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DEVICE FOR INJECTING FUEL INTO INTERNAL COMBUSTION ENGINES

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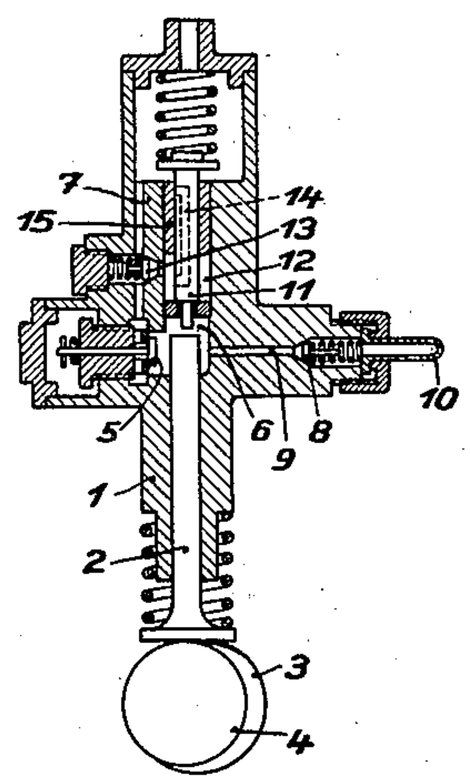
Fig. 1.



