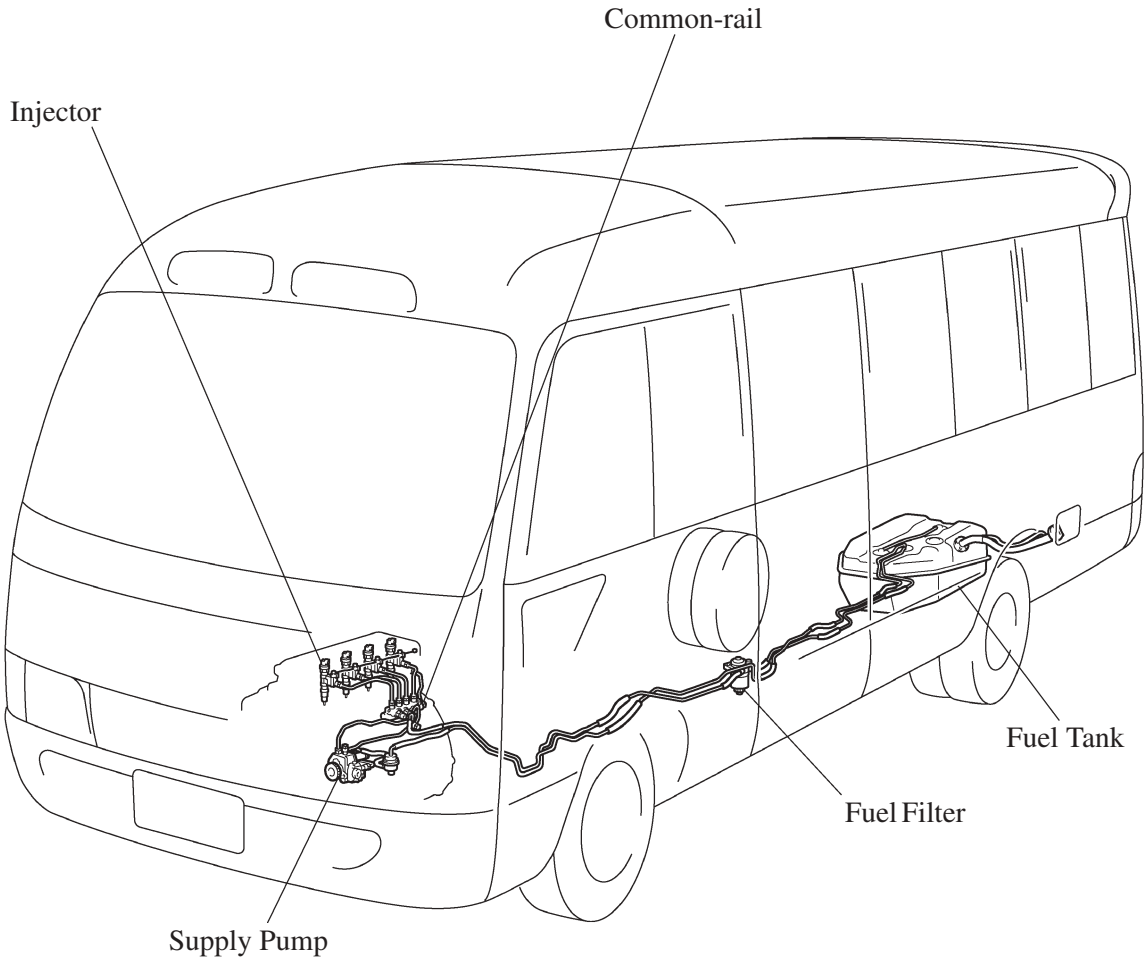
9. Fuel System

General

- A common-rail system is used.
- A supply pump that produces super high pressure (Max.160 MPa) and low drive torque is used.
- Solenoid-valve-controlled injectors that are compact and energy efficient are used.



