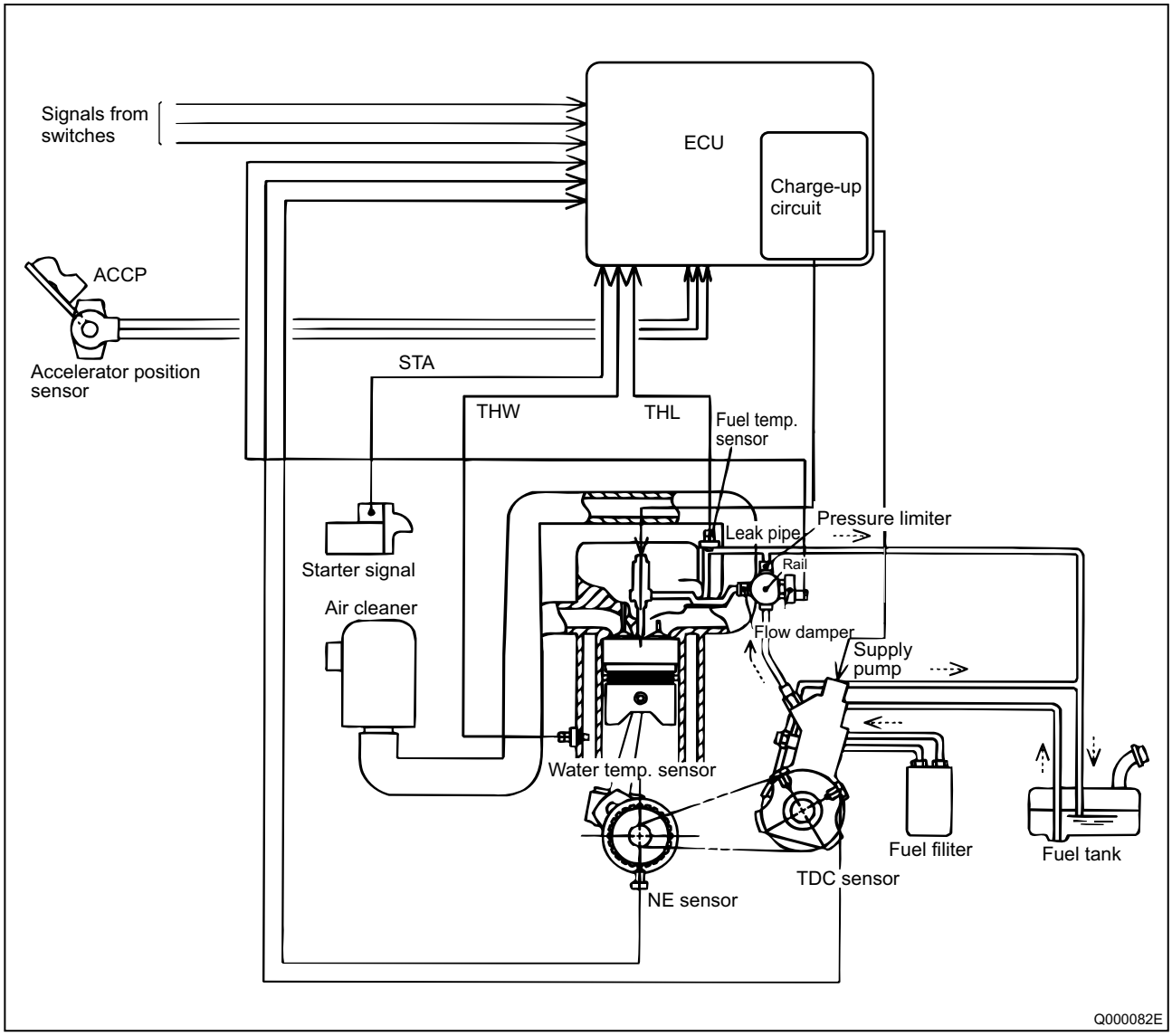
[2] Control System

Based on the signals received from various sensors mounted on the engine and the vehicle, the ECU controls current timing and the duration in which the current is applied to the injectors, thus ensuring an optimal amount of fuel is injected at an optimal time.

