

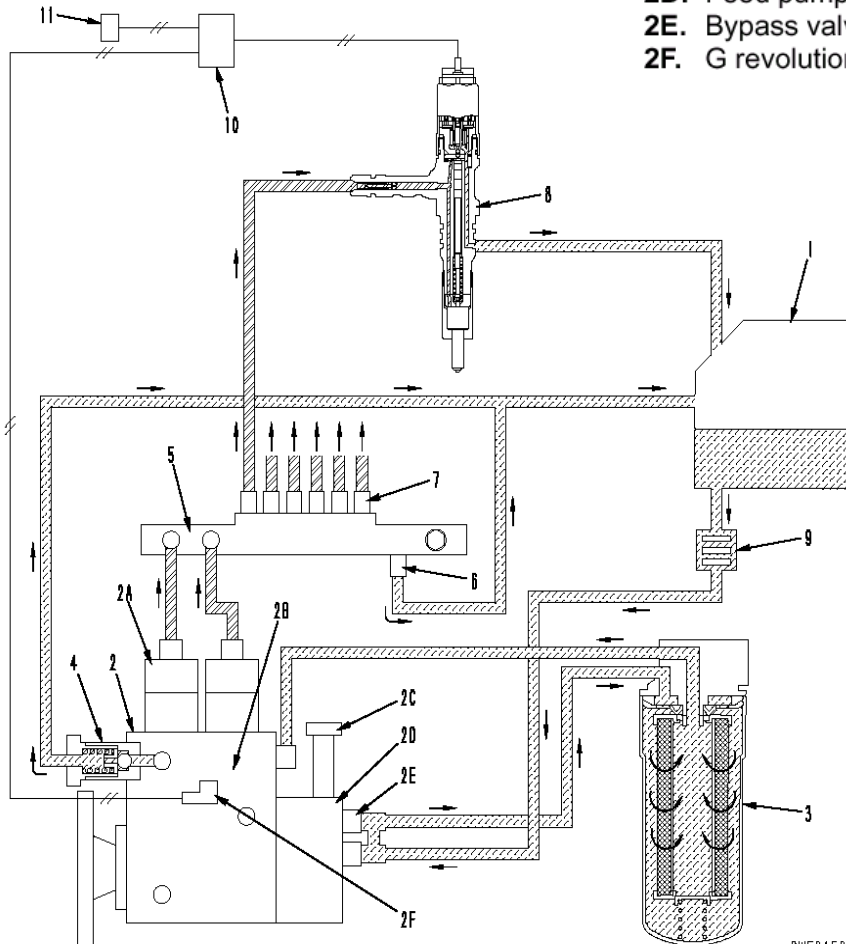
# D155AX-5 Bulldozers



## Chapter 4 : Engine

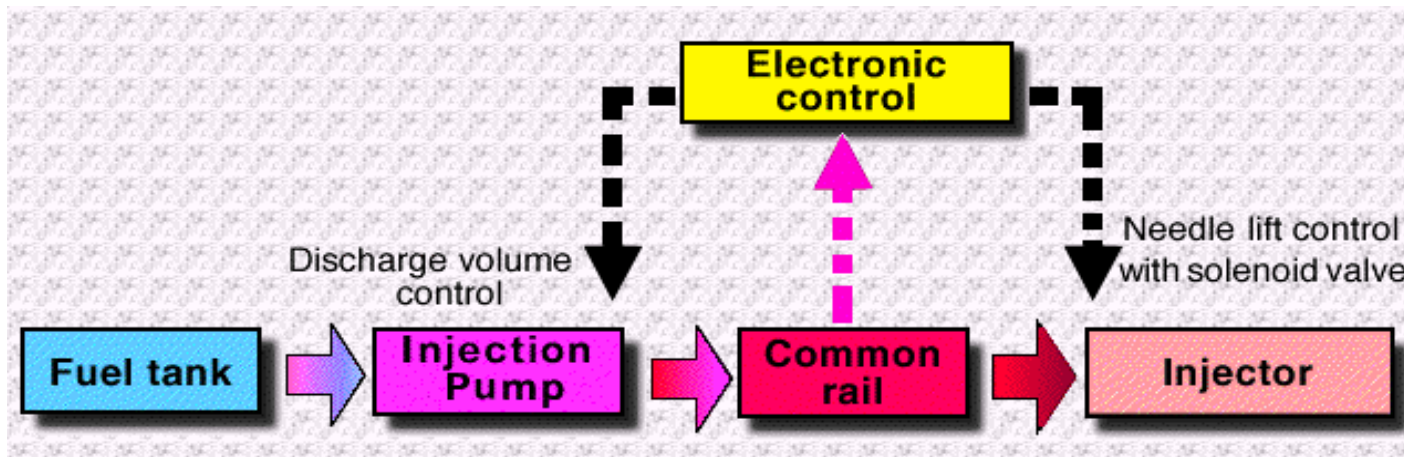
1. Fuel tank
2. Fuel supply pump assembly
  - 2A. PCV
  - 2B. High-pressure pump
  - 2C. Priming pump
  - 2D. Feed pump
  - 2E. Bypass valve
  - 2F. G revolution sensor

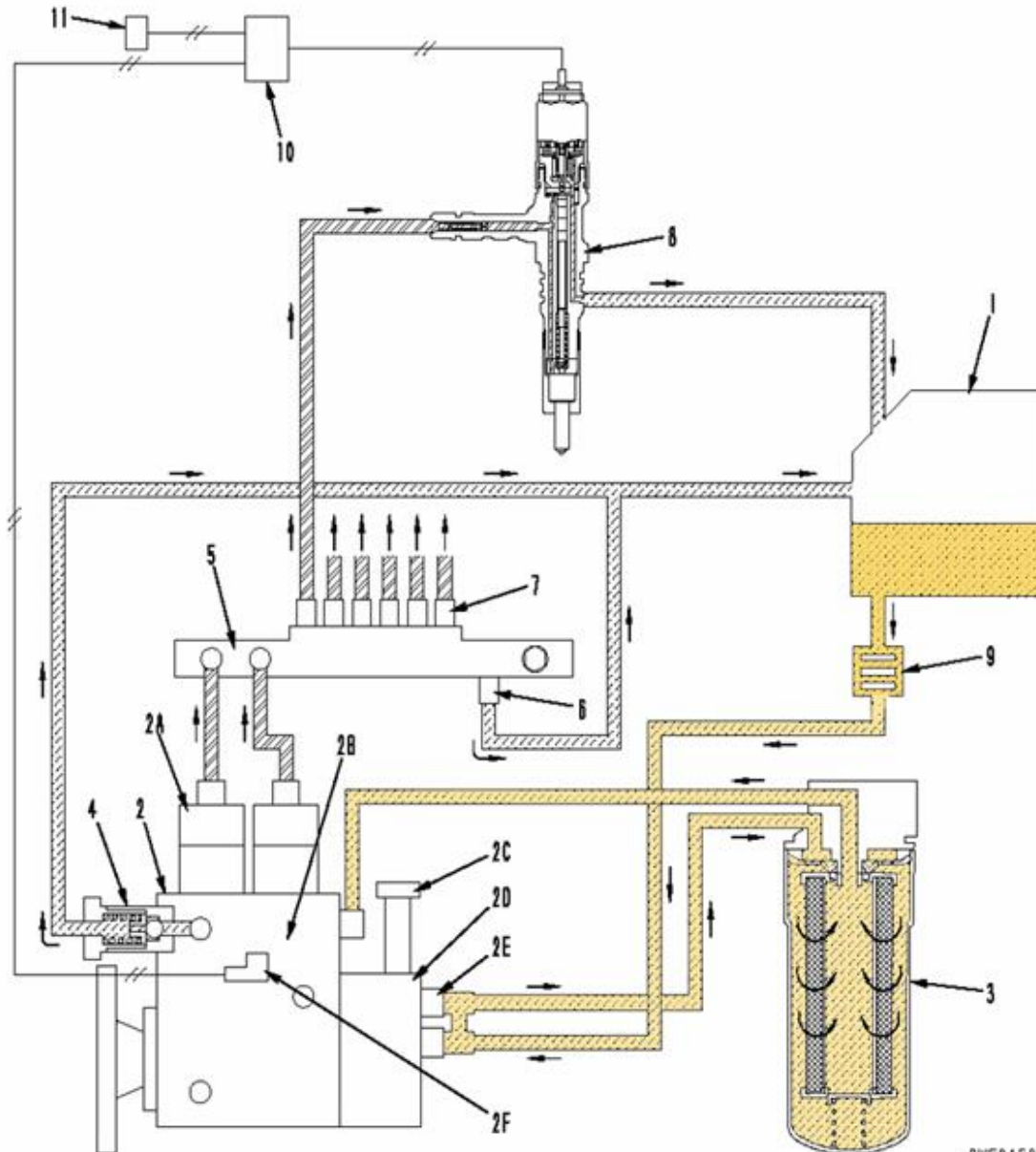
3. Fuel filter
4. Overflow valve
5. Common rail
6. Pressure limiter
7. Flow damper
8. Injector assembly
9. Fuel cooler
10. ECU (Engine Control Unit)
11. NE revolution sensor



## OUTLINE

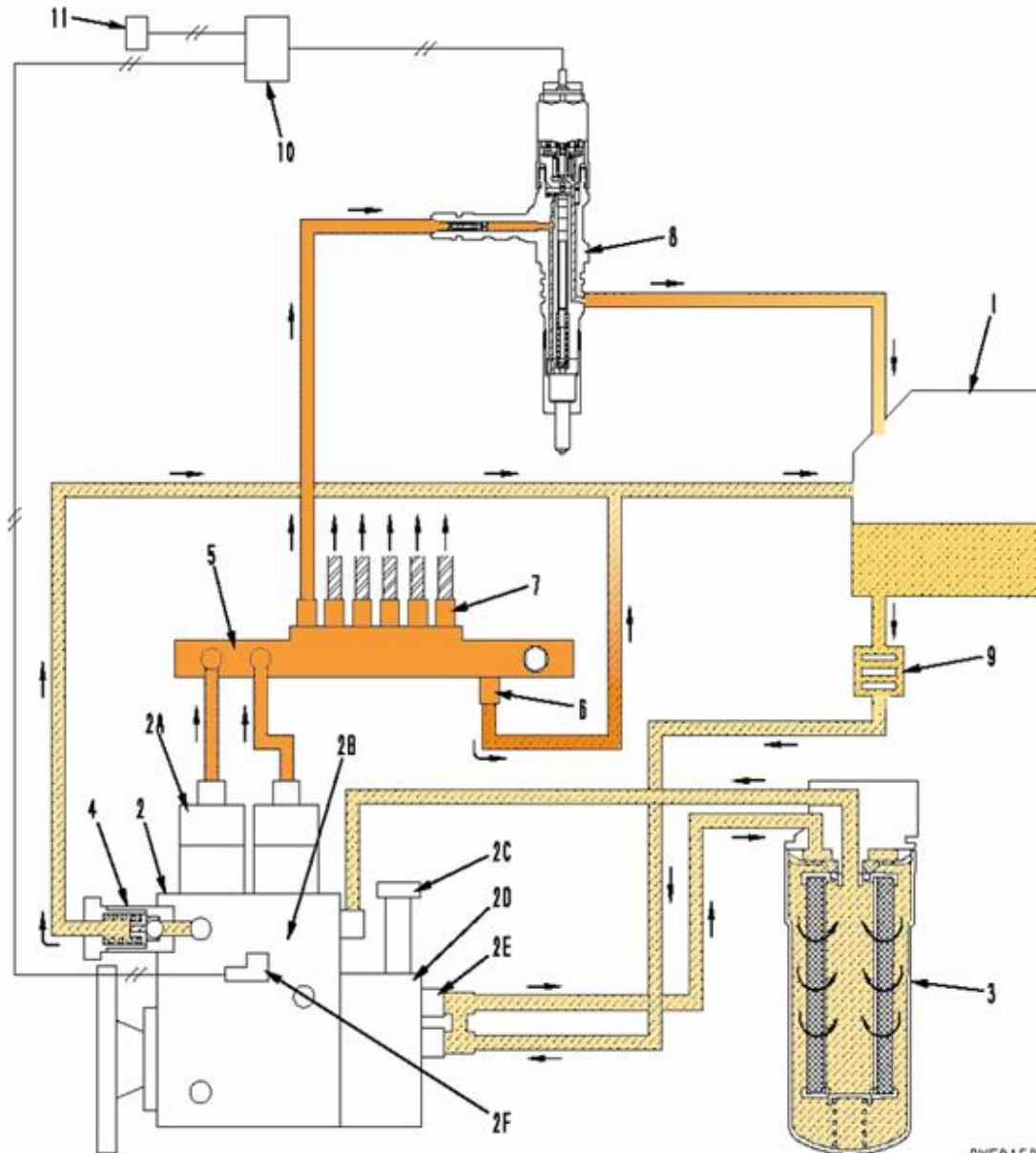
- The CRI system detects the condition of the engine (engine speed, accelerator angle, cooling water temperature, etc.) from various sensors, and uses a microcomputer to carry out overall control of the fuel injection amount, fuel injection timing and fuel injection pressure to operate the engine under the optimum conditions.
- The computer also carries out self-diagnosis of the main components, and if any abnormality is found, it carries out diagnosis and sends an alarm to inform the operator. It also has a fail-safe function to stop the engine according to the location of the abnormality and a backup function to switch the control method to make it possible to continue operation.





