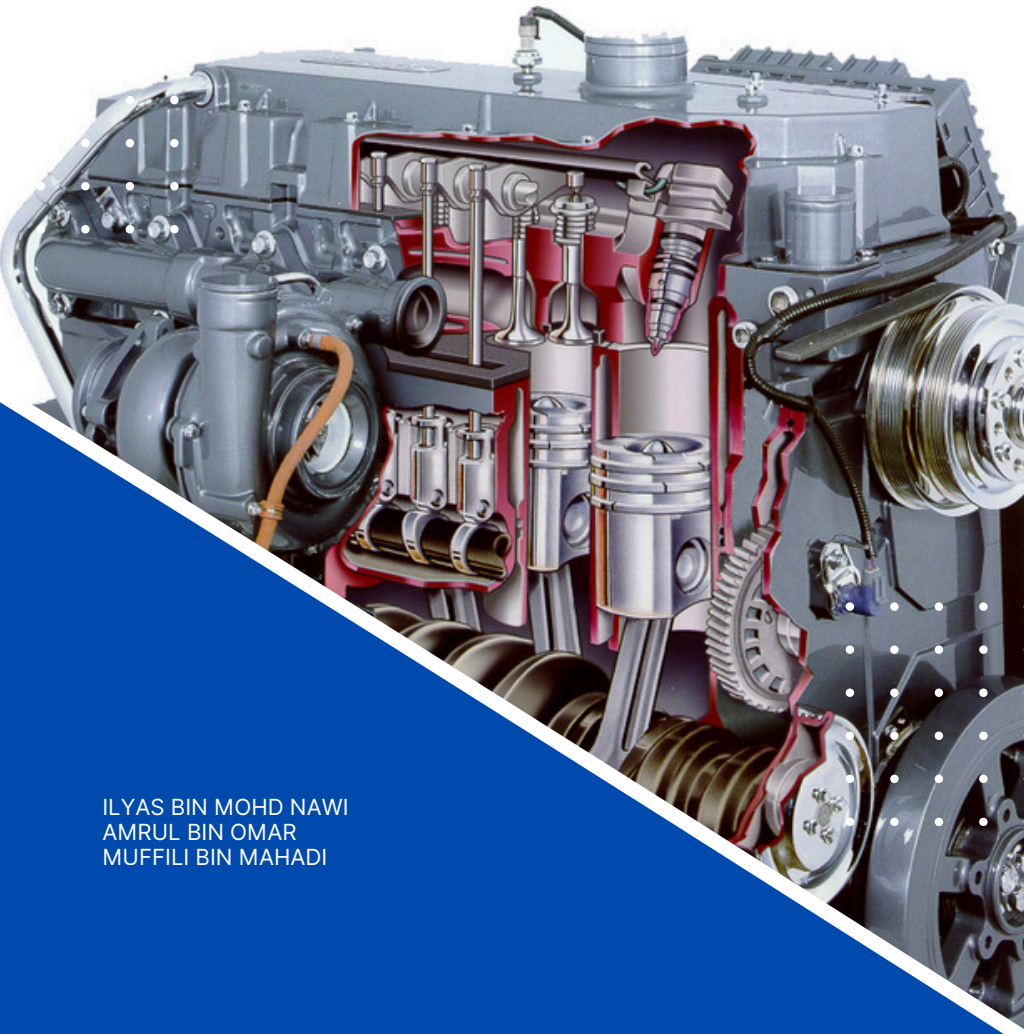
KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

KOLEJ KOMUNITI
BANDAR DARULAMAN

DIESEL FUEL SYSTEM

DIPLOMA IN COMMERCIAL VEHICLE TECHNOLOGY



ILYAS BIN MOHD NAWI
AMRUL BIN OMAR
MUFFILI BIN MAHADI

DIESEL FUEL SYSTEM

DIPLOMA IN COMMERCIAL VEHICLE TECHNOLOGY

Written By:
Ilyas bin Mohd Nawi
Amrul bin Omar
Muffiti bin Mahadi

First Print: 2024

Author:
Ilyas bin Mohd Nawi
Amrul bin Omar
Muffili bin Mahadi

Published by:
Kolej Komuniti Bandar Darulaman,
No. 17, Bandar Darulaman Jaya,
06000 Jitra, Kedah Darul Aman.

Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available from the National Library of Malaysia

eISBN 978-629-99747-2-7

PREFACE

Welcome to the Diesel Fuel System eBook. The diesel fuel system is a crucial component of diesel engines that determines vehicle performance, efficiency, and reliability. Understanding how this system functions and how to maintain it is key to ensuring optimal diesel engine operation.

In this eBook, you will explore various aspects related to the diesel fuel system, including key components such as fuel pumps, injectors, and the role of cutting-edge technologies in enhancing efficiency. We hope the material presented will provide comprehensive and valuable insights for readers, whether they are newcomers or experienced professionals in the diesel engine industry.

Thank you for choosing this eBook as your reference source. We trust that it will serve as a useful guide and inspire you to better understand and master the diesel fuel system.

CONTENTS

Chapter 1 - Introduction of diesel engine fuel system

1.1 Petrol Engine

1.1.1 In a petrol engine, the **speed and power are controlled by the throttle valve**, which controls the **amount of air entering the engine**.

1.1.2 Adding more fuel to the cylinders of a gasoline engine **without adding more air (oxygen)** will not increase the speed or power of the engine.

1.2 Diesel Engine

1.2.1 In a **diesel engine, speed and power are not controlled by the amount of air entering the cylinders because the engine air intake is always wide open**. Therefore, the engine always has **enough oxygen to burn the fuel** in the cylinder and will **increase speed (and power) when additional fuel is supplied**

1.2.2 the **amount of fuel injected - control power and speed**.

1.2.3 The **air-fuel mixture/air-fuel ratio** of a diesel engine can vary from as lean as 85:1 at **idle** to as rich as 20:1 at **full load**

1.2.4 This **higher air-fuel ratio** and the **increased compression pressures** make the **diesel** more **fuel efficient.**

Petrol Engine

Diesel Engine

1.3 Diesel fuel system function

1.3.1 The diesel fuel system on a commercial vehicle is the **group of components** responsible for **fuel storage** and **transfer it to the high-pressure injection circuit or pipeline**.

1.3.2 Basically there were **two fuel line (circuit)** involved in diesel fuel system operation which is :

- **Low Pressure Fuel Systems (suction circuit)**
- **High Pressure Fuel Systems (charging circuit)**

1.3.3 Low Pressure Fuel Systems

- Diesel engines **need a low-pressure fuel supply to transfer fuel with adequate volume and pressure**, from the **fuel tank** to the **high-pressure injection stage** of the fuel system

- Function of Low Pressure Fuel Systems (suction circuit)
  - **Store and supply** fuel **free of contaminants and vapor**
  - **Supply an adequate volume of fuel at the correct pressure** to the high-pressure injection systems
  - **Remove water contamination**
  - **Prevent wax gelling** (diesel gelling is when cold temperatures cause diesel fuel to turn from a liquid into a gel-like substance)
  - **Regulate fuel temperature**

1.3.4 High Pressure Fuel Systems

- Efficient diesel engine operation relies on **a precise quantity** of fuel being injected at high pressure at the **correct time (firing order)** to the combustion chamber.
- **Four most common diesel injection systems**
  - **Distributor injection system**
  - **Common rail systems (CRS)**
  - **Unit Injector systems (UIS)**
  - **Unit Pump System (UPS)**
- Function of High Pressure Fuel Systems (charging circuit)
  - Meter the correct quantity of fuel for injection
  - Time the injection of fuel
  - **Control the rate of fuel delivery**
  - Atomize the fuel
  - Distribute the fuel throughout the combustion chamber
- Purpose of High Pressure Fuel Systems
  - Sufficient pressure to penetrate the dense combustion chamber mass.
  - Meet the short amount of time available (just before the piston reaches TDC) for injection of fuel.
  - To break up the liquid fuel into a fine mist (atomization).