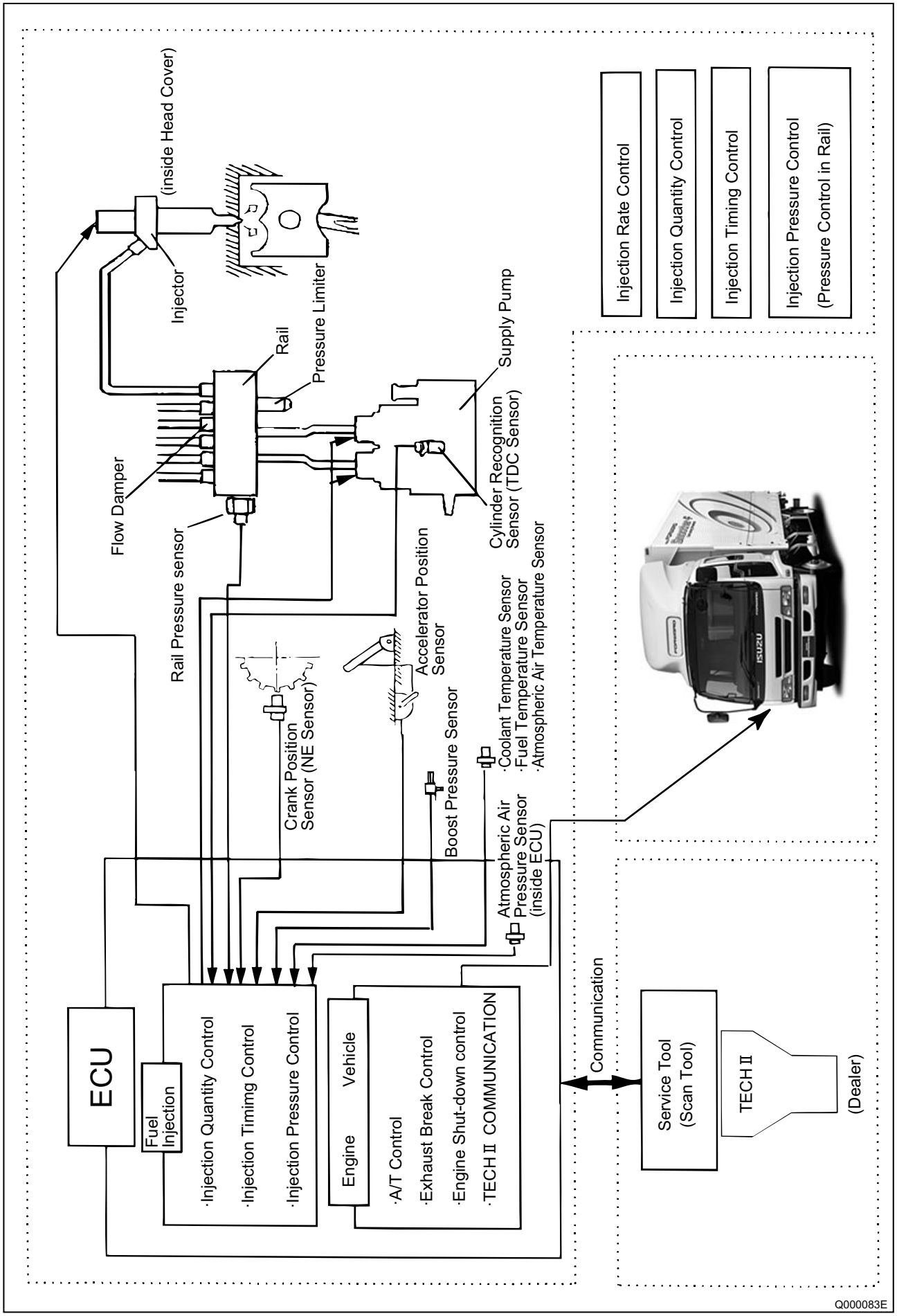
The control system can be broadly classified according to the following electronic components: sensors, computers, and actuators.



[3] System Configuration (1)



[4] System Configuration (2)



1.3 Construction and Operation of the System

The rail system is comprised of a supply pump, a rail, and injectors, and also includes an ECU and sensors to regulate those components.

