Sept. 22, 1942. H. LINKS ET AL 2,296,357

FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Fig. 1.

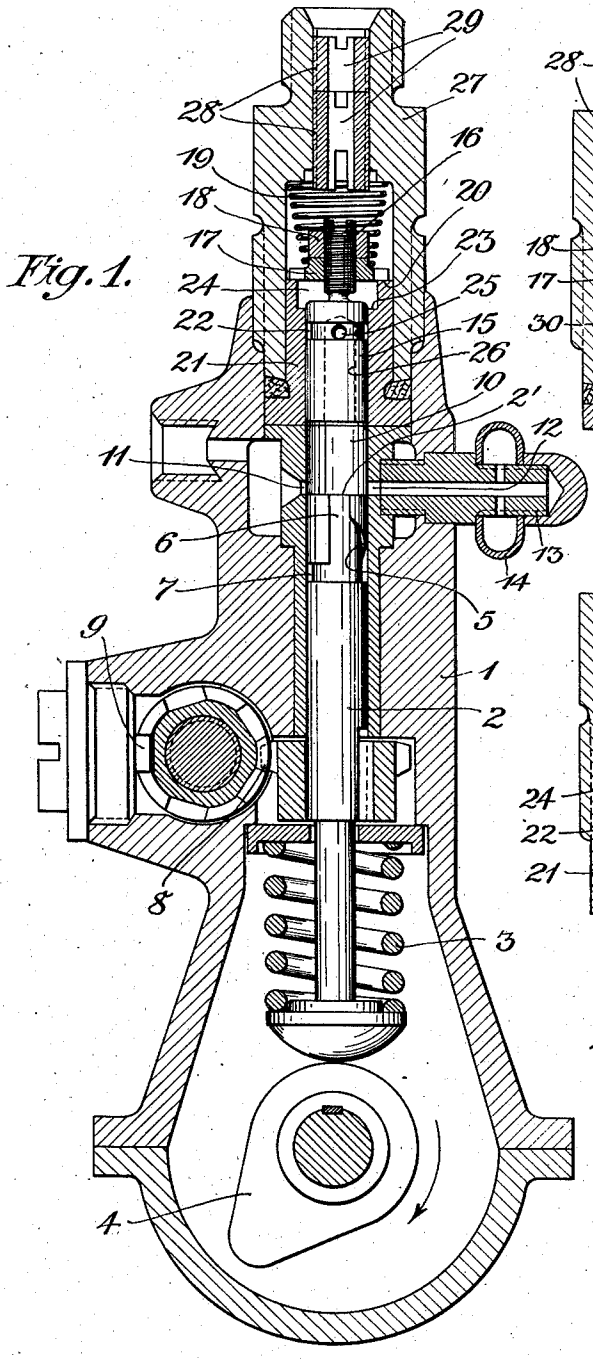


Fig. 3.

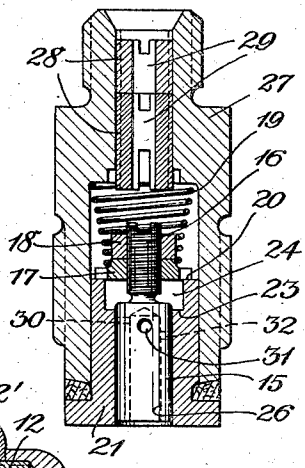
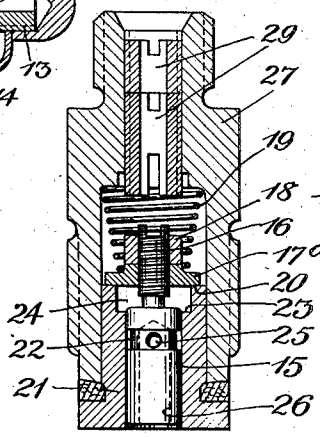


Fig. 2.



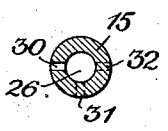


Fig. 4.

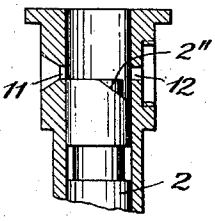


Fig. 5.

