June 12, 1934. F. CARTER ET AL 1,962,551

FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

Filed March 10, 1933

Fig. 1.

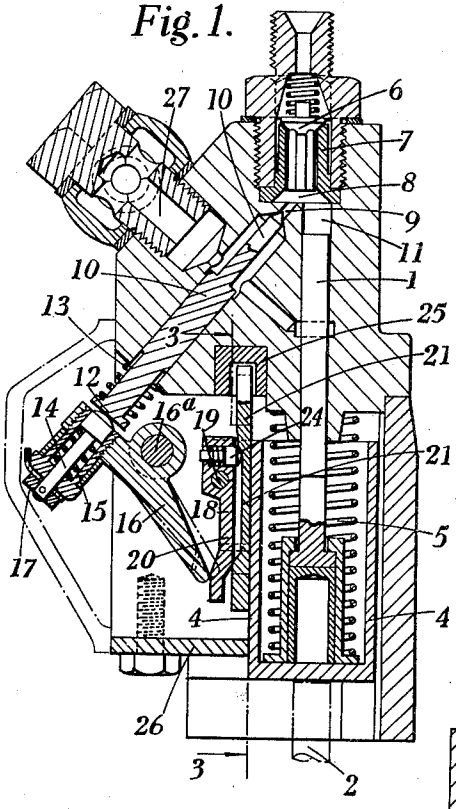


Fig. 2.

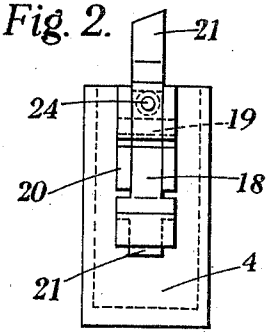


Fig. 3.

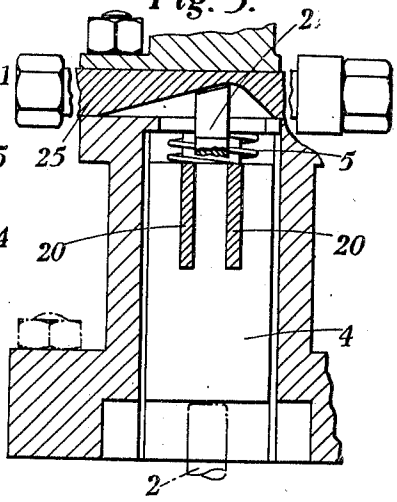


Fig. 4.

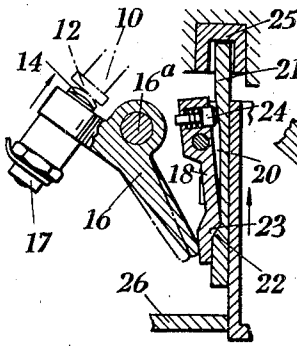


Fig. 5.

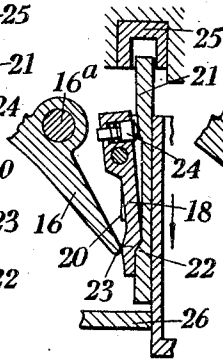


Fig. 6.

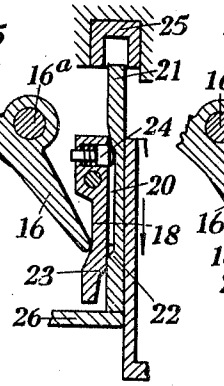
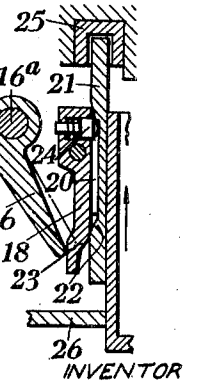


Fig. 7.



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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Application March 10, 1933, Serial No. 660,320
In Great Britain April 21, 1932

16 Claims. (Cl. 103—41)

This invention relates to fuel pumps for airless injection of liquid fuel into cylinders of internal combustion engines.

The invention relates more particularly to fuel pumps of the kind in which the pump plunger is operated to compress the fuel by a cam or equivalent and in which there is a self-opening delivery valve between the pump plunger and the injection nozzle in the engine cylinder.

There have been numerous proposals relating to such pumps, and it is an object of the present invention to provide a convenient, compact and efficient construction.

It is a further object of the invention to provide a pump in which the spill valve is entirely independent of the plunger and the cylinder in which the plunger works as opposed to arrangements in which the plunger itself or an extension thereof acts as a piston valve or in which the cylinder is itself moved to open or close the passage for spill: the spill valve can, however, be operated by mechanism actuated by a part reciprocating with the plunger.