The supply pump generates the internal fuel pressure in the rail. Fuel pressure is regulated by the quantity of fuel discharged by the supply pump. In turn, the fuel discharge quantity is regulated by electronic signals from the ECU that turn the PCVs (pump control valves) ON and OFF.

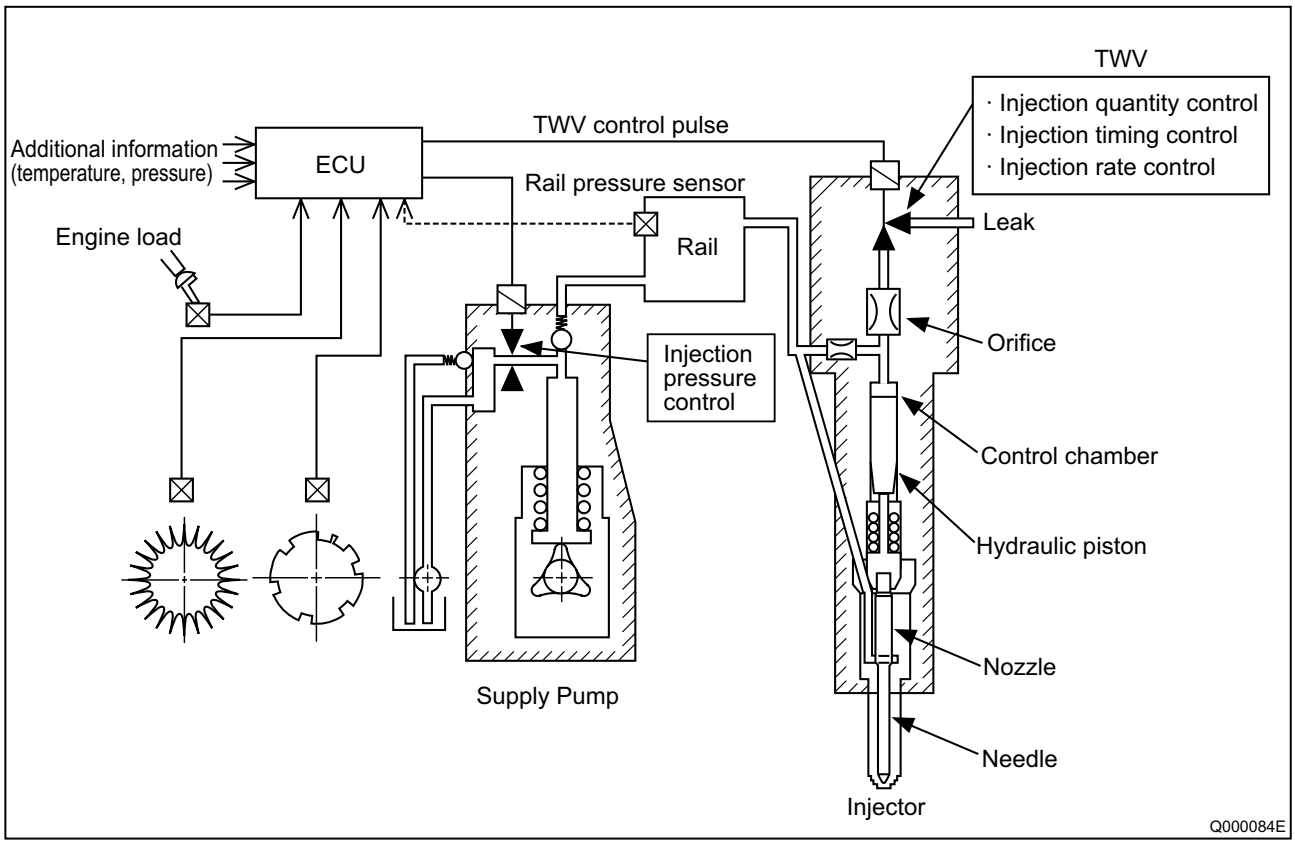
Upon receiving fuel pressurized by the supply pump, the rail distributes the fuel to the cylinders. The pressurized fuel is detected by the rail pressure sensor (installed in the rail) and undergoes feedback control so that actual pressure will match the command pressure (designated according to the engine speed and load).