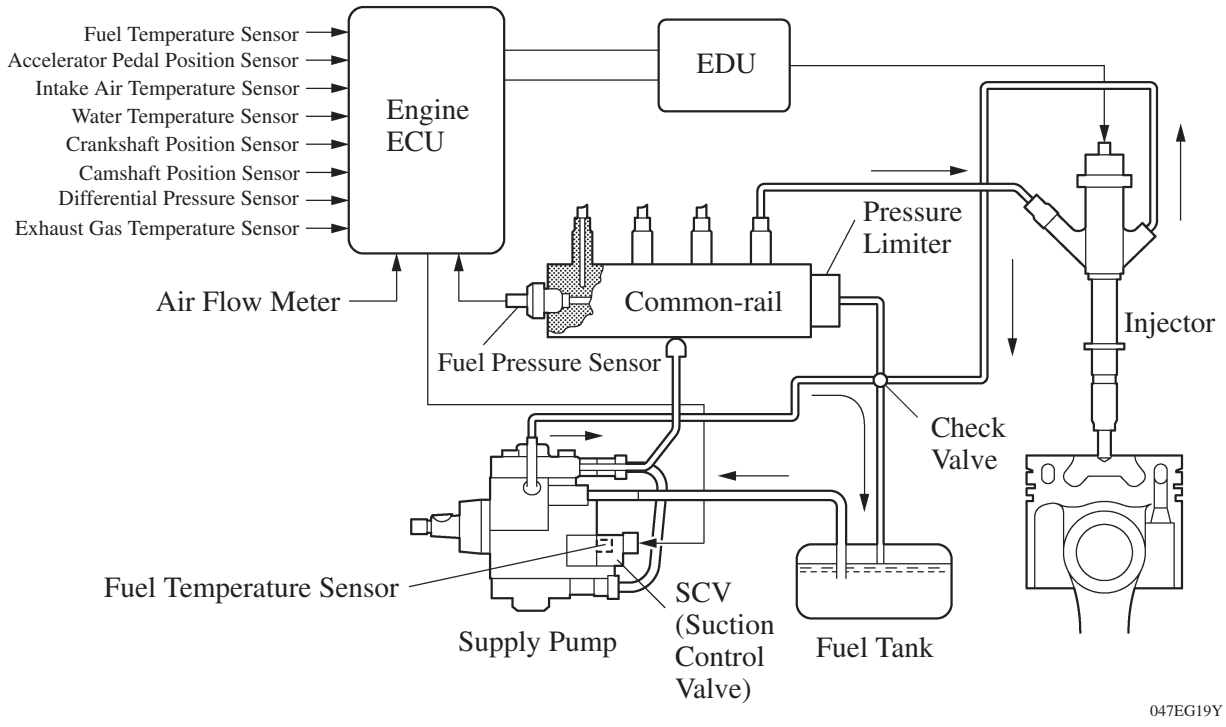
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Common-rail System

1) General

- In the common-rail system, the pressurized fuel provided by the supply pump is stored in the common-rail and injected by the solenoid injectors.
- The common-rail system stores the fuel, which has been pressurized by the pump, in the common-rail. Because the common-rail stores a constantly stable injection pressure without being affected by engine speed or load, this system is able to constantly provide a stable injection pressure even when the engine is operating at low speeds.
- The engine ECU transmits signals to the injector solenoid valves via the EDU (Electronic Driver Unit) in order to precisely control the fuel injection timing and injection volume.

▶ System Diagram ◀

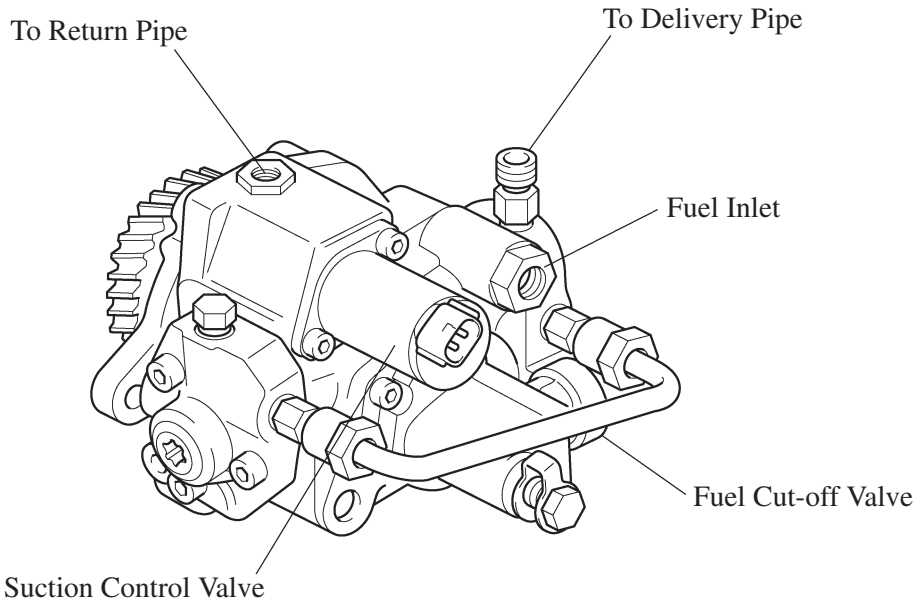


2) Main Components of Common-rail System

a. Supply Pump

i) General

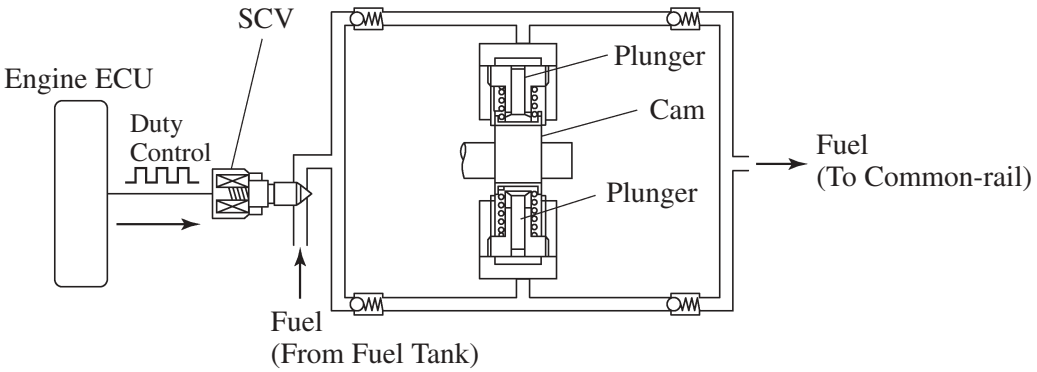
- The supply pump, which is driven by the crankshaft, pumps fuel to the common-rail.
- The suction and pumping of fuel have been divided into two systems in order to stabilize the fuel supply.