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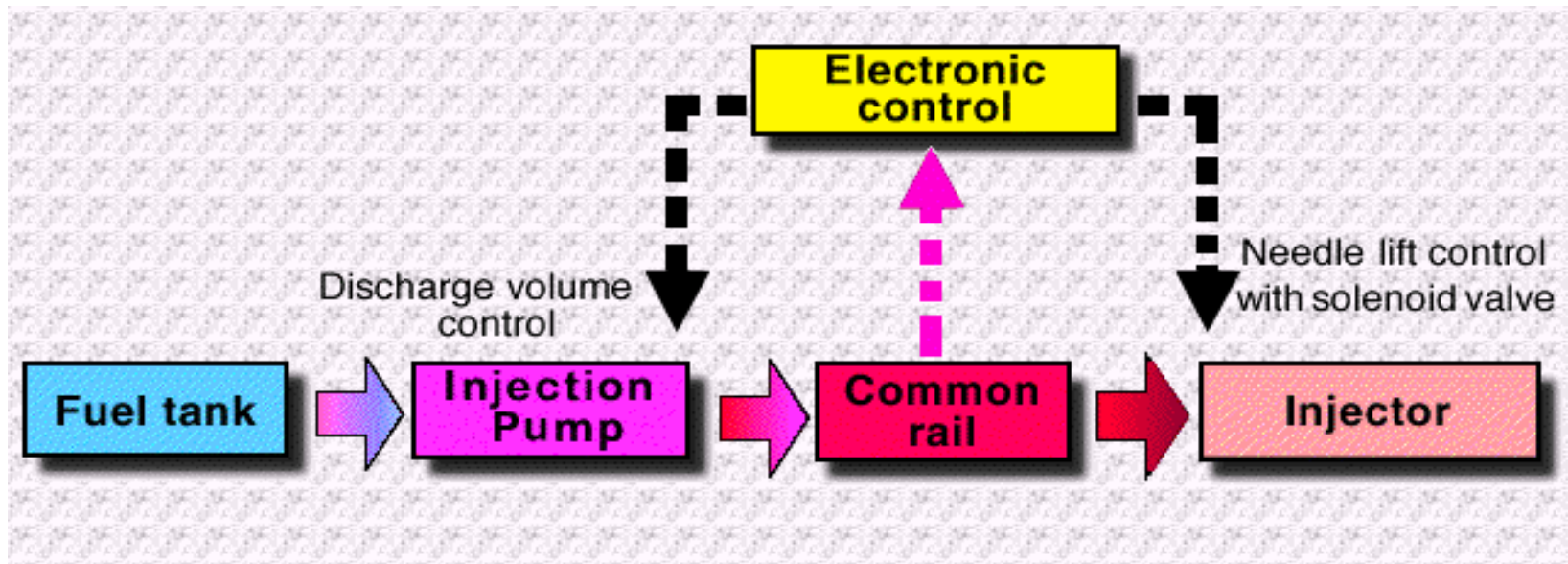
# Fuel System – High pressure circuit



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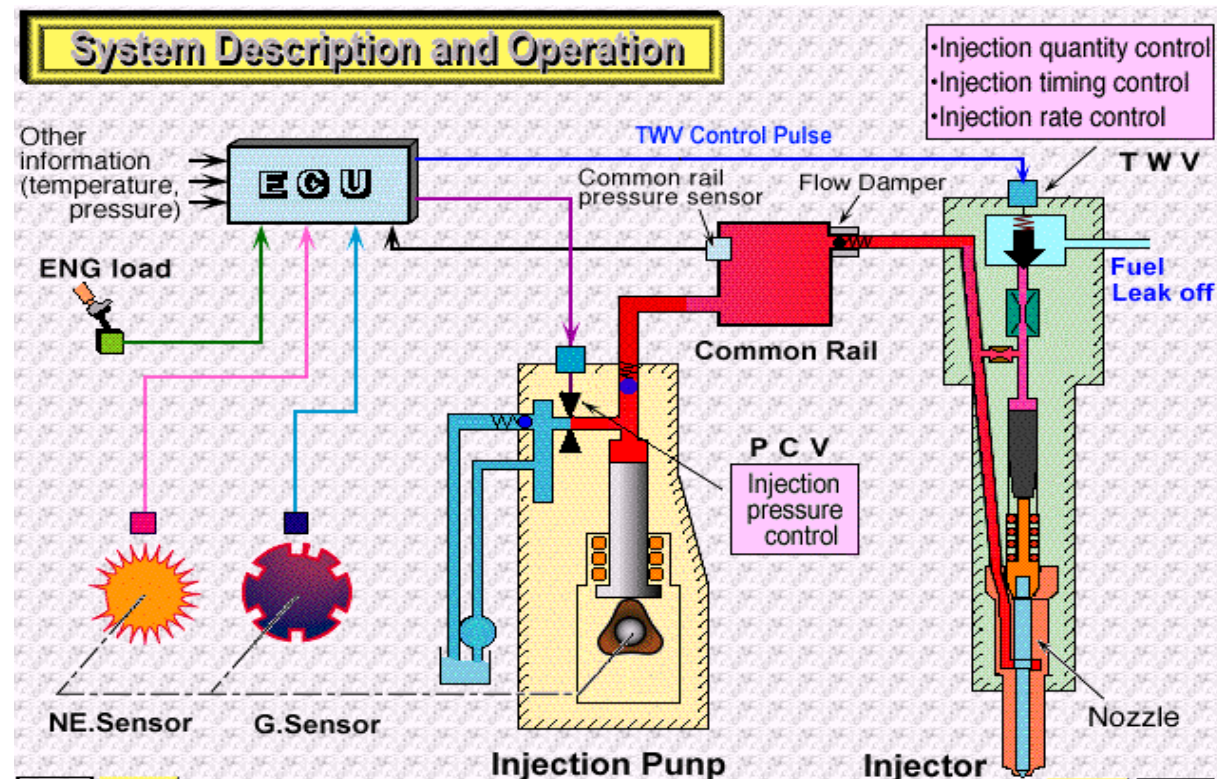
## Fuel system

The high-pressure fuel generated by the fuel supply pump goes from the common rail and is distributed to each cylinder. The start and finish of injection is controlled by opening or closing the nozzle needle valve by using an electromagnetic valve inside the injector.



The fuel supply pump generates fuel pressure inside the common rail. The fuel pressure is controlled by the amount of fuel discharged from the supply pump. The amount of fuel discharged is controlled by sending an electrical signal from the ECU to switch the PCV (discharge control valve) of the fuel supply pump ON-OFF. The common rail accepts the fuel pressure generated by the fuel supply pump and distributes it to the cylinders.

The fuel pressure is detected by the common rail fuel pressure sensor installed in the common rail. It carries out feed back control to ensure that the actual pressure value matches the command pressure value set in accordance with the engine speed and engine load.



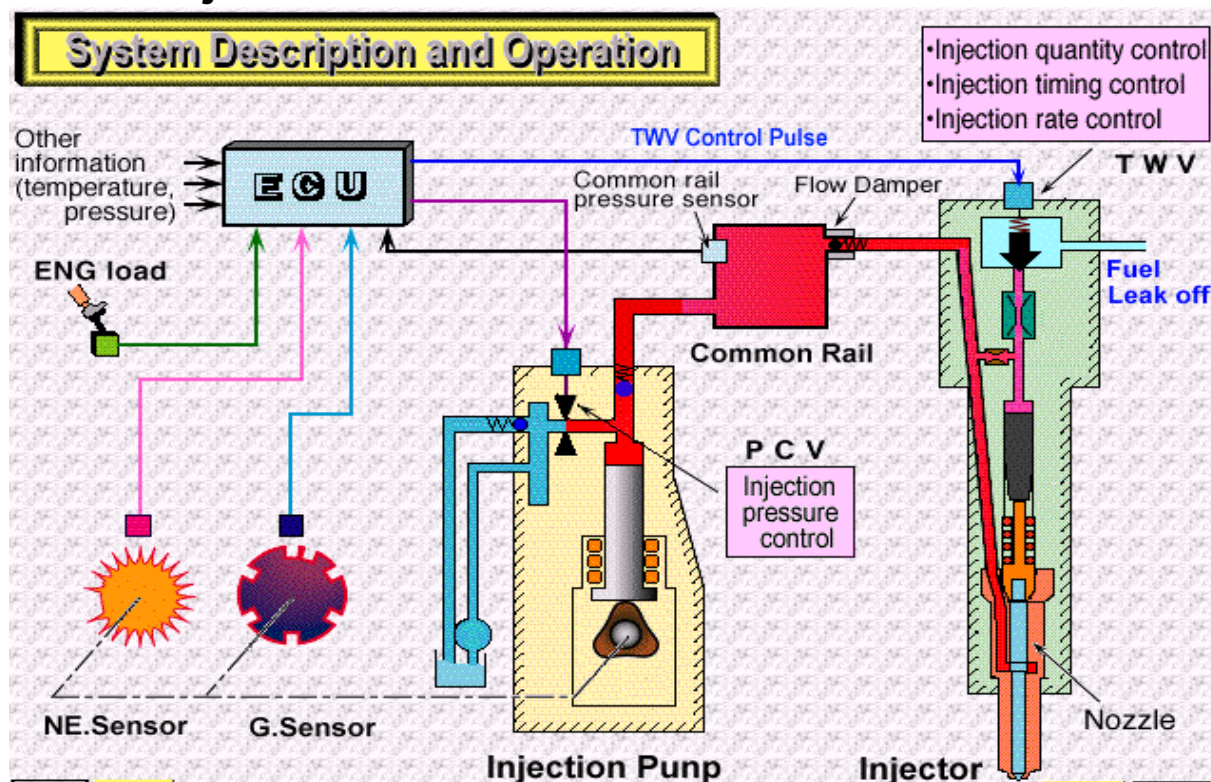
**The fuel pressure of the common rail passes through the fuel injection pipes of each cylinder and is applied to the control chamber and the nozzle of the injector.**