Pressurized fuel in the rail passes through the injection pipes that lead to the cylinders, and applies pressure to the injector nozzles and the control chamber.

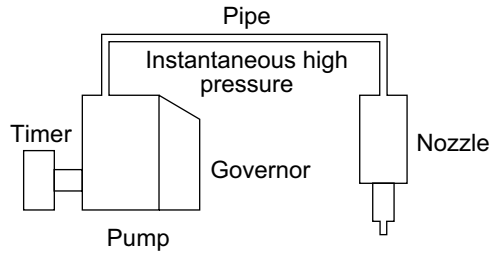
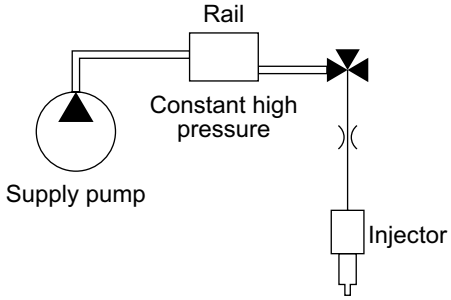
The injector regulates injection quantity and timing by turning the TWV (two-way valve) ON and OFF.

When the TWV is ON (current applied), the fuel circuit switches over, causing the high-pressure fuel in the control chamber to flow out via the orifice. As a result, the force of the high-pressure fuel at the nozzle valve opening causes the needle valve to lift, thus starting the injection of fuel. When the TWV is turned OFF (current not applied), the fuel circuit switches over so that high-pressure fuel, traveling via the orifice, is introduced to the control chamber. As a result, the needle valve lowers, thus ending the injection of fuel.

Thus, through electronic control, the timing of the current applied to the TWV determines the injection timing, and the duration in which current is applied to the TWV determines the injection quantity.



1.4 Comparison to Conventional Pump

	Inline Type	Common Rail System
System		
Injection quantity regulation	Pump (governor)	ECU, injector (TWV)
Injection timing regulation	Pump (timer)	ECU, injector (TWV)
Distribution of generated pressure	Pump	Supply pump
Distribution	Pump	Rail
Injection pressure regulation	(Dependent on engine speed and injection volume)	Supply pump (PCV)

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2. Construction and Operation of Components

