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INJECTION PUMP

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FIG. 1

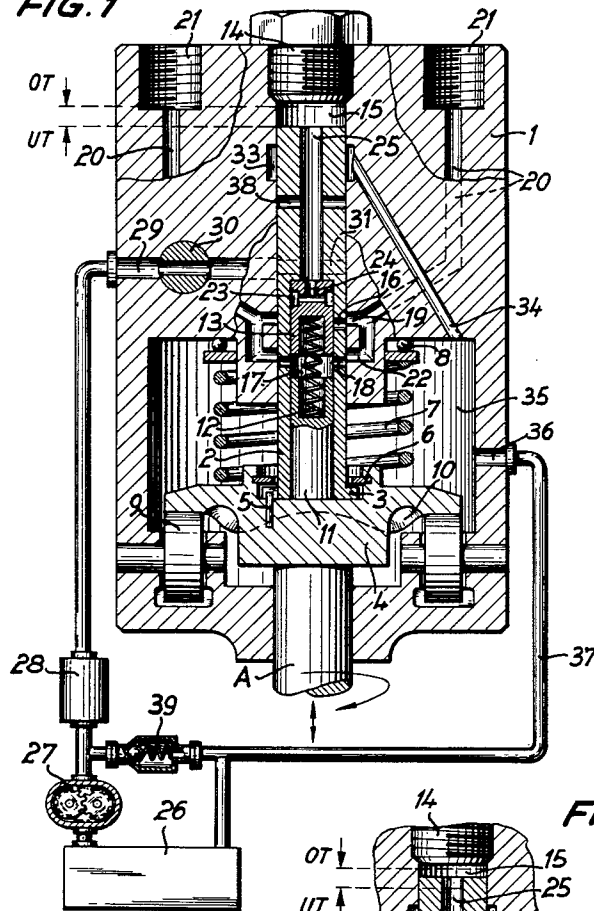
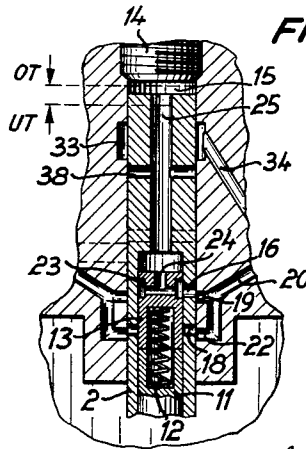


FIG. 2



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INJECTION PUMP

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The present invention relates to injection pumps.

More specifically the present invention relates to injection pumps for supplying fuel to the cylinders of internal combustion engines from a single pumping chamber by means of a combined distributor and pump means, which may contain valve means having a movable valve member, which during its closing movement at the end of each injection may provide a pressure relief in the passages leading from the pumping chamber of the pump to the cylinders of the combustion engine.

In such injection pumps, the amount of fuel injected during each pressure stroke of the combined distributor and pump means may sometimes vary considerably. An essential cause of such variation is the indefinite position of fuel vapor bubbles in the fuel discharge passages after the pressure therein has been relieved by the closing movement of the valve member.

One of the objects of the present invention is to overcome this disadvantage of injection pumps of this type.

It is an additional object of the present invention to provide an injection pump in which the pressure in all fuel discharge passages leading from the pumping chamber to the various combustion cylinders of the engine is reduced to the same pressure at the end of each injection.

It is an additional object of the present invention to provide an injection pump of this type which is composed of relatively few and rigid parts so that the pump will work trouble-free over an extended period.

With the above objects in view the present invention mainly consists of an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine which includes elongated cylinder means formed with a pumping chamber, fuel passage means formed in the cylinder means for feeding fuel into the pumping chamber and out therefrom into the cylinders of the combustion engine, respectively, relief passage means formed in the cylinder means for establishing communication between the fuel passages leading from the pumping chamber to the cylinders of the combustion engine, and combined distributor and pump means movable between a pressure stroke and a suction stroke and cooperating with the passage means for controlling the flow of fuel along said fuel passage means into the pumping chamber during the suction stroke and out of the pumping chamber into the cylinders of the combustion engine during the pressure stroke and for opening the relief passage means at the end of the pressure stroke so as to connect all of the fuel passage means leading from the pumping chamber to the cylinders of the combustion chamber with each other.

