

Tips & Technology

For Bosch business partners

Current topics for successful workshops No. 02

Trucks



BOSCH

Invented for life

High-pressure pumps in the common rail system for commercial vehicles

Requirements and tasks

The high-pressure pump forms the interface between the low and high-pressure section. Its function is to reliably provide a sufficient quantity of compressed fuel in all operating ranges and over the entire vehicle lifetime. This includes the provision of the fuel reserve required for quick starting and rapid pressure build-up in the rail. The high-pressure pump constantly generates the system pressure for the rail independently of injection. In contrast to conventional injection systems, there is thus no need for the fuel to be compressed in the course of injection.

Different high-pressure pump versions are used in commercial vehicles. Within each pump generation there are versions with different delivery rates and pressures.

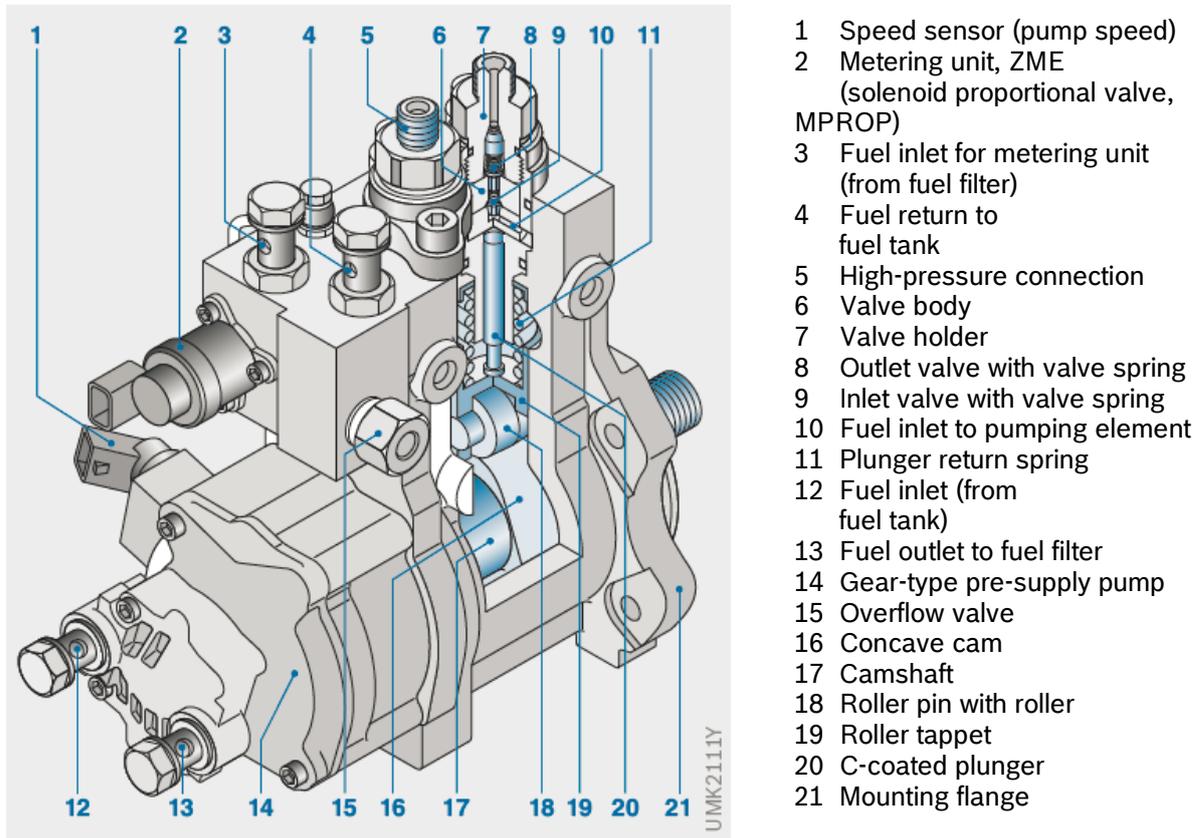
Pump	Pressure in bar
CP2	1400
CPN2.2	1600
CPN2.2+	1600
CPN2.4	1600
CP3.2	1600
CP3.2+	1600
CP3.3	1600/1800
CP3.4	1600
CP3.4+	1600
CP4-20, -22, -25	2000/2200/2500
CPN5-22, -25	2200/2500

+ Higher delivery rate

For commercial vehicle systems use is made of fuel or oil-lubricated radial piston pumps as well as oil-lubricated 2-plunger in-line pumps. Oil-lubricated pumps are more compatible with low-grade fuel.