It is a further object of the invention to employ a spill valve provided with a seating and means for closing the valve upon its seating at a predetermined point after the beginning of the up stroke of the plunger and for opening it at a variable point thereafter.

We prefer to employ a single valve operating both as inlet and spill valve and to actuate it by means of a cam through a lever pivoted to the body of the pump. While a cam reciprocating with the pump plunger is preferred, it might oscillate or revolve, but the preferred form of mechanism is characterized in that it is actuated by a reciprocating slide provided with a trip device enabling the spill valve to be opened earlier or later according to the amount of fuel to be delivered. Furthermore, since it is desirable that the pump be provided with a safety device to prevent excessive pressure in the pump, which might be caused by a stoppage on the delivery side of the pump, we prefer to close the valve against the pressure of the pump and provide in the mechanism which closes the valve for a captive spring, which will close the valve against ordinary pressures, but so arranged that excessive pressures will cause the valve to open as a safety valve.

Other objects of the present invention reside in the provision of the improved features, combinations and arrangements embodied in the preferred form which it is now proposed to describe, with reference to the accompanying drawing wherein:—

Figure 1 is a vertical section of a fuel pump viewed from one side.

Figure 2 is a front view of the pump plunger sleeve and the associated trip or compound cam.

Figure 3 is a section on the line 3, 3 of Figure 1.

Figures 4, 5, 6 and 7 are fragmentary views showing the parts of the cam device at various points on the up and down strokes of the plunger.

As illustrated, the pump plunger 1 is actuated by a cam or the like through the tappet 2 and sliding sleeve 4 which may conveniently be of square or other non-circular section. The sleeve 4 serves to house the greater part of the return spring 5 whereby the plunger is returned on its suction stroke, keeping the sleeve in contact with the operating cam or tappet 2. The delivery valve 6 and seating 7 are fixed above the upper end of the plunger, slightly offset axially relatively to it. The valve 6 may be of any known automatic type but with a small coned chamber 8 in the lower end of the valve seating; from the lower side of this conical chamber, where it overhangs the pump cylinder 11, we lead an inlet and spill port 9, in a generally downward direction, in the same plane, but at an angle to the axis of the plunger. The outer or lower end of this inlet and spill port is enlarged and into this enlargement is fitted the inlet and spill valve 10 so that when pressed upwards the valve closes the port near the cylinder 11. A head or enlargement 12 is formed on this valve and a light spring 13 lies between the head and valve guide, to hold the valve open against the suction of the plunger.

The outer side of the valve head rests on a tappet 14 spring-pressed by a spring 15 which is carried in the upper end of the actuating lever 16 pivoted to the body of the pump at 16a. The upward travel of this tappet under pressure of the spring 15 is limited by a nut 17 on its lower end, thus holding the spring captive at the pressure required to cause the valve to act as a relief or safety valve and at the same time accommodating inequalities of the cam path. The cam operating the valve comprises an appropriate cam surface reciprocating with the pump plunger. This surface may conveniently be formed on a piece 18 pivoted to the plunger sleeve 4 by means of a pin 19 passing through cheeks 20 formed on the sleeve 4 in order that it may reciprocate therewith, but that its effective timing may be controlled by causing it to rock towards or away from its effective position. This may be accomplished by forming behind the pivoted piece or cam 18 a second cam

surface adapted to be engaged by a reciprocating trip slide 21 situated between the cam 18 and the body of the plunger sleeve. This slide 21 has an incline or shoulder 22 adapted to co-act with an incline or shoulder 23 formed on the surface at the back of the cam 18 so as to permit the latter to rock into or out of its operative position according to the relative reciprocation between the cam 18 and the trip slide 21. Normally the trip slide moves with the plunger and cam and this may be ensured by the use of a spring pressed ball or frictional catch pin 24 or the like housed in an extension of the pivoted cam 18 and normally bearing in a slight recess formed in or under a shoulder on the slide (see Figures 1, 6 and 7). In this normal position the slide 21 is effective to hold the cam 18 in its operative position i. e. that in which it is rocked about its pivot away from the plunger sleeve and towards the lever through which it actuates the combined inlet and spill valve (see Figures 1, 6 and 7).

The reciprocating movement of the trip slide 21 is limited at the top of its stroke by means of an inclined transverse slide 25 operated by the engine governor or by means of some other appropriate movable abutment and at the bottom of its stroke by an abutment 26 which may be a fixed part of the pump housing.

