United States Patent [19]

Vuaille

[11] **3,759,235**

[45] **Sept. 18, 1973**

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

[75] Inventor: **André Vuaille**, Lyon, France

[73] Assignee: **Societe Industrielle Generale de Mecanique Appliquee S.I.G.M.A.**, Venissieux, France

[22] Filed: **Dec. 3, 1971**

[21] Appl. No.: **204,442**

[30] **Foreign Application Priority Data**

Dec. 4, 1970 France 7043751

[52] **U.S. Cl.** ..... **123/139 DP**

[51] **Int. Cl.** **F02m 63/00**

[58] **Field of Search** ..... 123/139 R, 139 AT, 123/139 AA, 139 DP; 417/494, 490, 499

[56] **References Cited**

UNITED STATES PATENTS

2,628,570 2/1953 Luca ..... 123/139 DP X

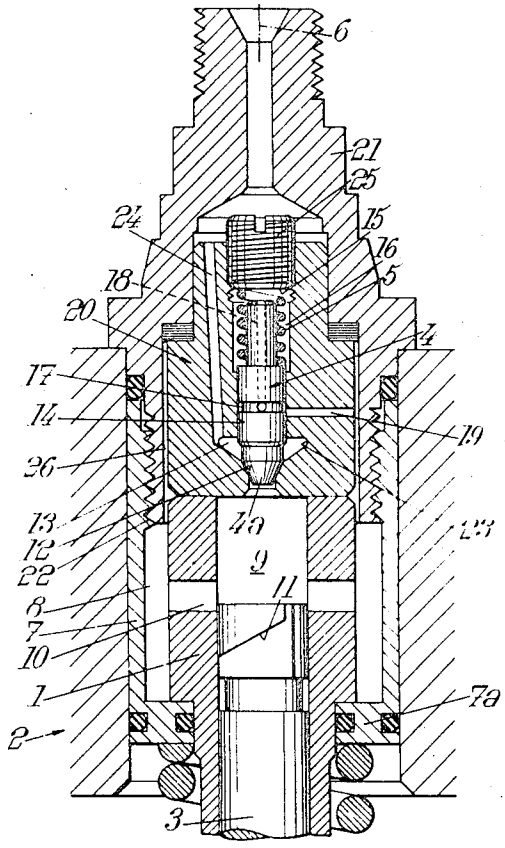
3,117,524 1/1964 Budzich ..... 417/494 X

Primary Examiner—Laurence M. Goodridge
Assistant Examiner—Dennis Toth
Attorney—Eric H. Waters et al.

[57] **ABSTRACT**

The device comprises in addition to a delivery valve, reaspirating means. The reaspirating means are constituted by the delivery valve itself which cooperates, through a cylindrical portion of greater diameter than the maximum diameter of the annular zone of contact of a collar of the valve,with a seating. The valve slides in a cylindrical guide bore in which the cylindrical part moves in a fluid-tight manner. The device has the advantage of simplified construction.

3 Claims, 3 Drawing Figures



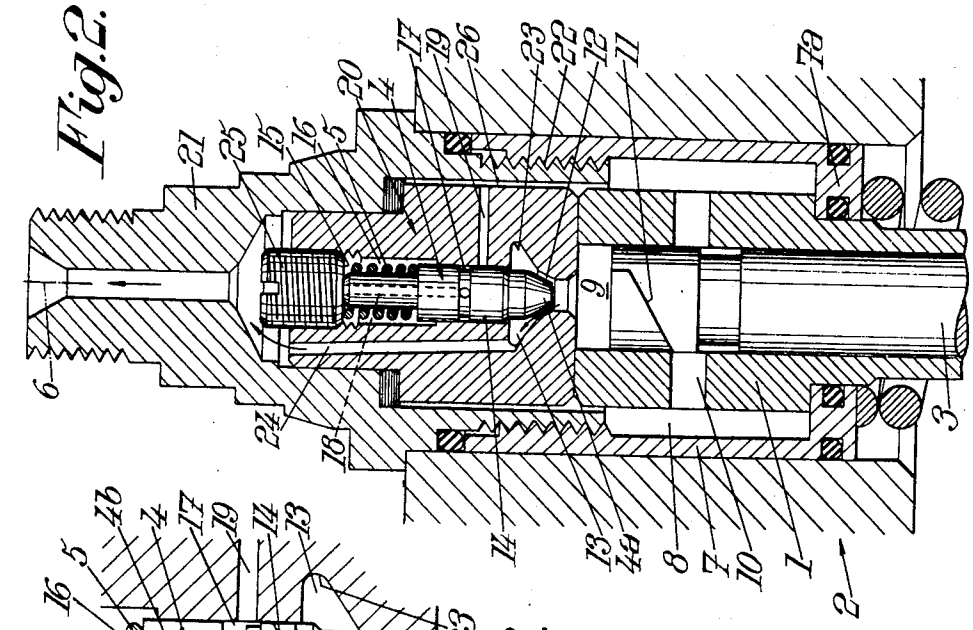


Fig. 2.