In-line pump CPN2

The oil-lubricated, flow-controlled high-pressure pump CPN2 is used exclusively in the commercial vehicle sector. It is a 2-plunger pump of in-line design, i.e. the two pumping elements are arranged side by side. Versions with four pumping elements in in-line arrangement are also available for special applications.



The spring seat provides a positive locking connection between the pump plunger (20) and the roller tappet (19). The cams (16) convert the rotary motion of the camshaft (17) into pump plunger lifting motion. The spring (11) is responsible for the pump plunger return motion. The combined inlet/outlet valve is mounted at the top of the pumping element. The speed increase gear-type pre-supply pump (14) located in the extension of the camshaft draws the fuel out of the tank via the fuel inlet (12) and routes it by way of the fuel outlet (13) to the fuel fine filter. The fuel is then routed via a further pipe into the metering unit located in the upper part of the high-pressure pump (ZME, Item 2; Fuel inlet, Item 3). Lubricating oil is supplied either directly by way of the CPN2 mounting flange or via an inlet on the side. The lubricating oil is returned to the engine sump by way of the front drive end bearing housing. The drive ratio is 1:2, which makes the CPN2 compatible for mounting with conventional in-line pumps.

Mode of operation

When the pump plunger moves from TDC towards BDC, the inlet valve (9) opens on account of the fuel pressure (pre-delivery pressure). The downward motion of the pump plunger causes the fuel to be drawn into the element chamber. The outlet valve (8) is closed by the valve spring. As the pump plunger moves upwards, the inlet valve closes and the fuel is compressed. When the rail pressure is attained, the outlet valve opens and the fuel is

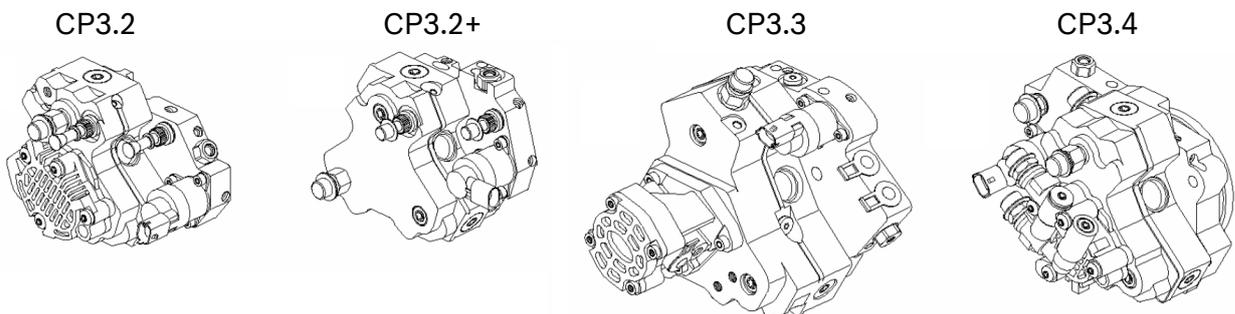
conveyed into the rail by way of the high-pressure connection (5). This increases the pressure in the rail, resulting in pressure pulsation. The rail pressure sensor measures the pressure and this is used by the electronic diesel control (EDC) system to calculate the actuation signals (PWM) for the metering unit. The metering unit regulates the quantity of fuel provided for compression to suit the current demand.

Radial piston pump CP3

The CP3 is a high-pressure pump featuring a metering unit (ZME) for suction-end quantity control. This control method was first employed in the CP3 and subsequently adopted for the CP1H for passenger vehicles. The basic design of the CP3 is similar to that of the CP1 and CP1H.

Main distinguishing features:

- Monoblock housing: This design reduces the number of sealing points in the high-pressure area and permits a higher delivery rate.
- Bucket tappets: The lateral forces arising from the lateral motion of the roller of the eccentric are not transmitted directly via the pump pistons but rather by way of buckets to the housing wall. This increases the load capacity of the pump and permits pressures as high as 1800 bar.