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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Fig. 6

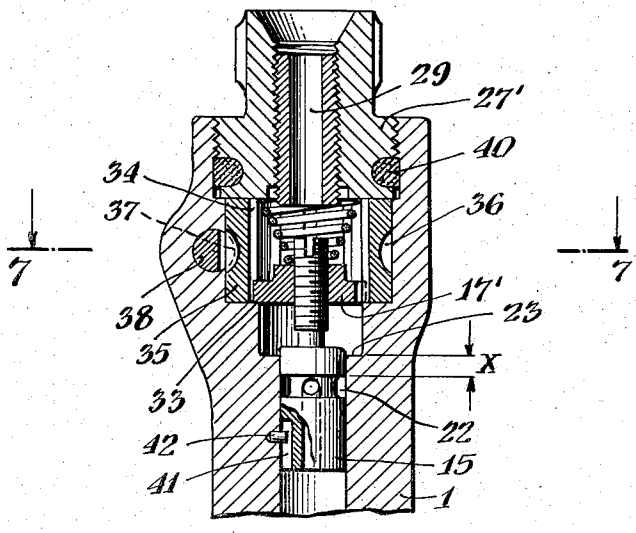
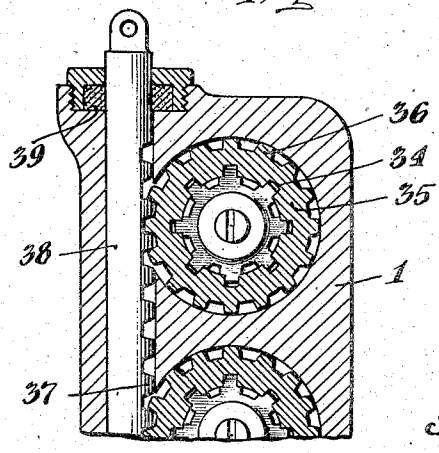


Fig. 7



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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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Application July 10, 1939, Serial No. 283,610
In Germany July 12, 1938

28 Claims. (Cl. 123—139)

This invention relates to improvements in fuel injection pumps for internal combustion engines and particularly motor vehicle engines, and is concerned with pumps having pressure-operated delivery valves disposed in the pressure passage leading to the injection nozzles.

According to this invention a delivery valve is adjustable for the purpose that the injection timing and the quantity injected can be altered independently of any adjustment of the pump piston, the valve being advantageously of the slide variety and adjustable in such a manner that its initial position can be varied with respect to the pump piston.

The invention will be described with reference to the accompanying drawings in which:

Figure 1 is a central vertical section of a fuel injection pump fitted with an adjustable valve;

Figure 2 is a central vertical section of the upper part of a pump fitted with a modified valve arrangement;

Figure 3 is a view similar to the upper part of Figure 1, but it shows another modified form of piston valve;

Figure 4 is a cross section of the piston valve seen in Figure 3;

Figure 5 is a sectional elevation of the upper portion of a pump cylinder with a form of piston differing from that seen in Figure 1;

Figure 6 is a central vertical section, similar to Fig. 1, illustrating a modified arrangement for varying the common adjustment of the valves of a plurality of side-by-side pumps; and

Figure 7 is a horizontal cross-sectional view along the line 7—7 of Fig. 6.

Referring to Figure 1, a pump piston 2 is guided in a cylinder or housing 1 and is pressed downwardly by a spring 3 which operates to maintain contact between the stem of the piston 2 and a cam 4. The upper end 2' of the piston has an inclined controlling edge 5 extending between one side edge of a longitudinal groove 6 and the top-wall of an annular groove 7 formed in the piston. The latter can be rotatably adjusted by means of teeth 8 engaging with suitable operating means in a known manner, and such means can be locked in any adjusted position by the locking device 9, also known per se.

A fuel supply passage 11 opens into the pressure space 10 above the piston 2, and an outlet or overflow passage 12 in a spigot 13 also opens into this space. The spigots 13 of several side-by-side pumps may be connected to a common discharge pipe 14.

