Design and Operation of the Fuel Injection System

Job No. 07–4

Change: Figure 07-4/2 corrected

A. OM 636

I. Injection Pump

The injection pump is a single-acting plunger pump. The injection pump contains one pump element consisting of cylinder and plunger for each engine cylinder. The plunger is lapped in the cylinder and has a clearance of 2 to 3 thousandth of a millimeter, so that it is sealed without special packing even at very high pressures and low speeds. Plunger and cylinder are therefore only interchangeable as a complete set.

The injection pump has the task of injecting a certain quantity of fuel at a pressure of approx. 110 to 150 atm. and at a certain time into the combustion space of the cylinder. Since the fuel in the diesel engine, as is well known, is self-igniting due to the highly compressed and therefore highly heated combustion air, the moment of injection is of essential importance. For this reason an injection timing device was incorporated in the drive assembly of the different injection pumps, so that the feed beginning is timed in relation to the engine speed.

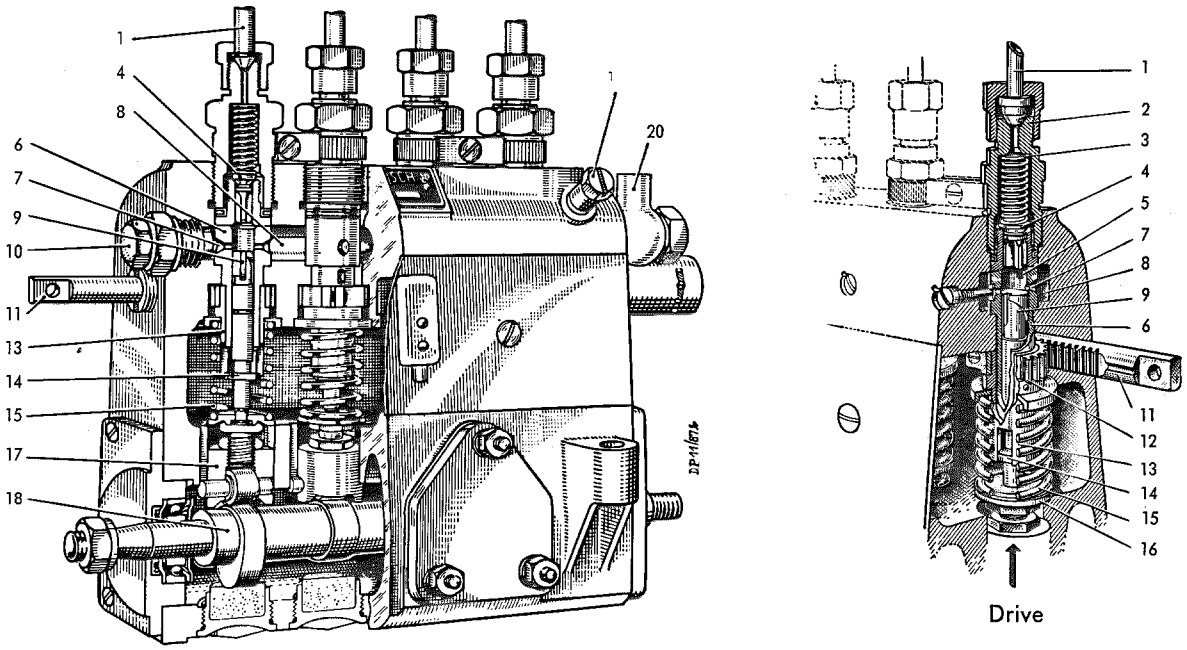

Fig. 07–4/1

1 Pressure line
2 Pipe connector
3 Valve spring
4 Pressure valve
5 Pressure space
6 Cylinder
7 Control port (inlet and return hole)
8 Suction space
9 Plunger
10 Screw plug
11 Control rod
12 Pinion
13 Control sleeve
14 Plunger lug
15 Plunger spring
16 Spring retainer
17 Roller tappet
18 Camshaft
19 Bleeder screw
20 Fuel inlet

The big advantage of the injection pump is the fact that each cylinder receives exactly the same quantity of fuel. The control of the fuel quantity and/or discharge rate is handled by the ingeniously designed pump elements in connection with the incorporated governor.