Pumps from the CP3 family are used in both cars and commercial vehicles. Different versions are employed to suit the delivery rate required. The range extends from the CP3.2 to the CP3.4, with the size and delivery rate increasing with each pump. The oil-lubricated CP3.4 is only fitted in "heavy-duty" commercial vehicles. Pumps designed primarily for cars may also be installed in vans and light commercial vehicles.

A special feature of systems for the "Medium Duty" and "Heavy Duty" commercial vehicle sector is that the fuel filter is located on the delivery end. The filter is situated between the gear pump and the high-pressure pump and permits a higher filter impact level before replacement becomes necessary. The high-pressure pump always requires an external connection for the fuel inlet, even if the gear pump is flange-mounted to the high-pressure pump.

Radial piston pump CP4

The delivery stroke of the pumping elements creates pressure pulsations in the rail which result in fluctuating injection quantities with the pump generations used to date. Precise injection with minimum fluctuations in injected quantity is increasingly gaining in significance with a view to satisfying ever more stringent emission limits. The CP4 common rail high-pressure pump permits synchronized delivery, i.e. the delivery stroke of the pumping elements is synchronized with the intake stroke of the engine cylinders. This means that pump delivery always takes place at the same crankshaft angle for each engine cylinder.

Three types of high-pressure pump are available for different engine sizes and system configurations. The CP4 high-pressure pump is suitable for medium duty applications up to a system pressure of 2 500 bar.

The CP4 was initially designed for a rail pressure of 1800 bar. It is of sufficient size to permit further increases in rail pressure to in excess of 2000 bar during the course of the product life cycle without having to alter the basic dimensions of the pump. This was achieved by the use of suitable materials and adaptation of the geometry in the high-pressure area for example.

To date the CP4 has been used in the common rail system CRSN3 with 2000 bar (CRSN3-20) and 2200 bar (CRSN3-22). Since 2013 the CP4 has additionally been available with 2500 bar (CRSN-25).

In-line pump CPN5

The CPN5-22/-25, based on in-line pump technology and provided with a new internal gear pump as pre-supply pump, is designed to satisfy the requirements of heavy duty operation up to a pressure of 2 200 bar. A more advanced version of this pump family generates up to 2 500 bar and not only helps to attain emission targets but also offers advantages in terms of fuel consumption. It is of particularly compact, sturdy and light-weight design. For pressures up to 2 000 bar, use can alternatively be made of a PF45 unit pump driven by way of the engine camshaft.

Checking high-pressure pumps in vehicles: Questions and answers

Interesting technical details.

Would you have known ...

... what differences there are between the various CP3 versions?

Answer:

The main version CP3.x is defined in terms of the piston stroke and diameter. Further sub-versions are distinguished by way of the housing bushing.

CP3 piston diameters and stroke

CP 3.2	7.5 mm piston dia.	6.8 mm stroke
CP 3.3	7.5 mm piston dia.	8.2 mm stroke
CP 3.4	7.5 mm piston dia.	9.5 mm stroke

... what the special features of CP 3.4 high-pressure pumps are?

Answer:

These are high-pressure pumps used for commercial vehicle applications. They are oil-lubricated.

... what the function of the zero delivery restrictor is on the CP3?

Answer:

It routes leakage fuel from the closed metering unit into the return.

... what the function of the flow control valve is on the CP3 with fuel lubrication?

Answer:

It provides lubrication for the pump.

... what the incoming inspection involves?

Answer:

- Cleaning the pump from the outside and sealing with plugs.
- Checking for damage
- Making sure the pump is free to turn
- Checking the sealing rings for leaks on the CP3 and checking for high-pressure valve leakage
- Making a record of the data

... what to watch out for when removing components?

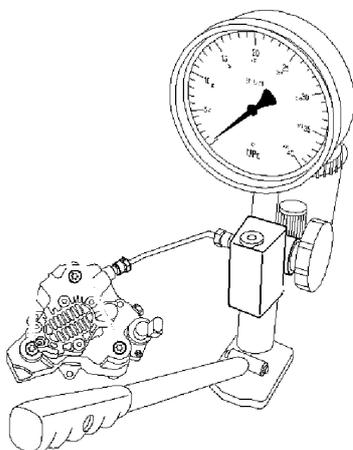
Answer:

Extract any flakes of paint.

... at which pressure levels high-pressure testing is performed on the CP3?

Answer:

Application of 100, 200 and 400 bar in succession. The pressure must not drop by more than 20 bar after 30 seconds in each case.



with the EPS100

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