Above the pressure space 10 of the pump there is a control member in the form of a small piston valve 15 having at its upper end a screw threaded reduced pin 16 which is screwed through a nut 17 having peripheral projections. The nut 17 is normally supported by its peripheral projections resting upon the upper end or shoulder 20 of the valve guide 21, and it will be apparent that the screwing of the pin 16 up or down in the nut 17 will alter the distance between the bottom of the valve 15 and the top of the piston 2. Any adjustment of the pin 16 in the nut 17 may be locked by tightening a locknut 18. The nut device 17 serves as the lower abutment for the valve loading spring 19 the upper end of which presses against a shoulder in the head piece 27 of the pump. The spring 19 constantly tends to keep the peripheral projections of the nut device 17 hard down upon the shoulder 20.

Near its upper end, the slide valve 15 has an annular groove 22 which coacts with a shoulder 23 formed by a recess 24 in the valve guide 21. Within this groove there are radial ports 25 which open into a longitudinal bore 26 of the slide valve. A two-piece tubular abutment 28 is screwed into and locked in the head-piece 27 above the pin 16. This tubular abutment limits upward movement of the pin 16 and slide valve 15, and its bore 29 opens into the duct for conveying the pressure delivery to an injection nozzle. As seen in the drawings, the top of the pin 16 and the bottom of the tubular abutment 28 are notched or slotted, to prevent cutting off of the delivery when the pin 16 comes against the abutment 28.

The operation is as follows: Upon descent of the piston 2 fuel is drawn into the space 10 from the passage 11. At the commencement of its following upward movement, the piston 2 displaces liquid from the space 10 through the passage 12 and into the overflow pipe 14. The upper edge 2' of the piston then cuts off the passage 12 and also the supply port 11, unless this latter cut-off has already happened previously. Further, upward movement of the piston 2 then puts under pressure the liquid fuel enclosed in the space 10 until the pressure acting upon the piston slide valve 15 overcomes the downward effort of the spring 19. When this occurs, the valve 15 with its nut devices 17 and 18 rises until the upper edge of the annular groove 22 is clear of the shoulder 23. At this instant, the liquid fuel in the space 10, bore 26 and groove 22 escape into the space 24 and, passing over the nuts 17, 18

and through the spring 19, flows through the bore 29 to the injection nozzle (not shown). This pressure flow will be interrupted at the instant that the controlling edge 5 of the piston 2 rises above and uncovers the outlet 12, thereby opening communication between the space 10 and the outlet 12 by way of the longitudinal groove 6. As only slight pressure exists in the passage 12, the remaining liquid fuel under pressure in the space 10 escapes through the passage 12, the pressure is relieved and the spring 19 is able to depress the piston valve 15 to its original position shown in Figure 1.

It will be apparent from Figure 1 that the end of the injection period is determined by the instant at which the controlling edge 5 uncovers the orifice of the passage 12. Also, it will be apparent that the injection period can be varied by adjusting the valve up or down by means of its screw adjustment. One effect of this adjustment is to vary the capacity of the space 10, the quantity of fuel drawn in by the pump piston being in accordance with the capacity of the space above the passages 11 and 12. Another effect is to vary the instant of injection, for if the valve 15 be adjusted to a deeper position, for example, the path traversed by the valve 15 before the annular groove 22 is uncovered at the shoulder 23 is increased, thereby retarding the instant of release of the fuel imprisoned in the space 10.

If desired, and as illustrated in Figure 2, the nut device 17 of Figure 1, may be formed with an unbroken annular flange 17a adapted for seating upon the shoulder 20 in the manner of a disc valve. The closure thus effected prevents the surging back over the valve 15 of a rather large column of liquid fuel.

In place of the annular groove 22, the valve 15, as shown in Figures 3 and 4, may be formed with transverse or radial ports 30, 31 and 32. These ports are arranged in stepwise fashion and so that there is no dead space between any port and the next above or below. The radial direction of the ports 30, 31, 32 in relation to each other is immaterial. Preferably, the highest port 30 has the smallest diameter, the next below being made larger and the next still larger. When quite small quantities are to be delivered, the smallest port 30 serves for the passing of such quantity into the space 24, the slide valve 15 being raised only sufficiently for the uncovering of this port. Upon descent of the valve, only a slight relief of pressure in the delivery passage occurs. For larger deliveries, the slide valve 15 must have a greater rise so as to uncover the next port 31, or the ports 31 and 32. Upon descent of the slide valve 15, a larger relief of pressure in the delivery passage is effected, as is desirable. By the arrangement of the ports 30, 31 and 32 without any intervening dead space as aforesaid, that is to say, so that as the uncovering of one port is concluded the uncovering of the next port commences, the enlargement or reduction of the delivery passage during ascent or descent of the valve 15 takes place according to a quadratic law. Thus, the relief of pressure in the delivery passage during descent of the valve 15 is less at partial loading, when smaller quantities are delivered per stroke, than at full load.