In place of the pivoted cam and reciprocating trip slide the trip action may be otherwise provided for, for example, by a catch and separate cam surface.

The operation is as follows:—

Assuming that the plunger is at the top of its travel (see Figure 4) the inlet and spill valve will be open, the cam 18 being ineffective to hold it in the shut position (indicated by the dotted lines) by means of the actuating lever 16 since the cam is rocked back into the recess or low portion of the surface of the tripping slide 21. As the plunger moves downward (see Figure 5) the raised part of the cam 18 which later engages the lever 16 passes down beyond the end of the lever: the trip slide 21 has meanwhile been stopped against the bottom abutment 26 and the cam 18 continuing its movement rocks into its effective position (see Figure 6) by engagement of the incline or shoulder 23 upon its back surface with that 22 upon the slide, until at (or near) the bottom of the stroke the slide and cam have become engaged as regards subsequent upward movement by means of the friction catch pin 24 as indicated in Figure 6. The cam 18, however, preferably only reaches its effective position after its raised part has passed beyond the end of the lever as will be apparent from a comparison of Figures 5 and 6, so that the inlet or spill valve remains open throughout the down stroke and fuel enters the pump cylinder 11 continuously from the fuel supply pipe 27 and through the inlet (and spill) port 9 as the plunger 1 moves down. Engagement of the pin 24 in the recess at or near the bottom of the travel of the cam 18 ensures that the trip slide 21 rises with the cam holding the latter in its effective position. As the up stroke proceeds the cam surface engages the end of the lever and closes the inlet and spill valve at the predetermined point where injection is to begin and continues to hold it closed (see Figures 1 and 7). Fuel is thereupon forced past the delivery valve 6 and injection into the engine cylinder starts and continues until the inlet and spill valve opens for permitting spill back into the inlet passage. The timing of spill (and finish of injection) is determined by the trip slide 21 reaching the end of its upward travel on striking the upper abutment 25, whereupon the pin 24 is forced from the recess and the cam continues to rise relatively to the slide until near the top of its stroke it rocks back into the recessed portion of the slide (as has just occurred at Figure 4), thereby permitting the lever 16 to move back into the full-line position of Figure 4 and the valve 10 to open for spill. The upper abutment may conveniently take the form of a transverse sliding rod 25 having a tapered slot into which the similarly tapered top of the trip slide 21 enters at the top of its stroke, the taper of the slot forming the abutment.

By sliding the rod along to bring deeper or shallower portions of the slot over the slide, the stroke of the latter (and finish of injection) is infinitely variable and the extreme positions may be such as in one to hold the slide stationary against the lower abutment so that the cam swings into the recess before actuating the lever at all and no injection takes place and in the other (that of the illustrations) to permit injection to continue until nearly the top of the stroke of the plunger and cam.

It will be observed that in this manner we have provided a cam whereof the effective action of the valve-actuating surface is timed by trip action, preferably by interaction of the primary cam with a relatively moving secondary or trip cam, represented in the actual mechanism described by the trip slide.

Considerable modifications of mechanical design may be made without departing from the underlying ideas of the invention, and it is to be understood that in referring for convenience to the top and bottom positions it is not intended to limit the invention to vertical arrangements but to include corresponding positions of the parts when otherwise arranged.

We claim:—

1. In a pump for airless injection of fuel in internal combustion engines, a plunger, a combined spill and inlet valve, a cam movable contemporaneously with said plunger and arranged to cause the closing of said valve during the delivery stroke of said plunger and a trip device operable at a variable point of said stroke to render said cam incapable of holding said valve closed during the remainder of said stroke and during the suction stroke of said plunger.

2. In a pump for airless injection of fuel in internal combustion engines, a plunger, a spill valve, a cam pivoted to and reciprocated with said plunger and capable of closing said valve, a slide movable with said cam in a position relative thereto in which it holds said cam in its operative position, and an adjustable member arranged to cause said slide to move relatively to said cam to trip the same and render it incapable of holding said valve closed.

3. In a pump for airless injection of fuel in internal combustion engines, a plunger, a spill valve, a cam pivoted to and reciprocated with said plunger and capable of closing said valve, a slide, a catch rendering said slide movable with said cam in a position relative thereto in which it holds said cam in its operative position, and an adjustable member arranged to disconnect said catch and cause said slide to move relatively to said cam to trip the same and render it incapable of holding said valve closed.