5

interactivespace

How a Diesel Engine Works

VIDEO

Chapter 2 - Diesel engine fuel system component

2.1 Fuel system components

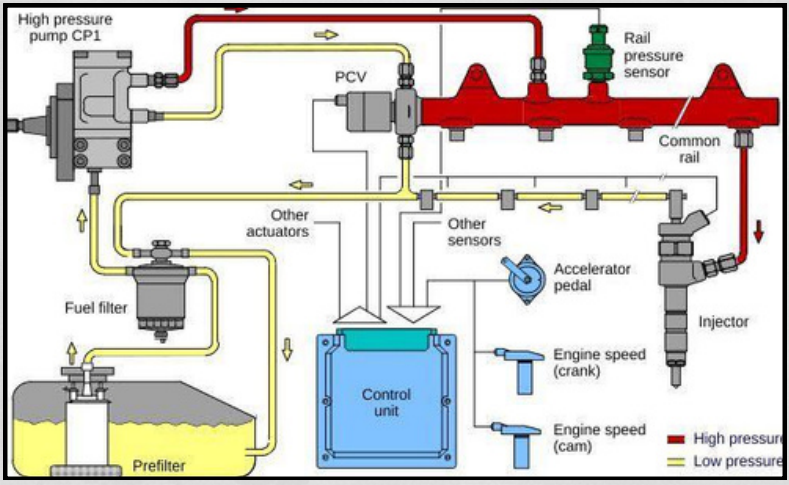
- Diesel fuel system components are divided into two circuit which is :
  - Low Pressure Fuel Systems components
  - High Pressure Fuel Systems components

2.2 Components of low pressure fuel systems

- Fuel tank
- Low pressure fuel lines
- Fuel level sending units and tank pickup
- Fuel filter
- Fuel heaters
- Water filtration
- Fuel coolers
- Fuel transfer pump

2.3 Components of High Pressure Fuel Systems

- High-pressure pump
- High-pressure rail
- Injector
- High-pressure oil pipe



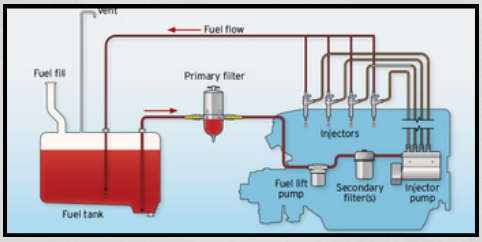
High and Low Pressure Diesel Common Rail Fuel System

2.4 Fuel tank

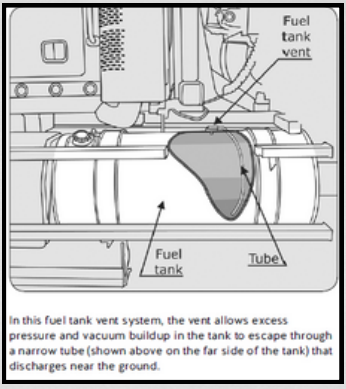
- **Two main functions of diesel fuel tank**
  - To store an adequate supply of fuel for the engine to operate
  - To allow fuel returned from engine to cool after absorbing heat from engine and fuel injectors

- Diesel fuel tank should be made of a **noncorrosive material** that remains free of leaks and is chemically compatible with diesel fuel.
- Commonly diesel fuel tank was made from :
  - aluminium
  - plastics
  - steel alloy

- Diesel fuel tank is mainly bigger than gasoline fuel tank.
- Diesel fuel tank's components are include
  - Tank vent line
  - Tank pickup
  - Fuel level **sending unit**
  - Fuel return line
  - Fuel suction line
- **Tank vent line -**
  - a completely sealed fuel tank may prevent leaks, but tanks require venting to atmosphere. Tank venting is necessary to **allow air into the tank** and **some fuel vapors to escape**.
  - a vent of **pressure-compensating valve** is usually located at the highest point in the tank, often in the tank fuel cap



Diesel Fuel Tank Circuit



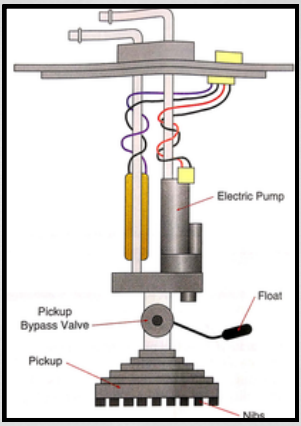
Diesel Fuel Tank Vent

interactivespace

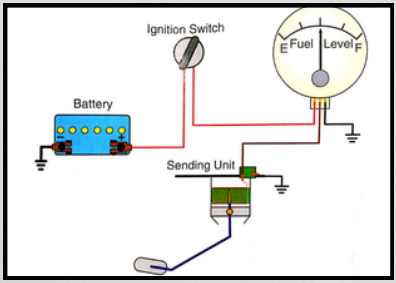
Engine Diesel
The Fuel Circuit

VIDEO

- **Tank Pickup -**
  - Fuel tank pickup were design to prevent the accumulation of contaminants such as **water, sediment and microorganisms** in the fuel tank
  - Fuel tank pickup usually integrated with **sending unit,electrically fuel pump** and others to **form a module.**
  - Medium duty vehicle typically rely on the tank pickup to keep their tanks relatively free of sediments.

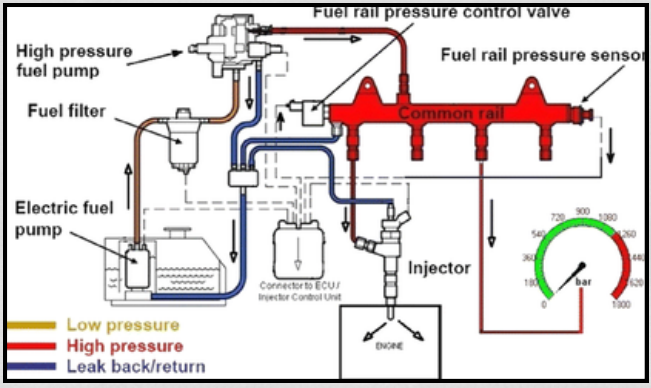


- **Fuel Level Sending Unit –**
  - Fuel level sending unit is an electrical unit, (typically a variable-resistance rheostat attached to a float) that transmit the fuel level in the tank to the driver's instrument panel.



- **Fuel Return Line**
  - Fuel return line or fuel return circuit collects fuel from **injectors**, **fuel pump**, and **relief valves** and returns the fuel to the tank.
  - Latest fuel systems is design to minimize the amount of fuel returned to the tank to improve fuel economy and meet greenhouse gas (GHG) emission standards.

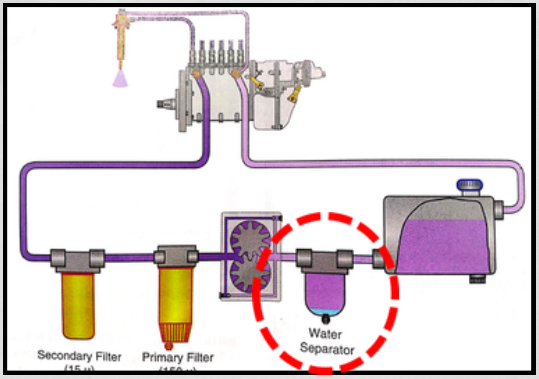
- **Fuel suction line**
  - The low pressure fuel system is connected by low pressure fuel transfer lines (fuel suction line)
  - Fuel suction line usually constructed of **braided steel**, **corrosion-resistant metal tubes** and **diesel fuel compatible rubber material**.
  - Fuel lines used on low pressure systems must be routed (pass through different sections of chasis to transfer fuel from fuel tank to the engine) where they cannot be mechanically damage.



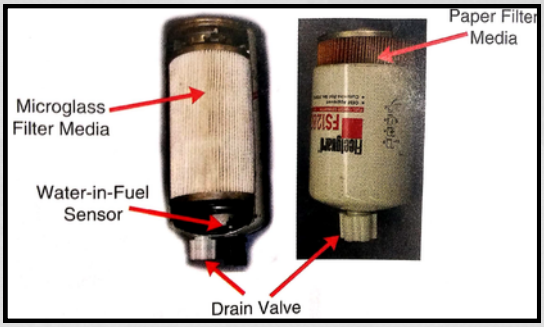
12

2.5 Water/ Fuel separator/ Fuel sedimenter

- Diesel fuel attracts and holds water (diesel fuel has hydrophilic and hydroscopic properties).
- Water can occur in diesel either as free water or as an emulsion.
- The **water in the diesel** fuel can lead to problems such as
  - **blown injector tip which will causes loss engine power and misfire**
  - Seize up (jammed) injector plungers (abnormal operation)
  - corrosion of the components and storage tanks
  - increased wear of the fuel system components
- The diesel fuel **water separator** performs as an added line of defense for the engine, filtering water and any particulates from the fuel before reaching the fuel filter and engine.