If the pump piston has a straight controlling edge 2' governing the commencement of delivery, as explained with reference to Figure 1 for example, and if control of the quantity delivered is effected by throttling fuel inflow at the passage 11, for example by a slide valve device (not shown), then the possibility of adjusting the commencement of delivery by the valve is particularly advantageous. The reason for this is that it may be very difficult to produce the slide valve devices referred to with great accuracy for prescribed throttling and so that each has the same form and controlling effect as another.

Figure 5 shows a different embodiment of the pump piston formed with an inclined edge 2'' for controlling the beginning of the injection, commencement of injection at partial load being later than at full load.

In the examples illustrated, the piston valves 15 are of the same diameter as their respective pump pistons 2. But they may be larger or smaller diameter than the pump pistons for obtaining an hydraulic transmission.

In the form of invention illustrated in Figs. 6 and 7, an arrangement is provided whereby the control members of a plurality of pumps may be simultaneously adjusted. The construction of the pumps as a whole is somewhat similar to that previously described in Fig. 1, but in this case the pump housing 1 surrounds the upper part of the pump which contains the control valve 15 for the control of the delivery conduit, although a similar construction as in Fig. 1 could be used. In this case a nut 17' serves as the adjustable abutment for the control valve 15, which, by means of outer teeth-like projections 33 engages groove 34 of a bushing 35 and is longitudinally shiftable therein. The bushing 35 is rotatably journaled in the housing 1 and, for its part, is provided with external teeth 36 which engage corresponding teeth 37 of a rack 38. The rack 38 is positioned on one side of the housing and is shiftably journaled in a bore of the housing, transverse to the individual pump cylinders, as is clearly shown in Fig. 7. The rack 38 is sealed on the outside by a packing 39. Additional packing 40 is provided between the bushing 35 on the housing or the threaded insertion 27'. In order to prevent rotation of the control valve in the housing, the latter is provided with a longitudinal groove 41 into which a pin 42 is inserted.

Upon a shifting of the rack 38, it will be clear that the bushings of the individual cylinders will be rotated about their axes, whereby the control valve 15, since it is prevented from rotating, will be shifted in the axial direction, one way or another. As a result of this adjustment, the distance x of the upper edge of the groove 22 of the control member from the shoulder 23 of the housing is changed, and also the stroke of the control member.

Instead of using a rack 38, it will appear equally obvious to those skilled in this art that a suitable worm could also be used.

While we have herein shown and described only certain embodiments of certain features of our present invention, it is to be understod that they are to be regarded merely as illustrative and that we do not intend to limit ourselves thereto except as may be required by the claims which follow:

What we claim as our invention and desire to protect by Letters Patent is:

1. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a pump piston reciprocal within said cylinder space, a delivery conduit, a slidable control member intermediate said pump chamber and said delivery conduit, having a

passage adapted to connect the pump chamber with the delivery conduit and which is opened or closed dependent upon the position of said control member, said control member being subjected to and movable in accordance with the pressure produced in said pump chamber in such a manner that it substantially follows the reciprocal movement of said piston to open and close said passage, and means for varying the initial setting of said control member relatively to said piston to vary the time of opening and closing said passage relatively to the position of said piston.

2. The combination according to claim 1, in which said last means includes an adjustable abutment on said control member.

3. The combination according to claim 1, in which the passage in said control member has a mouth on the outer side of the latter, which is opened and closed by the edge of said delivery conduit.

4. The combination according to claim 1, in which said control member is in the form of an axially shiftable piston whose one end face is subjected to the pressure within the pump chamber and whose other end face is subjected to the pressure in the delivery conduit.