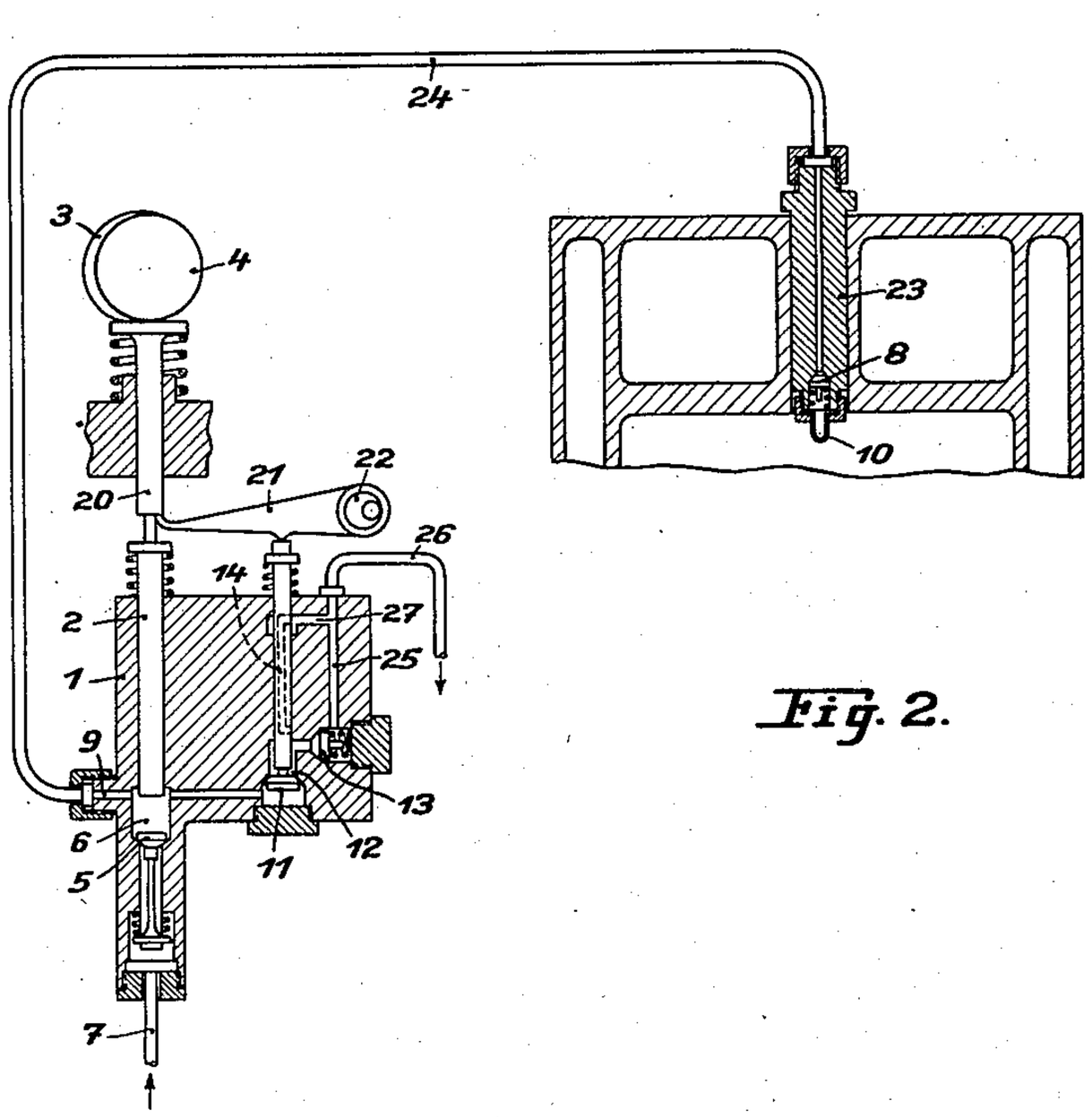


Fig. 2.

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DEVICE FOR INJECTING FUEL INTO INTERNAL COMBUSTION ENGINES

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5 Claims. (Cl. 123—139)

This invention relates to devices for injecting fuel into internal combustion engines of the kind which consist of pumping means, such as a fuel pump, and one or more injection nozzles having, however, no special fuel valve but only one or more pressure valves between the piston of the fuel pump and the injection nozzle or nozzles. In such devices it is known to interrupt the fuel injection by means of a special relief valve which is opened during the compression stroke of the pump piston and thus places the compression side of the pump in communication either with the suction pipe of the pump or with a special pipe which leads the oil flowing through the relief valve back to the fuel container.

On the opening of the relief valve during the compression stroke of the pump piston, the pressure in the pump space and the pressure pipe drops quickly to about atmospheric pressure. The closing movement of the pressure valve does not take place instantaneously upon this drop, however light the valve may be and however powerful its spring loading. As a result there is an opportunity for the high pressure which is set up in the motor cylinder during the injection to force a part of the oil back past the pressure valve before the latter has had time to close. This in turn results in hot gases flowing through the fine holes in the injection nozzle into the supply passage in the neighborhood of these holes and producing coking or carbonization of the oil in the holes and in the passage behind them. Such coking has a harmful influence on the injection process and on the atomization of the oil.

The object of the invention is to prevent the oil from flowing back in this way. With this object in view, the relief valve, according to the present invention, opens into a space provided with a spring-loaded outlet valve, the spring-loading of which is such that this outlet valve opens at a pressure which approximately corresponds to or exceeds the pressure present in the combustion space of the motor at the end of the injection, that is at the instant when the relief valve is opened. This valve arrangement makes it impossible for the pressure in the pump space to drop at the end of the injection period below the pressure in the combustion space of the motor. Flowing back of the oil as described above is therefore prevented, as also is any coking in the holes of the nozzles or in the passage behind them. After the pressure valve has once returned to its closed position, it can, of course, be assumed that it will hold tight and it is therefore possible subsequently to allow the pressure in the pump space to drop without risk.

In order that the invention may be clearly understood and readily carried into effect, two devices constructed in accordance therewith will now be described by way of example with reference to the accompanying drawing in which Figures 1 and 2 show longitudinal sections through the two devices. The device shown in Figure 1 is applicable to a low pressure motor in which the end of the injection takes place at the same crank angle at all loads, while in Figure 2 a device is shown for a motor with compression ignition in which the beginning of the injection remains constant but the end of the injection may be varied by opening the relief valve earlier or later in any suitable manner.