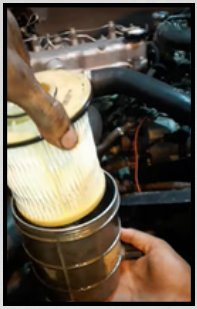
- Fuel and water are separated by specialized filter media and coalescing filter.
- Dirt and water settel in the housing at the bottom if they are not trapped in the filter media.
- Water is heavier than diesel fuel, it collects in a sediment bowl or in the bottom of the filter.



comparison of microglass and paper fuel filters. The drain valve enables water and sediment removal from the filter housing

2.6 Fuel filter

- Diesel fuel filters are specially designed **to keep diesel from being contaminated**. These filters help clean the fuel before it is sent to the engine.
- The fuel filter of diesel engine was designed to filter out the harmful impurities and moisture in the fuel system, protect the normal work of the engine, reduce wear and tear, avoid clogging and improve diesel engine life.
- a variety of materials are used to fabricate filters such as:
    - **paper (cellulose)**
    - **microglass/glass fibre**
    - **cotton**
    - **felt**
    - **wood**
- microglass or glass fibre, a synthetic media, is considered the best filter media, trapping the smallest particles and absorbing with greatest capacity.
- Paper cellulose filters usually the least expensive
- **Types of diesel fuel filters**
    - **Cartridge fuel filters (shell and element)**
    - **Spin on**
- Cartridge fuel filters (shell and element)
    - It has a metal or plastic housing which is a separate component
    - It can be used repeatedly, with only the cartridge being the disposable part
    - Cartridge fuel filters are environmentally friendly, when a filter goes bad, replacing this type of filter has less impact on the environment



Cartridge fuel filters (shell and element) replacement

example of Cartridge fuel filters (shell and element)

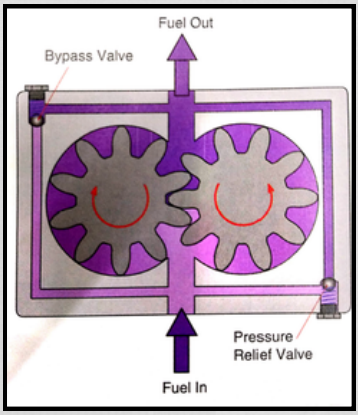
- Spin on
  - This type of fuel filter is easy to replace, so it only requires dismantling the damaged filter and fastening a new one in its place
  - Most countries has set some enviromental regulation on disposing spin-on types

example of spin-on fuel filters

2.7 Fuel Lift Pump or Fuel Transfer Pump

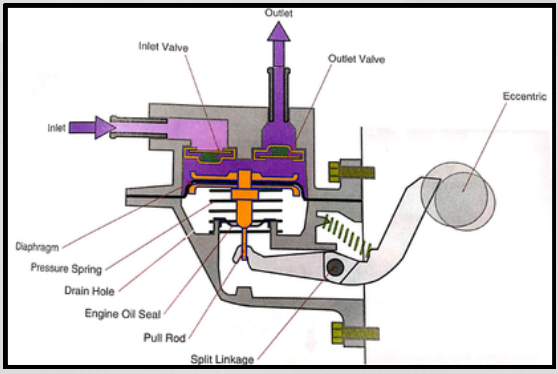
- The low-pressure fuel pump is typically referred to as a lift pump or transfer pump to differentiate it from the high-pressure injection pump.
- Fuel transfer pump are used to move fuel from the fuel tanks to the high-pressure fuel system.
- Types of lift pump or transfer pump :
  - **Gear pump**
  - **Mechanical diaphragm pump**
  - **Piston type pump**
  - **In-tank electric pump**

- **Gear Pump**
  - Is a positive displacement pump (a pump that deliver a fixed quantity of fluid for every revolution)
  - Advantages of gear pump
    - High volume
    - stable pressure output
    - simple design
    - durability
    - maintenance free
  - Disadvantages
    - If no fluid is in contact with gear it needs to priming/ bleeding
    - Difficult to prime/bleeding and restart if the vehicle has run out of fuel



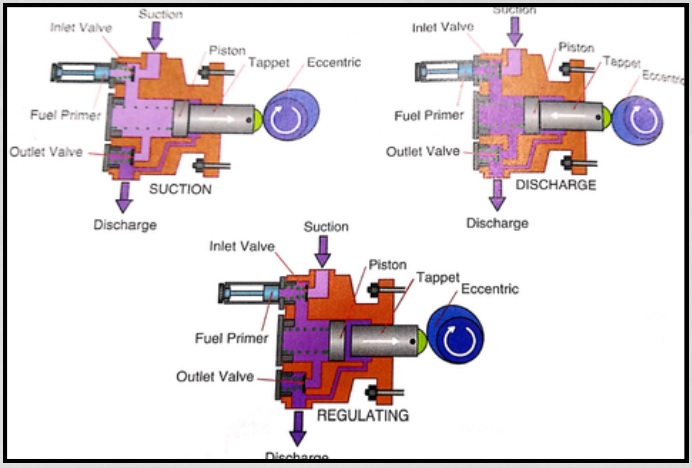
Mechanical diaphragm pump

- This pump is used to supply fuel at low pressure, usually not more than 7 pounds per square inch (psi) (48 kilopasclas[kPa]) with a variable output volume
- This pump is **operated by a push rod** which attached to the engine camshaft (eccentric cam lobe)
- As the eccentric cam lobe moves the rod or lever back and forth, it linkages pulls down a diaphragm located between the upper and lower pump halves.
- spring, diaphragm and check valve is use to develop pressure and delivering fuel.



mechanical diaphragm pump

- **Piston type pump**
  - This type of pump use piston to develop pressure differential which allows these pumps to operate at a higher pressure.
  - This type of pumps is more reliable than diaphragm pump

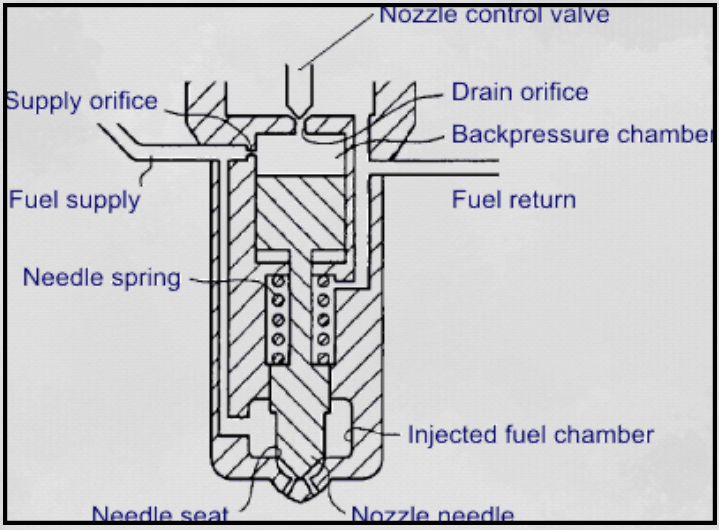


- **In-tank electric pump**
  - Some of medium duty vehicles use electrically operated transfer pumps located in the fuel tank or on the frame near the tank.
  - Advantages of in-tank electric pump
    - minimize the air to enter the fuel system
    - reducing of primaring/bleeding filters manually
    - longer fuel filter lifetime

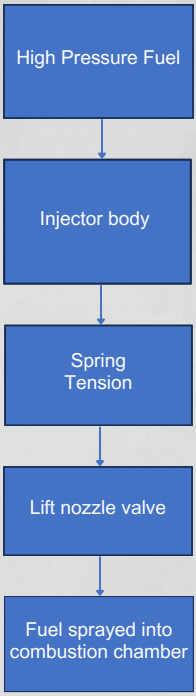
23

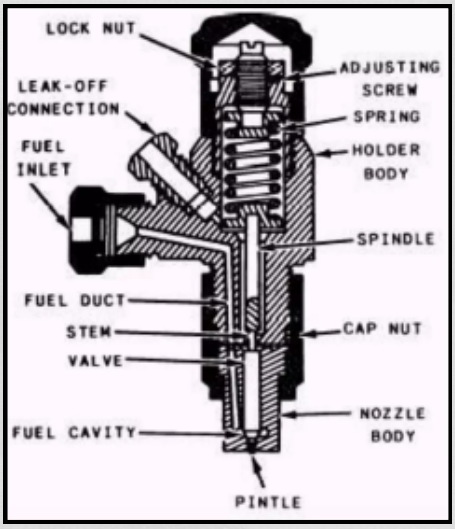
2.8 Fuel injector

- **Mechanical Fuel Injector**
- **Atomizing fuel** into very fine droplets for better combustion
- Atomizing is done by **forcing the fuel through a small orifice** under high pressure.
- An injector assembly consists of the following components
  - A needle valve
  - A compression spring
  - A nozzle
  - An injector body

