

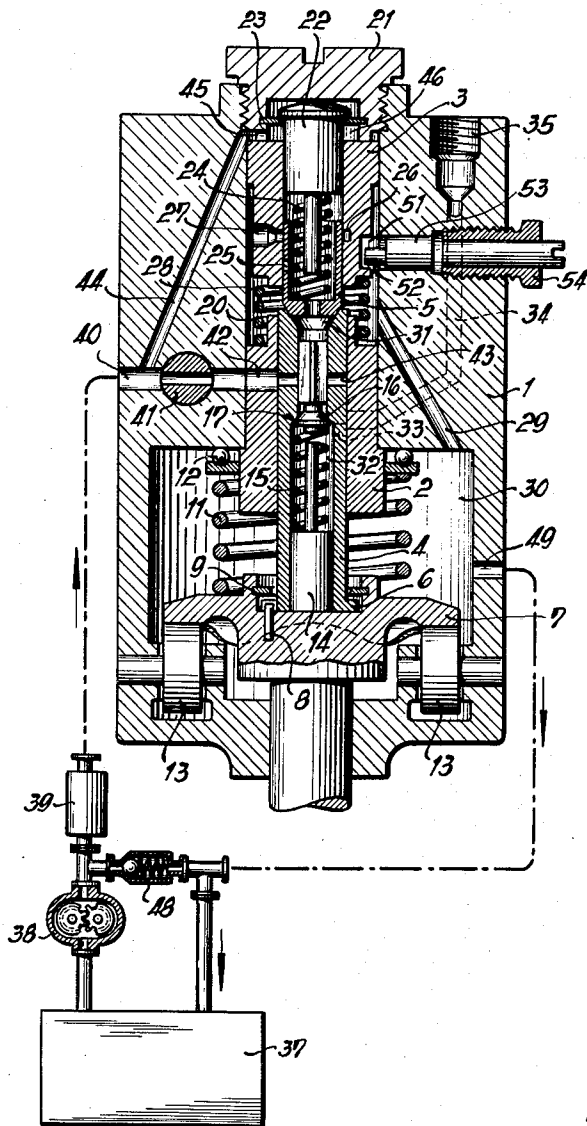
May 24, 1960

J. HEISER

2,937,637

INJECTION PUMP

Filed March 18, 1959



INVENTOR

Joachim Heiser

By Michael S. Striker  
Attorney

1

2,937,637

## INJECTION PUMP

Joachim Heiser, Bernhausen, Kreis Esslingen, Germany,  
assignor to Robert Bosch G.m.b.H., Stuttgart, Germany

Filed Mar. 18, 1959, Ser. No. 800,159

Claims priority, application Germany Mar. 26, 1958

6 Claims. (Cl. 123—140)

The present invention relates to injection pumps.

As is well known, injection pumps are used with internal combustion engines in order to control the supply of fuel to the cylinders of the internal combustion engines. Such pumps will deliver a certain amount of fuel to the cylinders of the engine when the engine is operating under usual full load conditions. However, there are times, as when the engine is started, when it is necessary to deliver to the cylinders of the engine more than the amount of fuel delivered during normal operating full load conditions. At the present time the structures used for providing this greater delivery of fuel in excess of that required for full load operating conditions are extremely complex and do not operate with the best possible reliability and efficiency.

One of the objects of the present invention is to provide an injection pump capable of providing the excess amount of fuel delivery to the cylinders of the engine necessary for starting purposes, for example, with a structure which is exceedingly simple and reliable in operation as well as highly efficient.

Another object of the present invention is to provide an injection pump which can be conveniently adjusted so as to regulate the amount of fuel delivered to the cylinders during full load normal operating conditions.

A further object of the present invention is to provide an injection pump where the structure which is used for providing the excess amount of fuel necessary for starting purposes, for example, is also capable of being used to regulate the maximum amount of fuel delivered to the engine during full load normal operating conditions.

