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Diesel engines are becoming ever more interesting for use in motor vehicles. They are traditionally known for fuel economy and long service life. In the past few years they have now become more powerful, quieter and cleaner. Here, the fuel-injection system has played a decisive role.

Diesel fuel-injection systems from Bosch have been a major contributor to a resurgence of diesel engines embracing every automotive sector, including the high-speed engines employed in passenger cars. The rotary, or distributor injection pump, has been the prime mover behind diesel propulsion for a number of years. This pump's inherently immense precision allows it to meter exactly the correct fuel dosage, even in minute inject-fuel quantities. Continuous evolution has spawned control racks and electronic control systems that contribute to the diesel car's smooth, spontaneous performance and supremely sensitive response.

When the VP44 radial-piston high-pressure pumps fitted with a high-pressure solenoid valve was launched in 1996, it opened up a range of new opportunities, for example pre-injection to reduce noise or regulating injected-fuel quantity to individual cylinders to achieve torque control. In 1998 the solenoid-valve-controlled axial-piston distributor pump appeared on the scene. The electronic control unit integrated in the pump created a system that links technological innovation to low system costs.

This Bosch Yellow Jacket booklet from the "Expert Know-How on Automotive Technology" series deals with the design and construction of port-controlled and solenoid-valve-controlled distributor injection pumps and how their components interact within the system.

The section on workshop technology provides insights in testing and tuning these fuel-injection systems.

The basics of "Diesel-Engine Management" and "Electronic Diesel Control EDC" are described in detail in separate booklets.

High-pressure stage of the radial-piston distributor injection pump

Radial-piston high-pressure pumps (Fig. 1) produce higher injection pressures than axial-piston high-pressure pumps. Consequently, they also require more power to drive them (as much as 3.5...4.5 kW compared with 3 kW for axial-piston pumps).

Design

The radial-piston high-pressure pump (Fig. 2 overleaf) is driven directly by the distributor-pump drive shaft. The main pump components are

- the cam ring (1)
- the roller supports (4) and rollers (2)
- the delivery plungers (5)
- the drive plate, and
- the front section (head) of the distributor shaft (6)

The drive shaft drives the drive plate by means of radially positioned guide slots. The guide slots simultaneously act as the locating slots for the roller supports. The roller supports and the rollers held by them run around the inner cam profile of the cam ring that surrounds the drive shaft. The number of cams corresponds to the number of cylinders in the engine.

The drive plate drives the distributor shaft. The head of the distributor shaft holds the delivery plungers which are aligned radially to the drive-shaft axis (hence the name "radial-piston high-pressure pump").

The delivery plungers rest against the roller supports. As the roller supports are forced outwards by centrifugal force, the delivery plungers follow the profile of the cam ring and describe a cyclical-reciprocating motion (plunger lift 3.5...4.15 mm).

