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Vuaille

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[54] **INJECTION DEVICES FOR INTERNAL COMBUSTION ENGINES**

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[51] **Int. Cl.** **F02m 59/02,** F02m 61/20

[58] **Field of Search** ..... 123/139 R, 139 AF, 123/139 AK, 139 AS, 139 DR, 139; 417/289, 307

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[57] **ABSTRACT**

The injection device has in addition to the delivery valve a reaspirating valve. The valves are arranged in sequence downstream of the pump cylinder and are aligned with this cylinder. The reaspirating valve is provided with an axial passage permanently open and adapted to allow the fuel delivered from the pump cylinder towards the delivery valve. The advantage of the device resides in a reduction in pressure drops.

5 Claims, 3 Drawing Figures

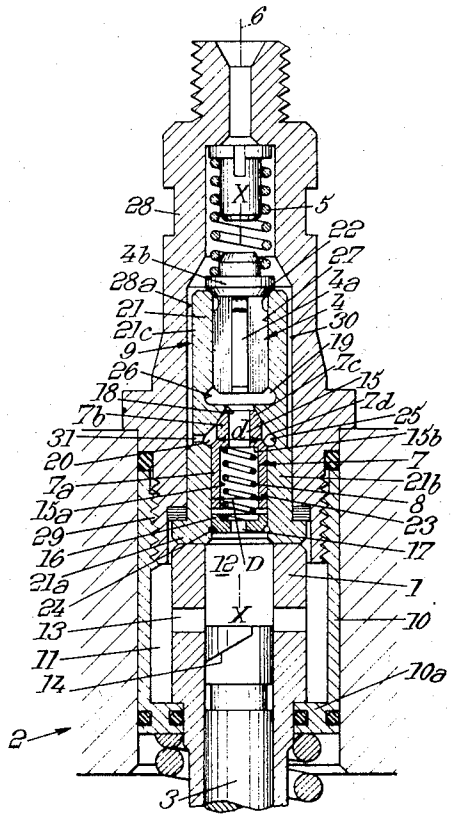

Fig. 1.

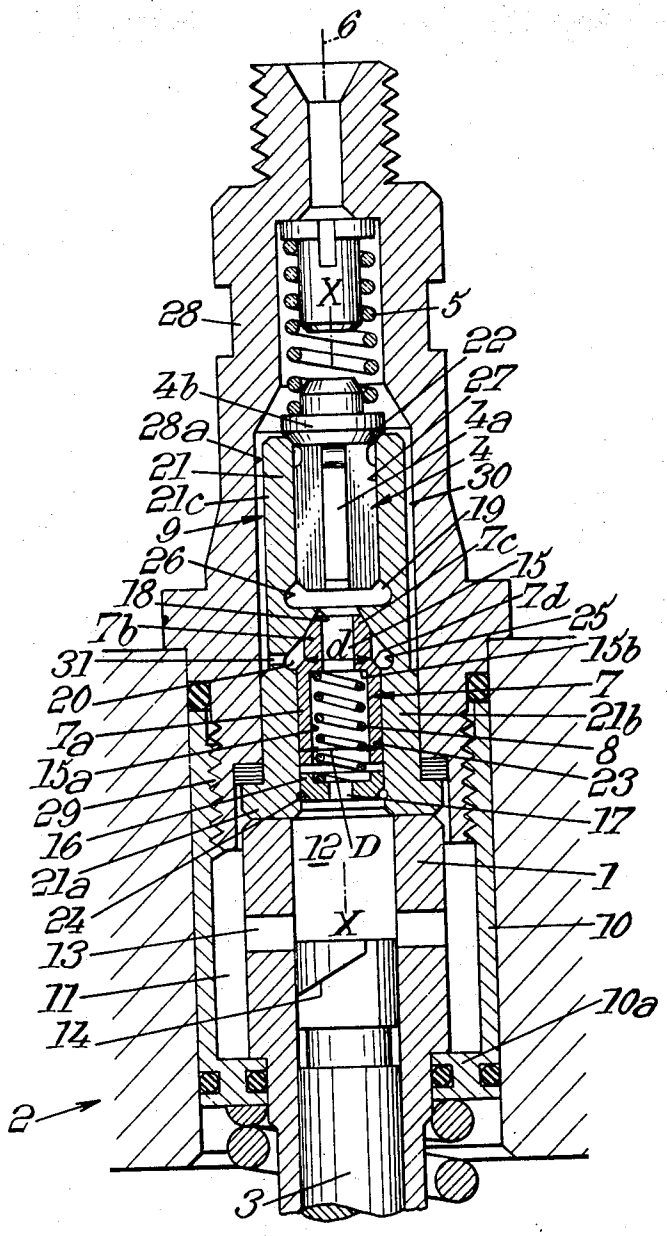
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Fig. 2.

