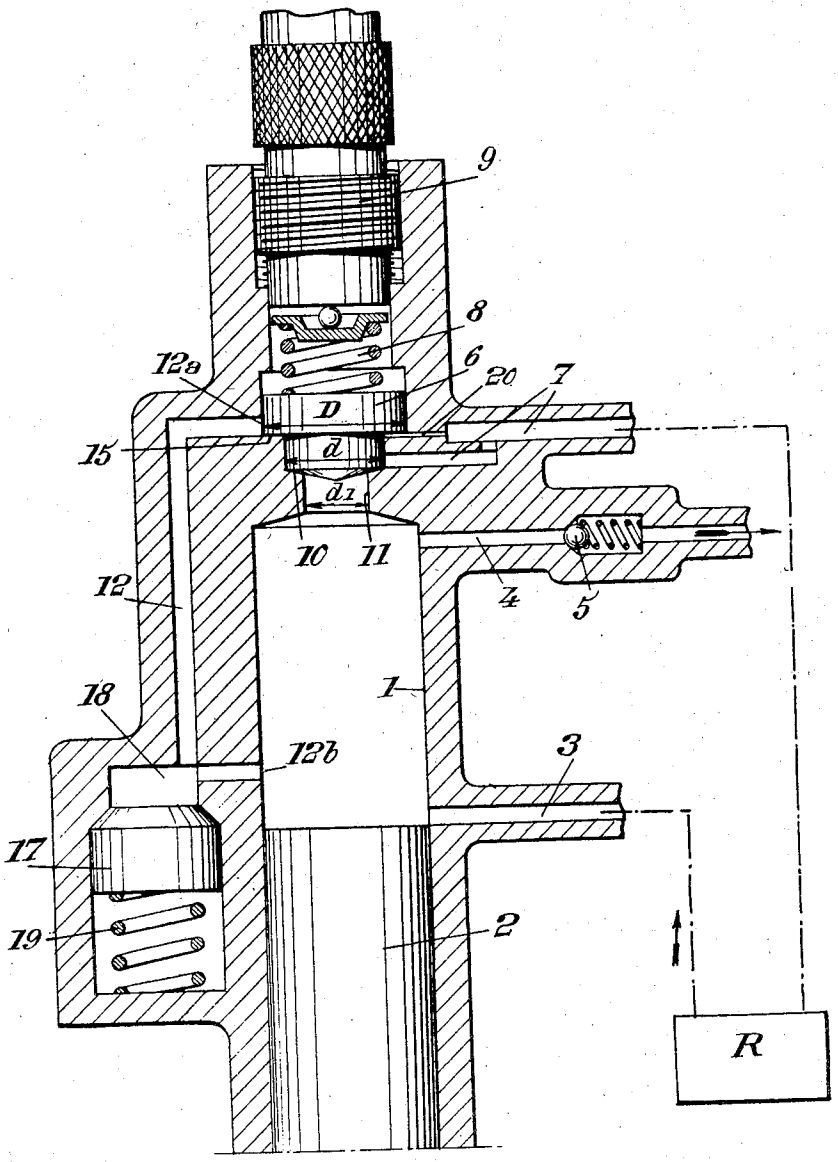
April 7, 1959 P. E. BESSIERE 2,880,675

RECIPROCATING PUMPS IN PARTICULAR IN FUEL INJECTION PUMPS

Filed Nov. 12, 1957 2 Sheets-Sheet 1

Fig. 1.