Referring first to Figure 1, the pump casing of a fuel pump or supply means is shown at 1 and the piston at 2. The piston 2 is driven by a cam 3 fixed on a shaft 4. This shaft can, for instance, be the control shaft of an explosion or prolonged combustion engine. As shown in the drawing the pump is provided with a suction valve 5, which controls the communication between the pump space or compression chamber 6 and the suction passage 7, and also with a pressure or check valve 8 which is arranged at the end of a pressure supply passage 9 immediately in front of an injection nozzle 10. The latter projects into the combustion space of a motor which is not shown. A relief valve 11 is provided on a bore in line with the piston 2 and is opened by the piston 2 during the stroke of the latter for the purpose of interrupting the fuel supply. The relief valve 11 controls the communication between the pump space or compression chamber 6 and a chamber 12 which is separated from the suction passage 7 by a spring-loaded valve 13. The spring for biasing the movable valve member towards its seat is located between the valve member and an adjustable plug screwed into a threaded hole of the pump casing. The spring-loading or biasing of this valve 13 is made such that the pressure required to open the valve is of the order of the pressure in the combustion space of the motor at the end of the fuel injection, that is on the opening of the relief valve 11. The valve 13 thus ensures that at the interruption of the injection the pressure in the pump space 6 shall not drop below the pressure in the cylinder. The closing of the pressure valve 8 at the end of the injection period is effected by the pressure in the combustion space and the spring for the valve. The pressure with which the spring forces the valve towards its

seat, together with the pressure in the combustion space, is greater than the pressure of the fuel in conduit 9. The closing of the pressure valve 8 may take somewhat more time than in ordinary arrangements. In spite of this fact no gases can escape from the combustion space into the fuel supply conduit 9 as the fuel pressure in conduit 9 is as great or greater than the pressure in the combustion space at the time when valve 8 closes. The slower closing of the pressure valve 8 has the advantage also that it minimizes undesirable oscillations of the fuel in conduit 9. The risk mentioned above of coking or carbonizing in the outlet holes or in the passage of the nozzle 10 is consequently removed, since on account of the said pressure ratio no oil will flow back past the pressure valve 8. The pressure required to open the valve 13 is, however, lower than that required to open the pressure valve 8, so that during the further movement of the piston 2, after this has opened the relief valve 11, oil can flow back from the chamber 12 to the suction passage 7.

In order that the pressure valve may be securely held in its closed position, the relief valve may be arranged in such a way that on the further movement of the pump piston the pressure in the pump space 6 or chamber 12 drops. This is effected, in the construction shown in Figure 1, by providing the relief valve 11 with a passage 14 which opens above the guide 15 of the valve rod when the relief valve moves further outward. This arrangement has the advantage that any air which may be present in the pump space on the starting of the motor is given an opportunity of escaping freely through the relief valve.

In the construction shown in Figure 2, 1 as before indicates the pump or fuel supply casing, 2 the pump piston, 3 the driving cam, 4 the cam shaft, 5 the suction valve, 6 the pump space or compression chamber and 7 the suction pipe. In this construction the pressure valve 8 is arranged in a special valve casing 23 immediately before an injection nozzle 10, the valve casing being mounted in the cover of a motor cylinder and being placed by a pipe 24 in communication with the pressure passage 9 in the pump casing 1. The cam 3 in this case actuates the piston 2 through biasing means, such as a spring-loaded intermediate member 20. The relief valve 11 is not actuated by the piston but by a lever arm 21 actuated by the intermediate member 20 and carried on an eccentric 22, so that it can be set to open the relief valve earlier or later during the compression stroke of the piston 2. The relief valve controls the communication between the pump space or compression chamber 6 and a chamber 12, from which a passage 25 and a pipe 26 lead to the suction pipe 7. The spring-loaded valve 13 is placed in the passage 25. The spring-loading of this valve is determined in the same way as is described above with reference to the valve 13 shown in Figure 1.