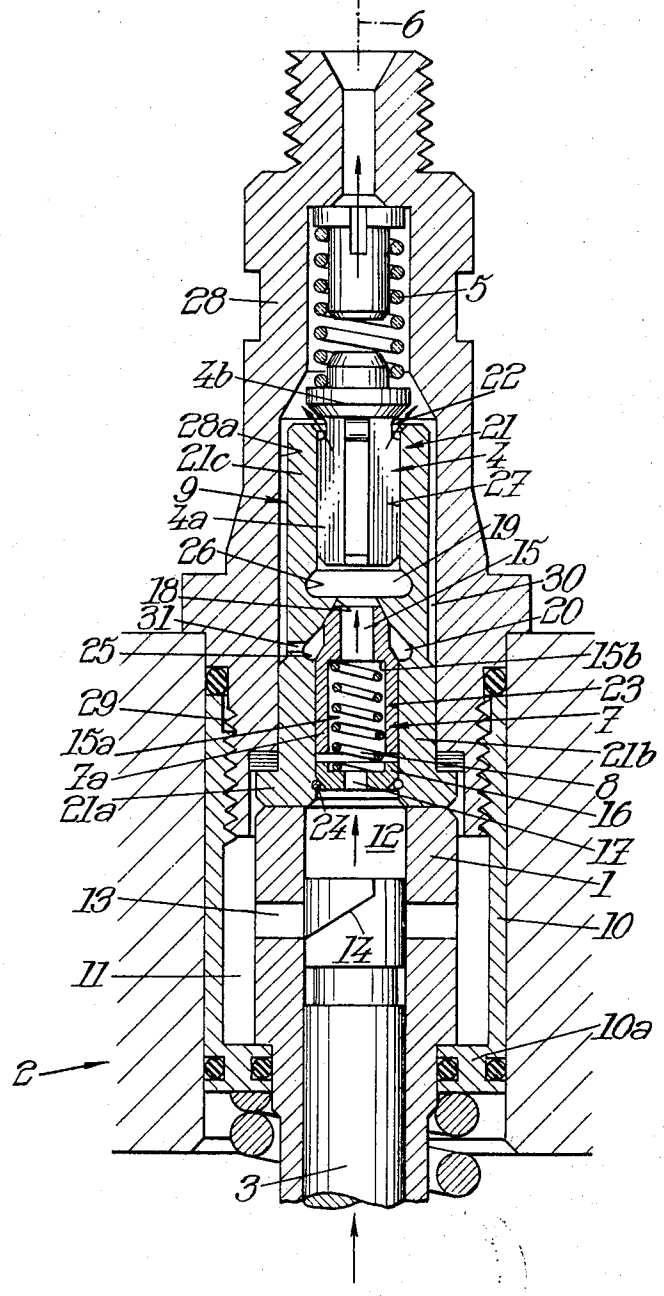
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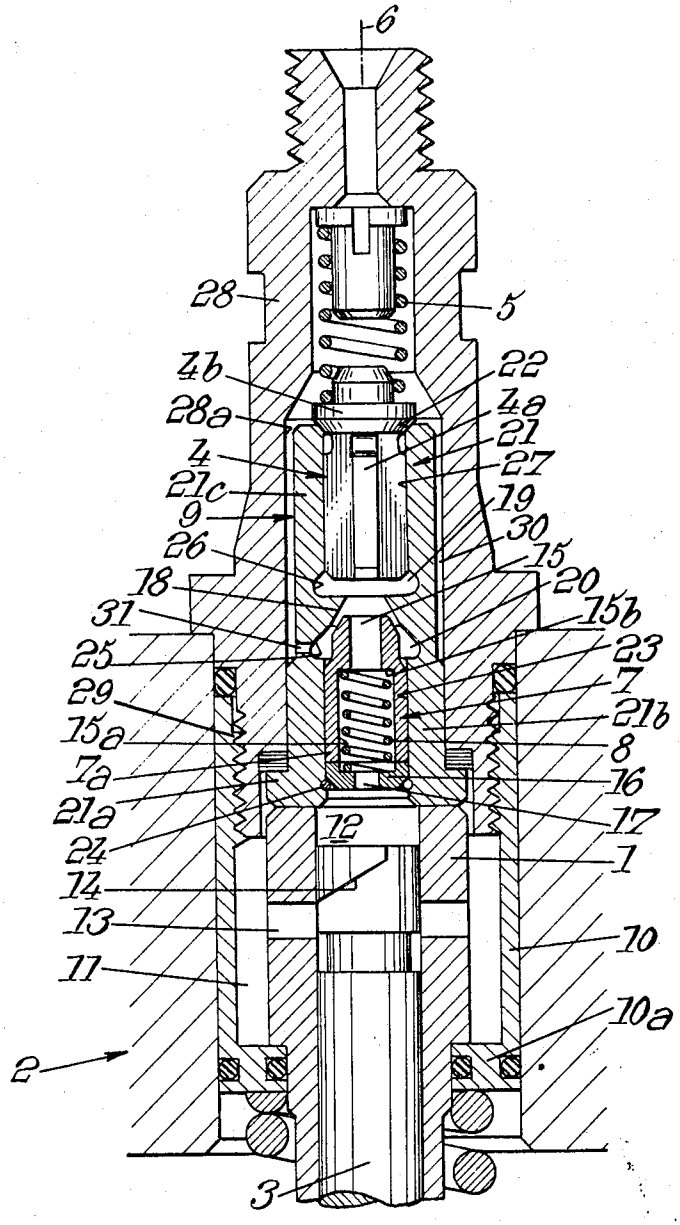
Fig. 3.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INJECTION DEVICES FOR INTERNAL COMBUSTION ENGINES