With the above objects in view the present invention includes in an injection pump a cylinder means having a closed end and an opposite open end and formed between its ends with an overflow passage extending through a wall portion of the cylinder means from the interior to the exterior thereof. A hollow piston extends slidably into the cylinder means through the open end thereof and has an open end directed toward the closed end of the cylinder means so that the interior of the piston forms part of a pumping chamber with the cylinder means, this piston having a side wall portion formed with an opening passing therethrough and communicating with the overflow passage of the cylinder means when the latter and the piston have a given axial position with respect to each other. A means cooperates with the cylinder means for automatically maintaining the overflow passage thereof beyond the opening of the piston when the latter reciprocates at a relatively low speed in the cylinder means and for automatically advancing the cylinder means along its axis to place the overflow passage of the cylinder means in a position where it will communicate with the opening of the piston during reciprocation of the latter at speeds which are higher than the above-mentioned relatively low speed, so that at such higher speeds less fuel is pumped than at the relatively low speed.

The novel features which are considered as character-

2

istic 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 drawing.

The drawing shows in an axial sectional elevational view an injection pump constructed according to the present invention.

Referring now to the drawing, it will be seen that the injection pump illustrated includes a housing 1. The injection pump illustrated is adapted to cooperate with an unillustrated internal combustion engine having four cylinders. The housing 1 is formed with an elongated bore into which a pump cylinder 2 is pressed so as to be fixedly connected in this way with the housing 1, and in the bore of the housing 1 which receives the pump cylinder 2 there is arranged an additional pump cylinder 3 which is axially shiftable in the housing 1 and which has a fluid-tight sliding fit with the surface of the bore of the housing 1 in which the cylinder 3 is axially slidable.

The injection pump illustrated includes a combined pumping and distributing member composed of the parts 4 and 5. The part 4 is an elongated tubular element which is axially slidable in the stationary cylinder 2 and at its top end, as viewed in the drawing, the part 4 is in engagement with the second part 5 which has a smaller diameter than the part 4 and which extends slidably into the cylinder 3 through the bottom open end thereof, as viewed in the drawing, this part 5 forming a hollow piston which cooperates with the cylinder 3 in a manner described below.

While the parts 3 and 5 are capable of sliding axially with respect to each other they nevertheless have a fluid-tight sliding fit.

The element 4 is provided at its bottom end, as viewed in the drawing, with a flange 6, and this lower end of the part 4 extends into a recess formed in the top end portion of a cam 7 which is driven so as to rotate about its axis, this cam 7 being driven by the engine itself and being coaxial with the parts 2—5. A pin 8 is fixedly carried by the cam 7 and extends into a cutout of the flange 6 so that the part 4 is constrained to rotate together with the cam 7, and in the recess of the cam 7 which receives the bottom end portion of the part 4 is located a snap ring 9 which constrains the part 4 to move axially with the cam 7.

A coil spring 11 bears at its top end, as viewed in the drawing, against a ball thrust bearing 12 which cooperates with the housing 1 in the manner shown in the drawing, and at its bottom end the coil spring 11 bears directly against the cam 7 so as to maintain the latter against the rollers 13 which are turnably supported for rotation about their axes by the housing 1 in the manner illustrated in the drawing. The cam 7 is provided at its outer periphery with four downwardly directed camming portions which are equidistantly spaced from each other by 90° about the axis of the cam 7, in the above example where the injection pump is used with a four cylinder engine, and these camming portions cooperate with the rollers 13 so that when the cam 7 is rotated about its axis it will simultaneously shift axially back and forth four times during each rotation of the cam 7. Thus, the combined pumping and distributing means 4, 5 will move through four cycles of operation during each revolution of the cam 7.

The part 4 is essentially an elongated hollow tube, and the bottom end of this tube is closed by a plug member 14 in the form of a stepped pin having between its ends a shoulder which is directed away from the cam 7. The

3

bottom end of a coil spring 15 engages this shoulder, and the top end of this coil spring 15 engages a valve 16 to urge the latter into engagement with a valve seat 17 formed in the interior of the part 4. The part of the valve 16 above its frusto-conical valve portion which engages the valve seat 17 is provided with elongated fins which extend axially along the interior of the part 4 and engage the inner surface thereof, as shown in the drawing, so that in this way the valve 16 is guided for axial movement with respect to the part 4.