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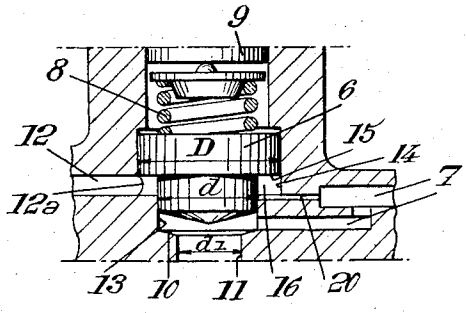
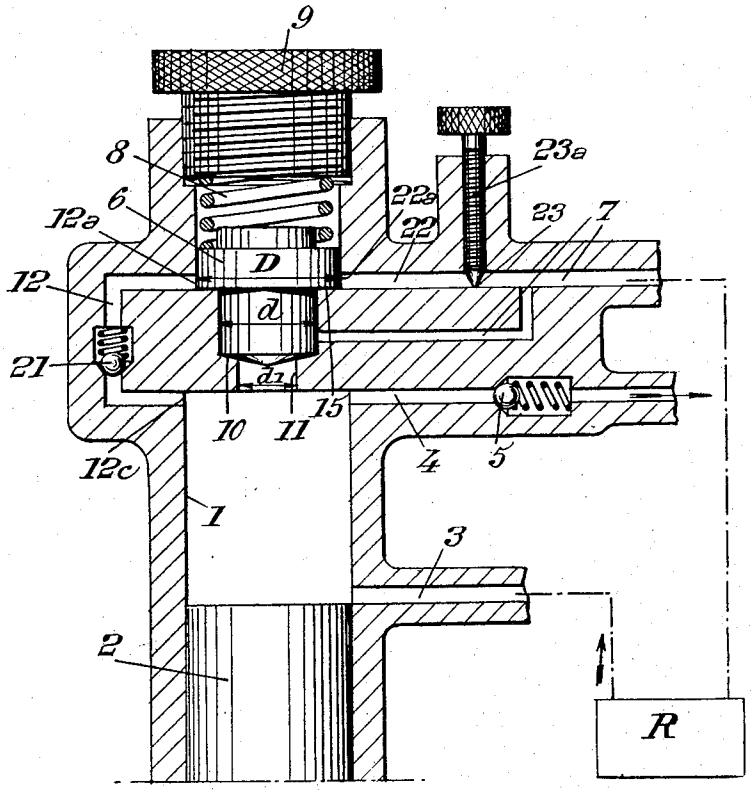


Fig. 2.

Fig. 3.



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RECIPROCATING PUMPS IN PARTICULAR IN FUEL INJECTION PUMPS

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6 Claims. (Cl. 103—42)

The present invention relates to reciprocating liquid pumps which include a discharge conduit or space placed in communication with the delivery chamber of the pump by an automatic valve on every cycle of operation as soon as the delivery pressure exceeds a predetermined maximum value.

My invention is especially concerned with fuel injection pumps, in particular for diesel engines, made as above stated.

It is known that the pumps of this kind existing at the present time have the following drawback. As soon as the automatic valve opens, the delivery pressure suddenly drops due to the fact that the delivery chamber of the pump is placed in communication with the discharge conduit. This causes the valve to close back, the pressure again increases, the valve opens a second time, again closes, and so on. Delivery of liquid from the pump is therefore not stopped sharply as it is desirable.

The object of my invention is to provide a pump of the above mentioned kind which avoids this drawback.

This pump is characterized in that the automatic valve, as it establishes communication between the pump delivery chamber and the discharge conduit, simultaneously opens a second conduit interposed between a source of liquid under pressure and a variable volume chamber having one wall constituted by a surface belonging to said valve, said chamber being so arranged that its volume is increased when said valve is opened.

Preferred embodiments of my invention will be hereinafter described with reference to the accompanying drawings, given merely by way of example, and in which:

Fig. 1 is a diagrammatic axial sectional view of a fuel injection pump made according to a first embodiment of my invention.

Fig. 2 is a detailed view showing a portion of the pump of Fig. 1 in a different position of operation.

Fig. 3 is a view similar to Fig. 1 showing another embodiment of the invention.

The pump includes means forming a variable volume chamber for the delivery of the liquid (fuel), said means including, in the conventional manner, a fixed part constituted by a cylinder 1 and a movable part constituted by a piston 2 having a reciprocating displacement in said cylinder 1 under the action of any suitable means such for instance as a cam (not shown on the drawings). On Figs. 1 and 3, piston 2 is shown in the vicinity of its outer dead center position (in this case its lower dead center position). A feed conduit 3 leading from a fuel tank R opens into cylinder 1 at a point such that it is cleared when piston 2 is in its lower dead center position but is closed by piston 2 when said piston moves upwardly in cylinder 1. A delivery conduit 4, leading to the fuel injector or injectors (not shown on the drawings) of the engine, starts from a point of cylinder 1 such that said conduit 4 is open whatever be the position of piston 2 in the cylinder. A check valve 5 is mounted in conduit 4.

This pump is designed in such manner that, during the delivery stroke of piston 2, the pressure of the fuel delivered by the pump rises as said piston 2 is moving upwardly. Furthermore, there is mounted in the wall of the variable volume chamber (delivery chamber) of the pump, and for instance in the top end wall of cylinder 1, an automatic valve 6 arranged so that, when the pressure of the fuel delivered by the pump reaches a predetermined maximum value, said valve 6 opens automatically, under the effect of this pressure, thus placing the delivery chamber of cylinder 1 in communication with a discharge conduit 7 connected with tank R and of a dimension sufficient to cause injection to be stopped. This rise of the pressure in the delivery chamber of cylinder 1 is due, for instance on the one hand to the fact that the means (cam or the like) which drives piston 2 accelerates its movement as it is travelling upwardly in the cylinder and, on the other hand, to the pressure drop produced by the injector (or injectors).