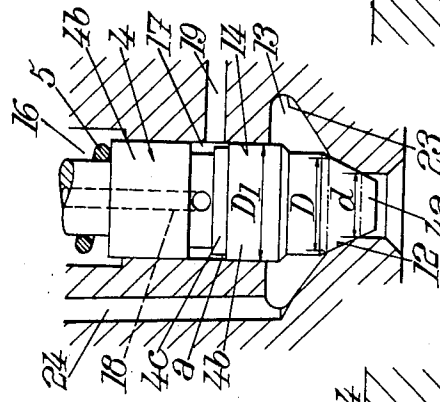


Fig. 3.

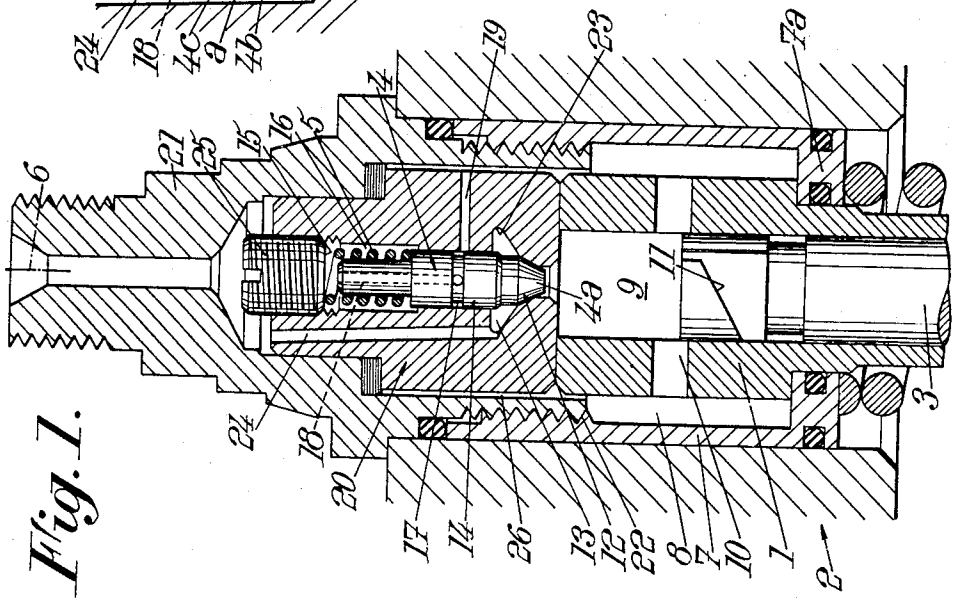


Fig. 1.

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, a delivery and reaspirating valve biased by a spring and adapted to open, on one hand, during the active portion of the delivery stroke of the piston to allow the liquid fuel to arrive from the cylinder pump at an injector by means of a linking passage and, on the other hand, when the difference in pressures between the linking passage and the cylinder of the pump exceeds a given limit, to allow the fuel to flow back towards this cylinder, which valve cooperates, on one hand, through a terminal sealing collar, with a seat arranged between the cylinder of the pump and an annular chamber connected permanently to the linking passage, said collar and seat being in contact through an annular zone when the valve is closed, and, on the other hand, through a cylindrical portion of greater diameter than the maximum diameter of the said annular zone, with a cylindrical guide bore in which this cylindrical portion slides with fluid-tightness.

It is known that such an injection device operates in the following manner. On leaving its bottom (or inner) dead center, the piston of the pump delivers, from its cylinder, fuel which lifts the delivery valve (by acting on the central zone of its sealing collar limited by the minimum diameter of the abovesaid annular contact zone), 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 connects the delivery chamber of the pump cylinder to suction pump. The delivery pressure of the pump then falls suddenly, which results in 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 especially to avoid this wave from being reflected again in reverse direction thereby risking causing an interfering opening of the injector that the delivery valve is arranged as a reaspirating valve (or relief valve) to allow the fuel to flow back under the effect of the reflected pressure wave. The delivery and reaspirating valve thus opens, on the arrival of the pressure wave, under the effect of the pressure existing on the abovesaid annular chamber and which exerts, in the sense of opening, over a surface equivalent to the difference between the cross-section of the abovesaid cylindrical portion of the valve and the surface of the circle having for diameter the maximum diameter defined above. The calibration of the abovesaid spring is such that the delivery and reaspirating valve 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 at the beginning of the subsequent injection period.

It is an object of the invention to render the abovesaid injection devices such that the movements of the valve are damped over a portion only of its stroke.