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ii) SCV (Suction Control Valve)

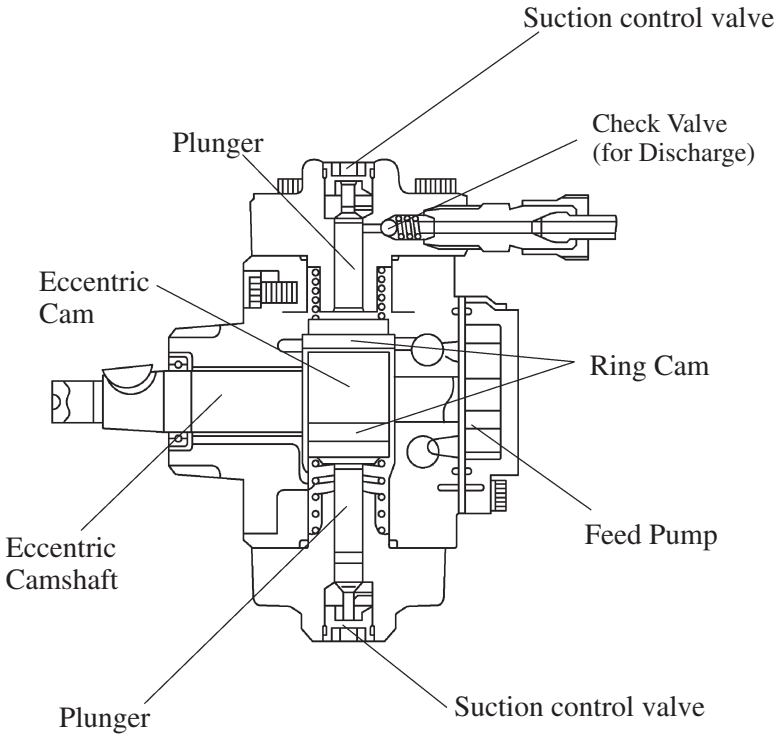
- The engine ECU determines the target fuel pressure based on the load condition.
  The engine ECU adjusts the SCV opening angle by the duty control to reach the target fuel pressure.
- The suction control valve adjusts the fuel pressure in the range from 32 MPa to 160 MPa.
- The SCV alone can be replaced.



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iii) Construction

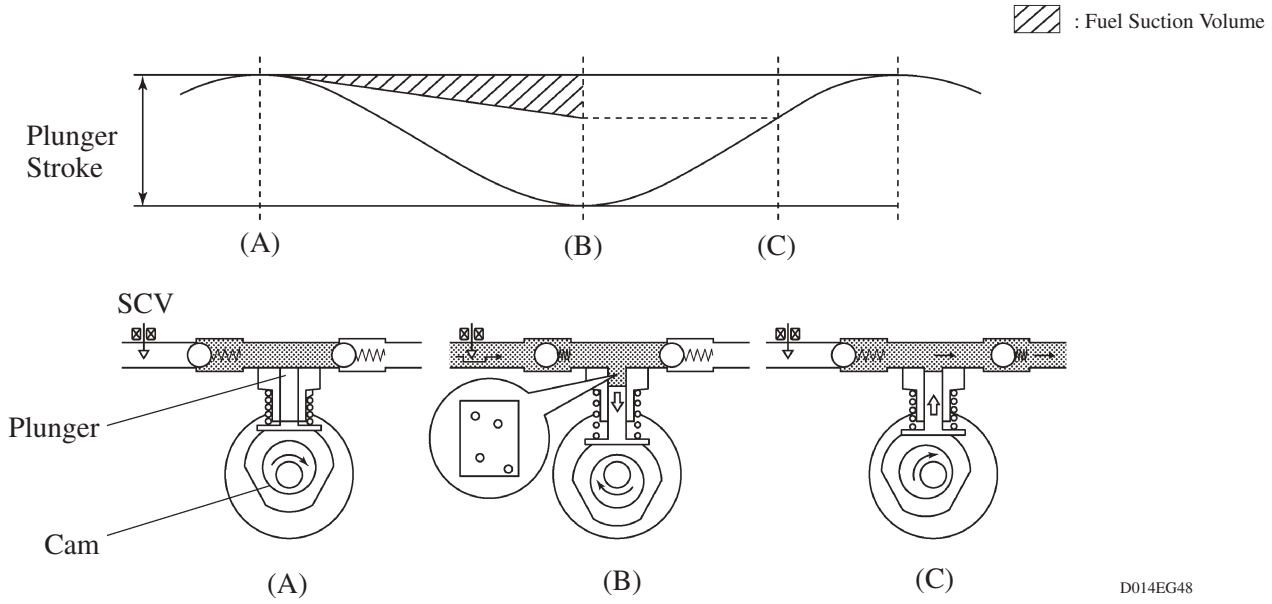
- The drive force of the pump outputs in the following order: the crankshaft, the idle gear, the gear that is attached to the front of the pump, and the ring cam.
- The supply pump consists of four portions: a pump body to pump pressurized fuel, a discharge check valve to regulate the fuel flow rate, a suction control valve to regulate the fuel pressure at the inlet to the suction control valve, and a feed pump to supply fuel to the pump body. The supply pump draws an appropriate amount of fuel and feeds pressurized fuel into the common-rail.
- The eccentric cam alternately moves two plungers via the ring cam.
- The two plungers are horizontally opposed, so when one plunger is in a suction stroke, the other is in a pumping stroke. The two plungers repeat these strokes in order to ensure a constant and stable delivery of fuel.