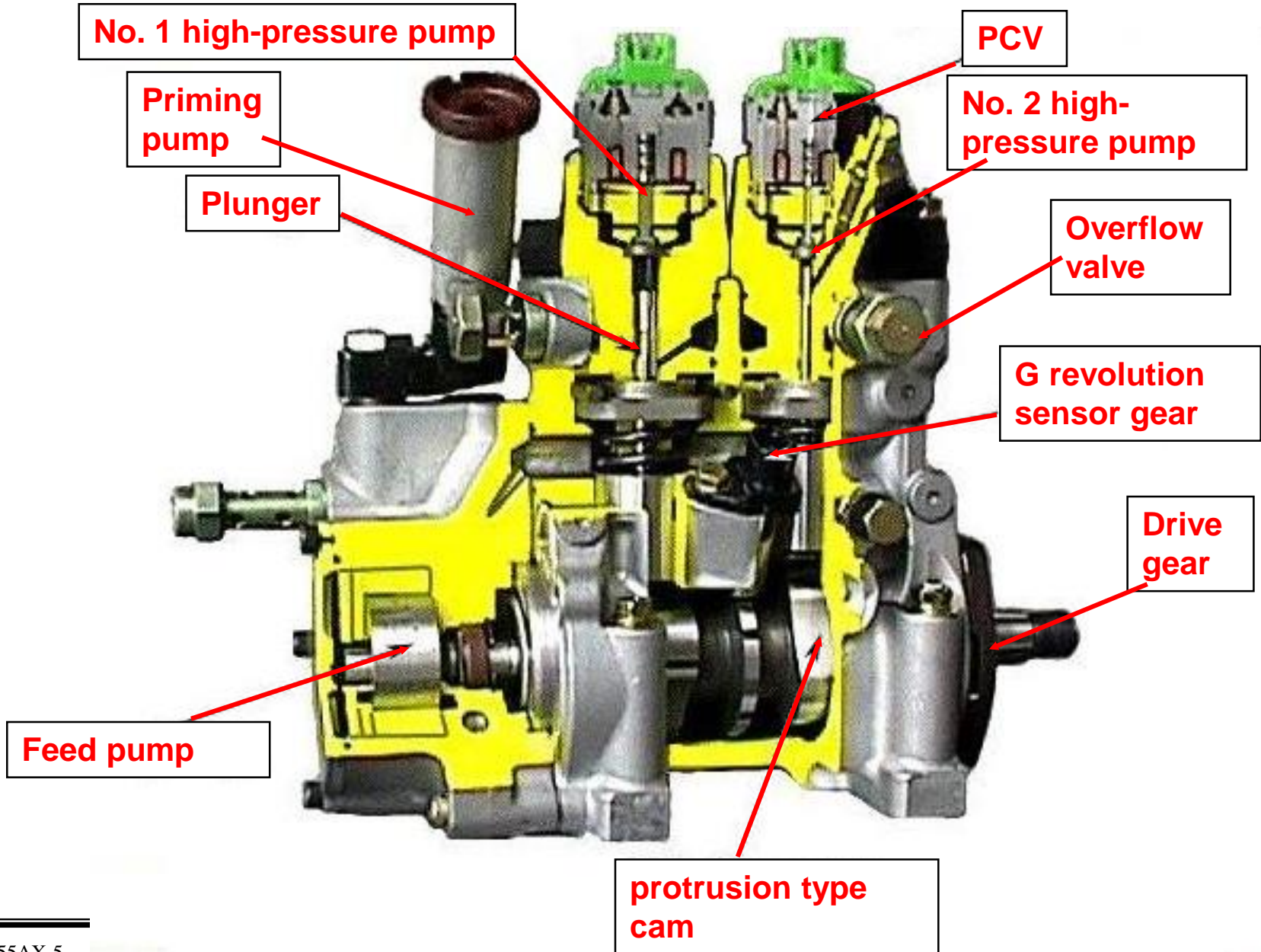
The injector controls the amount of fuel injection and the fuel injection timing. It controls by switching the TWV (Two-Way electromagnetic Valve) ON-OFF. When the TWV is turned ON (conducts electricity), the fuel circuit is switched so that the high-pressure fuel in the control chamber passes through the orifice and flows out. The needle valve goes up because of the nozzle cracking pressure actuated by the high-pressure fuel at the nozzle end, and fuel injection is started.

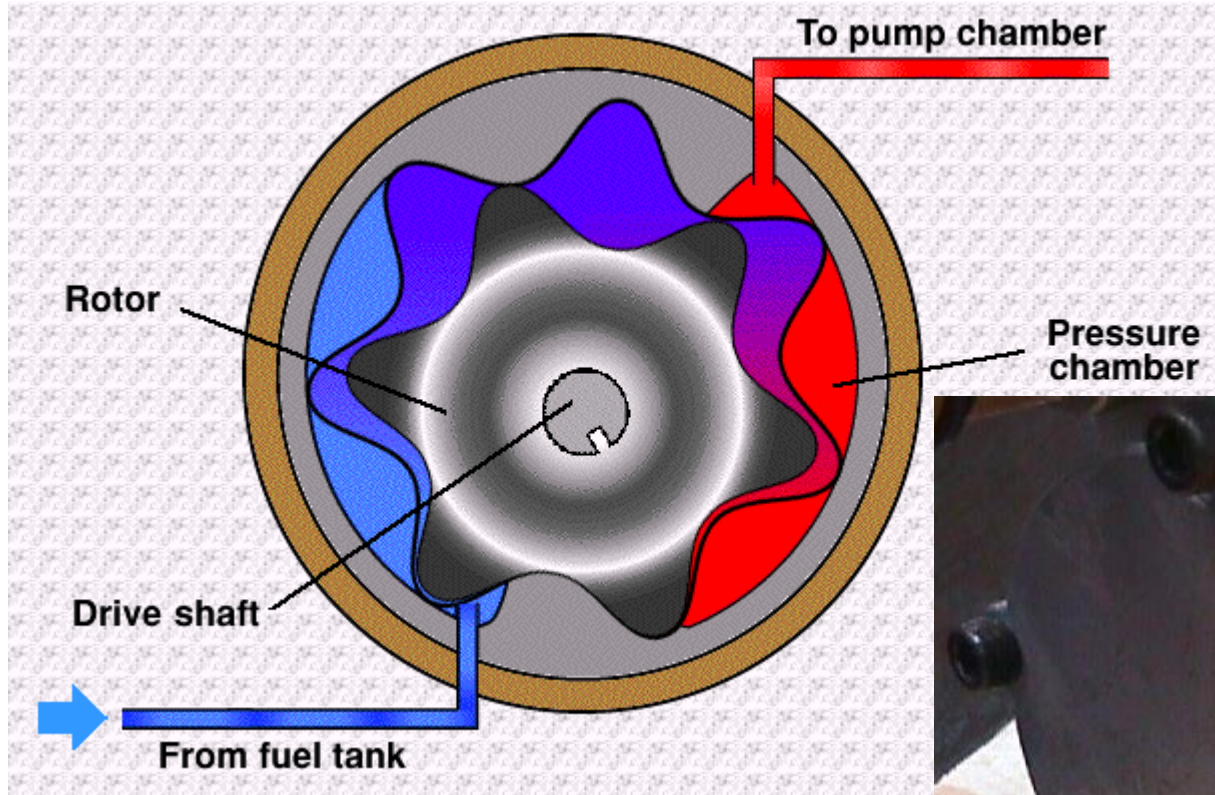
When the TWV is switched OFF (no current flows), the control chamber becomes a fuel circuit with the high-pressure fuel applied through the orifice, so the needle valve goes down and fuel injection is completed.

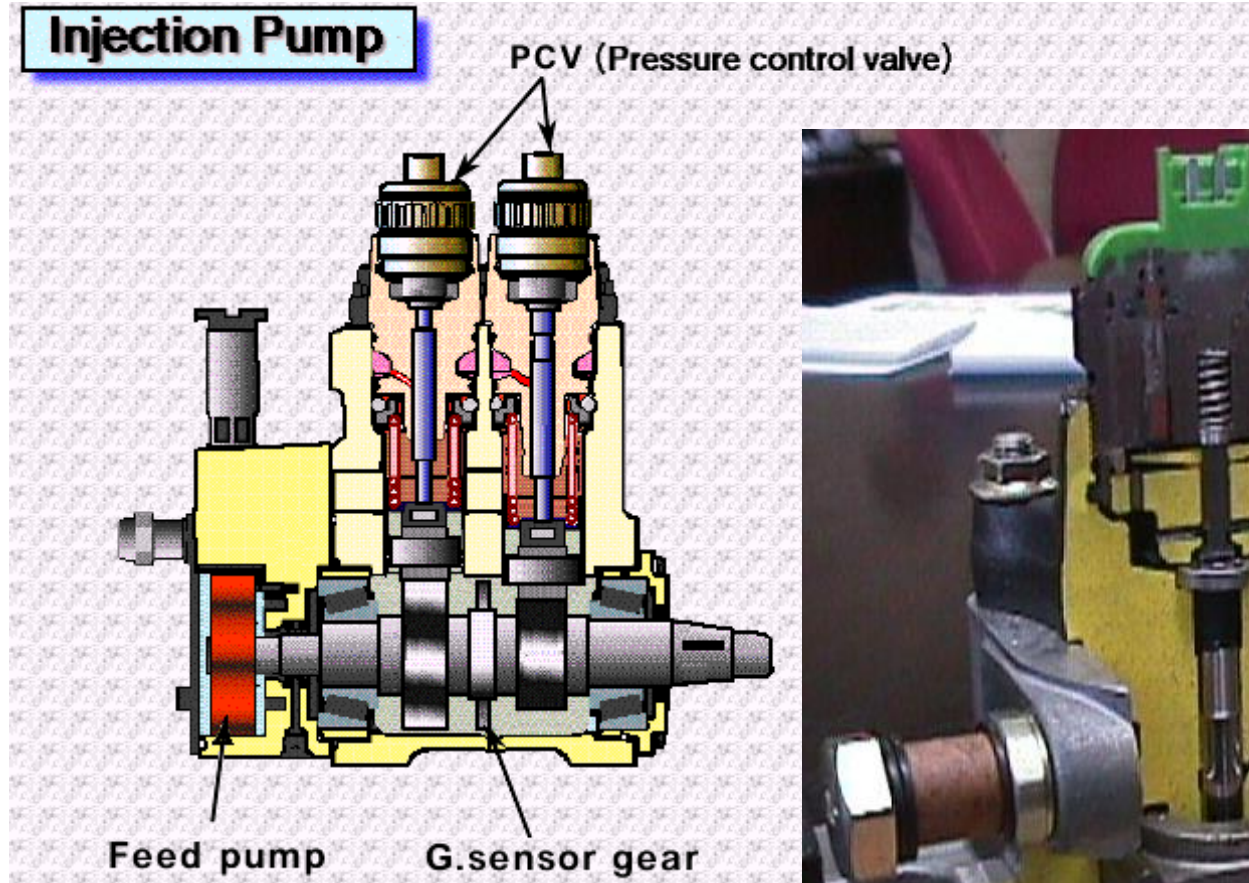


**Therefore, the fuel injection timing is controlled electronically by the timing of the electricity passing through the TWV, and the amount of fuel injected is controlled by the amount of time that electricity passes through the TWV.**