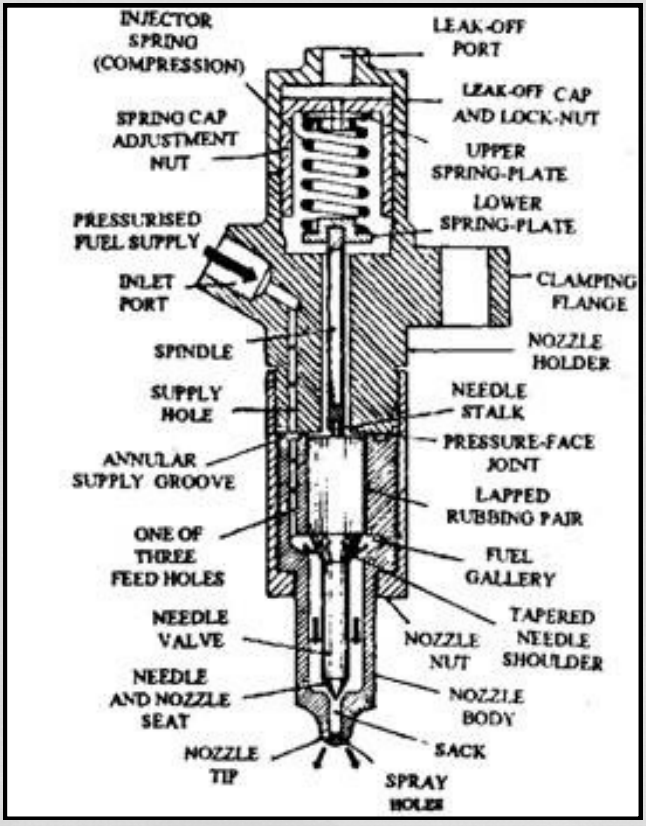


- **Operation of mechanical fuel injector**



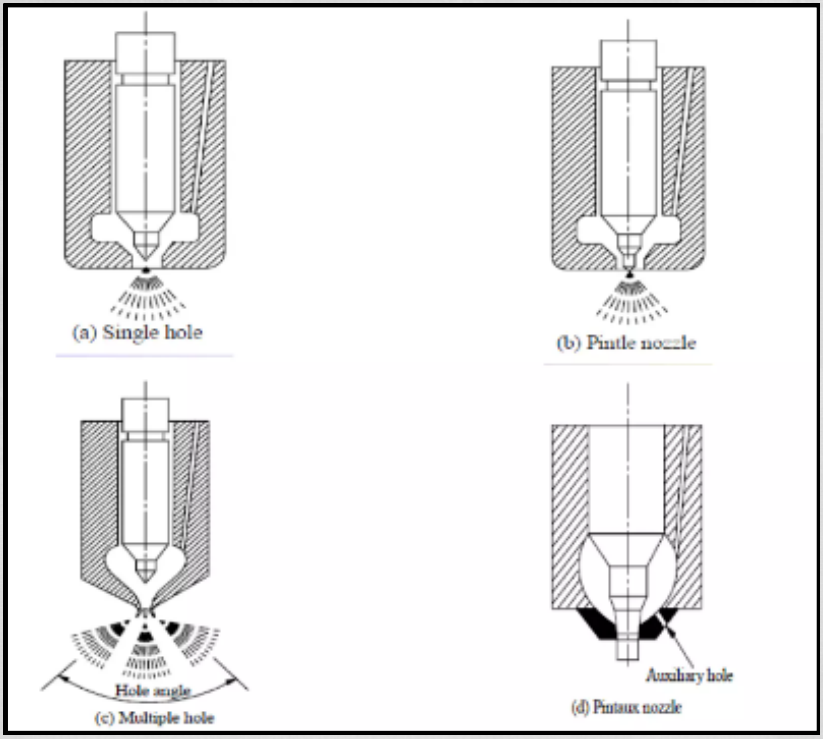


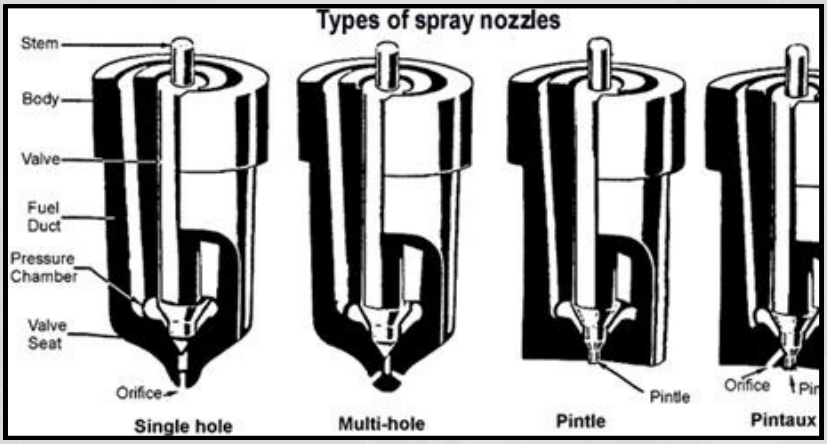
- **Nozzle**
  - Nozzle sprays the liquid fuel. The function of the nozzle are :
    - Atomization
      - **Atomization** - the process by which diesel fuel is broken down into small droplets
    - Distribution of fuel to the required area
    - Non-impingement on the walls
      - **Impingement** –
        - fuel spray to the walls of the combustion chamber not directed towards the center of the chamber
        - reduced combustion efficiency, increased emissions (smoky exhaust), and increased engine wear.
    - No dribbling
      - **Dribbling** - diesel fuel continues to flow out of a fuel injector nozzle after the injection event has ended



- **Single hole nozzle**
  - Requires a high injection pressure and this type of nozzle has a tendency to dribble
- **Pintle nozzle**
  - Develop to avoid weak injection and dribbling
  - results in good atomization and reduced penetration
- **Multi hole nozzle**
  - The number of holes may vary from 4 to 18, allows a proper mixing of air and fuel.
  - It able to distribute the fuel properly even with lower air motion within the chamber
- **Pintaux nozzle**
  - Pintle nozzle with an auxiliary hole drilled into the nozzle body.
  - At low speed, the needle valve does not lift fully and most of the fuel is injected through this auxiliary hole

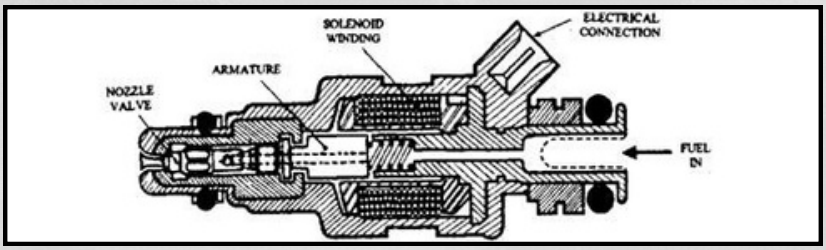
- **Nozzle defect usually indicates symptoms such:**
  - Black, gray or white exhaust smoke
  - Low power
  - Misfire
  - Rough engine operation after the engine is warmed up
  - Excessive fuel consumption
  - Engine will not reach high-idle or rated rpm
  - Excessive combustion noise or fuel knock in one cylinder or more at idle

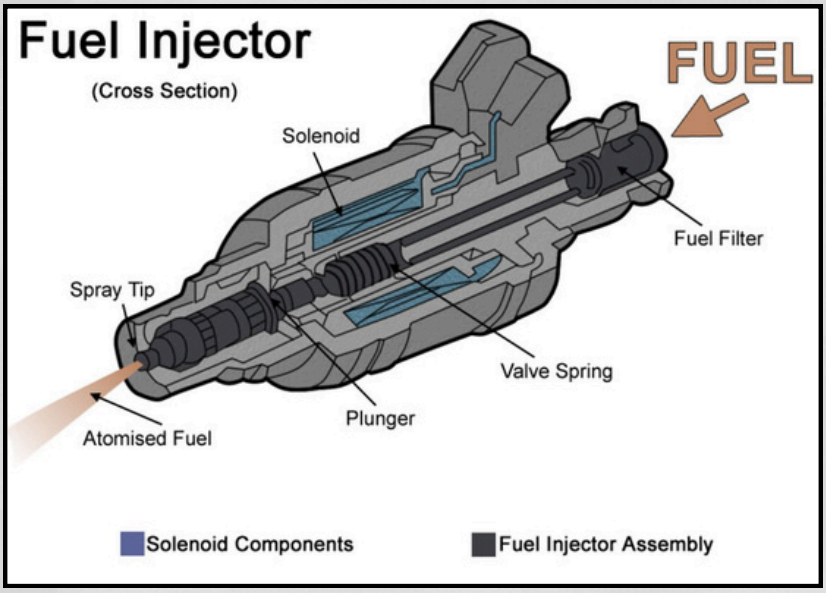

(a) Single hole
(b) Pintle nozzle
Hole angle
(c) Multiple hole
Auxiliary hole
(d) Pintaux nozzle