2.1 Supply Pump

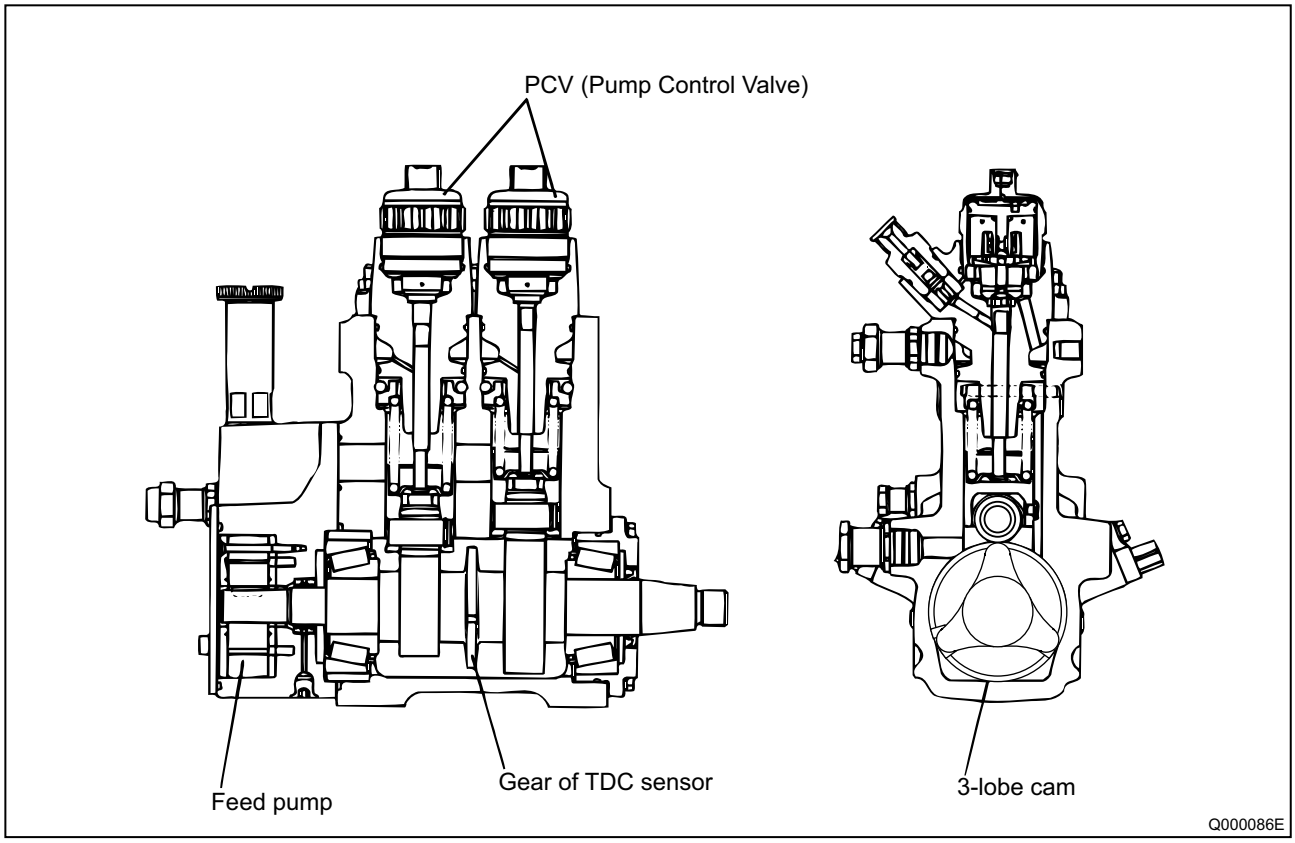
[1] Outline

The function of the supply pump is to regulate the fuel discharge volume, thus generating internal fuel pressure in the rail.

[2] Construction

The supply pump consists of a feed pump, similar to that of the conventional in-line pump, and the PCVs (pump control valves), provided at each cylinder, to regulate the fuel discharge volume.

The supply pump uses a three-lobe cam to reduce the number of engine cylinders supplied by the pump to one-third (e.g. a two-cylinder pump for a six-cylinder engine). Furthermore, smooth and stable rail pressure is obtained because the rate at which fuel is pumped to the rail is the same as the injection rate.