1 Solenoid-valve-controlled radial-piston distributor pump (cutaway view)

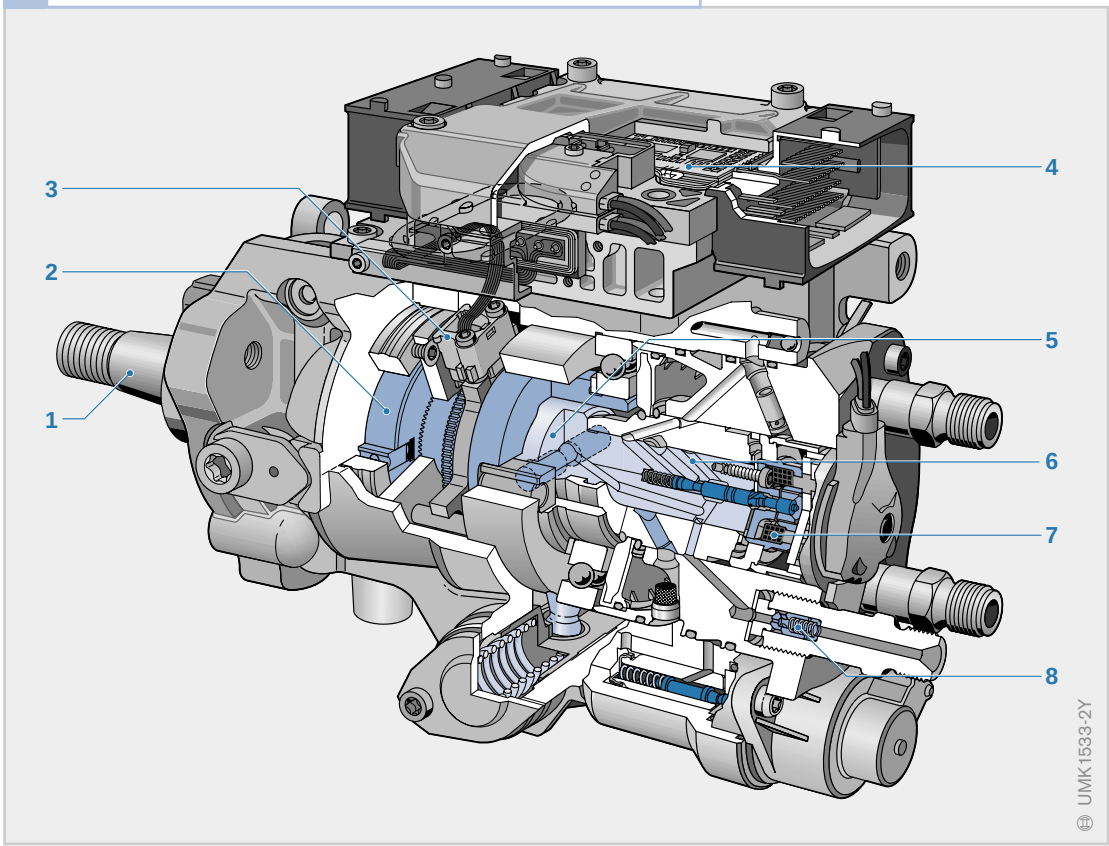

Fig. 1
1 Pump drive shaft
2 Vane-type supply pump
3 Angle-of-rotation sensor
4 Pump ECU
5 Radial-piston high-pressure pump
6 Distributor shaft
7 High-pressure solenoid valve
8 Delivery valve

When the delivery plungers are pushed inwards by the cams, the volume in the central plunger chamber between the delivery plungers is reduced. This compresses and pumps the fuel. Pressures of up to 1,200 bar are achievable at the pump.

Through passages in the distributor shaft, the fuel is directed at defined times to the appropriate outlet delivery valves (Fig. 1, Pos. 8 and Fig. 3, Pos. 5).

There may be 2, 3 or 4 delivery plungers depending on the number of cylinders in the engine and the type of application (Fig. 2). Sharing the delivery work between at least two plungers reduces the forces acting on the mechanical components and permits the use of steep cam profiles with good delivery rates. As a result, the radial-piston pump achieves a high level of hydraulic efficiency.

The direct transmission of force within the cam-ring drive gear minimizes the amount of "give", which also improves the hydraulic performance of the pump.