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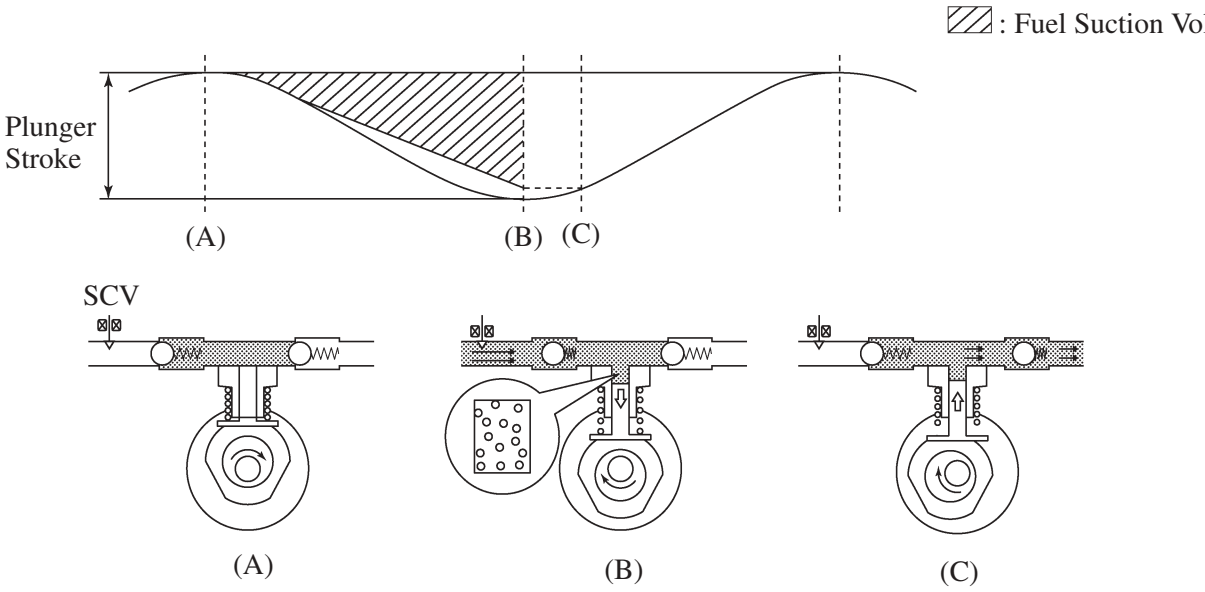
iv) Operation

- **Small Opening of Suction Control Valve**
- When the opening of the suction control valve is small, the fuel suction passage narrows and slows down the fuel flow.
- Even if the plunger reaches its maximum stroke, the volume of fuel drawn in by the plunger becomes restricted because the fuel suction passage is restricted. (See "B" in the diagram.)
- The supply pump discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail. (See "C" in the diagram.)



(A) Plunger Top-Dead-Center
(B) Plunger Bottom-Dead-Center
(C) Compression Starting Point

- **Large Opening of Suction Control Valve**
- When the opening of the suction control valve is large, the fuel suction passage widens and facilitates the fuel flow.
- When the plunger reaches its maximum stroke, the plunger draws an ample volume of fuel because the fuel suction passage is not restricted. (See "B" in the diagram.)
- The supply pump discharges fuel when the cam pushes the plunger upward and the fuel discharge pressure becomes higher than the fuel pressure in the common-rail. (See "C" in the diagram.)