The discharge rate is changed by turning the pump plunger (9). A pinion (12) is clamped to the upper end of the control sleeve (13) which houses the pump cylinder. In the lower part of the control sleeve (13) are two longitudinal slots (Fig. 07–4/1), which guide the piston lugs (14). The control rod (11) is geared to the pinion (12). The pump plungers can therefore be turned with the control rod; the discharge rate of the pump can thus be infinitely varied from zero to maximum.

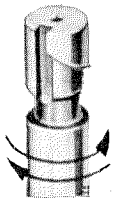

Fig. 07–4/2

Former design with compensating groove

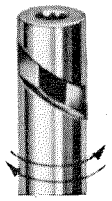

Fig. 07–4/3

Present design with compensating borehole, single-hole element

The plunger has a sloped groove, of which the upper edge serves as the control edge. In the plunger is a longitudinal hole (compensating hole), which connects the pressure space (5) (Fig. 07–4/1) with the sloped groove in the plunger (Fig. 07–4/3). The pump plungers of the former design have in place of the compensating hole a longitudinal groove in the plunger surface, which connects the pressure space (5) with the compensating groove in the plunger (Fig. 07–4/2).

The pump cylinder (6) is provided with a control port (inlet and return hole) (7), which connects the pressure space (5) with the suction space (8) depending on the position of the plunger (see Fig. 07–4/1).