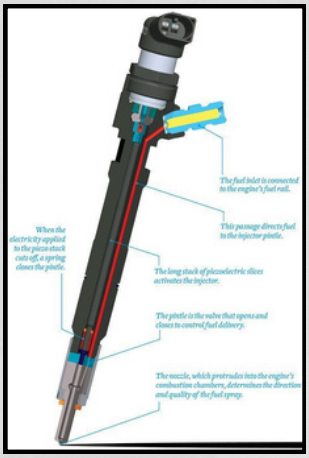

Types of spray nozzles
Stem
Body
Valve
Fuel Duct
Pressure Chamber
Valve Seat
Orifice
Pintle
Orifice
Single hole
Multi-hole
Pintle
Pintaux

2.9 Electronic Fuel Injectors

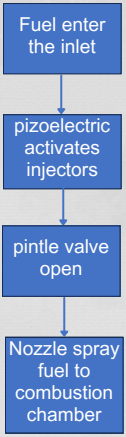
- a type of fuel injector used in diesel engines that use **electronic controls** to precisely **meter and deliver fuel** to the combustion chamber
- greater precision and control over the fuel injection process, leading to **improved performance, fuel efficiency, and emissions**
- Type of electronic fuel injectors
  - Solenoid injectors:
    - use a **solenoid to control the opening and closing** of the injector nozzle.
    - widely used in diesel engines due to their simplicity and reliability.
  - Piezo injectors:
    - use **piezoelectric crystals to control the opening and closing** of the injector nozzle.
    - faster response times and more precise control over fuel delivery than solenoid injectors.
  - Common rail injectors:
    - use a common fuel rail to supply **high-pressure fuel to individual injectors.**
    - precise control over fuel delivery and are widely used in modern diesel engines.
  - Unit injectors:
    - **combine the injector and high-pressure fuel pump into a single unit.**
    - commonly used in commercial diesel engines and offer high injection pressures and precise control over fuel delivery.

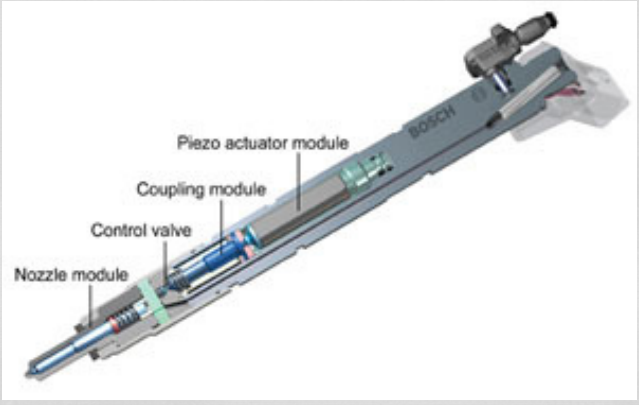

SOLENOID WINDING
ELECTRICAL CONNECTION
ARMATURE
NOZZLE VALVE
FUEL IN


Fuel Injector
(Cross Section)
FUEL
Solenoid
Fuel Filter
Spray Tip
Valve Spring
Plunger
Atomised Fuel
Solenoid Components
Fuel Injector Assembly


The fuel inlet is connected to the engine's fuel rail.
This passage directs fuel to the injector pintle.
When the electricity applied to the piezo stack cuts off, a spring closes the pintle.
The long stack of piezoelectric slices activates the injector.
The pintle is the valve that opens and closes to control fuel delivery.
The nozzle, which protrudes into the engine's combustion chambers, determines the direction and quality of the fuel spray.

- **Operation of Piezo injectors**
  - Fuel enter the inlet –> pizoelectric activates injectors –> pintle valve open –> nozzle spray fuel to combustion chamber

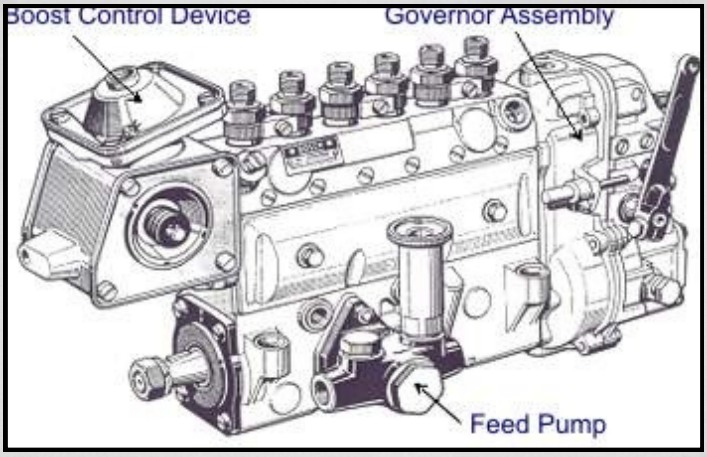


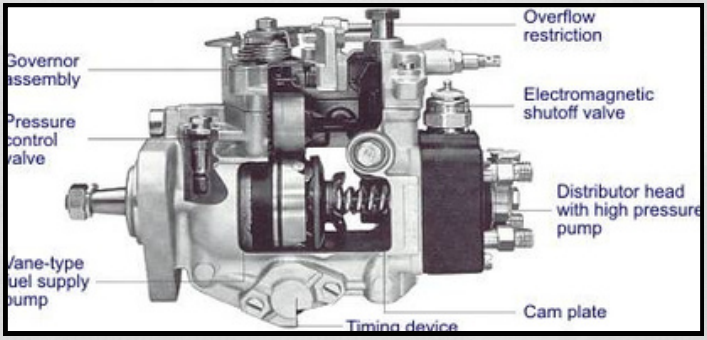


Chapter 3 - Types of diesel engine fuel pump

3.0 Governor

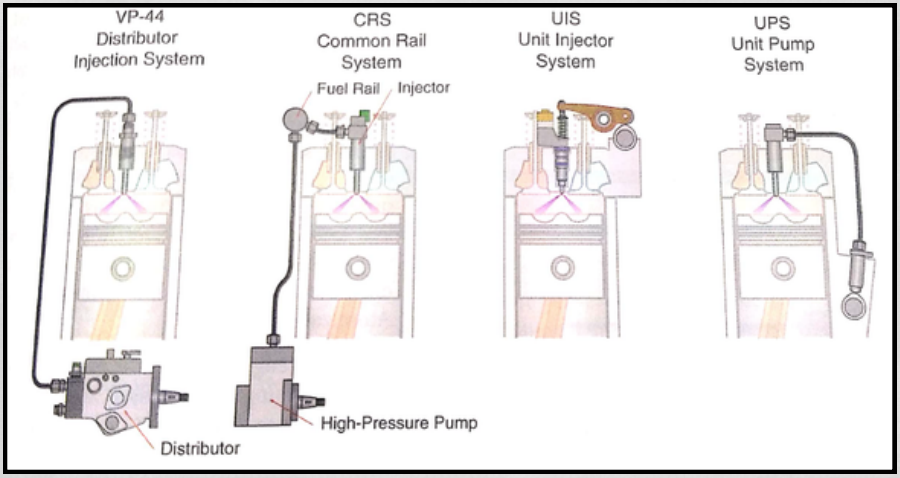
- **control the engine's speed and maintain** it within a **specified range or load changes**.
- **adjusts the fuel flow** to maintain the engine's speed
- **connected to the fuel injector pump, fuel pedal** and **regulates the amount of fuel** that is delivered to the engine
- **fuel pedal** is used by the driver to **increase or decrease the engine's power**
- fuel pedal in a diesel engine vehicle is typically linked to the engine's governor through an **electronic control unit (ECU) or a mechanical linkage**





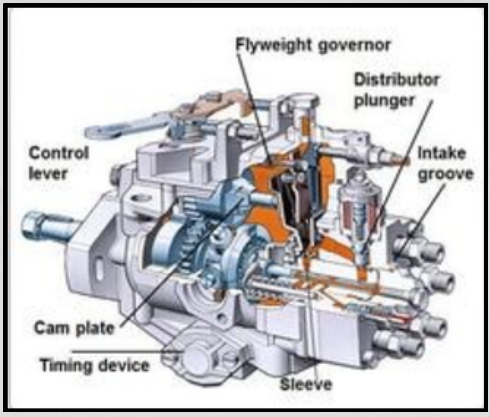
3.1 Fuel Injection Pump (FIP)

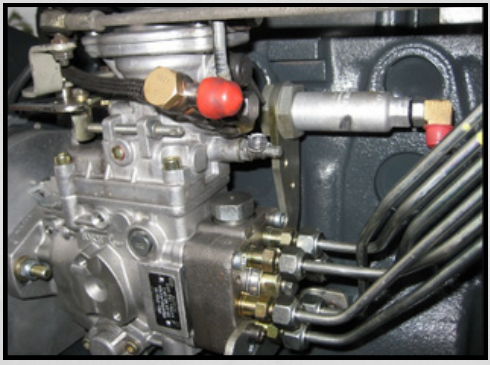
- a **device that delivers fuel** to the engine of a diesel vehicle.
- operates by **pressurizing the diesel fuel** and **injecting it into the engine's combustion chamber**
- typically **driven by a gear or a cam** on the engine, and it may be **mechanically or electronically controlled**.
- its **operating parameters** are important factors in **determining the performance and efficiency** of a diesel engine.
- Four common types of fuel injection pump :
  - Distributor injection system (mechanical)
  - In-line injection system (mechanical)
  - Common rail system (CRS)
  - Unit injector system (UIS)
  - Unit pump system (UPS)
  - Hydraulic Electronic Unit Injection (HEUI)