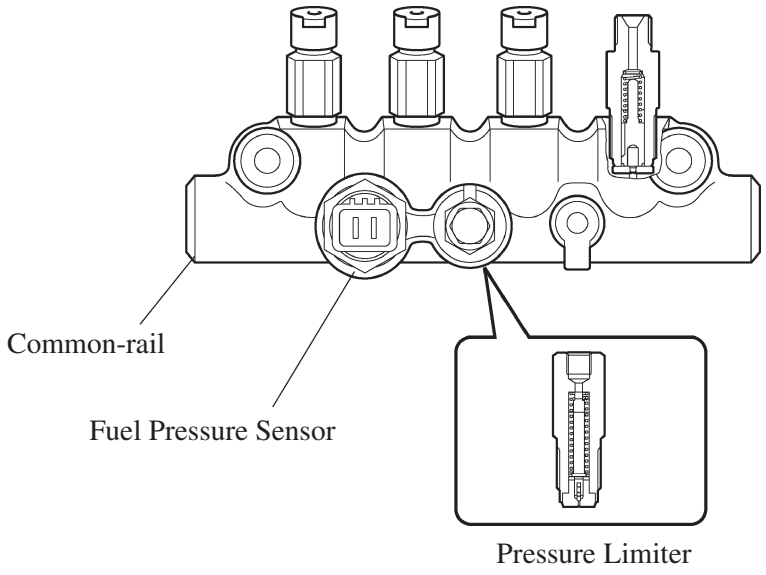


(A) Plunger Top-Dead-Center
(B) Plunger Bottom-Dead-Center
(C) Compression Starting Point

b. Common-rail

A common-rail made of chrome molybdenum alloy steel is used. It ensures proper reliability against fuel pressure fluctuations while achieving an optimal and lightweight configuration.

- The rail stores pressurized fuel (0 to 160 MPa) in order to enable electronically controlled injection through the injectors.
- An orifice is provided at the outlet of the common-rail to each injector in order to minimize fuel pressure pulsations.
- The fuel pressure sensor measures the fuel pressure and outputs it to the engine ECU.
- When the pressure in the common-rail becomes excessive (200 MPa or more), the pressure limiter opens and returns the fuel to the tank.



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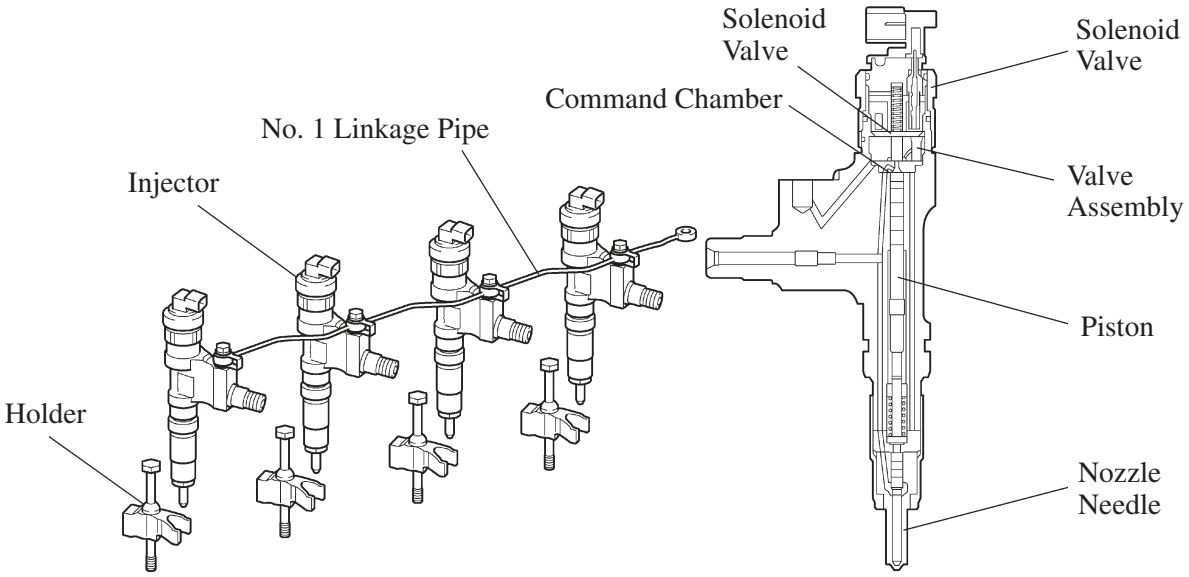
Service Tip

- Each part (the fuel pressure sensor and the pressure limiter) can be replaced individually.
- After the replacement of the common-rail, the injection pipe can be reused. For details, refer to the Coaster Repair Manual Supplement (Pub. No. RM0470E).