The bore of the housing 1 which receives the stationary cylinder 2 and the slidable cylinder 3 is closed at its top end, as viewed in the drawing, by a plug 21, and a spring 20 engages the top end of the stationary cylinder 2 and presses against the bottom end of the cylinder 3, as viewed in the drawing, so as to urge this cylinder 3 into engagement with the plug 21 so that the latter acts as a stop for limiting the movement of the cylinder 3 in one direction. It will be noted that the plug 21 is provided at its bottom end, as viewed in the drawing, with a peripheral portion of a smaller diameter than the remainder of the plug 21 and in direct engagement with the top end of the cylinder 3 so that this peripheral annular portion of the plug 21 at its bottom end, as viewed in the drawing, acts as a stop means for the cylinder 3.

An axially stationary piston 22 extends slidably into the cylinder 3 through its top open end, as viewed in the drawing. This axially stationary piston 22 is in the form of a stepped solid pin, as illustrated. The element 22 has a head end the underside of which is engaged by a snap ring 23 carried by the plug 21, so that in this way the piston element 22 is maintained axially stationary while at the same time it is free to turn about its axis. This axially stationary piston 22 is formed between its ends with a shoulder directed downwardly toward the hollow axially reciprocable piston 5, and a spring 24 presses with its top end against the latter shoulder and with its bottom end against the bottom end wall of the axially reciprocable piston 5 so as to maintain the latter in engagement with the top end of the element 4, in fluid-tight engagement with the latter, as illustrated in the drawing. It will be seen that the bottom end wall of the piston 5 is formed with an opening passing therethrough so that the parts 4 and 5 form an elongated hollow combined pumping and distributing means which is axially bored throughout its entire length.

The piston member 5 is formed in a side wall portion thereof with an opening 25 passing therethrough, and the cylinder 3 is formed in its interior with an annular groove 26 which communicates with a passage 27 extending from the groove 26 to the exterior of the cylinder 3, the groove 26 and passage 27 combining together to form an overflow passage formed in the cylinder 3 between its ends, as shown in the drawing. As may be seen from the drawing, the overflow passage 26, 27 of the cylinder 3 communicates with the chamber 28 in which the spring 20 is located, and this chamber 28 in turn communicates through the passage 29 formed in the housing 1 with the chamber 30 in which the spring 11 is located.

The cylinder 3 together with the axially stationary piston 22 cooperate together to form a cylinder means in which the hollow piston 5 is axially slidable, and the piston 5 forms with the cylinder means 3, 22 a pumping chamber 31 which is separated from the pressure chamber 32 in the part 4 by the valve 16. The element 4 is formed with an opening 33 extending from the chamber 32 to the exterior surface of the part 4, and the housing 1 is formed with four passages 34 one of which is shown in dotted lines in the drawing. The opening 33 communicates in succession with these four passages 34, and these passages 34 respectively communicate with the outlets 35 which are in turn placed in communication with the several cylinders of the engine, respectively, so

4

that the fuel is distributed in this way from the chamber 32 successively to the several cylinders of the engine during reciprocation and rotation of the part 4.

The fuel which is delivered to the pumping chamber 31 is derived from a fuel reservoir 37 and the fuel is pumped from the reservoir 37 by a fuel supply pump 38 which is driven by the engine itself. The fuel flows, after leaving the pump 38, through a filter 39 and then flows along a suitable conduit to the passage 40 formed in the housing 1. A turnable transversely bored valve member 41 is turnably carried by the housing 1 in a position extending across the passage 40 with the bore of the valve 41 capable of being turned with respect to the passage 40 so as to control the cross section through which the fuel flows to the opening 42 of the stationary cylinder 2. This opening 42 of the stationary cylinder 2 is placed in successive communication with four openings 43 formed in the part 4, and these openings 43 which are displaced by 90° from each other around the axis of the member 4 and two of which are shown in the drawing successively communicate with the opening 42 during axial reciprocation and rotation of the member 4, the several openings 43 forming inlets into the pumping chamber 31 through which the fuel flows into this pumping chamber during the suction strokes of the pump.

As is apparent from the above description the housing 1 together with the plug 21 form a housing means which provides the bore in which the cylinder 3 is axially slidable with a closed end directed toward the closed end of the cylinder means 3, 22 formed by the axially stationary piston 22 which extends into the cylinder 3. These closed ends, namely, the closed end of the cylinder means 3, 22 and the closed end of the bore of the housing means 1, 21, define between themselves a pressure chamber 46. The annular lip at the bottom end of the plug 21, as viewed in the drawing, which forms a stop means for the cylinder 3, is formed with a notch 45 passing radially therethrough, and the housing 1 is formed with a passage 44 extending from the passage 40 at a point thereof upstream of the valve 41 to the space in the bore of the housing 1 which surrounds the bottom annular lip of the plug 21. In this way the fuel supply pump 38 which delivers fuel to the pumping chamber 31 also delivers fuel to the pressure chamber 46.