Preferably, the combined distributor and pump means include valve means movable between a fuel supply position in which the valve means opens the fuel passage means leading from the pumping chamber to the respective combustion cylinder to permit flow of fuel from the pumping chamber into one of the cylinders of the engine and a relief position in which the valve means opens the release passage means to provide communication between all of the fuel passage means leading from the pumping chamber to the various combustion cylinders of the engine.

The arrangement preferably includes also a low pressure chamber and passage means leading from the pump-

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ing chamber to the low pressure chamber, which passage means are opened at the end of the pressure stroke of the combined distributor and pump means so that the pressure in the pumping chamber is reduced, and spring means cooperating with the valve means to move the latter after the pressure in the pumping chamber is reduced from the fuel supply position of the valve means to the relief position thereof.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a sectional, partly diagrammatic view of the injection pump according to the present invention, the movable parts of the pump being shown at the end of the suction stroke; and

FIG. 2 is a partial sectional view similar to FIG. 1, showing the movable parts of the pump during the pressure stroke.

Referring to FIG. 1, the structure illustrated therein includes a housing or elongated cylinder means 1 of the injection pump intended for use with unillustrated internal combustion engine having four combustion cylinders. The housing 1 is formed with an elongated bore therethrough which is closed at the upper end thereof by a plug 14 screwed into housing 1. Arranged within the bore of the housing 1 are combined distributor and pump means including an elongated piston means 2 which is fitted in the bore of the housing 1 for sliding movement towards and away from the closing plug 14 and for turning movement about its axis. The lower end of the elongated piston means 2 is provided with a flange 3 which is received in a cavity formed in the upper portion of a cam means 4. A pin 5 press-fitted in a hole formed in cam means 4 and engaging in a cut-out in flange 3 couples the piston means 2 with the cam means 4 for simultaneous rotation. A ring 6 located in a groove formed in the cavity of the cam means 4 and engaging the top face of the flange 3 prevents axial displacement of the piston means 2 relative to the cam means 4.

A spring 7 located in a chamber 35 formed in the housing 1 abuts with one end thereof against ball bearing 8, which in turn abuts against the top face of the chamber 35, whereas the opposite end of spring 7 abuts against the top face of the cam means 4 so as to press the cam face of the cam means 4 against rollers 9, mounted in the housing 1 turnable about axes substantially normal to the axis of the bore in housing 1. In the illustrated embodiment in which the injection pump cooperates with an internal combustion engine having four cylinders, the cam means 4 is provided with four camming projections 10 so that the combined distributor and pump means 2 will be moved through four working cycles during each revolution of the cam means 4. The cam means is driven by a shaft A turnably mounted in the housing 1 and connected to the main shaft of the combustion engine for rotation therewith.

The elongated piston means 2 is formed with a stepped longitudinal bore 25 therethrough which is closed at the lower end, as viewed in FIG. 1, by a plug 11. Plug 11 serves as an abutment for a spring 12 which engages with the upper end thereof, as viewed in FIG. 1, a valve member 13 slidably arranged in the bore 25. The spring 12 tends to keep the valve member 13 in its closed position, as shown in FIG. 1, in which the valve member 13 engages with the upper end face thereof the shoulder of the stepped bore 25.

The wall of the combined distributor and pump means

2 is formed in the region of the valve member 13 with single radial bore 16 and with four radial bores 18, only two of which are shown in the drawing, and which are respectively 90° displaced from each other. In the position of the valve member 13 as shown in FIG. 1, the valve member separates the pumping chamber 15 from the radial bore 16 and from the space 17 formed between the facing ends of the valve member 13 and the plug 11, and with which the radial bores 18 communicate. Formed in the housing 1 are four fuel discharge passage means or channels 19 which communicate with passage means 20 leading to the pump outlets 21, which in turn are respectively connected to the combustion cylinders of the engine by conduits not shown in the drawing. The bore 16 cooperates with the fuel passage means 19, 20 and 21 in a manner to be described later on in detail to supply the combustion cylinders of the engine with fuel during the pressure strokes of the combined distributor and pump means 2. While four fuel passage means 19, 20 and 21, only two of which are shown in the drawing, have been described, it is understood that when the injection pump is provided for a combustion engine having more than four combustion cylinders, the housing 1 would have to be formed with a number of fuel passage means according to the number of combustion cylinders provided in the engine.