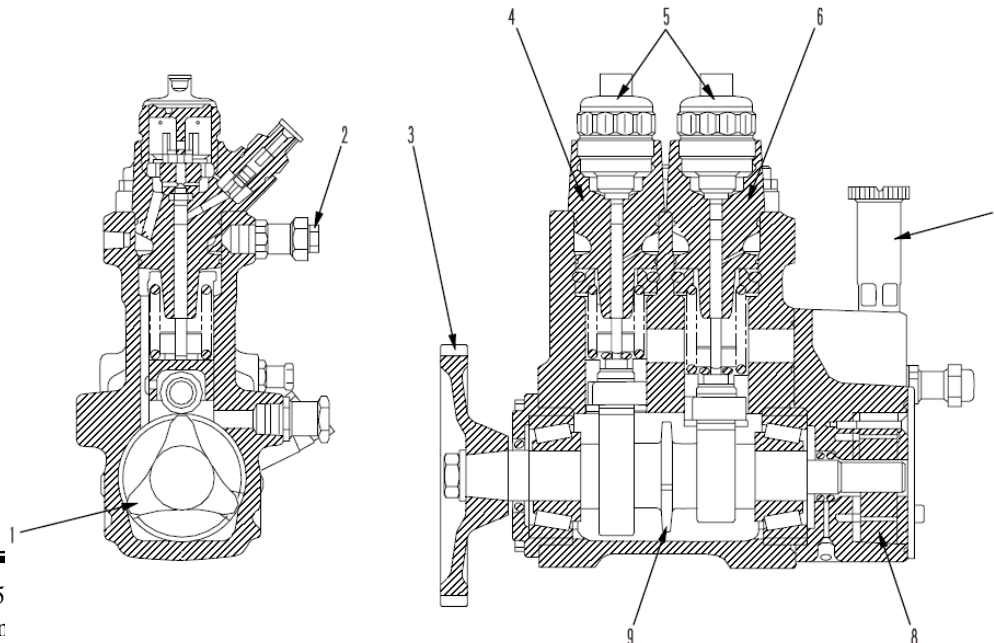






With the high-pressure pump, pump control valves (discharge amount control valves) are installed to each cylinder to control the force feed system and fuel discharge amount in the same way as the conventional in-line fuel injection pump.

By employing cams with 3 protrusions, the necessary number of high-pressure pumps (cylinders) is reduced to 1/3 of the number of engine cylinders. In addition, the force feed to the common rail is the same number of times as the number of times of fuel injection, so it is possible to obtain a smooth and stable common rail pressure.

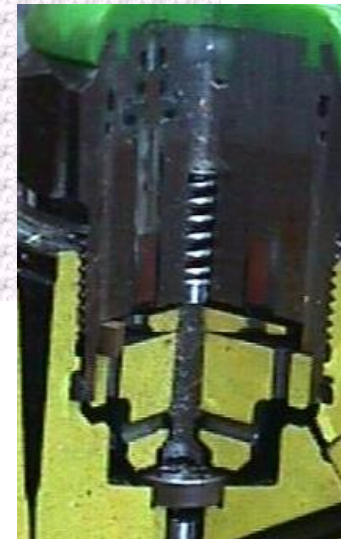
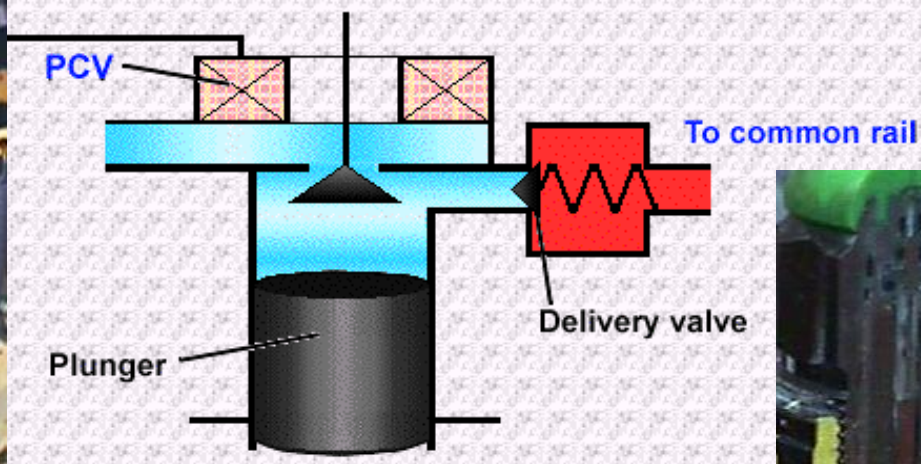
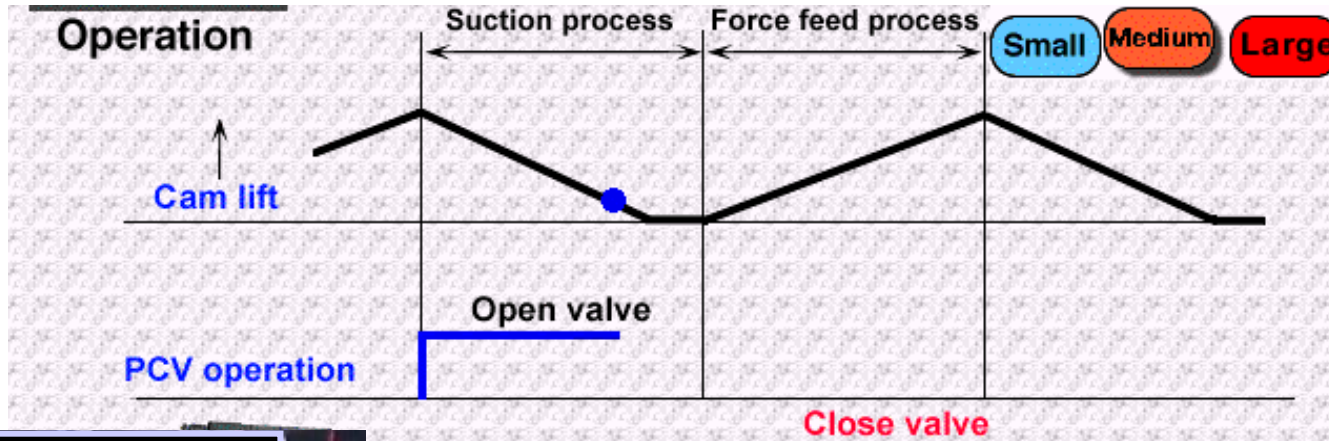


1. 3-protrusion type cam
2. Overflow valve
3. Drive gear
4. No.1 high-pressure pump
5. PCV (discharge control valve)
6. No.2 high-pressure pump
7. Priming pump
8. Feed pump
9. G revolution sensor gear

The fuel force fed from the high-pressure pump to the common rail is divided as follows for each pump.

The No. 1 high-pressure pump (drive gear side) (4) covers the drop in the pressure inside the common rail because of the fuel injection of the No. 1, No. 3 and No.5 cylinders, while the No. 2 high-pressure pump (feed pump side) (6) covers the drop in the pressure inside the No.2, No.4 and No.6 cylinders of common rail in the same way.