An overflow valve 48 communicates with the discharge conduit leading from the fuel supply pump 38 so that the excess fuel which is delivered by the pump 38 can flow through the overflow valve 48 back to the reservoir 37. Moreover, this overflow valve will guarantee that the pressure of the fuel pumped by the supply pump 38 will be proportional to the speed of the engine which drives the pump 38.

The chamber 30 of the housing 1 in which the spring 11 is located communicates through an opening 49 of the housing 1 and a suitable conduit with the fuel reservoir 37.

The cylinder 3 is formed in its outer surface with an elongated axially extending recess 51 into which a pin 52 extends. This pin is fixed to a rod 53 and the axis of the pin 52 is spaced from but parallel to the axis of the rod 53 and the latter is turnably supported by the housing 1 so that due to the eccentric mounting of the pin 52 the position of the latter along the axis of the cylinder 3 can be regulated. A tubular member 54 surrounds a portion of the rod 51 and is threaded into a bore of the housing 1 for clamping the rod 51 to the housing 1 in an adjusted angular position. When it is desired to change the position of the stop pin 52, it is only necessary to loosen the tubular member 54 and turn the rod 51, and when the stop pin 52 is in the desired position the tube 54 is again tightened.

The above-described structure operates as follows:

The cam 7 is illustrated in the drawing at the end of a suction stroke. During rotation of the cam 7 beyond the position shown in the drawing the part 4 will first

5

move upwardly as viewed in the drawing so as to close the opening 42 of the stationary cylinder 2. As soon as the opening 42 is in this way closed by the part 4, the pressure stroke starts. The cylinder 3 is illustrated in the drawing in the position it takes when the engine is started. In this position of the cylinder 3 the pressure stroke ends before the opening 25 can reach the overflow passage 26, 27. Thus, all of the fuel which can be pumped from the pressure chamber 31 during the pressure stroke of the piston will be pumped therefrom through the valve 16 into the chamber 32, this valve 16 opening due to the increased pressure of the fuel in the pumping chamber 31 during the pressure stroke of the pump. The fuel under pressure which in this way reaches the chamber 32 flows from the latter through the opening 33 along one of the passages 34 and the outlet 35 which communicates therewith to one of the cylinders of the engine.

During the subsequent suction stroke of the pump the valve 16 closes and the pumping chamber 31 is placed under vacuum so as to produce a suction. This results from the increased volume of the pumping chamber 31 produced by movement of the piston member 5 away from the stationary piston member 22. As soon as the member 4 has moved in a downward direction, as viewed in the drawing, through a distance sufficient to place the opening 42 in communication with one of the openings 43, the fuel flows into the pumping chamber under the pressure provided by the fuel supply pump 38. The amount of fuel which flows into the pumping chamber 31 depends upon the position of the valve 41 which controls the cross section of flow through the passage 40, the supply pressure of the pump 38 which supply pressure is proportional to the speed of the engine which drives the fuel supply pump 38, and also the time during which the particular opening 43 remains in communication with the opening 42, this latter time also depending upon the speed of the engine which drives the cam 7.

When the speed of the engine is substantially higher than the relatively low speed thereof when starting, for example, then the pressure of the fuel delivered to the pressure chamber 46 by the pump 38 is so great that it is capable of shifting the cylinder 3 in opposition to the spring 20 as far as possible, which is to say as far as is permitted by the position of the stop pin 52 which thus forms a stop means limiting the movement of the cylinder 3 away from the plug 21. In this operating position of the cylinder 3 the effective pressure stroke of the injection pump terminates before the time when the camming portions of the cam 7 have moved the piston 4, 5 to its top dead center position. The pressure stroke will terminate at this time at the moment when the opening 25 of the piston 5 communicates with the overflow passage 26, 27 of the cylinder 3. Once the cylinder 3 has moved into engagement with the stop means 52, this cylinder 3 will remain at this position during the entire subsequent operation of the engine. Thus, by adjusting the position of the stop means 52 the operating position of the cylinder 3 can be regulated and in this way it is possible to regulate the maximum amount of fuel delivered by the injection pump to the engine during normal full load operation thereof. This latter maximum amount of fuel is of course less than the amount of fuel delivered during starting of the engine when the pressure in the chamber 46 cannot hold the cylinder 3 against the stop means 52 so that the opening 25 does not reach the overflow passage 26, 27. It will be noted that with this construction because the piston 22 remains axially stationary the volume of the pumping chamber 31 does not change as a result of axial shifting of the cylinder 3.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of injection pumps differing from the types described above.