It is known that a self-regulation effect is obtained with such a construction because, as soon as the speed of the engine increases for any accidental or non desired reason, the pressure which causes the opening of valve 6 is reached for a shorter amplitude of the displacement of piston 2 in cylinder 1 and therefore the amount of fuel injected on every cycle of the pump decreases, which tends to restore the speed of operation of the engine back to its initial value.

The pressure under which value 6 opens is determined by a spring 8, the initial force of which may be adjusted through suitable means, such for instance a screw 9.

When valve 6 opens and connects the delivery chamber of cylinder 1 with discharge conduit 7, the pressure suddenly drops in said chamber of cylinder 1, which, as above explained, may cause a succession of openings and closings of the valve.

In order to obviate this drawback, it has already been suggested to arrange the valve in such manner that the area thereof on which the fuel under pressure is acting suddenly increases as soon as the valve is moved away from its seat (Fig. 2) by giving the diameter d of the working portion of the valve a value greater than that of the diameter d_1 of the conduit 11 interposed between cylinder 1 and valve seat 10.

But this arrangement only attenuates the above mentioned drawback. In order to eliminate it entirely, according to my invention, the pump is provided with a variable volume chamber, a portion of the wall of which is constituted by a surface of valve 6 and into which opens a conduit 12 leading from a source of fluid under pressure, this conduit being controlled by the valve in such manner that it communicates with said chamber only when the valve is moved away from its seat 10.

Advantageously, valve 6 includes two cylindrical portions of different diameters fitting slidably in respective cylindrical housings 13 and 14 (Fig. 2) of corresponding diameters provided in the pump body, conduit 12 opening into the housing 14 of greater diameter at a point 12_a such that the outlet of this conduit is closed by the portion of greater diameter D of the valve when said valve is applied upon its seat (Figs. 1 and 3) and is located opposite the portion of smaller diameter of the valve when said valve is moved away from its seat (Fig. 2). The portion of smaller diameter is preferably the portion of the valve of diameter d which is applied upon the valve seat 10. The portion of greater diameter D of the valve is on the other side of said portion of smaller diameter from the valve seat 10. The variable volume chamber which is to communicate with conduit 12 is therefore constituted by the annular space 16, shown on Fig. 2, and the wall of said variable volume chamber acted upon by

the pressure of the fluid in conduit 12 to keep the valve in open position is the annular surface 15 of the valve.

Of course, it is necessary to provide a source of fluid under pressure to be fed into chamber 16 as soon as port 12_a has opened and this fluid must be evacuated from chamber 16 at the latest at the end of the return stroke of piston 2, so as to enable valve 6 to drop back upon its seat before the beginning of the next upward stroke of said piston 2.

According to the embodiment of Figs. 1 and 2, cylinder 1 is provided with a passage 12_b extending through its wall at a level such that it is closed by piston 2 soon after feed conduit 3 has itself been closed by said piston. This passage 12_b opens into a chamber 18 constantly in communication with conduit 12 and the bottom of which is constituted by the top face of a piston 17 urged upwardly by spring 19.

This structure 17, 18, 19 constitutes an accumulator for liquid under pressure.

Advantageously, a conduit 20 of very small diameter extends between the bottom of chamber 16 and tank R, preferably through discharge conduit 7.

The operation of the pump illustrated by Figs. 1 and 2 is as follows. During its delivery stroke, piston 2, moving upwardly from the position shown by Fig. 1, closes the outlet of feed conduit 3 and delivers fuel into chamber 18 through passage 12_b. Piston 17 is pushed down against the action of spring 19 until passage 12_b is closed by piston 2. Chamber 18 then constitutes a reserve of fuel under pressure.

As piston 2 keeps moving upwardly, fuel is delivered past check valve 5 and is injected into the engine until the pressure in the delivery chamber of cylinder 1 becomes sufficiently high (as above explained) to lift valve 6 away from its seat (Fig. 2). This determines the end of injection since fuel is then allowed to flow out through discharge conduit 7. As soon as valve 6 is lifted, it clears the outlet 12_a of conduit 12 and, under the action of spring 10, piston 17 drives fuel from chamber 18 into chamber 16, under the surface 15 of the valve. Said valve 6 is thus locked in open position by a liquid cushion thus formed under surface 15.