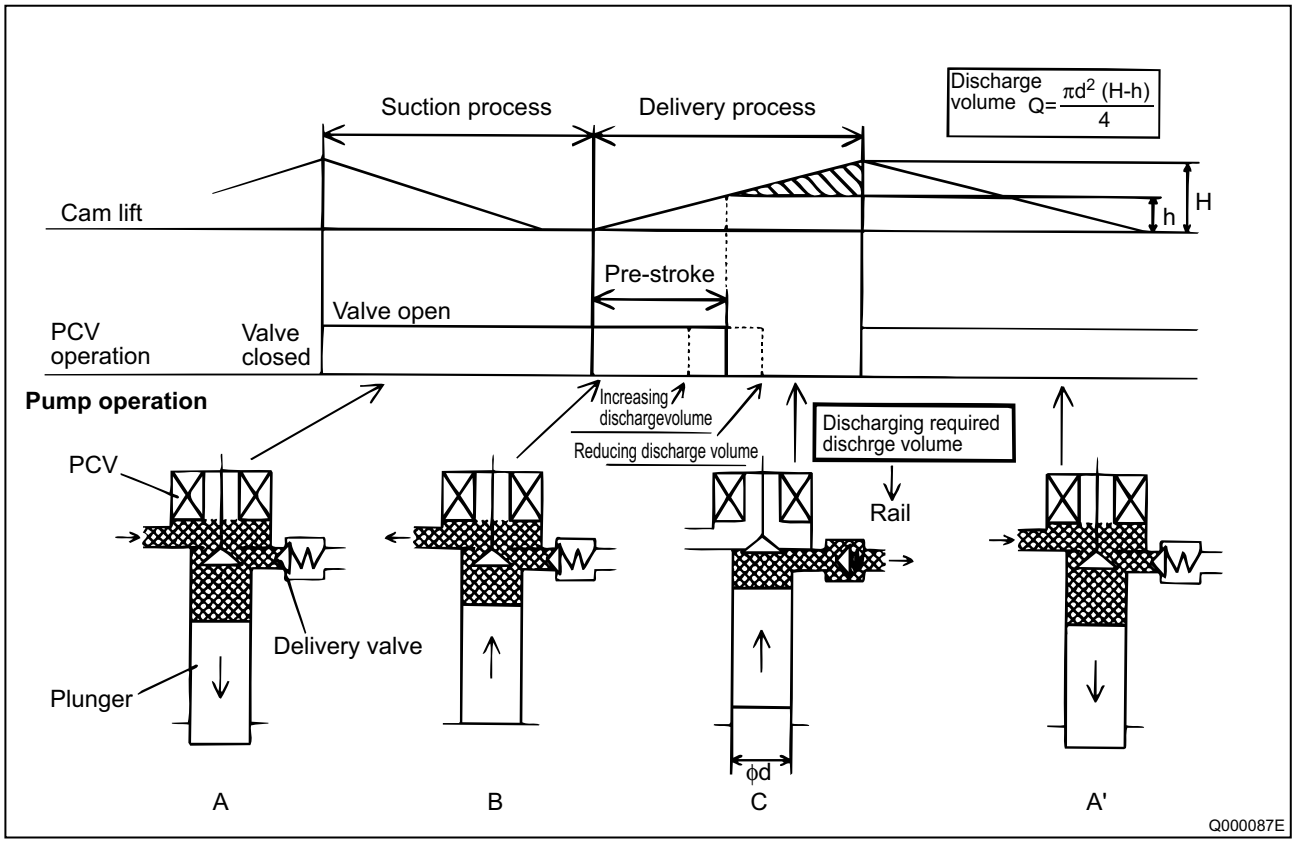
[3] Operation

A: The PCV remains open during the plunger's downward stroke, allowing low-pressure fuel to be drawn into the plunger chamber by way of the PCV.

B: If the valve remains open because current is not applied to the PCV, even after the plunger begins its upward stroke, the fuel that was drawn in returns via the PCV, without being pressurized.

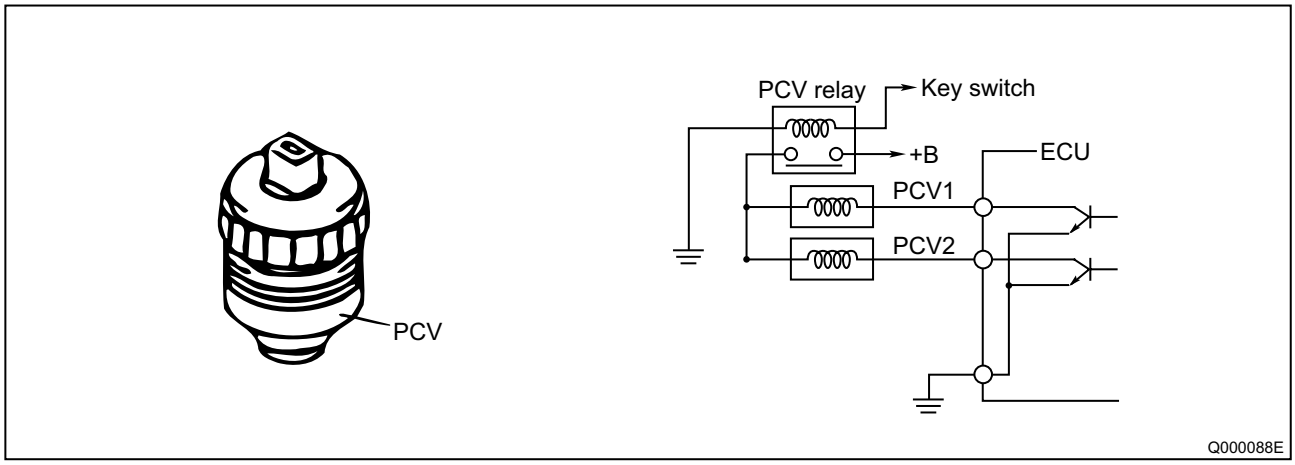
C: When current is applied to the PCV in order to close the valve at the timing that accommodates the required discharge volume, the return passage closes, causing pressure in the plunger chamber to rise. The fuel then passes through the delivery valve (check valve) to the rail. As a result, an amount of fuel that corresponding to the plunger lift after the PCV closes becomes the discharge volume, and varying the timing of the PCV closure (plunger pre-stroke) varies the discharge volume, thus regulating rail pressure.