c. Injector

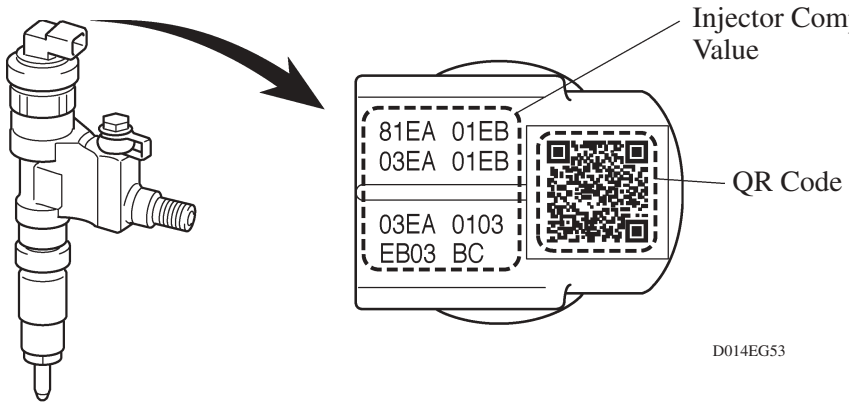
i) General

- Because this system uses solenoid injectors in which solenoid valves open and close their fuel passages, the engine ECU can precisely control the fuel injection volume and injection timing. Thus, this system minimizes the generation of black smoke, which is peculiar to diesel engines.
- An injector consists of a nozzle needle, piston, and solenoid valve.
- An injector compensation value and QR (Quick Response) code containing encoded characteristics of the injector are printed on each injector.
- The injector compensation value and QR code contain various pieces of information regarding the injector, such as model code, injection volume correction, and injection timing correction values.



Service Tip

- If the engine ECU is replaced, use the intelligent tester II and input the injector compensation values of all 4 injectors. If the injector is replaced, input the injector compensation value of the replaced injector. Then, the proper compensation will be made so that the injection volume precision prior to the replacement will remain unchanged. For details, refer to the Coaster Repair Manual Supplement (Pub. No. RM0470E).
- The QR code, which requires a special scan tool, is not used at TOYOTA dealers.



— REFERENCE —

What is QR (Quick Response) Code?

- *QR code, a matrix symbology consisting of an array of nominally square cells, allows omni-directional, high-speed reading of large amounts of data.*
- *QR code encodes may types of date such as numeric, alphanumeric, kanji, kana and binary code. A maximum of 7,089 characters (numeric) can be encoded.*
- *QR code (2D code) contains information in the vertical and horizontal direction, whereas a bar code contains date in one direction only. QR code (2D code) holds a considerably greater volume of information than a bar code.*

ii) Operation

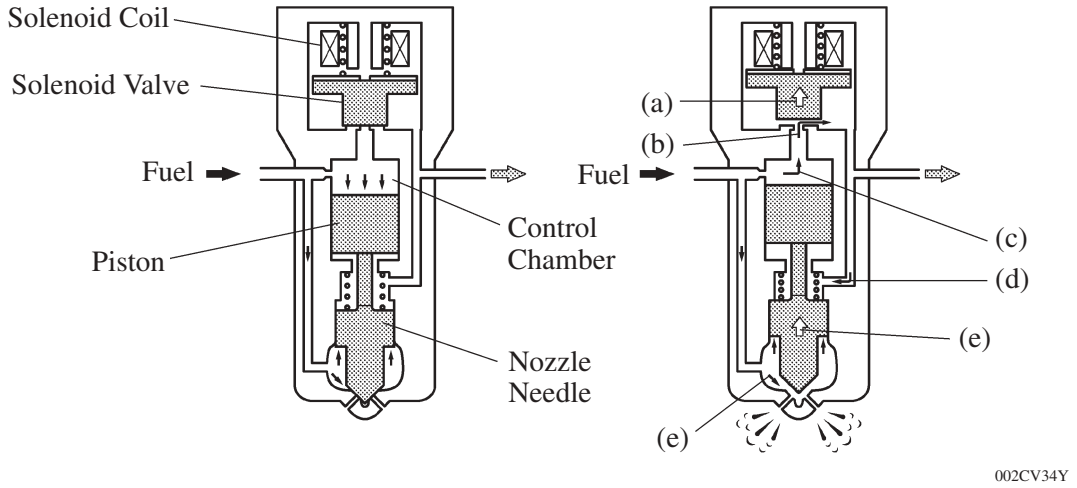
(a) When electrical current is applied to the solenoid coil, it pulls the solenoid valve up.

(b) The orifice of the control chamber opens, allowing the fuel to flow out.

(c) The fuel pressure in the control chamber drops.

(d) Simultaneously, fuel flows from the orifice to the bottom of the piston, which raises the piston up (to enhance response).