Conduit 20 enables the fuel which might have leaked under surface 15 before the opening of the valve to be evacuated without causing an undesirable lifting of said valve. This conduit 20 is of sufficiently small cross-section to create a counter-pressure which is sufficient to keep valve 6 in lifted position at least until piston 2 has reached the top of its upward stroke.

When piston 2 starts on its downward movement, valve 6 starts moving down (it may have begun this downward movement a little earlier due to liquid leaking out through conduit 20). Then piston 2 clears passage 12_b, piston 17 and valve 6 are pushed back toward their respective seats by springs 19 and 8, and the cycle begins again.

According to a second embodiment illustrated by Fig. 3, the source of liquid under pressure to be fed to the variable volume chamber associated with valve 6 is constituted by cylinder 1 itself. In this case, conduit 12 starts from cylinder 1 with which it communicates at 12_c. Orifice 12_c is never closed by piston 2. A check valve 21 is provided in conduit 12 so that liquid can only flow from cylinder 1 toward the variable volume chamber associated with valve 6. Said chamber 16 further communicates with a leak conduit 22 provided with throttling means 23 constituted by the end of an adjustable screw 23_a. Advantageously, this leak conduit 22 opens into discharge conduit 7.

The operation of the pump illustrated by Fig. 3 is as follows. During its delivery stroke, piston 2 moving upwardly from the position shown by Fig. 3 first closes the outlet of feed conduit 3, then delivers fuel under

pressure past check valve 5. Injection takes place and goes on until the pressure in cylinder 1 is sufficiently high to lift valve 6 from its seat. This stops injection since fuel is discharged through conduit 7. As soon as valve 6 opens, it clears orifice 12_a and some amount of fuel is delivered past check valve 21 into chamber 16.

Valve 6 is then kept in this position by the liquid present in said chamber 16. This liquid is allowed to leak out, after a time which depends upon the rate of flow of said liquid, past throttling means 23 under the action of the pressure exerted by return spring 8. This time is independent of the speed of the engine and depends only upon the cross-section determined by throttling means 23 and upon the strength of spring 8 adjustable by means of screw 9.

It should be understood that if piston 2 starts on his next upward stroke before valve 6 has been given time to drop back upon its seat (the speed of the engine exceeding a given limit value), the valve remains open due to the formation of a kind of liquid abutment under it and there is no longer any injection. The engine is therefore restored to its limit speed or to a value below said speed. Adjustment of this limit speed is performed by acting upon screw 23_a and/or screw 9. Said screws may possibly be interconnected through any suitable means.

It should be noted that in the embodiment of Fig. 3, conduit 12 does not necessarily start directly from cylinder 1 but may quite as well start from any point of conduit 4 between the pump and the engine.

What I claim is:

1. A liquid pump which comprises, in combination, a hollow fixed part and a part fitting movably in said fixed part and having a reciprocating displacement with respect thereto so as to form therewith a variable volume chamber for the delivery of liquid, a delivery conduit in said fixed part starting from said variable volume chamber, said fixed part being provided with a discharge orifice in communication with said chamber, said orifice being entirely distinct from said delivery conduit, so that the opening of said orifice during the periods where said chamber is under pressure causes a sudden drop of pressure in said chamber and instantaneously stops the feed of liquid through said delivery conduit, a valve slidably mounted in said fixed part to cooperate with said orifice for controlling it, resilient means interposed between said valve and with said fixed part for yieldingly holding said valve in orifice closing position, said fixed part and said valve forming together a fluidtight chamber of a volume variable in accordance with the position of said valve with respect to said fixed part, said chamber being so arranged that its volume is increased when said valve is opened, a source of liquid under pressure carried by said fixed part, and second conduit means forming a communication between said source and said second mentioned variable volume chamber, said second conduit means being arranged to be closed when said valve is closed and to be opened when said valve opens under the action of the pressure of the liquid in said first mentioned variable volume chamber.

2. A pump according to claim 1 in which said valve includes a portion integral therewith forming a slide valve to open said second conduit means when said valve opens.

3. A pump according to claim 1 further including a discharge conduit starting from said second mentioned variable volume chamber, said discharge conduit having at least a portion thereof of very small diameter.

4. A pump according to claim 3 including adjustable throttling means in said discharge conduit.

5. A pump according to claim 1 in which said source of liquid under pressure is an accumulator of liquid un-

der pressure connected with said first mentioned variable volume chamber during a first portion of every volume reduction thereof.

6. A pump according to claim 1 in which said source of liquid under pressure is said first mentioned variable volume chamber, further including a check valve inserted in said second conduit means and opening toward said second mentioned variable volume chamber.

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