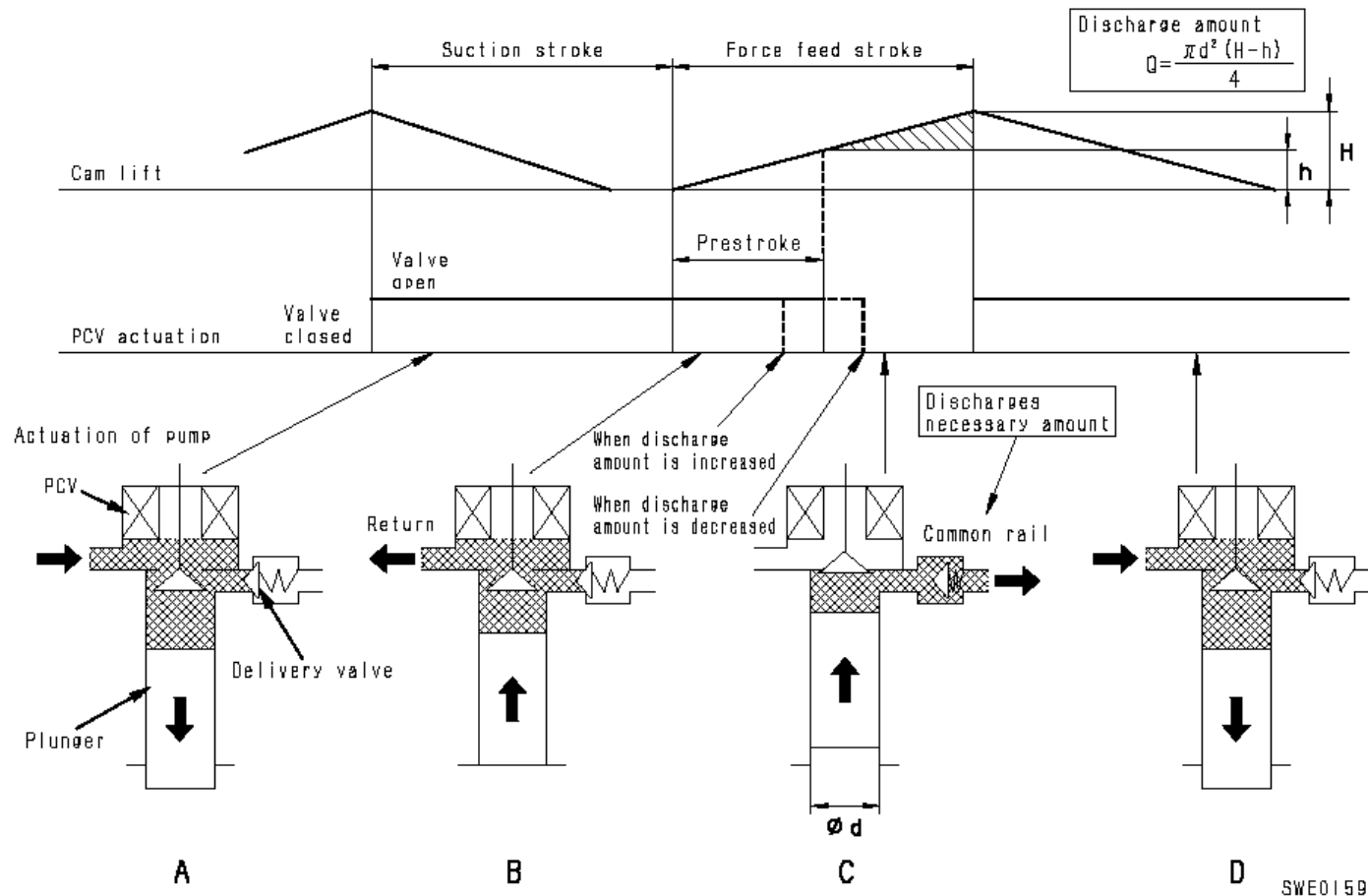




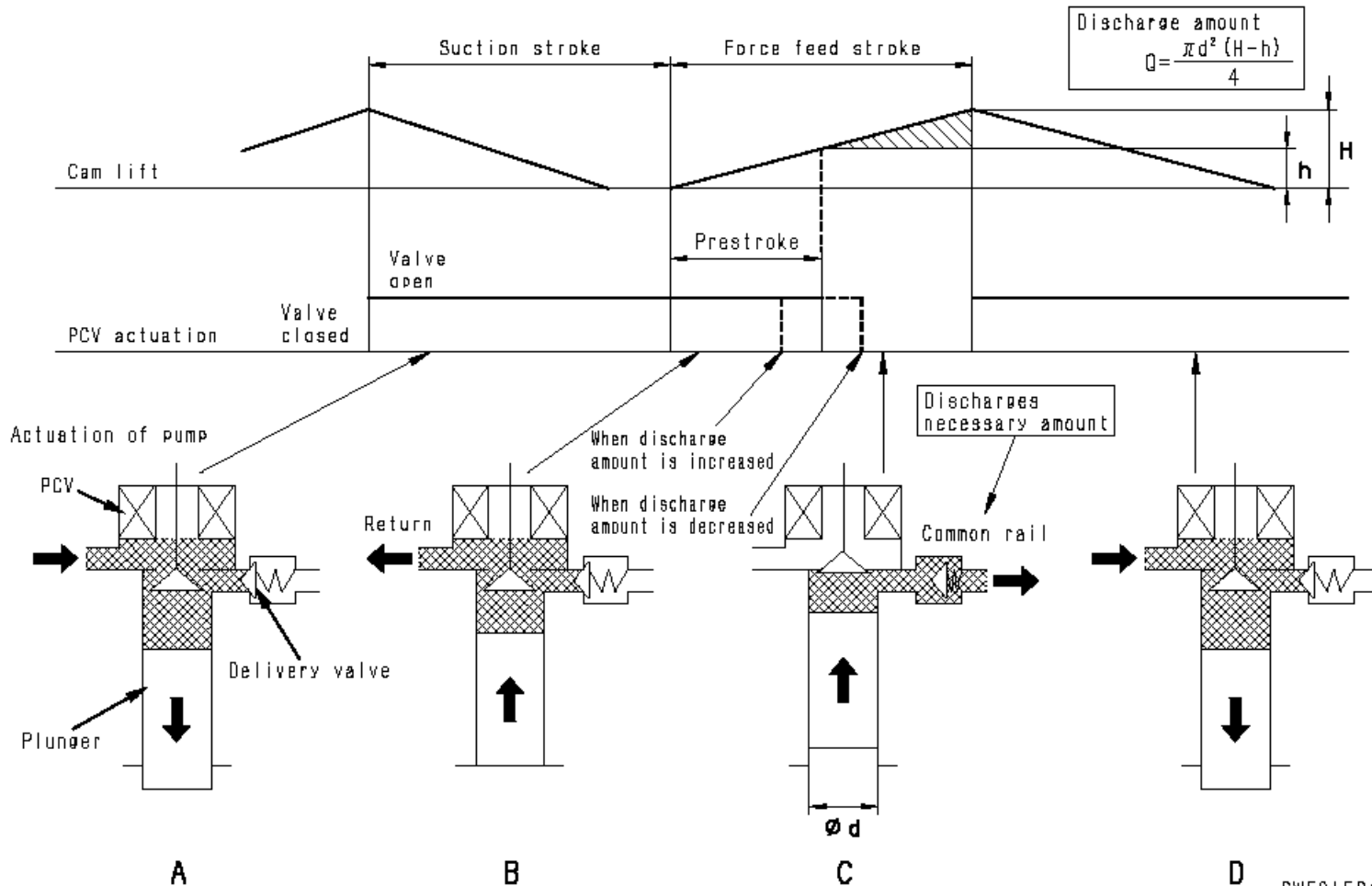


## Operation

A. During the down stroke of the plunger, the PCV is open, so the low-pressure fuel passes through the PCV and is sucked into the plunger chamber.

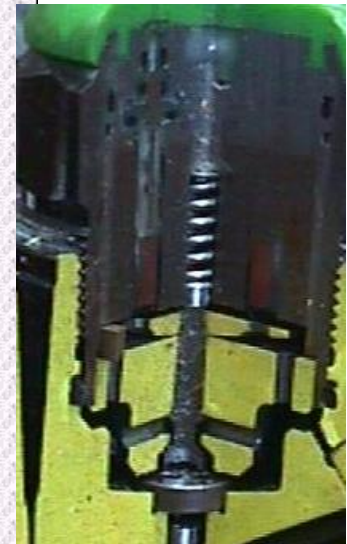
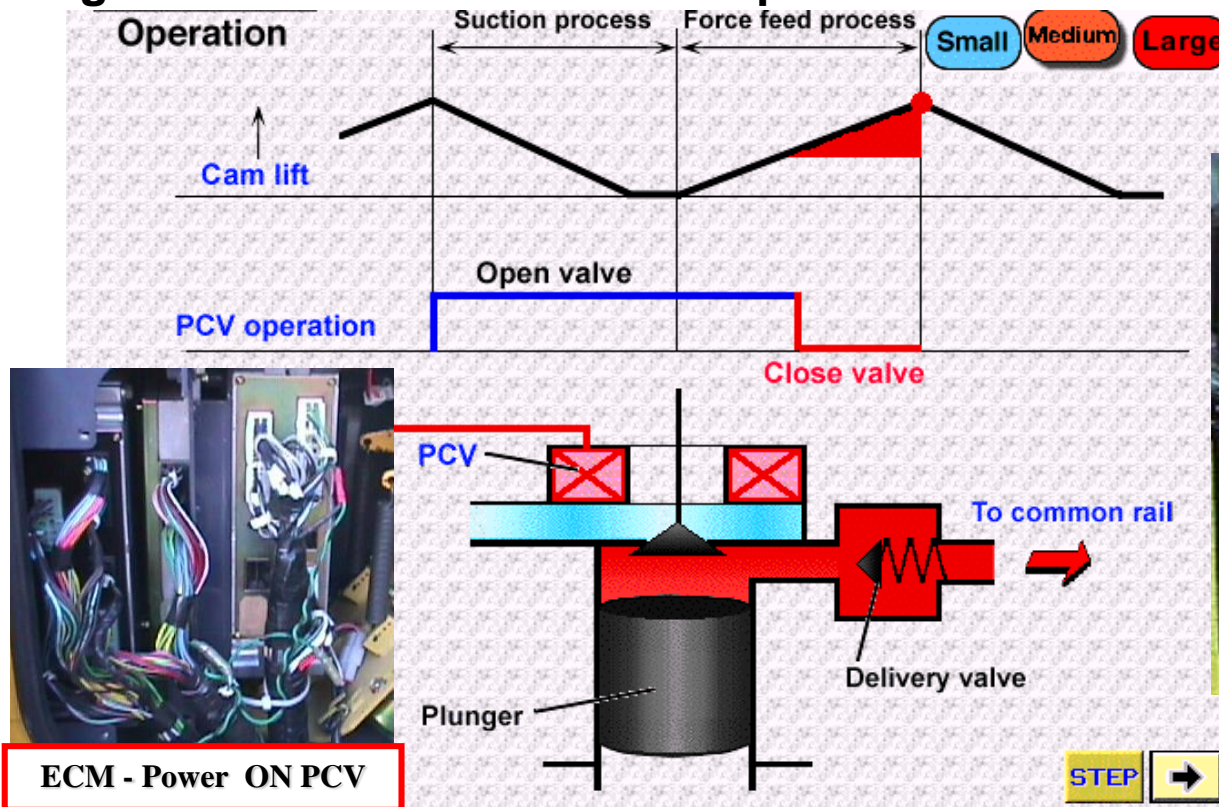


**B. Even when the plunger enters the up stroke while there is no electricity flowing to the PCV and it remains open, the fuel taken in passes through the PCV, so the pressure does not rise and it is returned.**