6

While the invention has been illustrated and described as embodied in adjustable injection pumps, 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, in combination, cylinder means having a closed end and an opposite open end and formed between said ends with an overflow passage extending through a wall portion of said cylinder means from the interior to the exterior thereof; a hollow piston extending slidably into said cylinder means through said open end thereof and having an open end directed toward said closed end of said cylinder means so that the interior of said piston forms part of a pumping chamber with said cylinder means, said piston having a side wall portion formed with an opening passing therethrough and communicating with said overflow passage when said cylinder means and piston have a given axial position with respect to each other; and means cooperating with said cylinder means for automatically maintaining said overflow passage thereof beyond said opening of said piston when the latter reciprocates at a relatively low speed in said cylinder means and for automatically advancing said cylinder means along its axis to place said overflow passage of said cylinder means in a position where it will communicate with said opening during reciprocation of said piston at speeds higher than said relatively low speed, so that at said higher speeds less fuel is pumped than at said relatively low speed.

2. In an injection pump, in combination, cylinder means having a closed end and an opposite open end and formed between said ends with an overflow passage extending through a wall portion of said cylinder means from the interior to the exterior thereof; a hollow piston extending slidably into said cylinder means through said open end thereof and having an open end directed toward said closed end of said cylinder means so that the interior of the piston forms part of a pumping chamber with said cylinder means, said piston having a side wall portion formed with an opening passing therethrough and communicating with said overflow passage when said cylinder means and piston have a given axial position with respect to each other; housing means formed with an elongated bore in which said cylinder means is axially slidable, said bore of said housing means having a closed end toward which said closed end of said cylinder means is directed, and said closed end of said bore forming with said closed end of said cylinder means a pressure chamber so that when fuel from a fuel supply pump which delivers fuel to said pumping chamber is also delivered to said pressure chamber the pressure of the fuel in the pressure chamber will urge said cylinder means along its axis toward a position where said overflow passage will communicate with said opening of said piston during reciprocation of the latter; stop means carried by said housing means and cooperating with said cylinder means for limiting the movement thereof toward said closed end of said bore; and spring means urging said cylinder means toward said stop means whereby when the pressure of the fuel in said pressure chamber overcomes the force of said spring means said cylinder means will be shifted along its axis to place said

7

overflow passage thereof nearer to said opening of said piston means.

3. In an injection pump, in combination, cylinder means having a closed end and an opposite open end and formed between said ends with an overflow passage extending through a wall portion of said cylinder means from the interior to the exterior thereof; a hollow piston extending slidably into said cylinder means through said open end thereof and having an open end directed toward said closed end of said cylinder means so that the interior of the piston forms part of a pumping chamber with said cylinder means, said piston having a side wall portion formed with an opening passing therethrough and communicating with said overflow passage when said cylinder means and piston have a given axial position with respect to each other; housing means formed with an elongated bore in which said cylinder means is axially slidable, said bore of said housing means having a closed end toward which said closed end of said cylinder means is directed, and said closed end of said bore forming with said closed end of said cylinder means a pressure chamber so that when fuel from a fuel supply pump which delivers fuel to said pumping chamber is also delivered to said pressure chamber the pressure of the fuel in the pressure chamber will urge said cylinder means along its axis toward a position where said overflow passage will communicate with said opening of said piston during reciprocation of the latter; stop means carried by said housing means and cooperating with said cylinder means for limiting the movement thereof toward said closed end of said bore; spring means urging said cylinder means toward said stop means whereby when the pressure of the fuel in said pressure chamber overcomes the force of said spring means said cylinder means will be shifted along its axis to place said overflow passage thereof nearer to said opening of said piston means; and second stop means carried by said housing means and cooperating with said cylinder means for limiting the movement of the latter away from said closed end of said bore, whereby said second stop means controls the position of said cylinder means when the pressure of the fuel in said pressure chamber is above a given value sufficient to move said cylinder means away from said closed end of said bore into engagement with said second stop means.