A release passage means 22 communicates with each of the fuel passage means 19 as shown in the drawing. The radial bores 18 cooperate with the release passage means 22 in a manner as will be described later on in detail.

Formed in the cylindrical surface of the valve member 13 is an annular groove 23 which is connected by a channel 24 to the longitudinal bore 25 of the member 2 and therethrough with the pumping chamber 15.

The fuel is pumped from a container 26 by a supply pump 27 driven from the combustion engine, and fed through a filter 28 into the fuel inlet passage means 29 formed in the housing 1. The open cross section of the fuel inlet passage means 29 can be changed by means of a turnable valve 30 located in the fuel passage means 29 so as to change the amount of fuel provided during each suction stroke of the member 2. The fuel passage means 29 communicates during each revolution of the member 2 consecutively with four radial bores 31 formed in the wall of the member 2, only two of which are indicated in dotted lines in the drawing.

The longitudinal bore through the housing 1 is formed with an annular groove 33 which is connected through a bore 34 with the relief chamber 35 formed in the housing. The relief chamber 35 is connected through an opening 36 in the housing 1 and a schematically illustrated conduit 37 to the container 26.

The member 2 is formed with an additional cross bore 38 which provides near the end of the compression stroke a connection between the pumping chamber 15 and the annular groove 33 and thereby a connection between the pumping chamber 15 and the relief chamber 35.

Connected to the feed conduit of the pump 27 is an overflow valve 39, schematically illustrated in FIG. 1 through which any excess fuel pumped by the pump 27 may flow back to the container 26.

The pump described above will operate as follows:

The pumping or pressure stroke starts when the cam means 4 and the member 2 connected thereto are turned from the position shown in FIG. 1, in which the inlet bores 31 are closed and the control bore 16 is in substantial alignment with one of the discharge passage means 19, as the projections 10 of the cam means 4 move onto the rollers 9. As the member 2 moves from its starting position indicated by the dotted line UT towards its upper end position indicated by the dotted line OT, the pressure in the pumping chamber 15 increases, and this increasing pressure moves the valve member 13 from its position shown in FIG. 1 against the pressure of the

spring 12 to a fuel supply position as shown in FIG. 2 so that fuel is pumped from the pumping chamber 15 through the channels 25, 24, the ring groove 23, the control bore 16 into one of the fuel passage means 19, 20, 21, communicating in the angular position of the member 2 with the bore 16, and from there to the respective combustion cylinder of the engine.