5. The combination according to claim 1, in which said setting means includes a threaded extension on said control member and a nut-like abutment threaded on said extension, in combination with spring means urging said abutment toward said pump chamber.

6. The combination according to claim 1, in which said setting means includes a threaded extension on said control member and a nut-like abutment threaded on said extension, in combination with spring means urging said abutment against one end of said cylinder space, said abutment being provided with an opening to permit flow of fuel from said passage to said delivery conduit when said abutment rests against the end of said cylinder space.

7. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member shiftable in said pump housing, positioned intermediate said pump chamber and said delivery conduit so that one end face is subjected to the pressure within said pump chamber and the other end face to the pressure within said delivery conduit, whereby said control member follows the reciprocal motion of said pump piston during the suction and delivery stroke thereof, said control member being provided with a controlling edge cooperating with the edge of said delivery conduit for making or breaking communication between said pump chamber and delivery conduit upon movement of said control member, and adjustable abutment means on said control member for limiting the motion of said control member during the suction stroke of the pump piston after the connection between said pump chamber and delivery conduit has been interrupted.

8. The combination according to claim 7, in which said control member is provided with a passage communicating with said pump chamber and having a mouth discharging laterally at said control edge.

9. The combination according to claim 7, in which said control member is positioned axially to said pump piston and the end face of said control member opposite said pump chamber projects into a space forming part of said delivery conduit.

10. The combination according to claim 7, in which said control member is positioned axially to said pump piston and the end face of said control member opposite said pump chamber projects into a space forming part of said delivery conduit, and in which said abutment means are positioned in this space.

11. The combination according to claim 7, in which said controlling edge on said control member is formed by a ring-like depression about said control member, near said delivery conduit, and said control member is provided with a passage connecting said ring-like depression with said pump chamber.

12. The combination according to claim 7, in combination with resilient loading means biasing said control member toward said pump piston.

13. The combination according to claim 7, in which said control member is provided with a threaded extension, and said abutment means is a nut threadable upon said extension.

14. The combination according to claim 7, in which said control member is provided with a threaded extension, and said abutment means is a nut threadable upon said extension, in combination with a spring pressing against said abutment to urge said control member in one direction to the limit of its motion.

15. The combination according to claim 1, in which said setting means includes a threaded extension on said control member and a nut-like abutment threaded on said extension, and spring means urging said abutment against the end of said cylinder space, said abutment being formed as a disc valve closing communication between said passage and said delivery conduit when said abutment rests against the end of said cylinder space.

16. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member shiftable in said pump housing, positioned intermediate said pump chamber and said delivery conduit so that one end face is subjected to the pressure within said chamber and the other to the pressure within said delivery conduit, whereby said control member follows the reciprocal motion of said pump piston during the suction and delivery stroke thereof, said control member being provided with a plurality of axially spaced, radially extending canals cooperating with the edge of said delivery conduit for making or breaking communication between said pump chamber and delivery conduit upon movement of said control member, and abutment means on said control member for limiting the motion of said control member during the suction stroke of the pump piston after the connection between said pump chamber and delivery conduit has been interrupted.

17. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a pump piston reciprocal within said cylinder space, a delivery conduit, a slidable control member intermediate said pump chamber and said delivery conduit, having a passage communicating with said pump chamber at one end and with a plurality of axially displaced canals at the other end, which cooperate with the edge of said delivery conduit to open one after the other upon movement of said control mem-

ber during the delivery stroke of said pump piston to connect the pump chamber with the delivery conduit, said control member being subjected to and movable in accordance with the pressure produced in said pump chamber in such a manner that it substantially follows the reciprocal movement of said piston.

18. The combination according to claim 17, in combination with means for varying the initial setting of said control member relatively to said piston to vary the time of opening and closing said canal.

19. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member shiftable in said pump housing, positioned intermediate said pump chamber and said delivery conduit so that one end face is subjected to the pressure within said pump chamber and the other to the pressure within said delivery conduit, whereby said control member follows the reciprocal motion of said pump piston during the suction and delivery stroke thereof, said control member being provided with a plurality of canals so arranged in cooperation with the edge of said delivery conduit as to produce an increasingly larger opening between said pump chamber and said delivery conduit upon movement of said pump piston and control member during the delivery stroke of said pump piston.