To this end, the delivery and reaspirating valve comprises, in addition, a second cylindrical portion which is arranged with a slight spacing in the abovesaid bore, which is closed beyond this second cylindrical portion

to constitute a fuel chamber, linking means being provided to connect this chamber to the suction side of the pump as long as the separation between the valve and its seat has not exceeded a predetermined value.

In this way, the movements of the valve are damped by the passage of the liquid towards the said chamber or from the latter, by the abovesaid spacing, when the separation between the valve and its seat is greater than the said limit. Nonetheless, the beginning of the opening stroke and the end of the closing stroke of the valve are rapid, since the damping is then eliminated by the abovesaid linking means.

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 and non-limiting example, with reference to the accompanying drawing, in which :

FIGS. 1 and 2 show in diagrammatic axial section, the essential elements of an injection device constructed according to the invention, In the positions corresponding respectively to the bottom dead center and to the top dead center of the pump piston; and,

FIG. 3 shows on a larger scale a detail of this embodiment.

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 of FIG. 2) of each cylinder 1 of an injection pump 2 wherein a piston 3 moves, on one hand, a delivery valve 4 biased by a spring 5 and adapted to open during the active portion of the delivery stroke of the piston 3 to allow liquid fuel to arrive at an injector (not shown) by means of a linking passage 6 and, on the other hand, reaspirating means situated between the said passage 6 and the pump cylinder 1 and adapted to allow the fuel to flow back towards the said cylinder 1 when the difference of 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 7 with which it defines an annular supply chamber 8. This chamber receives fuel from a supply pump (not shown) and can communicate with the delivery chamber 9, which is bounded by the piston 3 in the cylinder 1, by p o r t s 10 which are obturated by the said piston when the latter has travelled from the beginning of its delivery stroke, to a position intermediate between those of FIGS. 1 and 2. As soon as the ports 10 are obturated, the fuel imprisioned in the chamber 9 is delivered towards the injector which it reaches by passing through 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 9 to the supply chamber 8 by means of ports 10 and a passage arranged in the piston and bounded by a ramp 11, the rotation of the piston on itself enabling the volume of fuel injected per cycle to be regulated.

The abovesaid reaspirating means are constituted by the delivery valve 4 itself which, at this end, cooperates on one hand, through a terminal sealing collar 4*a*, with a seat 12 arranged between the pump cylinder 1 and an annular chamber 13 permanently connected to the linking passage 6, the said collar 4*a* and the seat 12 being in contact through an annular zone (limited by two circles indicated by dot-dash lines in FIG. 3, namely a circle of large diameter D and a circle of small

diameter *d*) when the valve 4 is closed and, on the other hand, by a cylindrical portion 4*b* of diameter D_1 greater than the maximum diameter D of the said annular zone with a cylindrical guide bore 14 in which this portion 4b slides with fluid-tightness.

The single valve 4 comprises in addition a second intermediate cylindrical portion 4*c* which is arranged with slight spacing *a* in the bore 14, which is closed beyond the valve by a transverse wall 15 to constitute a fuel chamber 16. Linking means are also provided to connect this chamber 16 to the supply chamber 8 of the pump as long as the separation between the valve 4 and its seat 12 has not exceeded a predetermined value.

In the embodiment shown, these linking means are constituted by a groove 17, arranged around the valve 4 against its cylindrical portion 4*c*, which is connected permanently to the chamber 16 by a passage channel 18 traversing the top of the valve 4 and which communicates, in the first part of the lifting stroke of this valve, with a channel 19 permanently connected to the supply chamber 8.

The seat 12 of the valve 4, the annular chamber 13, the bore 14 and the chamber 16 are preferably arranged in a single part 20 housed inside a tubular connector 21 on which the passage 6 is formed. The part 20 can be supported on the connector 21 by the cylinder 1 which is held by a shoulder 7*a* on the sleeve 7, the sleeve 7 and the connector 21 being in their turn assembled by screwing together by means of threads 22. The annular chamber 13 is defined externally by a groove 23, arranged in the part 20, and communicates with the central passage of the connector 21 through at least one passage 24 also formed in the part 20. The transverse wall 15 is constituted by the terminal surface of a threaded plug 25, screwed into the part 20 and serving as adjustable support for the spring 5. Finally, the channel 19 traverses the part 20 radially and opens externally into an annular space 26 left free between the outer wall of the part 20 and the inner wall of the connector 21.

There is thus obtained an injection device whose 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 9 is connected to the supply chamber 8 by ports 10. It is then under low pressure. The valve 4 is hence held against its seat 12 by the spring 5. The delivery chamber 9 fills with fuel.