In this construction also a pressure-reducing and air escape passage 14 is provided in the spindle of the relief valve 11, and places the chamber 12 in communication with a by-pass passage 27, leading to the passage 25, after the valve 11 has opened to a given extent.

The invention is not limited to the constructions described but may be applied to other constructions. For example the air escape passage 14 is not necessary. In the absence of this, a pressure is preferably maintained in the pump space which, during the whole time that there is pressure in the cylinder space, is higher than that pressure. The height of the pressure in the pump space is determined by the spring-loading of the valve 13, and the time during which the pressure must be maintained is adjusted by the cam 3 of suitable dimensions. Again when provision is made for reduction of pressure or escape of air, the passage 14 may be replaced by any suitable passage or opening controlled by the relief valve and uncovered or opened after the latter has moved off its seat through a predetermined distance.

I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In combination with an engine having a combustion cylinder, a device for injection of fuel into the cylinder, said device including a fuel pump comprising a compression space and a piston, at least one fuel injecting nozzle in said cylinder, a conduit for connecting said nozzle with the compression space, a pressure valve between the pump and the nozzle, a relief valve opening into the compression space, a chamber defined by the pump casing, said relief valve opening into said chamber, a spring-loaded outlet valve in said chamber, said outlet valve being so loaded by the spring, that the pressure necessary to open it is of the order of the pressure in the combustion space of the cylinder to prevent backflow of gases from the combustion space into the compression space during the opening of the relief valve and before the pressure valve is seated.

2. In combination with an engine having a combustion cylinder, a device for injection of fuel into the cylinder, said device including a fuel pump, a piston in said pump, at least one fuel injecting nozzle in said cylinder, a pipe connecting said nozzle with the compression space of said pump, a pressure valve between the pump and the nozzle, a relief valve in said pump, a space in said pump, said relief valve opening into said space, a spring-loaded outlet valve in said space, said outlet valve being so loaded by the spring, that the pressure necessary to open it at least corresponds to the pressure in the combustion space of the cylinder at moment at which the relief valve is opened, a bypass for said outlet valve, said bypass leading from said pump space and being opened after said relief valve has moved off its seat through a predetermined distance.

3. In combination with an engine having a combustion cylinder, means for injecting fuel into the cylinder comprising a compression chamber, pump means for supplying fuel to the chamber, a conduit between the chamber and the cylinder, a check valve means including a biasing spring in the conduit and means including said check valve for interrupting the fuel injection to the cylinder comprising a valve means, and means for biasing the valve means against its seat with a pressure of the order of the pressure existing in the combustion space of the cylinder at the moment when the check valve means is closed to prevent back flow of fuel from the cylinder into the conduit.

4. In combination with an engine having a

combustion cylinder, means for injecting fuel into the cylinder, a fuel pumping means having a compression chamber, a conduit between the compression chamber and the fuel injecting means, a pressure valve means in the conduit, another chamber, a relief valve means between the compression chamber of the pumping means and the other chamber actuated by the pumping means, an outlet valve in the other chamber, and means for biasing the outlet valve against its seat with a pressure of the order of the pressure existing in the combustion space of the cylinder at the moment when the relief valve is opened.

5. In combination with an engine having a combustion cylinder, a nozzle for injecting fuel into the cylinder, a fuel pump comprising a compression chamber and a piston, a conduit between the compression chamber and the nozzle, a pressure valve in the conduit, means for supplying fuel to the compression chamber, another chamber adjacent the compression chamber, a relief valve between the two chambers actuated by the piston, an outlet valve for the other chamber, and means biasing the outlet valve against its seat with a pressure of the order of the pressure in the combustion space of the cylinder and adapted to permit opening of the valve when the relief valve is opened, the pressure of the biasing means being lower than the pressure for forcing the pressure valve against its seat.

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