The invention relates to injection devices, for internal combustion engines, which comprise, immediately downstream of each cylinder of an injection pump wherein a piston moves, on one hand, a delivery valve urged by a spring and adapted to open on the active portion of the delivery stroke of the piston to allow liquid fuel to arrive at an injector through a linking passage and, on the other hand, a reaspirating valve also urged by a spring, arranged in a by-pass passage which connects said linking passage to the pump cylinder thereby by-passing the delivery valve and adapted to open towards the said cylinder when the difference in pressures between the linking passage and the cylinder exceeds a given limit.

It is known that such an injection device operates in the following manner. In leaving its bottom (or inner) dead center, the piston of the pump delivers, from its cylinder, fuel which lifts the delivery valve, passes into the linking passage and arrives at the injector whence it escapes by lifting the needle (or valve) of the latter. The end of the active portion of the delivery stroke of the piston corresponds to the moment when the latter effects connection of to the suction side of the pump cylinder with the delivery chamber of said cylinder. The delivery pressure of the pump then falls suddenly, which results the closing of the injector and of the delivery valve. A pressure wave is then reflected into the linking passage, from the injector to the delivery valve. It is particularly to avoid this wave being reflected again in reverse direction thereby risking the causing of an interfering opening of the injector that the reaspirating valve (also called equilibrating valve) is provided, which opens under the effect of the reflected pressure wave. The calibration of the spring of the reaspirating valve is such that it closes again in time to allow the persistance, in the linking passage, of a sufficient pressure at the end of an injection period for the injector to be able to reopen without delay from the beginning of the subsequent injection period.

It is an object of the invention to render the abovesaid injection devices such that their reaspirating valve does not disturb the flow of fuel during injection periods.