The fuel feed is finished when the cross bore 38 is moved during the compression stroke of the member 2 to a position in which it communicates with the annular groove 33 provided in the housing 1. In this position, the pumping chamber 15 is placed in communication with the relief chamber 35 so that the pressure in the pumping chamber 15 decreases, whereupon the spring 12 will move the valve member 13 back again to the relief position thereof as shown in FIG. 1. During its movement from the position shown in FIG. 2 to the position shown in FIG. 1, the valve member 13 closes first the control bore 16 and opens subsequently thereto the bores 18 communicating with relief passage 22. During the closing movement of the valve member 13, the volume of the space 17 between the valve member 13 and the plug 11 is increased and therefore, after the valve member has opened the bores 18 communicating with the relief passages 22, fuel is sucked from relief passages 22 and all fuel passages 19, 20, 21 communicating therewith. Thereby the pressure in all of the fuel passages 19, 20 and 21 is reduced in the same manner. The simultaneous connection of all fuel discharge passages at the end of each compression stroke of the combined distributor and pump means provides—regardless of the position of any fuel vapor bubbles in these passages—a simultaneous pressure reduction in all fuel discharge passages to the same pressure, which is an essential condition for the feeding of uniform amounts of fuel to all cylinders of the engine. During the first part of the movement of the valve member 13 from the position shown in FIG. 1 to the position shown in FIG. 2, the chamber 17 remains connected to the relief passage means 19 through the bores 18, so that the fuel contained in the space 17 may leave this space through the passages 18 and 22. The bores 18 are closed by the valve member 13 only during the last part of the downward movement thereof, so that fuel cannot leave any longer through the bores 18 from the chamber 17 and is compressed therein. It is pointed out that the fuel always contains a certain amount of gas so that it is compressible to a certain extent. It is further mentioned that the valve overlap is shown exaggerated in FIG. 2, and actually the bottom edge of the valve 13 passes beyond the bores 18, when the valve is in its lowermost position, only a distance of 0.3 to 0.4 mm., which is sufficient to properly close the bores 18. The actual overlap at the end of the movement of the valve 13 will be determined by the compressibility of the fuel contained in the chamber 17 and by the pressure acting on the top of the valve 13.

During the following suction stroke of the member 2 a partial vacuum will be created in the pumping chamber 15. As the member 2 is turned at the same time about its axis as it moves downwardly to its position illustrated in FIG. 1, one of the cross bores 31 is placed in communication with the fuel passage means 29 and fuel flows under the pressure of the feed pump 27 into the pumping chamber 15. The amount of fuel entering into the pumping chamber 15 will depend on the position of the valve 30, which determines the open cross section of the fuel inlet passage 29 and the feeding pressure of the feed pump 27 which in turn is dependent on the speed with which the combustion engine rotates and to which feed pump 27 is connected. The amount of fuel will further depend on the time during which the inlet passage 29 remains connected to one of the bores 31, which time depends likewise on the engine speed.

It will be understood that each of the elements described above, or two or more together, may also find a useful ap-

plication in other types of injection pumps differing from the types described above.

While the invention has been illustrated and described as embodied in injection pumps formed with relief passage means, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, elongated cylinder means formed with a pumping chamber; inlet fuel passage means communicating with said pumping chamber for feeding fuel thereinto; a plurality of fuel discharge passage means communicating with said pumping chamber for feeding fuel from said pumping chamber; relief passage means for establishing communication between all of said fuel discharge passage means; combined distributor and pump means located in said cylinder means and movable between a plurality of angularly displaced positions and in each of said positions between a pressure stroke and a suction stroke for controlling the flow of fuel through said fuel inlet passage means into said pumping chamber and for sequential distribution of fuel from said pumping chamber into said plurality of fuel discharge passage means and for simultaneously connecting all of said fuel discharge passage means with said relief passage means at the end of each pressure stroke to provide for simultaneous relief of all fuel discharge passage means at the end of each pressure stroke; and means for moving said combined distribution and pump means between said plurality of angularly displaced positions and in each of said turned positions between a pressure and a suction stroke.

2. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, elongated cylinder means formed with a pumping chamber; inlet fuel passage means communicating with said pumping chamber for feeding fuel thereinto; a plurality of discharge fuel passage means communicating with said pumping chamber for feeding fuel from said pumping chamber; a low pressure chamber; first relief passage means for establishing communication between said pumping chamber and said low pressure chamber; second relief passage means for establishing communication between all of said fuel discharge passage means; combined distributor and pump means located in said cylinder means and movable between a plurality of angularly displaced positions and in each of said positions between a pressure stroke and a suction stroke for controlling the flow of fuel through said fuel inlet passage means into said pumping chamber during said suction stroke and for opening said first relief passage means at the end of said pressure stroke, said combined distributor and pump means including valve means subjected to pressure in said pumping chamber and cooperating with said fuel discharge passage and said relief passage means for opening and closing the same, said valve means being movable between a fuel supply position in which said valve means opens in each of said angularly displaced positions a different one of said fuel discharge passage means to permit flow of fuel from said pumping chamber into said one of the fuel discharge passage means and a relief position in which said valve means opens said relief passage means to establish communication between all of said fuel discharge passage

means; spring means engaging said valve means and tending to keep said valve means in said relief position, said valve means being moved from said relief to said fuel supply position against the pressure of said spring means during increase of pressure in said pumping chamber during said pressure stroke and being moved to said relief position at the end of the pressure stroke of said combined distributor and pump means after said combined distributor and pump means has opened said first relief passage means; and means for moving said combined distribution and pump means between said angularly displaced positions and in each of said positions between said pressure and said suction stroke.