A': After surpassing the maximum cam lift, the plunger begins its downward stroke, causing pressure in the plunger chamber to decrease. At this time, the delivery valve closes, thus stopping the pumping of the fuel. In addition, because current to the PCV valve is cut off, the PCV opens, allowing low-pressure fuel to be drawn into the plunger chamber. Thus, the pump assumes condition "A".



[4] PCV (pump control valve)

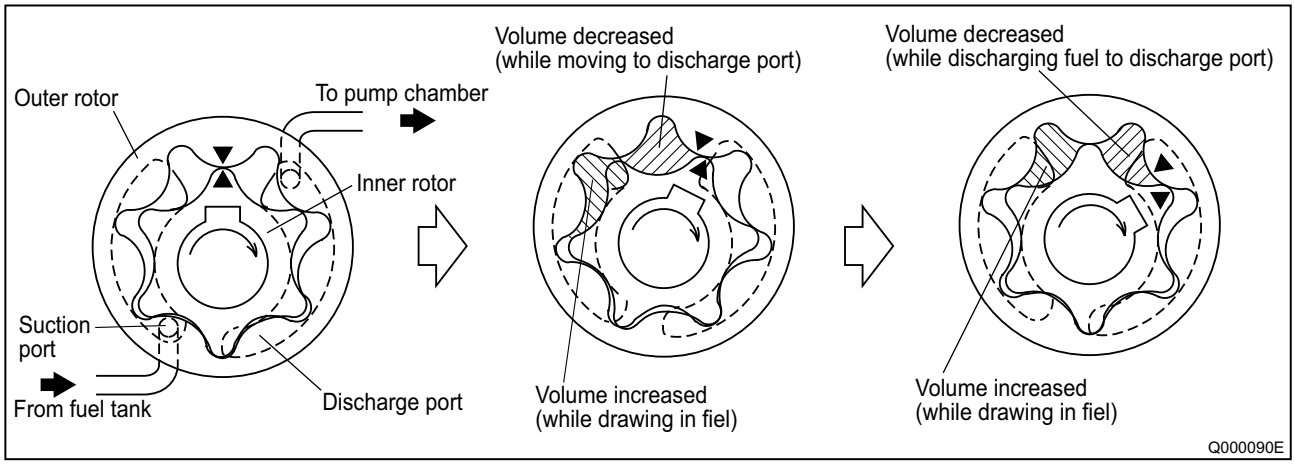
The PCV regulates the volume of fuel discharged by the supply pump in order to regulate rail pressure. The volume of fuel discharged by the supply pump to the rail is determined by the time at which current is applied to the PCV.



[5] Trochoid Type Feed Pump

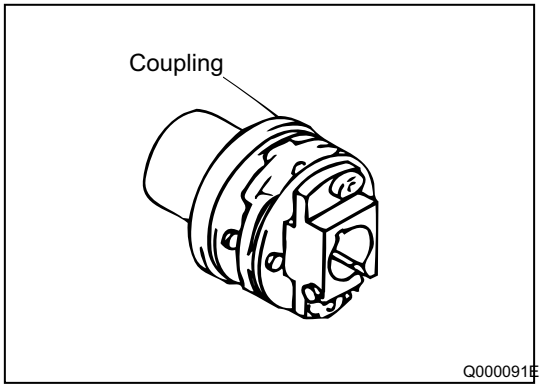
The feed pump, which is housed in the supply pump, draws fuel up from the tank and delivers it to the chamber via the fuel filter. The feed pump rotor is driven by the camshaft.

The rotation of the camshaft causes the outer and inner rotors to rotate. At this time, the suction port side pump chamber volume (the space surrounded by the outer and inner rotors) increases gradually, causing the fuel entering from the fuel inlet to be drawn into the pump chamber via the suction port. Along with the rotation of the rotor, the fuel that has been drawn in moves towards the discharge port and is discharged. The discharged fuel travels via the fuel outlet and is fed into the supply pump body.