To this end, the injection device defined above is characterised by the fact that the reaspirating valve and the delivery valve are arranged in this order downstream of the pump cylinder and are aligned with this cylinder and by the fact that the reaspirating valve is provided with an axial passage permanently open and adapted to allow to pass towards the delivery valve the fuel delivered from the pump cylinder.

It is clear that, during injection periods, the fuel passes directly from the pump cylinder to the delivery valve, thereby passing through the axial passage of the reaspirating valve, so that the presence of the latter valve does not disturb the flow.

The reaspirating valve cooperates with a frustoconical seat forming part of the abovesaid by-pass passage and communicating, when this valve is open, with the portion of the delivery passage situated between the two valves and aligned with these valves, so that the axial passage of the reaspirating valve is traversed also by the fuel flowing again from the linking passage, on the opening of the latter valve. The reaspirating valve and its seat are advantageously formed according to injector technique with a reversed direction of opening, due to which good sealing is ensured and, consequently, keeping a sufficient pressure of fuel in the linking passage.

Preferably, lastly, the two valves are housed in a one piece part bearing their respective seats and mounted at the end of the pump cylinder.

In order that the invention may be more fully understood, a preferred embodiment of an injection device according to the invention is described below, purely by way of illustrative but non-limiting example, with reference to the accompanying drawings, in which:

FIGS. 1 to 3 show in diagrammatic axial section, the essential elements of one embodiment of an injection device constructed according to the invention, in positions corresponding respectively to the bottom dead center of the pump piston (valves closed), to an injection period (delivery valve alone open) and to the top dead center of the said piston (reaspirating valve alone open).

As regards the injection device, as a whole, it is constructed in any way, such that it comprises, downstream (the direction of flow being shown diagrammatically by the arrows in FIG. 2) of each cylinder 1 of an injection pump 2 wherein a piston 3 moves, on one hand, a delivery valve 4 calibrated by a spring 5 and adapted to open on the active portion of the delivery stroke of the piston 3 to allow liquid fuel to arrive at an injector (not shown) through a linking passage 6 and, on the other hand, a reaspirating valve 7 also calibrated by a spring 8, arranged on a by-pass passage 9 which connects the said linking passage 6 to the pump cylinder 1 thereby by-passing the delivery valve 4, and adapted to open towards the cylinder 1 when the difference in pressures between the passage 6 and the cylinder 1 exceeds a given limit.

In the embodiment shown, the cylinder 1 is housed inside a sleeve 10 with which it defines an annular supply chamber 11. This chamber receives the fuel from a supply pump (not shown) and can communicate with the delivery chamber 12, which is bounded by the piston 3 in the cylinder 1, by ports 13 which are obturated by the said piston when the latter has travelled from the beginning of its delivery stroke, from an intermediate position between those of FIGS. 1 and 2. As soon as the ports 13 are obturated, the fuel trapped in the chamber 12 is circulated towards the injector which it reaches by passing through the passage 6 after having lifted the delivery valve 4 against the effect of its spring 5. The end of the active portion of the delivery stroke of the piston 3 corresponds to the moment when the latter connects the delivery chamber 12 to th supply chamber 11, through ports 13 and a passage fashioned in the piston and bounded by a ramp 14, the rotation of the piston on itself enabling the volume of fuel injected per cycle to be adjusted.

According to the invention, the reaspirating valve 7 and the delivery valve 4 are arranged in this order downstream of the pump cylinder 1 and are aligned with this cylinder (along the axis X—X of FIG. 1). The reaspirating valve 7 is provided with an axial passage 15 permanently open and adapted to allow the fuel circulated from the pump cylinder 1 (or more accurately from the chamber 12) to pass towards the delivery valve 4.

To further facilitate the flow of fuel, the spring **8** is a helical spring housed in a widened portion **15***a* of the axial passage **15**, so that its turns are outside the geometrical extension of the unwidened portion of the said passage **15**. This enables the spring **8** to thrust (by its upper end in the FIGS.) on the shoulder **15***b* connecting the enlarged portion **15***a* to the rest of the passage **15**. The other end of the spring **8** bears on a fixed cup **16**, itself traversed by a hole **17** which is aligned with passage **15**.