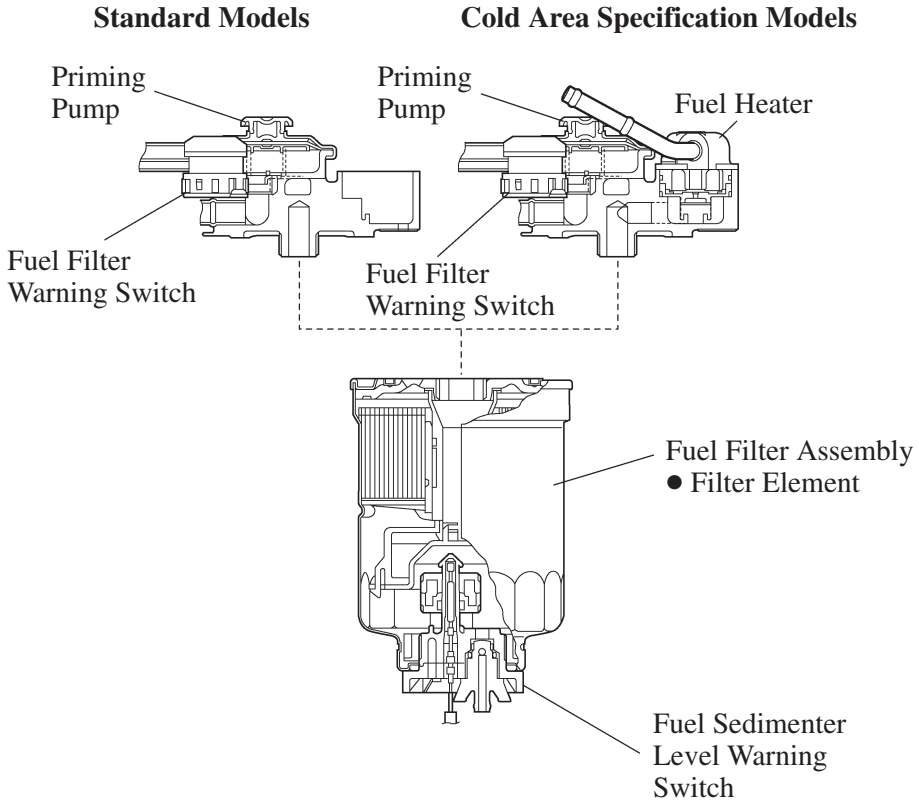
(e) As a result, the piston raises the nozzle needle to inject fuel.



Fuel Filter

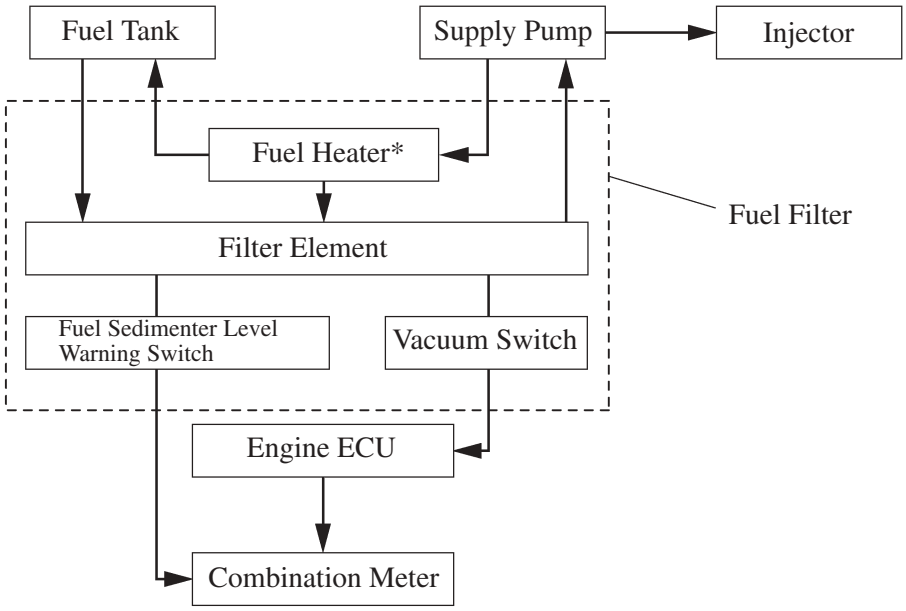
1) General

- A fuel filter consists of a fuel filter element integrated with the fuel filter housing.
- A recirculation type fuel heater is used on the cold area specification models.
- A fuel filter warning switch is provided in the fuel filter.



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▶ System Diagram ◀



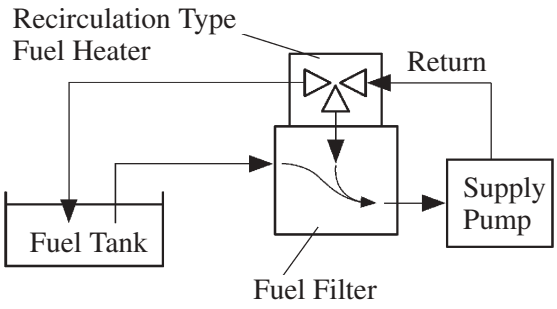
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*: Cold Area Specification Models