[6] Coupling

The coupling is an intermediary device that transmits the engine driving torque to the supply pump camshaft.



2.2 Common Rail

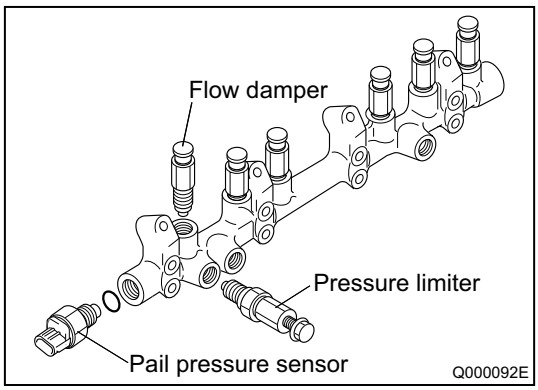
[1] Construction

The functionof the rail is to distribute the high-pressure fuel pressurized by the supply pump to each cylinder injector.

The rail pressure sensor, flow damper, and pressure limiter are mounted on the rail.

A fuel injection pipe is attached to the flow damper to deliver high-pressure fuel to the injector.

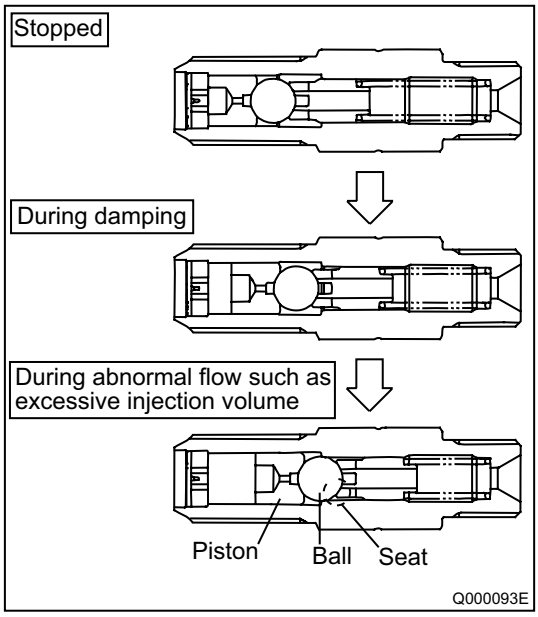
The pressure limiter piping is routed back to the fuel tank.



[2] Flow Damper

The flow damper reduces pressure pulsation in the high-pressure pipe, thus delivering fuel to the injectors at a stable pressure. Furthermore, in the event an excessive flow of fuel, the flow damper shuts off the fuel passage, thus preventing the abnormal fuel flow.

When abnormal amount of fuel flows the high-pressure is applied to the piston. As shown in the illustration, this causes the piston and ball to move right, until the ball reaches the seat and closes the fuel passage.

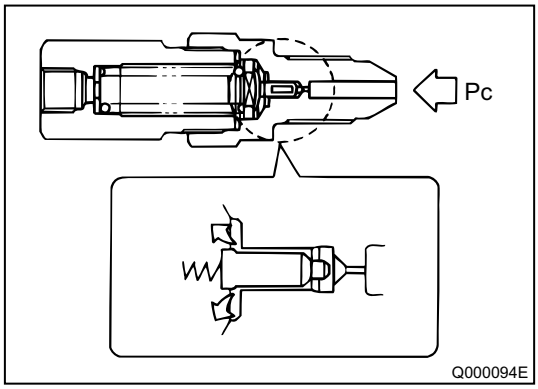


[3] Pressure Limiter

The function of the pressure limiter is to dispel abnormally high pressure by opening its valve to release pressure.

The pressure limiter operates (opens the valve) when rail pressure reaches approximately 140MPa.

Then, when the pressure decreases to approximately 30MPa, the pressure limiter resumes (closes the valve) its function to maintain pressure.



NOTE:
Do not attempt to remove or to reinstall the flow damper, pressure limiter, or rail pressure sensor.