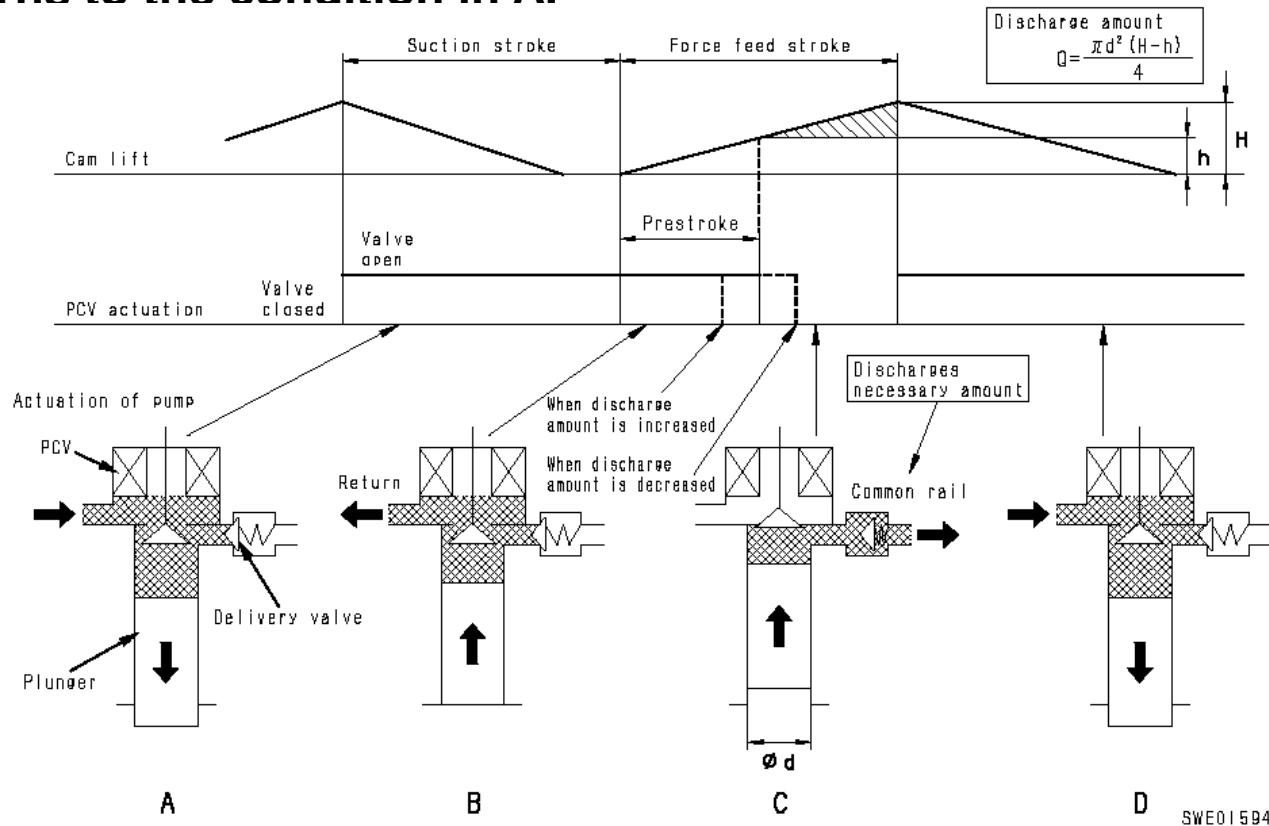


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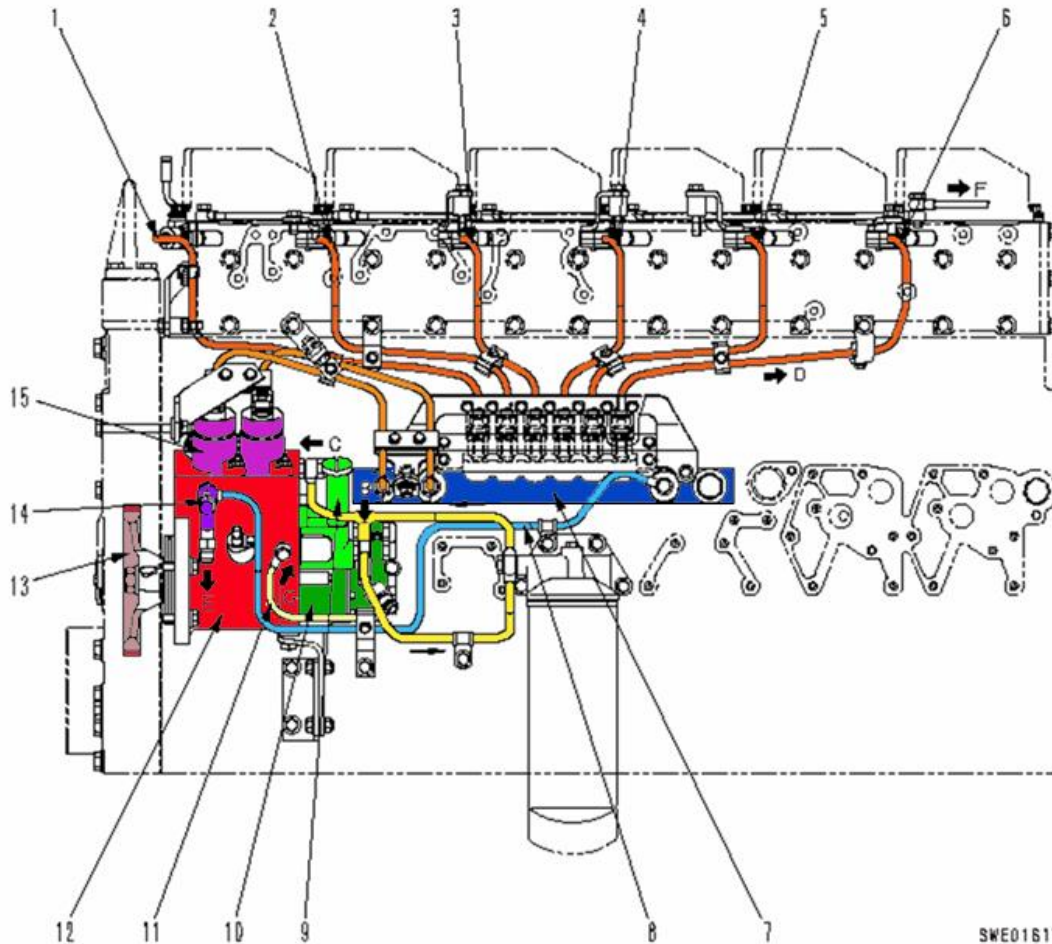
C. When electricity is sent to the PCV to close the valve with timing matching the necessary discharge amount, the return passage is cut off, and the pressure in the plunger chamber rises. Therefore, the fuel passage through the delivery valve (check valve) and is force fed to the common rail. In other words, when the PCV is closed, the plunger lift becomes the amount of discharge, and by changing the timing of closing the PCV (plunger pre-stroke), the discharge amount changes and the common rail fuel pressure is controlled.



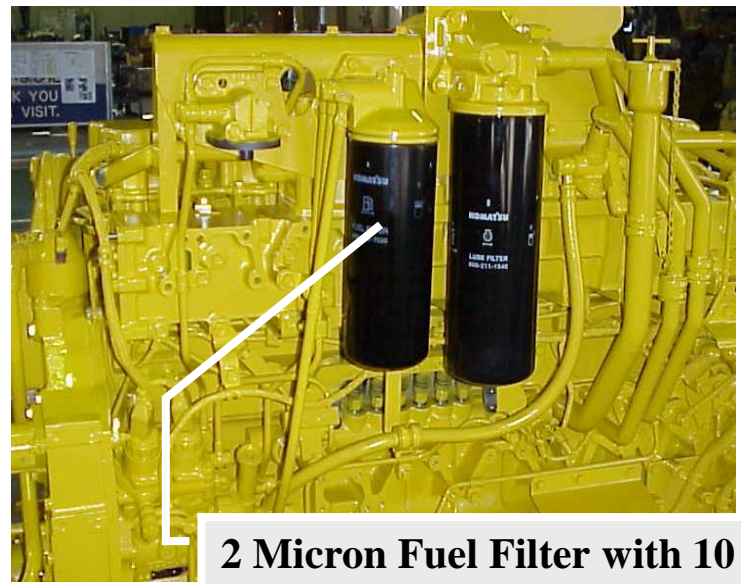
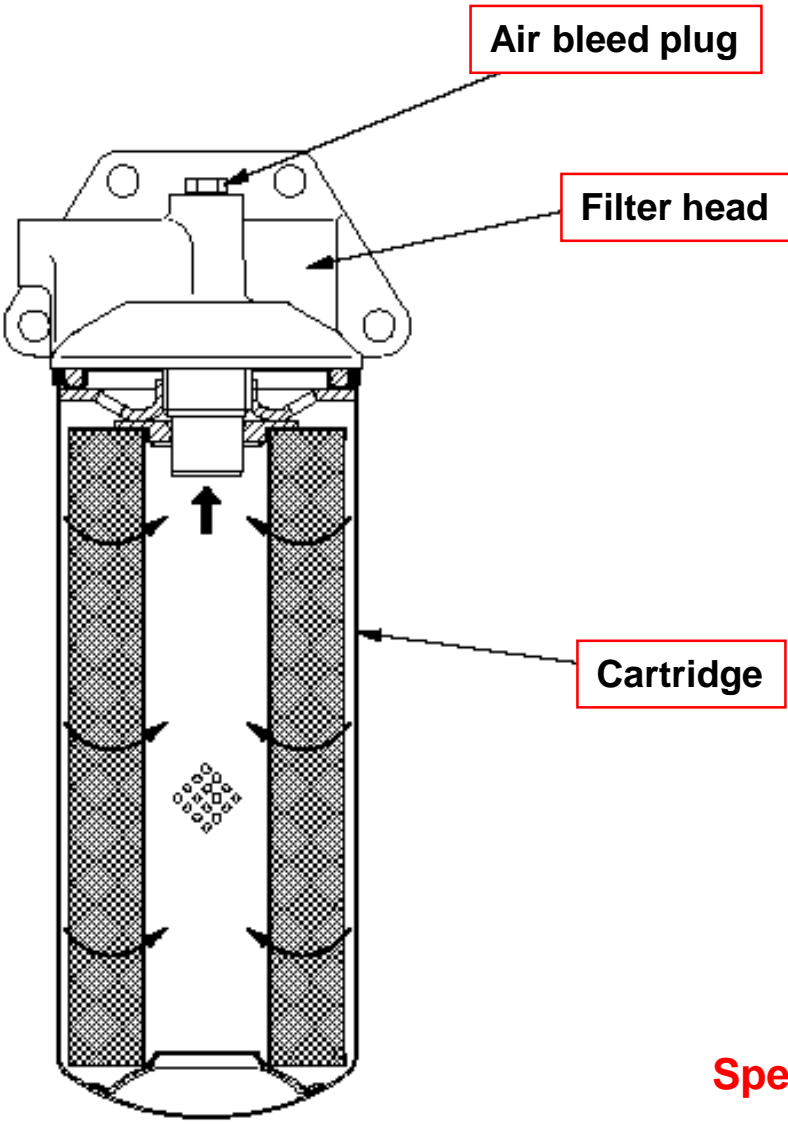
**D. When the cam passes the maximum lift, the plunger enters the down stroke and the pressure inside the plunger chamber goes down. When this happens, the delivery valve closes and stops the force feed of fuel. In addition, the flow of current to the PCV is stopped, so the PCV opens and low-pressure fuel is sucked into the plunger chamber. In other words, it returns to the condition in A.**



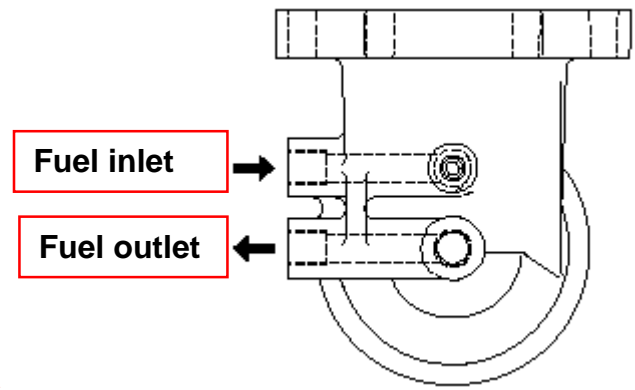
## 140-3 series



1. Fuel injection pipe (No. 1 cylinder)
2. Fuel injection pipe (No. 2 cylinder)
3. Fuel injection pipe (No. 3 cylinder)
4. Fuel injection pipe (No. 4 cylinder)
5. Fuel injection pipe (No. 5 cylinder)
6. Fuel injection pipe (No. 6 cylinder)
7. Common rail
8. Fuel return pipe
9. Priming pump
10. Feed pump
11. Oil inlet pipe (for pump lubrication oil)
12. High-pressure pump
13. Fuel supply pump drive gear (No. of teeth: 48)
14. Overflow valve
15. PCV

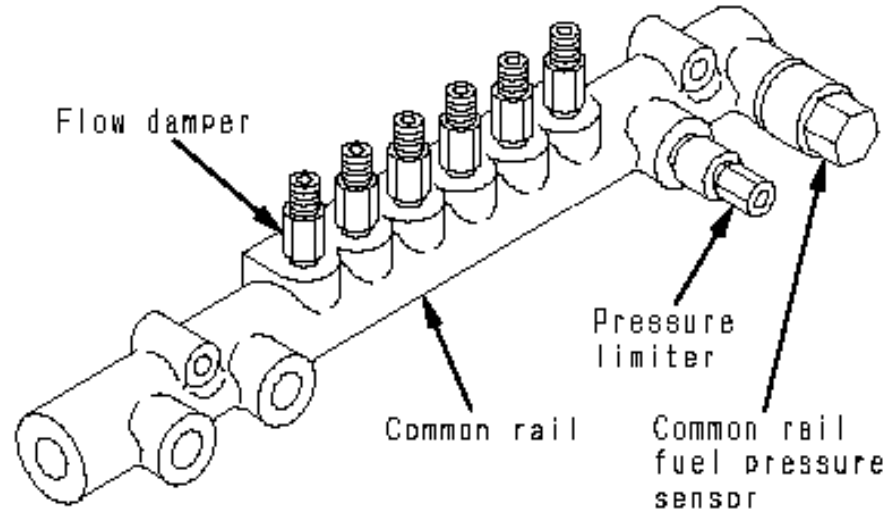


**2 Micron Fuel Filter with 10 Micron pre-filter**



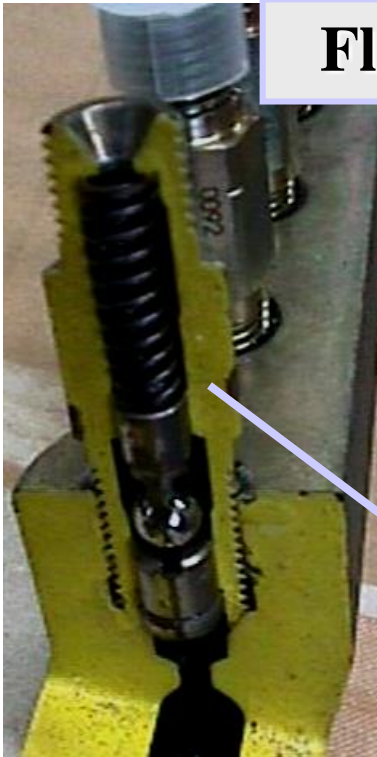
## Specifications

- Filtering area: 1.0 m<sup>2</sup>

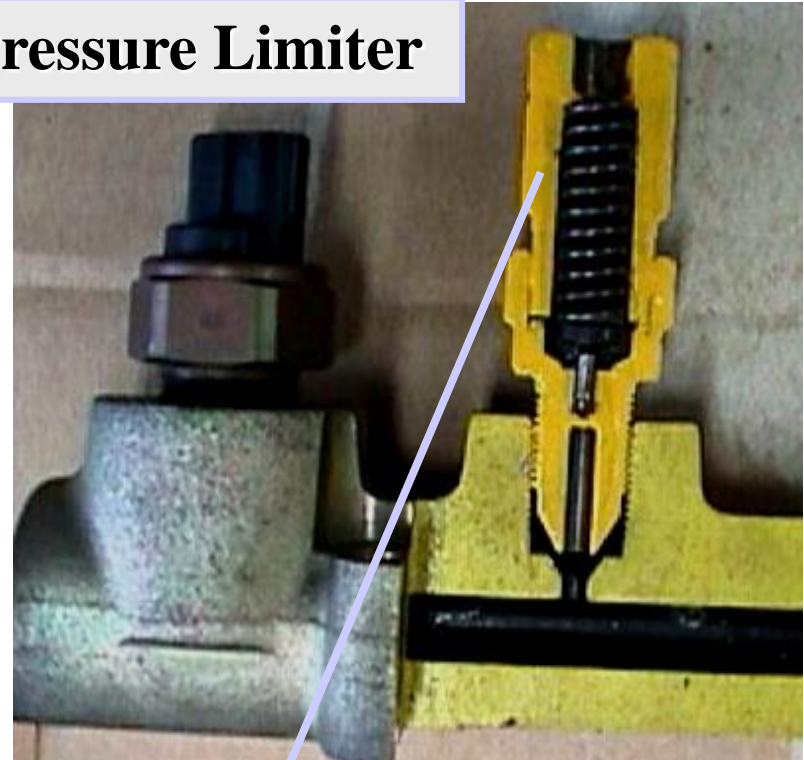


The common rail acts to distribute the high-pressure fuel generated by the high-pressure pump and send it to the injector of each cylinder. The common rail is equipped with a common rail fuel pressure sensor, flow damper and pressure limiter. The flow damper is equipped with a fuel injection pipe and sends high-pressure fuel to the injector. The piping of the pressure limiter is arranged to return to the fuel tank.