4. In an injection pump, in combination, cylinder means having a closed end and an opposite open end and formed between said ends with an overflow passage extending through a wall portion of said cylinder means from the interior to the exterior thereof; a hollow piston extending slidably into said cylinder means through said open end thereof and having an open end directed toward said closed end of said cylinder means so that the interior of the piston forms part of a pumping chamber with said cylinder means, said piston having a side wall portion formed with an opening passing therethrough and communicating with said overflow passage when said cylinder means and piston have a given axial position with respect to each other; housing means formed with an elongated bore in which said cylinder means is axially slidable, said bore of said housing means having a closed end toward which said closed end of said cylinder means is directed, and said closed end of said bore forming with said closed end of said cylinder means a pressure chamber so that when fuel from a fuel supply pump which delivers fuel to said pumping chamber is also delivered to said pressure chamber the pressure of the fuel in the pressure chamber will urge said cylinder means along its axis toward a position where said overflow passage will communicate with said opening of said piston during reciprocation of the latter; stop means carried by said housing means and cooperating with said cylinder means for limiting the movement thereof toward said closed end of said bore; spring means urging said cylinder means toward said stop means whereby when the pressure of the fuel in said pressure chamber overcomes the force of

8

said spring means said cylinder means will be shifted along its axis to place said overflow passage thereof nearer to said opening of said piston means; second stop means carried by said housing means and cooperating with said cylinder means for limiting the movement of the latter away from said closed end of said bore, whereby said second stop means controls the position of said cylinder means when the pressure of the fuel in said pressure chamber is above a given value sufficient to move said cylinder means away from said closed end of said bore into engagement with said second stop means; and adjusting means cooperating with said second stop means for adjusting the position of the latter along the axis of said cylinder means, whereby said adjusting means can be used to control the maximum amount of fuel pumped by said cylinder means and piston after the pressure of the fuel in said pressure chamber has exceeded the value necessary for placing said cylinder means in engagement with said second stop means.

5. In an injection pump, in combination, an elongated hollow cylinder having a pair of opposed open ends and formed between said ends with an overflow passage extending through a wall portion of said cylinder from the interior to the exterior thereof; an axially stationary solid piston extending slidably into said cylinder through one of said open ends thereof so that said cylinder can move axially along said axially stationary piston; and an axially reciprocable hollow piston extending slidably into said cylinder through the other of said open ends thereof, said hollow piston having an open end directed toward said solid piston so that the latter together with said hollow piston define a pumping chamber in said cylinder, said hollow piston being formed with an opening passing through a wall portion thereof so that when said opening communicates with said overflow passage fuel in said pumping chamber will flow through said overflow passage, whereby the position of said cylinder along its axis can be regulated to control the point when said opening communicates with said overflow passage without changing the volume of said pumping chamber.

6. In an injection pump, in combination, an elongated hollow cylinder having a pair of opposed open ends and formed between said ends with an overflow passage extending through a wall portion of said cylinder from the interior to the exterior thereof; an axially stationary solid piston extending slidably into said cylinder through one of said open ends thereof so that said cylinder can move axially along said axially stationary piston; an axially reciprocable hollow piston extending slidably into said cylinder through the other of said open ends thereof, said hollow piston having an open end directed toward said solid piston so that the latter together with said hollow piston define a pumping chamber in said cylinder, said hollow piston being formed with an opening passing through a wall portion thereof so that when said opening communicates with said overflow passage fuel in said pumping chamber will flow through said overflow passage, whereby the position of said cylinder along its axis can be regulated to control the point when said opening communicates with said overflow passage without changing the volume of said pumping chamber; a housing formed with an elongated bore in which said cylinder is axially slidable; a plug closing said bore of said housing; and means carried by said plug and cooperating with said solid piston for maintaining the latter axially stationary while free to turn about its axis.

References Cited in the file of this patent

70	UNITED STATES PATENTS	
	2,810,376	Aldinger ----- Oct. 22, 1957
		FOREIGN PATENTS
75	265,005	Switzerland ----- June 9, 1948
	200,171	Australia ----- Nov. 2, 1955