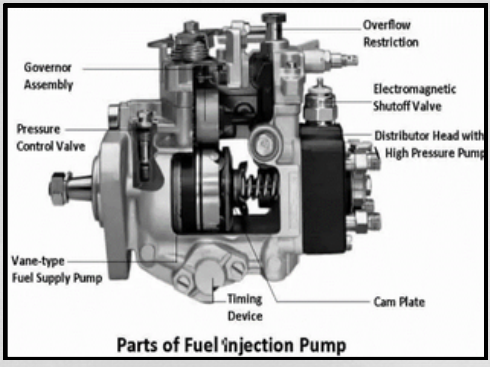


example of four common types of diesel injection systems

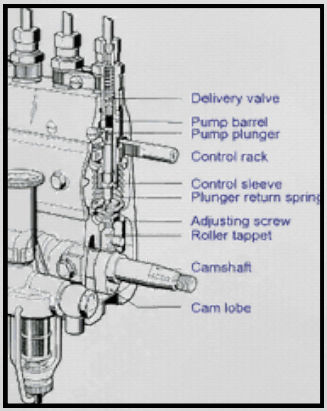
- **Distributor injection system – mechanical type**
  - smaller design for vehicles with limited space
  - uses a **rotating distributor to deliver fuel to each cylinder**
  - also uses **a single plunger** for all injectors
  - fuel is **delivered in pulses**, **timed with the engine's cycle**,
  - this system is known for its **reliability and ability** to produce high torque output

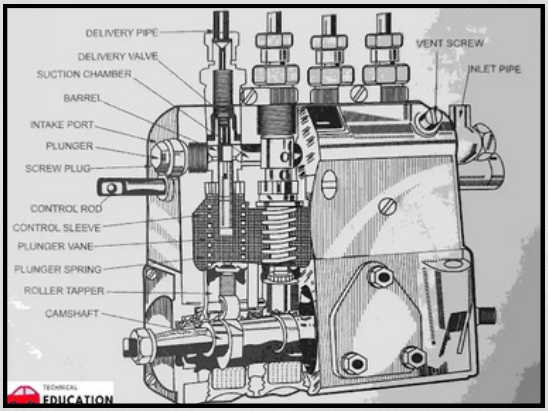




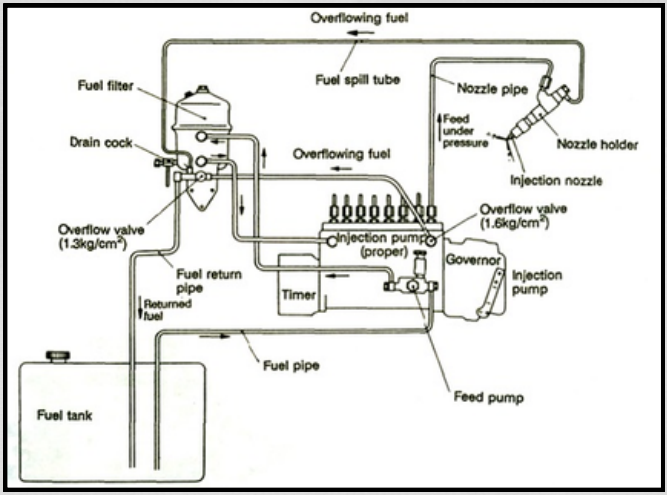


- **In-Line Injection Pumps or Plunger Type Pump or Diesel Jerk Pump – Mechanical type**
  - "in-line" because the pump is mounted directly in line with the **fuel supply** and **delivery pipes**.
  - driven by the **engine's camshaft**, and the amount of fuel delivered is regulated by **control rack**
  - uses a **plunger** to create **high pressure** in the fuel line and inject fuel into the engine.
  - "jerk pump" refers to the pumping action created by the plunger, which **moves back and forth in a jerky motion** to deliver fuel to the engine.
  - is a high pressure pump on a diesel engine - fuel pressure up to **18,000 PSI** individually.
  - simple in design, reliable, and widely used in older diesel engines.
  - less complex than other types of diesel fuel injection pumps, but may **not provide as precise control** over fuel delivery and timing as other pump designs.
  - There are 5 main components in the inline injection pump :
    - Camshaft pump
    - Plunger
    - Fuel barrel
    - Fuel feed
    - Rack and pinion





- **Multiple plunger injection pump - Mechanical type**
  - inline type uses one plunger for one injector
  - uses multiple plungers instead of just one, to deliver fuel to the engine in a precise manner.
  - commonly used in diesel engines
  - allows for the delivery of multiple injections per engine cycle
  - improve engine performance, fuel efficiency, and emissions



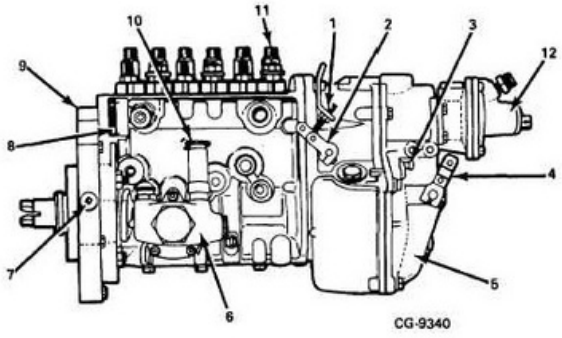
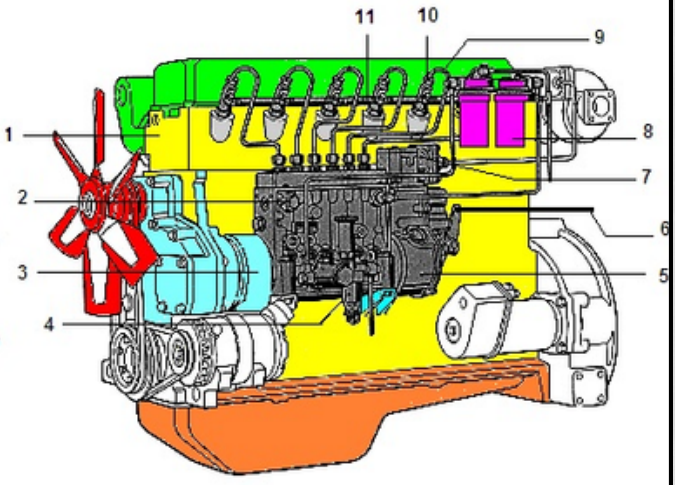


Figure 1. Robert Bosch Model MW Fuel Injection Pump

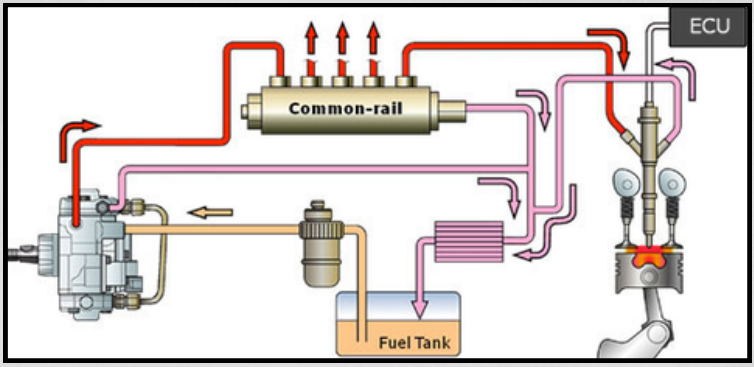
1.	Shut-off Stop Screw	5.	RQV Governor Housing	9.	Mounting Adapter
2.	Shut-off Lever	6.	Fuel Supply Pump	10.	Hand Priming Pump
3.	High Idle Stop	7.	Timing Pointer Plug	11.	Plunger
4.	Throttle Lever	8.	Serial Number Plate	12.	Aneroid