4. In a pump for airless injection of fuel in internal combustion engines, a plunger, a combined inlet and spill valve, a cam pivoted to and reciprocated with said plunger and capable of

closing said valve, a slide movable with said cam in a position relative thereto in which it holds said cam in its operative position, and an adjustable member arranged to cause said slide to move relatively to said cam to trip the same and render it incapable of holding said valve closed during the remainder of the delivery stroke of said plunger and during the suction stroke thereof.

5. In a pump for airless injection of fuel in internal combustion engines, a plunger, a combined inlet, spill and safety valve, a seating therefor, a spring tending to hold said valve off said seating, a cam moving contemporaneously with said plunger, and a lever operable by said cam to press said valve onto its seating, the arrangement including a spring between said cam and said valve whereby said valve is pressed onto its seating with a pressure limited to that exerted by said last mentioned spring.

6. A fuel pump of the kind referred to having a self-opening spill valve, a cam moving axially with the plunger and also movable into and out of an operative position wherein it is capable of operating the spill valve, a trip device, means to carry the trip device with the cam in a relative position in which it holds the cam up in its operative position, and means to move the trip device relatively to the cam at a variable point in the delivery stroke of the plunger and thereby enable the cam to assume its inoperative position and the spill valve to open.

7. In a pump for airless injection of fuel in internal combustion engines, the combination of a plunger, an outwardly opening spill valve, mechanism operated from a part connected with said plunger to close said spill valve at a predetermined point after the start of the delivery stroke of said plunger, and means to enable said spill valve to open at a variable point during the remainder thereof and to remain open for the rest of the cycle.

8. In a pump for airless injection of fuel in internal combustion engines, the combination of a plunger, a self-opening combined spill and inlet valve, means to close said valve at a predetermined point after the start of the delivery stroke of said plunger, and means to release said valve to open at a variable point thereafter and permitting it to remain open during the rest of the cycle.

9. In a pump for airless injection of fuel in internal combustion engines, the combination of a plunger, a valve seating and a combined spill, inlet and safety valve normally open except for a determined period during the delivery stroke of said plunger and incapable of closing at any time when excess of pressure prevails on the delivery side of the plunger.

10. In a pump for airless injection of fuel in internal combustion engines, a plunger, a spill valve, a cam movable contemporaneously with said plunger, and a lever operated by said cam to close said valve for a period commencing at a predetermined point after the beginning of the delivery stroke of said plunger and terminating at a variable point during said stroke, said valve remaining open for the rest of the cycle.

11. In a pump of airless injection of fuel in internal combustion engines, a plunger, a normally open spill valve, a cam movable contemporaneously with said plunger and arranged to cause the closing of said valve at a predetermined point after the beginning of the delivery stroke of said plunger, and a trip device operable at a variable point of said stroke to render said cam incapable of holding said valve closed.

12. In a pump for airless injection of fuel in internal combustion engines, a plunger, an outwardly opening spill valve, a spring tending to hold said valve open, a cam reciprocating with said plunger, and a lever operated by said cam to close said valve for a period terminating at a variable point on the delivery stroke of said plunger.

13. In a pump for airless injection of fuel in internal combustion engines, a plunger, an outwardly opening combined inlet and spill valve, a cam, means rendering said cam capable of closing said valve during a relatively early part of the delivery stroke of said plunger but incapable of doing so during the final remainder of said stroke and during the suction stroke, and means to vary the point at which said cam ceases to be capable of closing said valve.

14. In a pump for airless injection of fuel in internal combustion engines, a plunger, an outwardly opening combined inlet and spill valve, a cam reciprocated with said plunger, means to render said cam capable of closing said valve during a period starting from a fixed point and ending at a variable point on the delivery stroke of said plunger but incapable thereof for the remainder of the delivery stroke and for the whole of the suction stroke.

15. In a pump for airless injection of fuel in internal combustion engines, a cylinder, a plunger reciprocating therein, a spill valve, means normally holding said spill valve open, a cam moving synchronously with said plunger, a second cam adapted to raise the operative surface of said first cam into position to hold said spill valve closed, and means to render said second cam effective during the movement of said plunger from a fixed to a variable point on its delivery stroke.

16. In a pump for airless injection of fuel in internal combustion engines, a cylinder, a plunger reciprocating therein, a spill valve, means normally holding said spill valve open, and a cam reciprocating with said plunger, a second cam adapted to move with said cam and to raise the operative surface of said cam into position to hold said spill valve closed, together with means to render said second cam effective during the movement of said plunger from a fixed to a variable point on its delivery stroke.

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