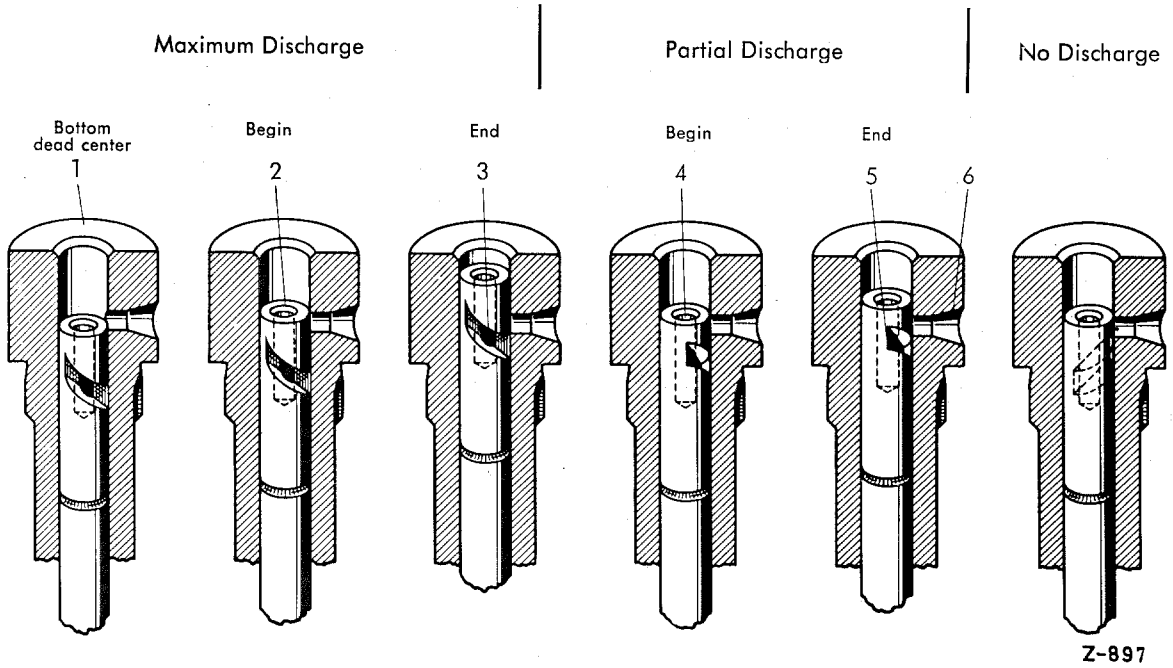

Fig. 07–4/4

1 Cylinder
2 Plunger
3 Sloped control edge
4 Compensating hole
5 Sloped groove
6 Control port (inlet and return hole)

During the pressure stroke the pump plunger (9) is lifted by a cam and during the suction stroke it is forced down again by the plunger spring (15) (Fig. 07–4/1). The stroke of the pump plunger cannot be varied.

The suction space is filled with fuel constantly kept under a gauge pressure of 1 to 1.5 atm. by the feed pump. If the pump plunger is at the bottom dead center, the control port (6) is opened and the pressure space is filled with fuel. During the upward motion the plunger closes the control port (6) and presses the fuel through the pressure valve into the pressure line. The delivery begins (see Figure 07–4/4).

The delivery ends as soon as the upper control edge has reached the control port (6), because the pressure space is now connected with the suction space via the compensating hole (4) in the plunger (Figure 07–4/4) or at the former units via the longitudinal groove, thus bringing about an equalization of pressure.

As already mentioned, the discharge rate is varied by the turning of the plunger. Figure 07–4/4 clearly shows that the plunger opens the control port sooner or later during the discharge stroke depending on the respective turning position. The output is largest if the plunger is turned full clockwise, the output becomes smaller if the plunger is turned counter-clockwise. In order to reach the zero output position (stop position) the plunger must be turned fully counter-clockwise. In this position the upper control edge immediately opens the control port (6). Thus the pressure space (5) is continuously connected with the suction space (8) and there will therefore be no discharge (Figure 07–4/1). The feed begin of the injection pump is constant, excepting the injection pumps (e.g. Model RS 204) with pump plungers with additional upper ("double") control edge. The end of delivery, however, depends on the discharge rate and/or the turning position of the plunger.

II. Pressure Valve

The pressure valve has the task of closing the top of the pressure space and relieving the pressure line. Relieving of the pressure line is necessary to allow a fast closing of the nozzle needle and to prevent dribbling of fuel into the combustion chamber. This is simply and safely achieved by the special design of the pressure valve, as can be seen in Figure 07–4/5.

The stem (5) of the pressure valve is guided in the valve seat (1). During the discharge stroke the valve is lifted off the seat, so that the short cylindrical stem section (3) (small plunger) leaves the bore and opens the way for the fuel which enters the pressure line via the annular groove (4) and the longitudinal groove (6).

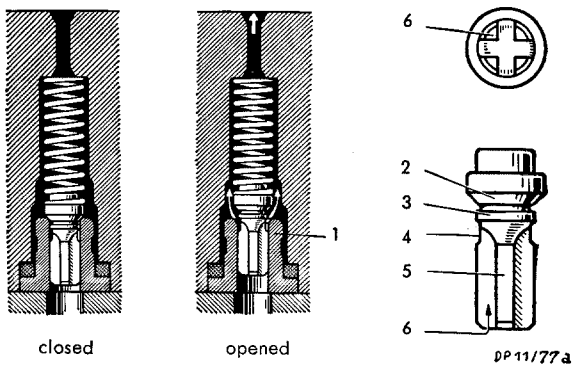

Figure 07–4/5
Pressure valve

1 Valve seat
2 Valve cone
3 Plunger
4 Annular groove
5 Stem
6 Longitudinal groove

As soon as the control edge opens the control port, the pressure drops in the pump cylinder. The higher pressure in the line and the valve spring press the pressure valve on its seat. The pressure valve closes the pressure line against the pump cylinder until the fuel output starts again during the next discharge stroke.

At the end of discharge the small plunger located above the valve seat first enters the bore and closes the pressure line against the pressure space. Only then, the cone drops on the seat.