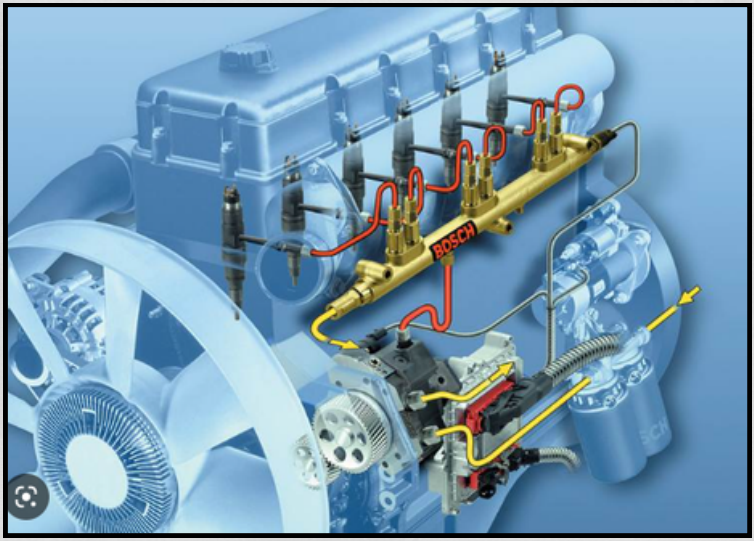
Fig. 1
1. Diesel engine
2. Standard in-line fuel-injection pump
3. Timing device
4. Presupply pump
5. Governor
6. Control lever with linkage to accelerator
7. Manifold pressure campensator
8. Fuel filter
9. High pressure delivery line
10. Nozzel and holder assembly
11. Fuel return line

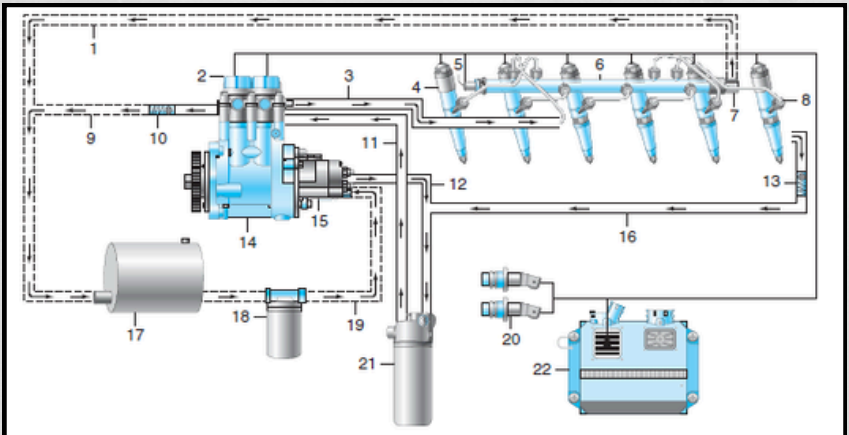


1. Type PE in-line fuel pump on 6 cylinder diesel engine

- **Common rail systems (CRS)**
  - uses a **continuous pump** (high-pressure pump) to supply fuel to a common rail, which then distributes fuel to each injector
  - Continuous pump generate pressure at (**30,000 - 40,000 PSI**).
  - pump will suppress the fuel and hold the fuel pressure at the applied limit to ensures that once the **Electronic Control Unit (ECU) opens the injector**, fuel can be atomized
  - improved **engine performance, fuel efficiency**, and **reduced emissions**.



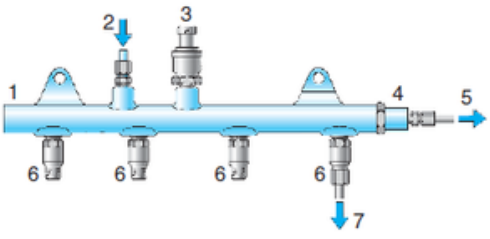




FUEL SYSTEM DIAGRAM

1. Return line from pressure relief valve to tank
2. Solenoid for the fuel pump
3. High-pressure supply line
4. Electrohydraulic injector (EHI)
5. Fuel pressure sensor
6. Fuel rail
7. Pressure relief valve for the fuel rail
8. Quill tube
9. Return line from fuel pump to tank
10. Pressure relief valve for the fuel pump
11. Fuel line from secondary filter to fuel pump
12. Fuel line from transfer pump to fuel filter
13. Pressure regulator for the drain line
14. Fuel pump
15. Transfer pump
16. Fuel line for the drain back to filter
17. Fuel tank
18. Primary fuel filter
19. Fuel line from the primary filter to the transfer pump
20. Speed/timing sensor
21. Secondary fuel filter
22. Engine control module (ECM)

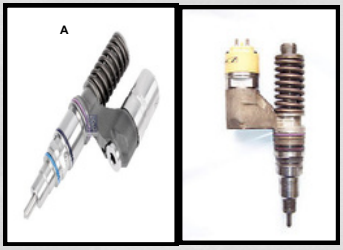
- **Components top of common rail system**
  - **common rail or accumulator**
    - receives fuel from the high-pressure pump
  - **Pressure Limiter Valve/ Pressure Relief Valve**
    - acts to limit the maximum fuel pressure in the rail to a specification
  - **Rail pressure sensor**
    - Monitoring and send a signal of fuel pressure, temperature and flow to electronic control module
  - **flow limiter**
    - prevents continuous injection
    - flow limiter shuts off the line to the problem injector.
    - The flow limiter is a fail-safe device that is rarely engaged.
  - **High-Pressure Fuel Lines.**
    - handling the fuel with maximum pressures

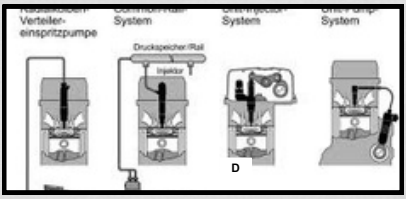


1. Rail
2. Inlet from the high-pressure pump
3. Rail pressure sensor
4. Pressure limiter valve
5. Return from the rail to the fuel tank
6. Flow limiter
7. Line to the injector

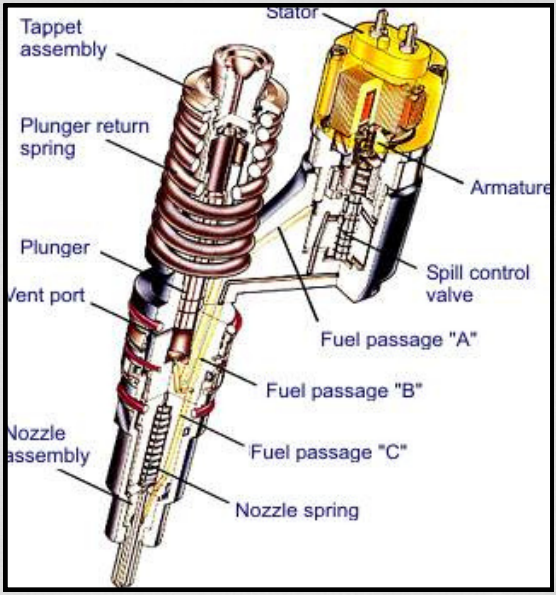
Figure 15-18 Bosch common rail. *(Courtesy of Robert Bosch GmbH, www.bosch-presse.de)*

- **Unit Injector systems (UIS)**
  - **combining the injector nozzle and the injection pump in a single component**
  - **consists of individual fuel injectors for each cylinder**
  - mounted directly into the cylinder head.
  - combine the functions of the fuel pump, fuel filter, and fuel nozzle into a single compact unit.
  - require more maintenance due to the presence of multiple injectors
  - commonly used **in heavy-duty vehicles such as trucks and buses**.
  - Technical **characteristics:**
    - **individual pump** is assigned to each cylinder
    - The **pump and nozzle** combined in a compact assembly which is installed directly in the cylinder head
    - injection pressures up to **2,200 bar @ 36,000 psi**
  - Advantages:
    - **High performance** for **clean and powerful engine**
    - High engine **power balanced** against low consumption and low engine emissions
    - High **degree of efficiency** due to compact design
    - **Low noise level** due to direct assembly in the engine block
    - Injection pressures up to 2,200 bar for the **ideal combination of air-fuel mixture**.