20. The combination according to claim 19, in combination with abutment means on said control member for limiting the movement of said control member during the suction stroke of said pump piston, and means for axially shifting said abutment means relatively to said control member.

21. The combination according to claim 7, in which said pump is provided with a fuel conduit controlled by said pump piston, and said pump piston is provided with an oblique controlling edge for opening and closing said fuel conduit relatively to said pump chamber, in combination with means for rotating said pump piston for changing the relationship of said oblique controlling edge to said fuel conduit to vary the relative time at which said fuel conduit is connected to the pump chamber.

22. The combination according to claim 1, in which said pump comprises a plurality of cylinder spaces, pump chambers, pump pistons and control members, in combination with common means for simultaneously controlling said setting means.

23. The combination according to claim 7, in which said pump is provided with an overflow conduit controlled by said pump piston, and said pump piston is provided with an oblique controlling edge for opening and closing said overflow conduit relatively to said pump chamber, in combination with means for rotating said pump piston for changing the relationship of said oblique controlling edge to said overflow conduit to vary the relative time at which said overflow conduit is connected to the pump chamber.

24. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a pump piston reciprocal within said cylinder space, a delivery conduit, a control member slidable relatively to said pump housing, intermediate said pump chamber and said delivery conduit, one of said relatively slidable parts having a passage adapted to connect the pump chamber with the delivery conduit, which passage is opened or closed dependent upon the position of said control member, said control member being subjected to and movable in accordance with the pressure produced in said pump chamber in such a manner that it substantially follows the reciprocal movement of said piston to open and close said passage, and means for varying the initial setting of said control member relatively to said piston to vary the time of opening and closing said passage relatively to the position of said piston.

25. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member slidable relatively to said pump housing, positioned intermediate said pump chamber and said delivery conduit so that one end face is subjected to the pressure within said chamber and the other to the pressure within said delivery conduit, whereby said control member follows the reciprocal motion of said pump piston during the suction and delivery strokes thereof, one of said relatively slidable parts being provided with a plurality of axially spaced canals having radially extending mouths opened or closed by movement of said control member for making or breaking communication between said pump chamber and delivery conduit, and abutment means on said control member for limiting the motion of said control member during the suction stroke of the pump piston after the connection between said pump chamber and delivery conduit has been interrupted.

26. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a pump piston reciprocal within said cylinder space, a delivery conduit, a control member slidable relatively to said pump housing, intermediate said pump chamber and said delivery conduit, one of said relatively slidable parts having at least one passage communicating with said pump chamber at one end and a plurality of axially displaced mouths at the other end, controlled by said control member to open one after the other upon movement of said control member during the delivery stroke of said pump piston to connect the pump chamber with the delivery conduit, said control member being subjected to and movable in accordance with the pressure produced in said pump chamber in such a manner that it substantially follows the reciprocal movement of said piston.

27. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member slidable relatively to said pump housing, positioned intermediate said pump chamber and said delivery conduit, so that one end face is subjected to the pressure within said pump chamber and the other to the pressure within said delivery conduit, whereby said control member follows the reciprocal motion of said pump piston during the suction and delivery strokes thereof, one of said relatively slidable parts being provided with a plurality of canals having mouths controlled by movement of said control member to produce an increasingly larger opening between said pump chamber and said delivery conduit upon movement of said pump piston and control member during the delivery stroke of said pump piston.

28. A fuel injection pump having a pump housing provided with a cylinder space including a pump chamber, and a pump piston reciprocal within said cylinder space, a delivery conduit, a piston-shaped control member directly positioned and movable in said cylinder space, whose one side is subjected directly to the pressure in said pump space and whose other side to the pressure in said delivery conduit, said control member being shiftable in said cylinder space by the pressure in the pump space produced by the pump piston, whereby it follows the suction and pressure strokes of the latter, said control member having a control edge for opening and closing the connection between said cylinder space and said delivery conduit, and an adjustable abutment member on said control member, cooperating with said pump housing to limit the movement of said control member during the suction stroke of said pump piston, after the control edge has closed the connection between said cylinder space and said delivery conduit.

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