2) Fuel Heater

a. General

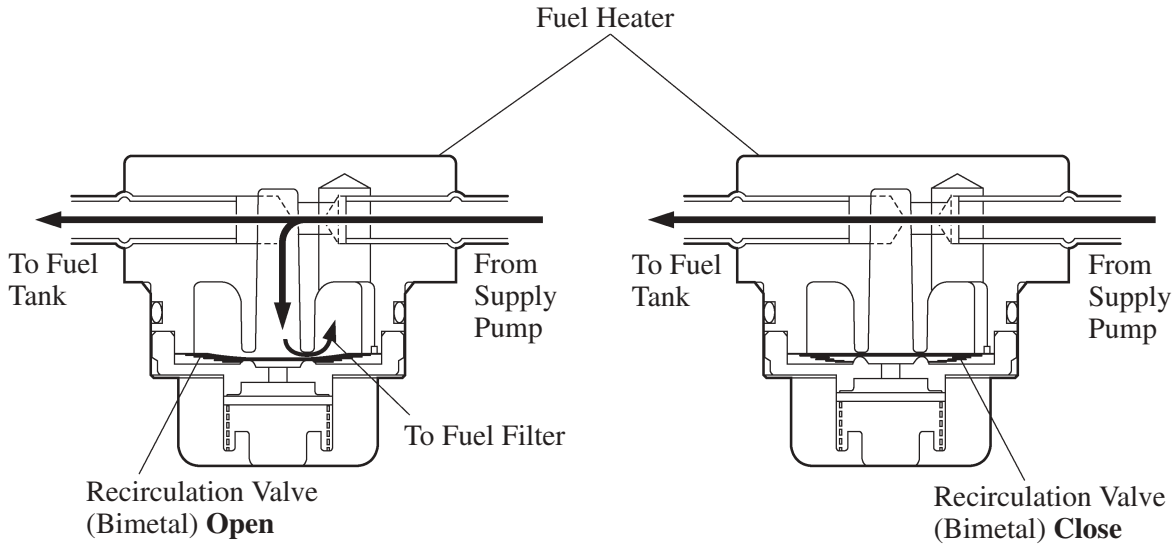
A recirculation type fuel heater is used on cold area specification models. This heater heats the fuel by recirculating the returned fuel, which becomes to have a high temperature by the fuel pumping of the supply pump, to the fuel filter.



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b. Operation

- While the engine is cold, the recirculation valve inside the fuel heater will open due to the bimetal action, so the return fuel will return to the fuel filter and the fuel tank.
- While the engine is warm, the recirculation valve will close due to the bimetal action, so all the return fuel will return to the fuel tank.



Cold Engine

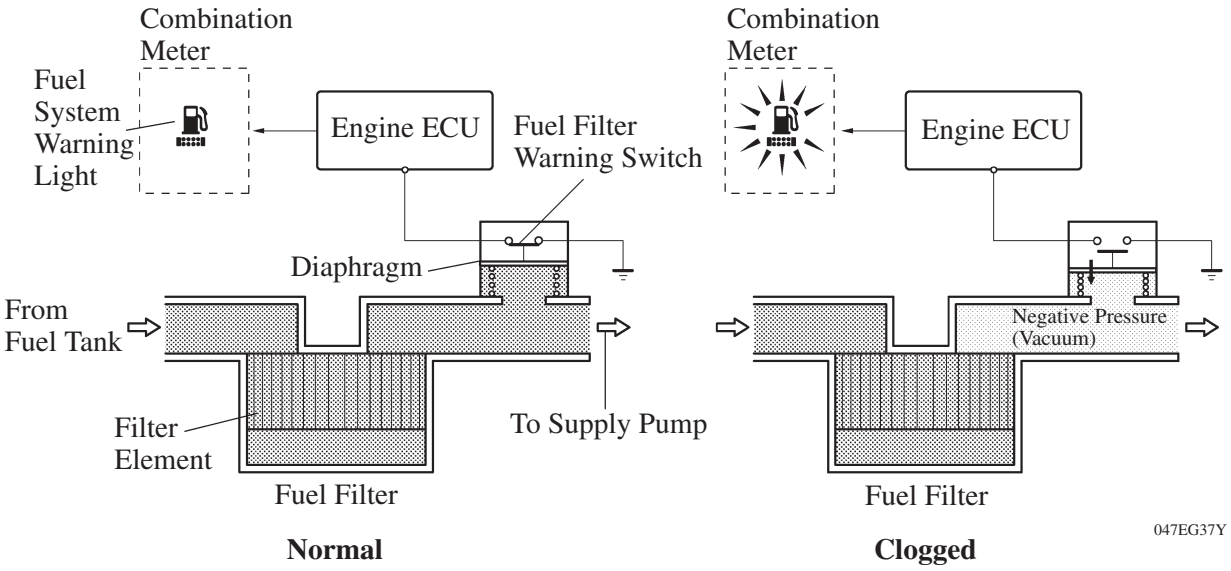
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Warm Engine

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3) Fuel Filter Warning Switch

- A fuel filter warning switch, which turns ON/OFF when the internal vacuum of the filter increases, is provided in the fuel filter. This switch, which turns OFF when the internal vacuum of the fuel filter increases to a predetermined level, is connected by wire to the engine ECU.
- When the engine ECU detects that the internal vacuum of the fuel filter has increased (by way of the fuel filter warning switch OFF signal), it determines that the fuel filter has become clogged. Then, it illuminates the fuel system warning light on the combination meter to urge the driver to replace the fuel filter.



Service Tip

When the fuel filter warning switch detects a failure, the engine ECU stores this failure in memory, and continues to illuminate the fuel system warning light. Therefore, after replacing the fuel filter, the illumination information stored in the engine ECU memory must be erased. For details, refer to the Coaster Repair Manual Supplement (Pub. No. RM0470E).