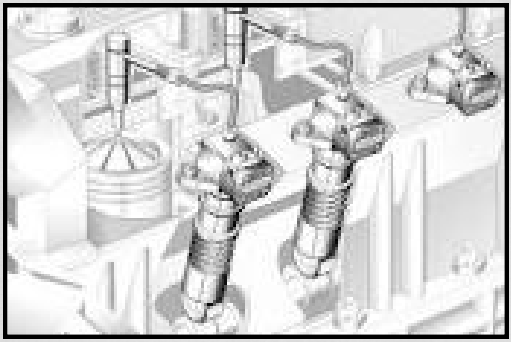


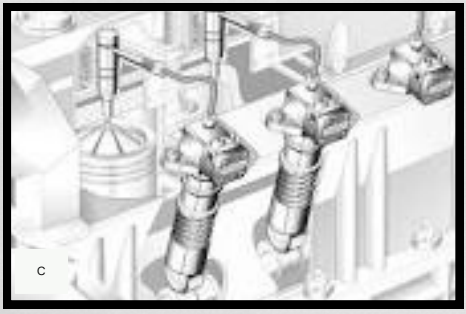
a. **Unit Injector**
b. **Unit Injector on Scania V8 engine**
c. **Bosh Unit Injector**
d. **Types of injector**

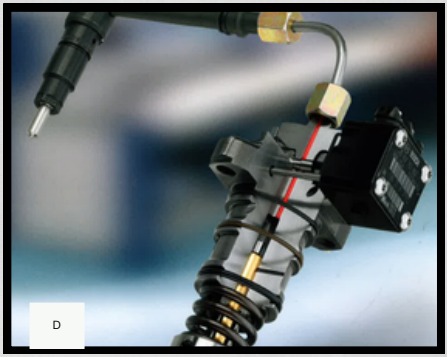

Stator
Tappet assembly
Plunger return spring
Armature
Plunger
Spill control valve
Vent port
Fuel passage "A"
Fuel passage "B"
Nozzle assembly
Fuel passage "C"
Nozzle spring

49

- UNIT PUMP SYSTEM (UPS)
  - EACH CYLINDER OF THE ENGINE HAS ITS OWN FUEL PUMP
  - INDIVIDUAL INJECTION PUMP MOUNTED ON THE ENGINE BLOCK FOR EACH CYLINDER
  - DESIGNED FOR OHV (AN OVERHEAD VALVE (OHV) ENGINE, SOMETIMES CALLED A PUSHROD ENGINE) OR “CAM IN THE BLOCK“ ENGINES
  - EITHER DRIVEN BY AN EXTRA CAMSHAFT LOBE OR BY AN ELECTRICAL SUPPLY
  - ARE RELATIVELY SIMPLE AND REQUIRE LESS MAINTENANCE
  - PRECISE CONTROL OVER FUEL DELIVERY, IMPROVES ENGINE PERFORMANCE, REDUCE EMISSIONS, ENGINE NOISE AND FUEL EFFICIENCY.

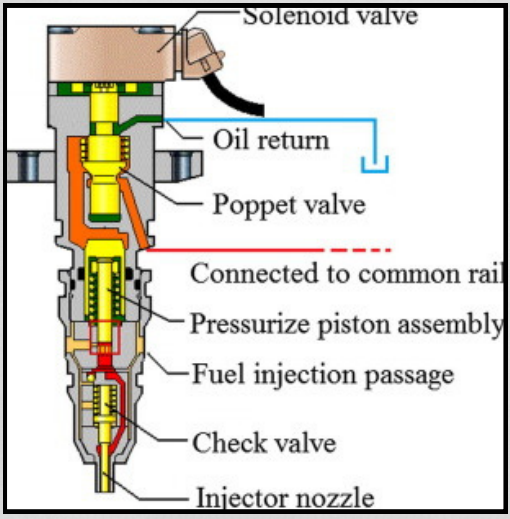


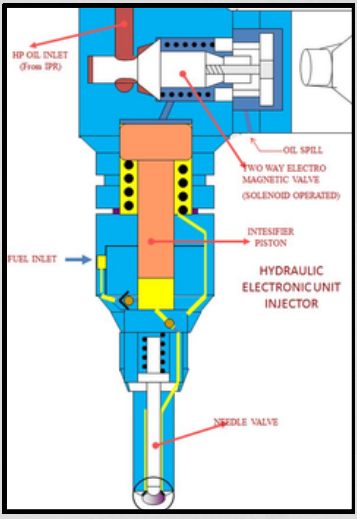




A. UNIT PUMPS ON MACK'S E7 DIESEL ENGINE
B. UNIT PUMPS ON MERCEDES OM906LA ENGINE
C. BOSCH UNIT PUMP
D. BOSCH UNIT PUMP

- **Hydraulic Electronic Unit Injection (HEUI)**
  - It uses **high-pressure oil**, **instead of a camshaft** rather than the traditional mechanical fuel pump, to pressurize and inject fuel into the engine.
  - The **electronic unit controls** the **timing** and **amount** of fuel delivered to the engine, resulting in improved fuel efficiency and emissions control.
  - HEUI systems are commonly found in heavy-duty trucks and off-road equipment.





Chapter 4 - Diesel engine injector testing procedure

Diesel Injector Nozzle Test

Equipment : Pop Tester

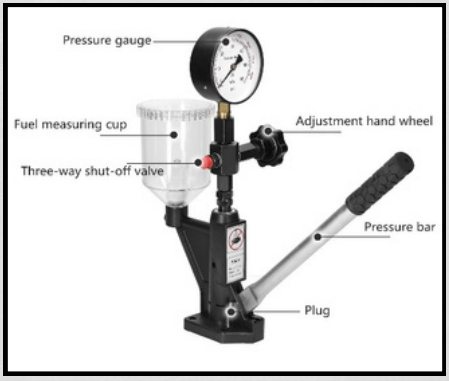
Function : to run a mechanical diesel fuel injector test procedure such as pressure, spray pattern and dribbling (under pressure)

Nozzle defects are usually indicated symptoms such as:

a. Black,gray, or white exhaust smoke
b. Low power
c. Misfire under load
d. Rough engine operation after the engine is warmed up

Test Fluid:

Hydraulic fluid ISO VG10



Types of testing procedure :

1. Nozzle opening pressure (NOP)
2. Nozzle spray pattern
3. Dribbling/ leak test

Safety procedure :

Never put hand on nozzle during test!

Pressure test procedure :

1. **Nozzle Opening Pressure (NOP) Test**
    a. To determine whether a nozzle valve is opening and closing at the pressure recommended by manufacturer
    b. Procedure :
        1. Remove nozzles from the engine
        2. Inspect and clean the nozzles
        3. Visually check for missing sealing washers or improperly installed nozzles
        4. Set up pop tester
        5. Purge the nozzle tester of air by pumping the handle several times until clean fluid appears from the high pressure line
        6. Ensure the workbench area is clean
        7. Install the nozzle to high pressure adapter (tester line)
        8. Bleed air 8 – 10 quick strokes to expel air from injector nozzle
        9. Observe and record the NOP by pumping the pressure bar within the specified pressure (usually 1500-2000 psi)
        10. Injector NOP may vary according to type of nozzle and manufacturer Compare the result with specifications.
        11. Recommend replacement or overhaul if the NOP does not consistently fall within an acceptable range.

2. Nozzle Spray Pattern

a. To determine whether a nozzle spray patterns is uniform and symmetrical

b. valve is opening and closing at the pressure recommended by manufacturer (normally 1500-2000 psi)

c. Procedure :

1. Install the nozzle in the pop tester following the steps **1 – 8** in NOP tests.
2. Carefully observe the spray pattern or characteristic of the nozzle by pumping the tester handle rapidly.
3. Spray pattern from each orifice should be the same size and uniform in shape. Injectors showing poor patterns should be replaced or rebuilt.
4. Listen for **nozzle chatter**. If nozzle doesn't chatter should be replaced or rebuilt.

3. Dribbling/ leak test

d. To determine a nozzle for any signs of fuel leakage or dribbling

e. Procedure :

1. Install the nozzle in the pop tester following the steps 1 – 8 in NOP tests.
2. Apply the specified pressure by pumping the tester handle (normally <1000 psi)
3. Observe the nozzle and collect the fuel that is dripping from it into the container.
4. Measure the quantity of fuel that has dripped from the nozzle for a specified amount of time (usually 60 seconds).
5. Compare the quantity of fuel collected with the manufacturer's specifications. If the quantity of fuel collected is outside the specified range, then the nozzle is considered to have failed the dribbling test and needs to be replaced or repaired.
6. Repeat the test for all the other diesel injector nozzles in the engine.
7. Once the dribbling test is complete, reassemble the diesel injector nozzles and reinstall them in the engine

References

- Main :

1. Halderman, J.D. (2021). Automotive Technology: Principles, Diagnosis, and Service. Prentice Hall
2. Bennet, S. (2019). Heavy Duty Truck Systems. Boston USA: Cengage

- Additional :

3. Duffy O.C. & Wright G. (2019). Fundamentals of Medium-Heavy Duty Commercial Vehicle Systems. Jones & Bartlett Learning
4. Thomas M. (2014). Truck and Trailer Systems. McGraw-Hill Education.
5. Bennet S.(2014). Modern Diesel Technology: Diesel Engine (2nd Ed.) Delmar Cengage Learning

DIESEL FUEL SYSTEM DIPLOMA IN COMMERCIAL VEHICLE TECHNOLOGY

e ISBN 978-629-99747-2-7

KOLEJ KOMUNITI BANDAR DARULAMAN
(online)

AUTHOR
ILYAS MOHD NAWI
AMRUL OMAR
MUFFILI MAHADI