The reaspirating valve **7** cooperates with a frustoconical seat **18** forming part of the by-pass passage **9** and communicating, when this valve is open, with a portion **19** of the delivery passage situated between the two valves **4** and **7** and in line with these values.

The reaspirating valve **7** and its seat **18** are produced according to injector technique, its direction of opening being however reversed with respect to that of the injector. To this end, the valve **7** comprises a cylindrical portion **7***a* of outer diameter D serving for its guidance, a cylindrical portion **7***b* of outer diameter *d* less than diameter D of the part **7***a* and a frustroconical portion **7***c* cooperating with the seat **18** of which the shape corresponds to that of the part **7***c*, the maximum diameter of the part **7***c* being equal to *d*. The cylindrical parts **7***a* and **7***b* are connected by a shoulder **7***d* which can have a frustroconical shape. The part **7***b* of small diameter and the shoulder **7***d* bound internally an annular chamber **20** which forms part of the by-pass passage **9**. It is clear that the pressure of the fuel in the chamber exerts a thrust on the valve **7** in the direction of opening and equal to the product of this pressure and the annular surface of outer diameter D and of inner diameter *d*.

The two valves **4** and **7** are housed in a one piece part **21** bearing their respective seats **22** and **18** and mounted at the end of the cylinder **1**. Such a part comprises internally, and successively in the normal direction of flow of the fuel: a cylindrical housing **23** for the spring cup **16**, which can be retained by an elastic ring **24**, as well as for the cylindrical part **7***a* of the reaspirating valve **7**; a groove **25** externally limiting the chamber **20**; the seat **18**; a groove **26** externally bounding the part **19** of the delivery passage; a cylindrical housing **27** for the guidance of the tail **4***a* of the valve **4**; and the seat **22** which is generally fructroconical to cooperate with the head **4***b*, also fructroconical, of the valve **4**.

The part **21** comprises a shoulder **21***a* which is gripped between the end of the cylinder **1** and a tubular connection **28** on which the linking passage **6** is adapted. The cylinder **1** is itself fixed in position against by a shoulder **10***a* at one end of the sleeve **10**, the other end being screwed to the connection **28** by means of threads **29**.

The part **21** possesses, on the side of the shoulder **21***a*, a cylindrical portion **21***b* which is adapted practically without play to the inner surface **28***a* of the tubular connection **28**, and beyond the part **21***b*, a cylindrical part **21***c* of outer diameter less than the diameter of the surface **28***a*, so that there is left outside the part **21***c* a free annular space **30**. The by-pass passage **9** is then constituted by the annular space **30**, by at least one radial channel **31** connecting the space **30** to the chamber **20** itself and the seat **18**.

There is thus obtained an injection device of which the operation is as follows. When the piston **3** is at its bottom dead center, the elements of the device occupy the positions of FIG. **1**. The delivery chamber **12** is connected to the supply chamber **11** by the ports **13**. It is therefore under low pressure; in the same way as the central passage **15** of the reaspirating valve **7** and the part **19** of the delivery passage situated upstream of the delivery valve **4**. This valve is hence maintained against its seat **22** by the spring **5**. The reaspirating valve **7** is itself held against its seat **18** by the spring **8** as will be explained below. The delivery chamber **12** is filled with fuel.

When the piston **3** moves upwardly from the position shown in FIG. **1**, it starts to obturate the ports **13**, then passes through the position illustrated in FIG. **2**. As soon as the ports **13** are closed, the fuel trapped in chamber **12** is delivered in a straight line to the part **19** of the delivery passage situated immediately upstream of the delivery valve **4**, by passing through the hole **17** of the cup **16** and through the axial passage **15** of the valve **7**. The valve **4** is thus lifted from its seat **22**, against the effect of the spring **5**, and the fuel arrives at the injector through the passage **6**. The flow of fuel is shown diagrammatically by arrows in FIG. **2**. The valve **7**, being subject over all its transverse surfaces to the delivery pressure, remains applied on its seat by the spring **8**.