When the piston 3 moves upwardly from the position shown at FIG. 1, it commences by obturating the ports 10. As soon as these ports are obturated, the fuel imprisoned in the chamber 9 is delivered towards the seat 12. The valve 4 is thus lifted from this seat, against the action of the spring 5, and arrives at the injector through the chamber 13, the passage 24 and the passage 6. The flow of fuel is shown diagrammatically by arrows at FIG. 2.

In the course of its upward movement, the piston 3 reaches a position when it starts to connect the delivery chamber 9 to the supply chamber 8 through its ramp passage 11 and ports 10. The placing in communication of the delivery chamber 9 with the supply chamber 8, which is at moderate pressure, causes the closing not only of the injector placed at the end of the passage 6, which creates a pressure wave in this passage towards the pump 2, but also of the valve 4 which is opposed to the propagation of this pressure wave. This wave is manifested, in the annular chamber 13, by an increase of the pressure which, in acting on the valve 4 through an annular surface limited by circles of diameters D and D_1, causes possibly the opening of this valve against the effect of the spring 5, as shown in FIG. 2. This enables the fuel to flow back from the passage 6 to the supply chamber 8 by passing through the passage 24, the annular chamber 13, the seat 12, the delivery chamber 9, the ramp passage 11 of the piston 3 and the ports 10. The pressure of the column of fuel, which is situated downstream of the valve 4, falls to the bias value of the spring 5, by which valve is then closed again. Due to the fact of the fluid-tight construction of the valve 4, the bias pressure is maintained in the said portion of the delivery circuit whilst the piston 3 effects the resting portion (inactive) of its delivery stroke, then its suction stroke (downward in the Figures), then the first portion of its subsequent delivery stroke until it closes the ports 10. At this moment, due to the fact of the maintenance in the delivery circuit of a pressure equal to the bias pressure of the valve 5, the opening of the injector is produced practically without delay.

In the two successive opening movements (injection and attentuation of the reflected pressure wave), the valve 4 is moved firstly rapidly thereby overcoming the resistance of the spring 5, since the liquid contained in the chamber 16 can escape freely through the channel 18, the groove 17 and the channel 19 towards the supply chamber 8. Then, when the separation between the valve 4 and its seat 12 exceeds a predetermined value, the movement of the valve is damped due to the fact that the liquid contained in the chamber 16 can no longer escape except through the small spacing *a* existing between its cylindrical portion 4c and the bore 14. Similarly, the closing movement is firstly slowed by the reintroduction of the liquid into the chamber 16 through the spacing *a*, then un-slowed. As a result the opening of the valve 4 is free, which enables the beginning of the injection to be effected normally, and its closing is equally free, which ensures a clean cut-off of the injection. On the other hand, the rest of the movement of the valve is damped, which offers as an advantage a control of the speed of the valve 4 at the moment it contacts, at the end of its stroke, the transverse wall 15.

As is self-evident, and as emerges already from the foregoing, the invention is in no way limited to those of its types of application, nor to those of the embodiments of its various parts, which have been more especially indicated; it encompasses, on the contrary, all variations.

I claim:

1. Injection device, for an internal combustion engine, which comprises an injection pump having a cylinder wherein a piston moves, and immediately downstream of said cylinder a delivery and reaspirating valve biased by a spring and adapted to open, on one hand, on the active portion of the delivery stroke of the piston to allow liquid fuel to arrive from the cylinder to an injector through a linking passage and, on the other hand, when the difference in pressures between the linking passage and the cylinder of the pump exceeds a given limit, to allow the fuel to flow back towards the cylinder, for which purpose said valve cooperates, on one hand, through a terminal sealing collar with a seat arranged between the cylinder and an annular chamber connected permanently to the linking passage, said col-

lar and seat being in contact through an annular zone when the valve is closed, and, on the other hand, through a cylindrical portion of greater diameter than the maximum diameter of the said annular zone, with a cylindrical guide bore in which this cylindrical portion slides with fluid-tightness, the valve comprising, in addition, a second cylindrical portion which is arranged with slight spacing in the bore, which is closed beyond this second cylindrical portion to constitute a fuel chamber, connecting means being provided to connect said fuel chamber to the suction side of the pump as long as the spacing between the valve and its seat has not exceeded a predetermined value, wherein the connecting means are constituted by a groove, formed around the valve against its second cylindrical portion, which is connected permanently to the fuel chamber by a passage passing through the valve and which communicates, in the first part of the lifting stroke of this valve, with a channel permanently connected to the suction side of th pump.

2. Injection device according to claim 1, wherein the seat of the valve, the annular chamber, the bore in which the valve moves and the fuel chamber are formed in a single part housed inside a tubular connector in which the connecting passage is formed.

3. Injection device according to claim 2, wherein the single part is supported on the connector by the cylinder which is held by a shoulder forming part of a sleeve, the sleeve and the connector being in their turn assembled by screwing by means of threads, and the sleeve bounding an annular supply chamber around the pump cylinder.

* * * * *