**Flow Damper**



**Pressure Limiter**

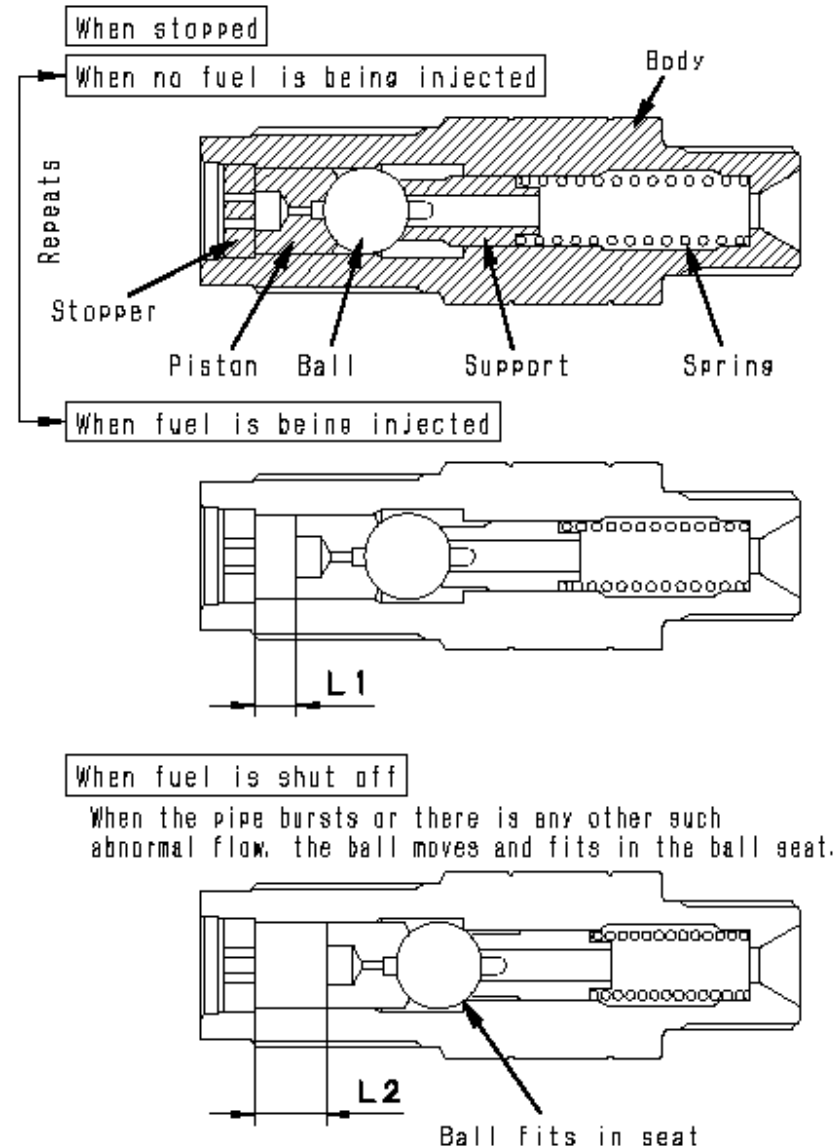


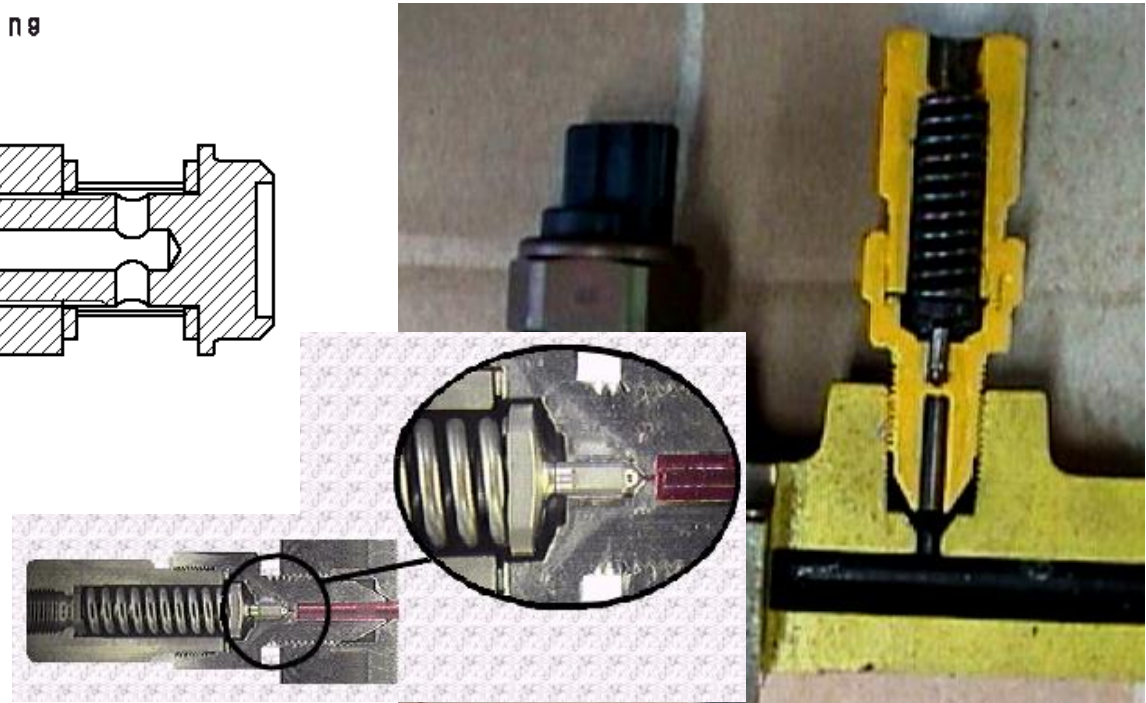
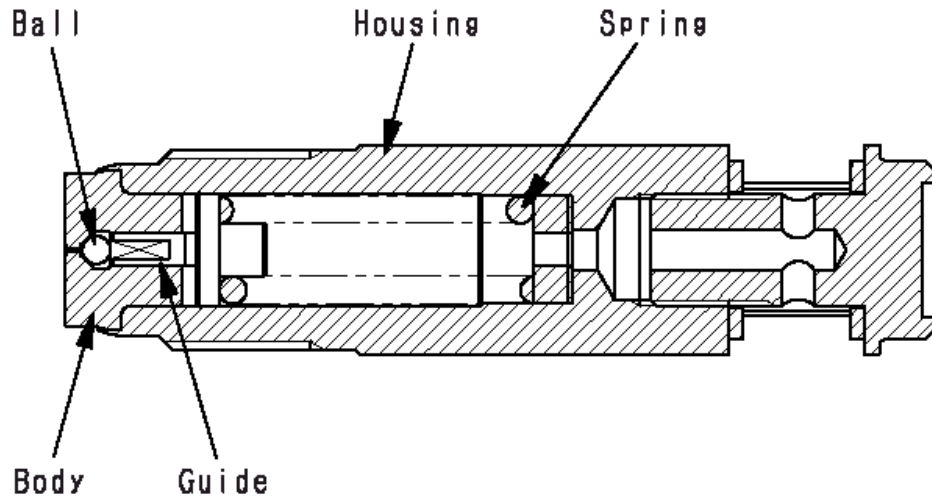


The flow damper reduces the pressure pulses inside the high-pressure piping and acts to supply fuel at a stable pressure to the injector.

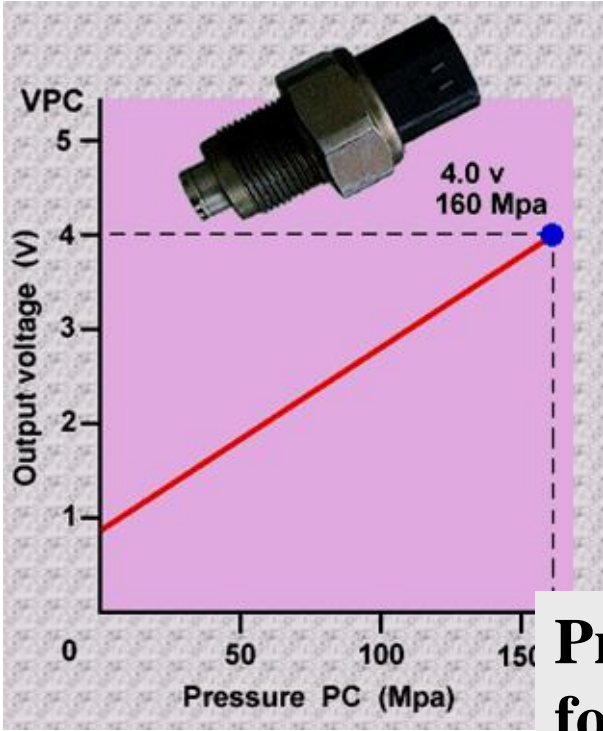
If any excess fuel flow out, it acts to shut off the fuel passage and prevent any abnormal outflow of fuel.

If any abnormal outflow is generated, high pressure bears on the piston, so the piston and ball move to the right as shown in the diagram and come into contact with the seat. As a result, the fuel passage is shut off.