3. In an injection pump having combined distributor and pump means for supplying fuel from a pumping chamber to a plurality of cylinders of an internal combustion engine during the suction and pressure strokes of the combined distributor and pump means, in combination, a plurality of fuel discharge passage means communicating with said pumping chamber for discharging fuel therefrom; relief passage means communicating with all of said fuel passage means; valve means forming part of said combined distributor and pump means and movable between a fuel supply position and a relief position and cooperating with said passage means for opening said fuel discharge passage means in said supply position, for opening said relief passage means in said relief position thereof and for reducing the pressure in said fuel discharge passage means during its movement from said fuel supply position to said relief position means subjecting said valve means to pressure in said pumping chamber so that said valve means is moved from said relief position to said fuel supply position when the pressure in said pumping chamber increases during the pressure stroke of said combined distributor and pump means; spring means cooperating with said valve means and tending to move said valve means from said fuel supply position to said relief position thereof; and means controlled by said combined distributor and pump means for relieving the pressure in the pumping chamber near the end of each pressure stroke to allow said spring means to move said valve means from said fuel supply position to said relief position.

4. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, elongated cylinder means formed with a first bore extending in longitudinal direction therethrough; closing means fixed to one end of said first bore for closing the same; fuel inlet passage means formed in said elongated cylinder means and communicating with said bore for feeding fuel thereinto; a plurality of fuel discharge passage means formed in said elongated cylinder means communicating with said first bore for feeding fuel from said bore; combined distributor and pump means including elongated piston means located in said first bore and turnable about the axis thereof between a plurality of angularly displaced positions and movable in each of said turned positions along a pressure stroke towards said closing means and along a suction stroke away from said closing means, said elongated piston means being formed with a second bore extending in longitudinal direction thereof and being open at the end of said piston means facing said closing means and closed at the other end thereof; relief passage means formed in said elongated cylinder means and communicating with all of said fuel discharge passage means; valve means slidably mounted in said second bore for movement between a fuel supply position providing communication between said first bore and said fuel discharge passage means, respectively so that fuel may flow from said first bore to a different one of said fuel discharge passage means during the pressure stroke of said piston means in each of the turned positions thereof and a relief position opening said relief passage means to provide communication between all of said fuel discharge passage means, said valve means being moved from said relief position to said fuel supply position dur-

ing the pressure stroke of said piston means by the increasing pressure of fuel in said bores; spring means cooperating with said valve means and tending to move the same from said fuel supply position to said relief position thereof, said valve means reducing the pressure in said fuel discharge passage means during the movement thereof from said fuel supply position to said relief position; means controlled by said combined distributor and pump means for relieving the pressure in said pumping chamber near the end of each pressure stroke so as to allow said spring means to move said valve means to said relief position at the end of each pressure stroke; and means for turning said combined distributor and pump means between said plurality of displaced positions thereof and for moving said combined distributor and pump means in each of said turned positions between said pressure and suction strokes.

5. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, elongated cylinder means formed with a first bore extending in longitudinal direction therethrough; closing means fixed to one of said first bore for closing the same; fuel inlet passage means formed in said elongated cylinder means and communicating with said bore for feeding fuel thereinto; a plurality of fuel discharge passage means formed in said elongated cylinder means communicating with said first bore for feeding fuel from said bore; combined distributor and pump means including elongated piston means located in said first bore and turnable about the axis thereof between a plurality of angularly displaced positions and movable in each of said turned positions along a pressure stroke towards said closing means and along a suction stroke away from said closing means, said elongated piston means being formed with a second bore extending in longitudinal direction thereof and being open at the end of said piston means facing said closing means and closed at the other end thereof; a relief chamber formed in said elongated cylinder means; first relief passage means formed in said elongated cylinder means and connecting said first bore with said relief chamber, said combined distributor and pump means at the end of the pressure stroke thereof opening said first relief passage means to provide communication between said first bore and said relief chamber so as to reduce the fuel pressure in said bores at the end of the pressure stroke; second relief passage means formed in said elongated cylinder means and communicating with all of said fuel discharge passage means; valve means slidably mounted in said second bore for movement between a fuel supply position providing communication between said first bore and said fuel discharge passage means, respectively so that fuel may flow from said first bore to a different one of fuel discharge passage means during the pressure stroke of said piston means in each of the turned positions thereof and a relief position opening said second relief passage means to provide communication between all of said fuel discharge passage means, said valve means being moved from said relief position to said fuel supply position during the pressure stroke of said piston means by the increasing pressure of fuel in said bores; spring means cooperating with said valve means and tending to move the same from said fuel supply position to said relief position thereof, said valve means reducing the pressure in said fuel discharge passage means during the movement thereof from said fuel supply position to said relief position; and means for turning said combined distributor and pump means between said plurality of displaced positions thereof and for moving said combined distributor and pump means in each of said turned positions between said pressure and suction strokes.

6. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, cylinder means formed with a pumping chamber; inlet fuel passage means formed in said cylinder

means for feeding fuel into said pumping chamber; a plurality of fuel discharge passage means formed in said cylinder means and communicating with said pumping chamber for discharging fuel therefrom; relief passage means for establishing communication between said plurality of fuel discharge passage means; combined distributor and pump means movable between a plurality of angularly displaced positions and movable in each of said angularly displaced positions between a pressure stroke and a suction stroke and cooperating with said inlet fuel passage means for controlling the flow of fuel along said inlet fuel passage means into said pumping chamber during each of said suction strokes and for controlling flow of fuel out of said pumping chamber during the pressure stroke in each angularly displaced position into a different one of said plurality of fuel discharge passage means and for opening said relief passage means at the end of each pressure stroke so as to connect all of the fuel discharge passage means with each other; and means for moving said combined distributor and pump means between said plurality of angularly displaced positions and in each of said positions between said pressure and said suction stroke.

7. In an injection pump for supplying fuel to a plurality of cylinders of an internal combustion engine, in combination, cylinder means formed with a pumping chamber; inlet fuel passage means communicating with said pumping chamber for feeding fuel thereinto; a plurality of fuel discharge passage means communicating with said pumping chamber for feeding fuel from said pumping chamber; relief passage means for establishing communication between all of said fuel discharge passage means; combined distributor and pump means movable between a plurality of angularly displaced positions and movable in each of said angularly displaced positions between a pressure stroke and a suction stroke for controlling the flow of fuel through said fuel inlet passage means into said pumping chamber during each of said suction strokes for increasing fuel pressure in said pumping chamber during each pressure stroke and for reducing pressure in said pumping chamber at the end of each pressure stroke, said distributor means including valve means subjected to pressure in said pumping chamber and cooperating with said fuel discharge passage and said relief passage means for opening and closing the same, said valve means being movable between a fuel supply position in which said valve means opens said fuel discharge passage means to permit in each of said angularly displaced positions flow of fuel from said pumping chamber into a different one of said fuel discharge passage means and a relief position in which said valve means open said relief passage means to establish communication between all of said fuel discharge passage means; means for turning said combined distributor and pump means between said plurality of angularly displaced positions and for moving said combined distributor and pump means in each of said turned positions between said pressure and said suction stroke; and spring means engaging said valve means and tending to keep the latter in said relief position against the pressure in said pumping chamber so that said valve means moves from said relief position to said fuel supply position during each pressure stroke and from said fuel supply position to said relief position at the end of each pressure stroke of said combined distributor and pump means.

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