In the course of its upward movement, the piston **3** reaches a position intermediate between those of FIGS. **2** and **3** where it starts to connect the delivery chamber **12** to the supply chamber **11** through its ramp passage **14** and ports **13**. The placing of the delivery passage in communication with the supply chamber **11**, which is at a moderate pressure, causes the closing not only of the injector positioned at the end of the passage **6**, which creates a pressure wave in this passage towards the pump **2**, but also of the delivery valve **4** which opposes the propagation of this pressure wave. This wave is manifested, in the by-pass passage **9**, by an increase in the pressure which, by acting on the annular shoulder of **7***d* the reaspirating valve **7** defined above, causes possibly the opening of this valve against the effect of the spring **8**, since, at this moment, the transverse surfaces of the valve **7**, other than those bounding the chamber **20**, are subject to the pressure of the supply chamber **11**. This enables the fuel to flow back from the passage **6** to the supply chamber **11** by passing through the annular space **30**, the one or more channels **31**, the chamber **20**, the seat **18**, the axial passage **15** of the reaspirating valve **7**, the hole **17**, the delivery chamber **12**, the ramp passage **14** of the piston **3** and the ports **13**. The pressure of the column of fuel, which is situated downstream of the reaspirating valve, falls to the calibration value of the valve **7**, which then closes, the two valves thus again occupying the positions of FIG. **1**. Due to the fact of the fluid-tight construction of the valve **7**, the calibration pressure is maintained in the said portion of the delivery passage whilst the piston **3** effects the inactive portion of its delivery stroke, then its suction stroke (downward in the Figures), then the first portion of the subsequent delivery stroke until it closes the ports **13**. At this moment, due to the fact of the maintenance in the delivery passage of a pressure equal to the calibration pressure of the reaspirating valve **7**, the opening of the injector is effected practically without delay.

The essential advantage of the device according to the invention is that the flow of fuel is effected in a straight line, in the injection periods, from the delivery

chamber 12 to the delivery valve 4, as though there was no reaspirating valve 7, that is to say without impeding the flow and, consequently, without pressure loss.

I claim:

1. Injection device, for an internal combustion engine, which comprises, immediately downstream of each cylinder of an injection pump wherein a piston moves, on the one hand, a delivery valve biased by a spring and adapted to open on the active portion of the delivery stroke of the piston to allow liquid fuel to arrive at an injector through a linking passage and, on the other hand, a reaspirating valve also biased by a spring, said reaspirating valve being provided with a constantly open axial passage and adapted to allow the fuel delivered from the pump cylinder to pass to the delivery valve and arranged in another passage which connects said linking passage to the pump cylinder thereby bypassing the delivery valve and adapted to open towards said cylinder when the difference in pressures between the linking passage and the cylinder exceeds a given limit, the reaspirating valve comprising a first cylindrical portion of external diameter D serving for its guidance, a second cylindrical portion of external diameter d, less than D, and a frustoconic portion, an annular seat of shape corresponding with said frustoconic portion and cooperating therewith, the maximum diameter of the frustoconic portion being equal to d, said cylindrical portions being connected by a shoulder, said second cylindrical portion and said shoulder defining internally an annular chamber which forms part of the by-pass passage.

2. Injection device according to claim 1, wherein the spring of the reaspirating valve is a helicoidal spring housed in a widened portion of the axial passage so that its turns lie outside the geometrical extension of an unwidened portion of said axial passage.

3. Injection device according to claim 1, wherein said annular seat communicates, when the reaspirating valve is open, with the portion of the delivery circuit which is situated between the two valves and has an axis common with the two valves.

4. Injection device according to claim 3, wherein a one-piece part mounted at the end of the pump cylinder bears respective seats for said reaspirating and delivery valves.

5. Injection device according to claim 4, wherein the one-piece part comprises internally, and successively in the normal direction of flow of the fuel, a cylindrical housing for a cup serving as a support for the helicoidal spring of the reaspirating valve, as well as for said first cylindrical portion; a groove externally bounding said annular chamber; the seat of the reaspirating valve; a groove externally bounding the portion of the delivery circuit situated between the two valves; a cylindrical housing for the guidance of a tail fast to the delivery valve; and the seat of said delivery valve.

* * * * *