2 Delivery-plunger configurations for radial-piston high-pressure pumps (examples)

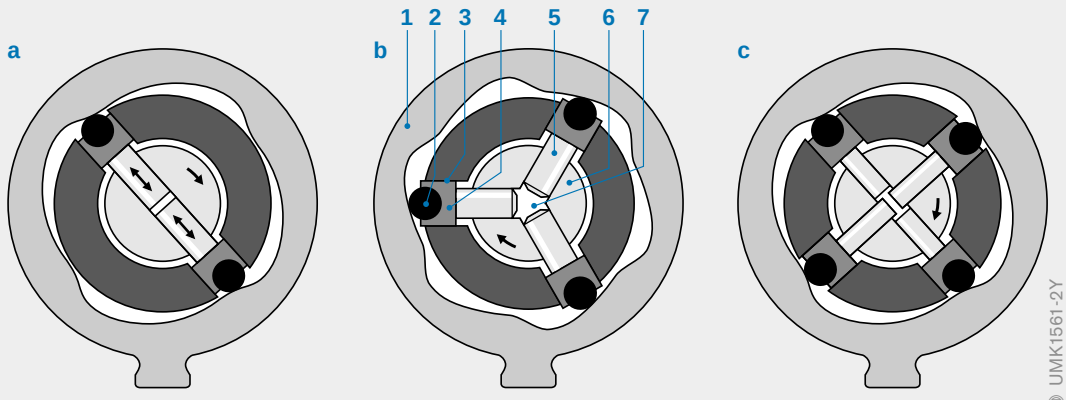

Fig. 2
a For 4- or 6-cylinder engines
b For 6-cylinder engines
c For 4-cylinder engines

1 Cam ring
2 Roller
3 Guide slot in drive shaft
4 Roller support
5 Delivery plunger
6 Distributor shaft
7 Plunger chamber

3 High-pressure stage within a solenoid-valve controlled radial-piston distributor injection pump

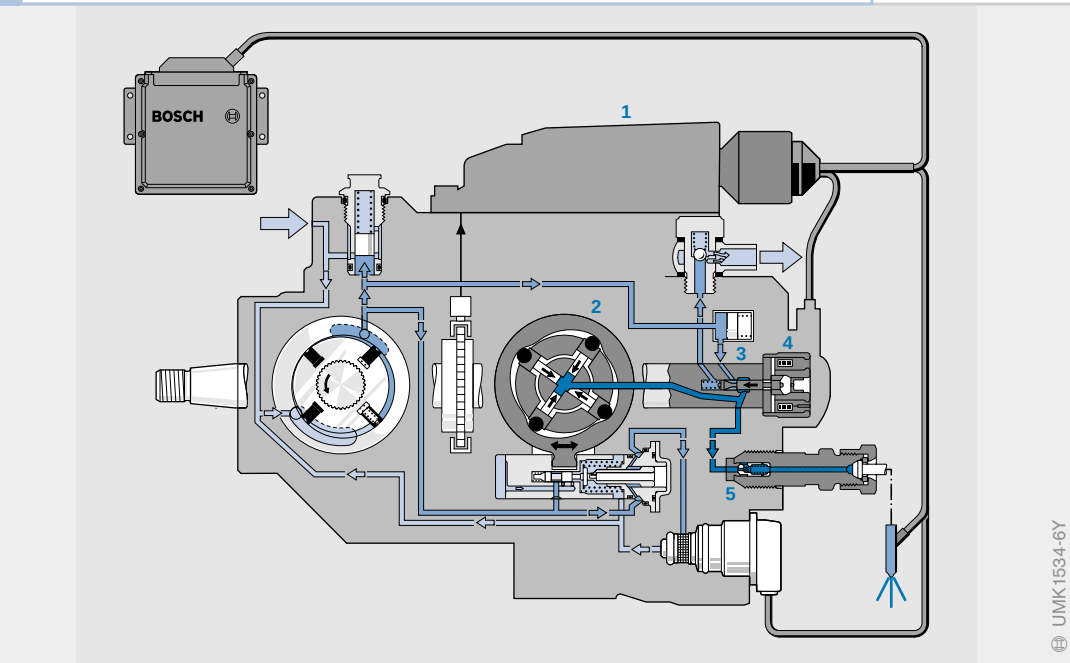

Fig. 3
For the sake of clarity, various components are shown end-on rather than side-on.

1 Pump ECU
2 Radial-piston high-pressure pump (end-on view)
3 Distributor shaft
4 High-pressure solenoid valve
5 Delivery valve