**The pressure limiter opens if any abnormal high pressure is generated, and acts to allow the pressure to escape. It is actuated (opens) if the fuel pressure in the common rail reaches approx. 140 MPa {1,430 kg/cm<sup>2</sup>}, and when the pressure goes down to approx. 30 MPa {310 kg/cm<sup>2</sup>}, it is restored (closes) and acts to maintain the pressure.**



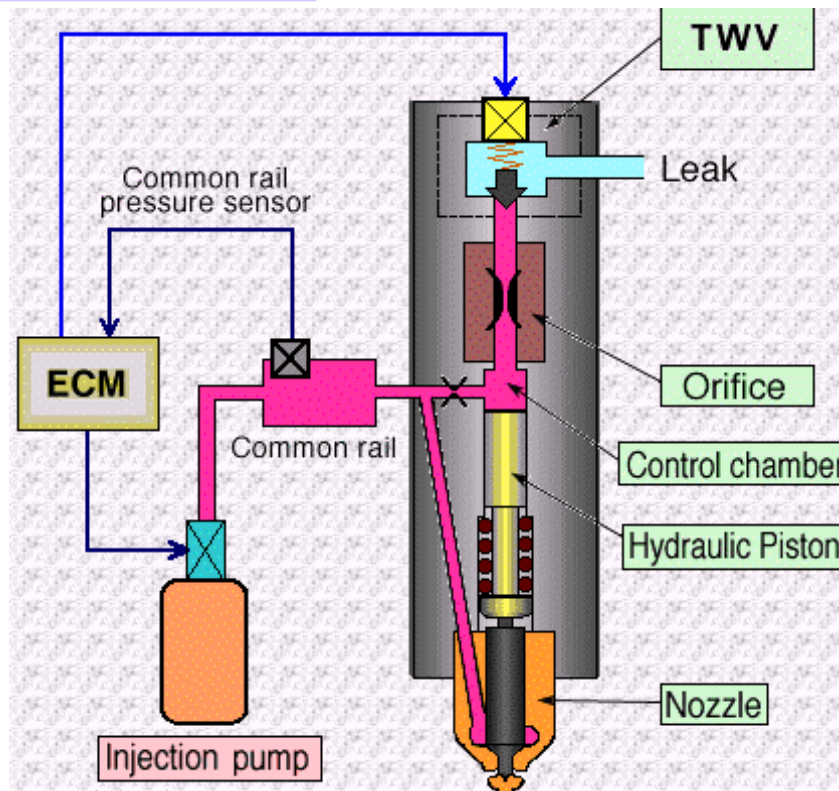
**Common Rail Pressure Sensor**

**Provides pressure reading for feed back to ECM**

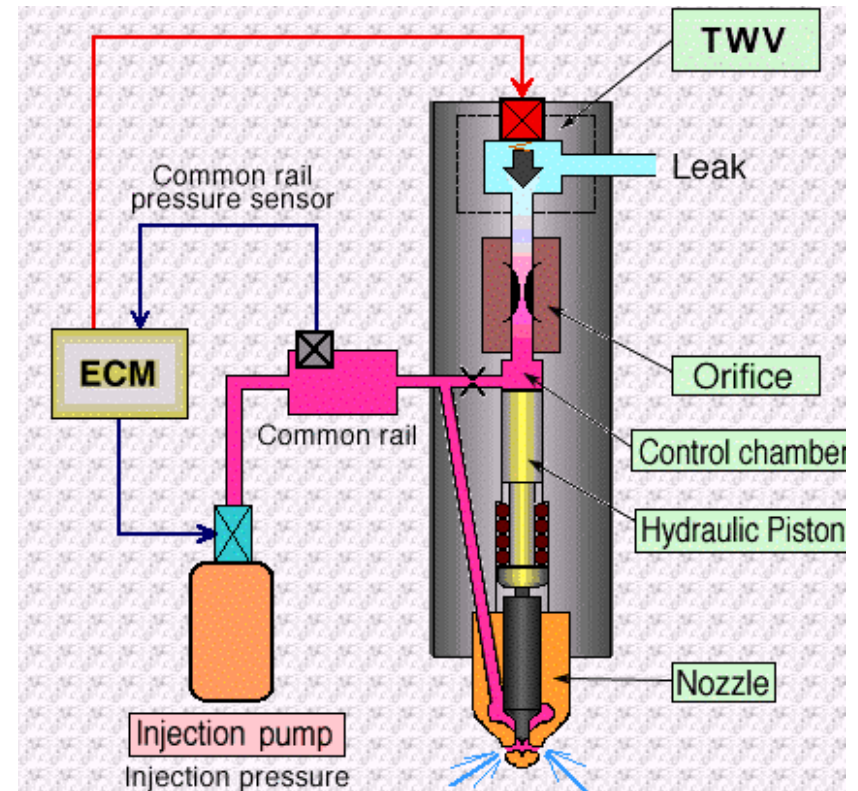


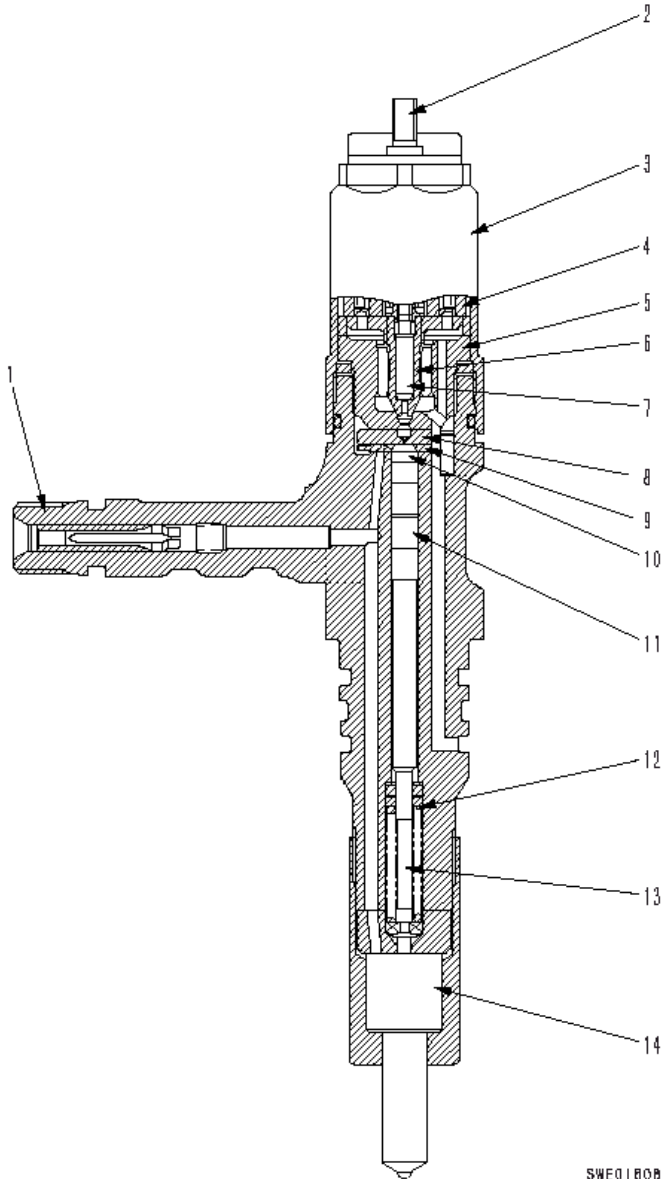
The TWV (Two-Way electromagnetic Valve) controls the pressure in the control chamber in order to control the start and finish of the fuel injection.

## TWV Off



## TWV On





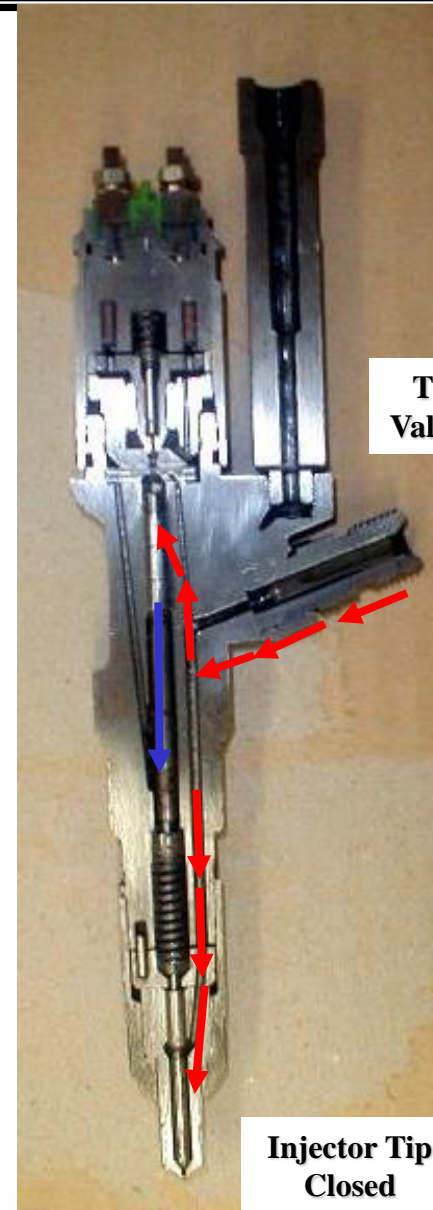
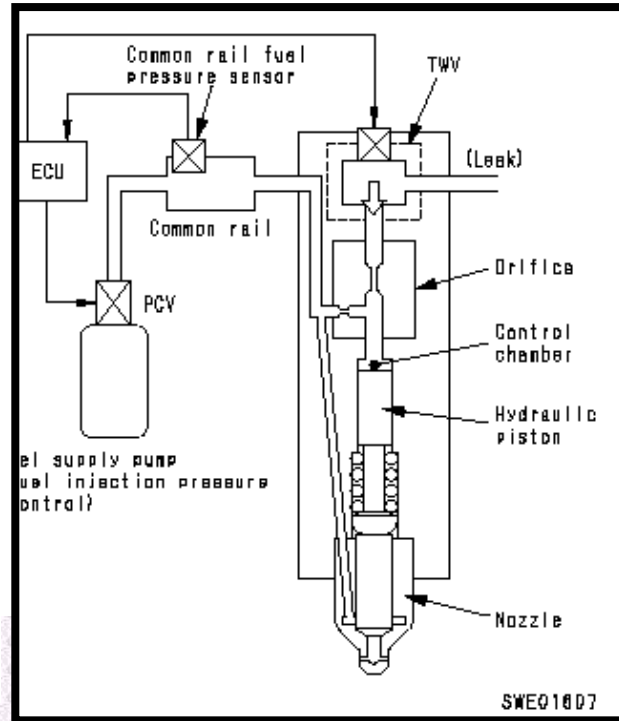
1. Inlet connector
2. Terminal
3. Upper body
4. Solenoid
5. Outer body
6. Inner valve Valve assembly
7. Valve body
8. OUT orifice
9. IN orifice
10. Control chamber
11. Command piston
12. Spring
13. Pressure pin
14. Nozzle assembly

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# Injector - Components TWV Off

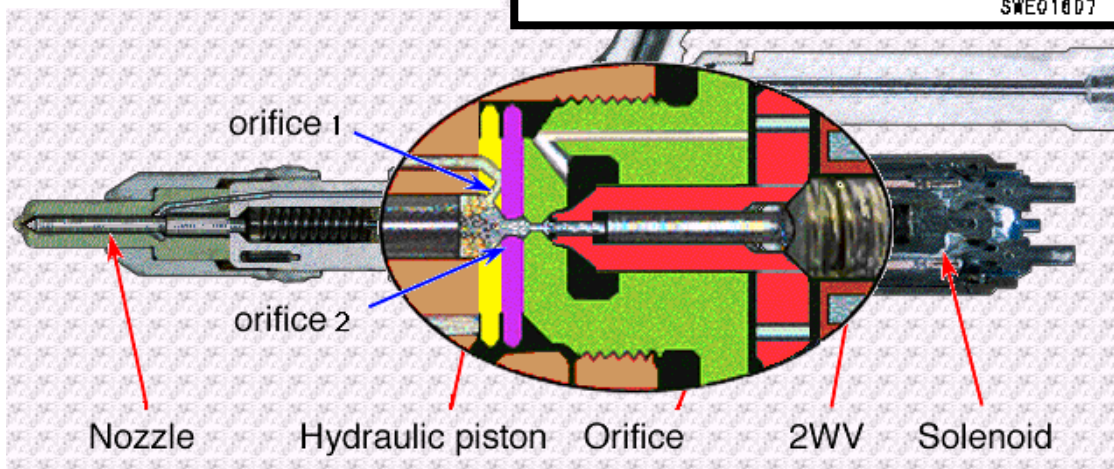


The hydraulic piston transmits force to the needle valve of the nozzle according to the pressure in the control chamber.



**TWV Off  
Valve Closed**

**Injector Tip  
Closed**



# Injector - Components TWV On

