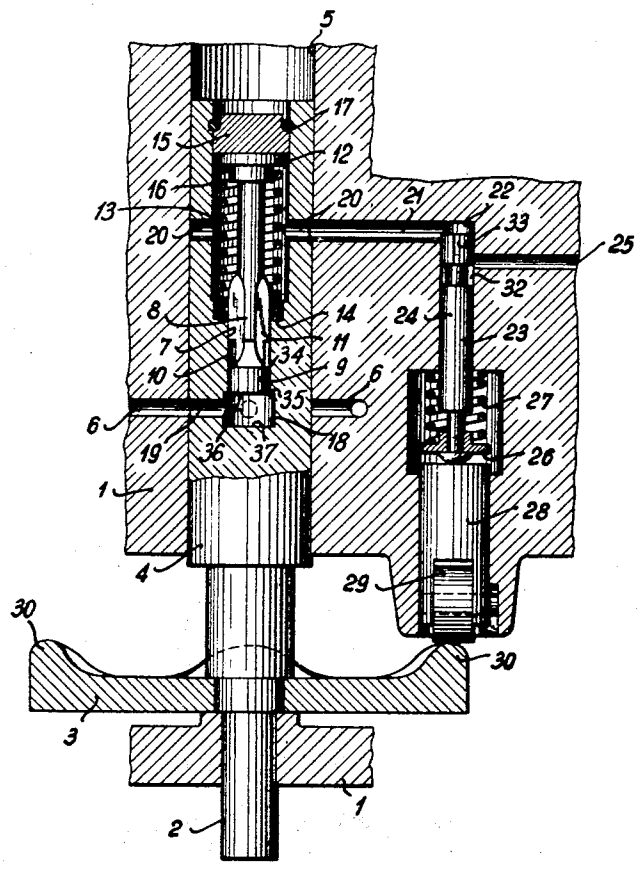
Nov. 22, 1960 U. ALDINGER ET AL 2,961,004

FLOW CONTROL FOR INJECTION PUMPS

Filed July 13, 1955



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United States Patent Office 2,961,004 Patented Nov. 22, 1960

2,961,004

FLOW CONTROL FOR INJECTION PUMPS

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Filed July 13, 1955, Ser. No. 521,840

Claims priority, application Germany July 17, 1954

6 Claims. (Cl. 137—624.13)

The present invention relates to injection pumps. More particularly, the present invention relates to an injection pump of the type which includes a rotating distributor for distributing the fuel to the several cylinders of a multicylinder combustion engine.

One object of the present invention is to provide an injection pump capable of very accurately metering the fuel which is delivered to each cylinder.

Another object of the present invention is to provide an injection pump with a piston which participates directly in the metering of the fuel and which also serves the function of a valve for a fuel pump associated with the distributor.

Furthermore, it is another object of the present invention to provide an injection pump which is capable of fully releasing the pressure in the fuel flowing to the cylinders after the metered amount of fuel has been fed in order to prevent fuel under pressure from flowing to the cylinders immediately after the metered amount of fuel has been delivered thereto.

With the above objects in view, the present invention relates to an injection pump which includes a fluid guiding member formed with an inlet conduit portion, a discharge conduit portion, and with a chamber communicating with both the inlet and the discharge conduit portions, this chamber including an elongated bore portion and a chamber end portion of a larger cross section than this bore portion communicating with the latter and with the discharge conduit portion. A piston having a cross section equal to that of the bore portion is slidably mounted in the latter for slidable movement from the bore portion into the above-mentioned end portion of the chamber and from this latter end portion back into the bore portion, this piston having a volume which is smaller than that of the end portion of the chamber into which the piston moves by an amount only sufficient to provide unrestricted fluid flow from the bore portion of the chamber through the end portion of the latter to the discharge conduit portion when the piston is located in the above-mentioned chamber end portion.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention istelf, 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 is a fragmentary, sectional elevational view of an embodiment of the present invention the selection being taken in a plane which passes centrally through the distributor of the injection pump.

Referring now to the drawing, it will be seen that this injection pump includes a housing 1 which turnably supports a drive shaft 2 driven from any suitable source of power (not shown). The particular fuel injection pump illustrated in the drawing is intended to deliver fuel to the several cylinders of a multicylinder internal combustion engine, and in the illustrated example the injection pump serves a four cylinder engine. Within the housing 1 the drive shaft 2 is fixed to a cam disc 3 which carries four cam portions 30 spaced from each other by 90° and distributed about the axis of rotation of shaft 2 and disc 3.

At the side of the cam disc 3 opposite from the lower end of shaft 2 shown in the drawing, this shaft 2 is integral with a fluid guiding member forming a cylindrical distributor 4, this cylindrical distributor 4 being turnable within a cylindrical bore 5 formed in the housing 1. As is apparent from the drawing, the distributor 4 slidably engages the housing 1. In a horizontal plane, as viewed in the drawing, the housing 1 is formed with four fuel feeding bores 6 spaced from each other by 90°, distributed about the axis of the bore 5, extending radially from this axis, and leading to the several cylinders. Only two of the fuel feeding bores 6 are visible in the drawing.

The distributor 4 is formed with an axial stepped bore extending inwardly from its top end, as viewed in the drawing. This stepped bore has an intermediate bore portion 7 of a smaller cross section than the elongated end portions of the stepped bore located at the opposite ends of the intermediate bore portion 7. Within the bore portion 7 is located a piston rod portion 8 which slidably engages the distributor to be guided by the latter for axial movement, and at its bottom end as viewed in the drawing, the piston rod portion 8 is fixed to a piston 9 which has the same cross section as that of the intermediate bore portion 7 and which slidably engages the distributor 4 with the smallest possible clearance consistent with fairly free slidable movement of the piston 9. At its top face, as viewed in the drawing, the piston 9 is adjacent an annular cutout 10 formed in the piston rod portion 8, and this annular cutout 10 in turn communicates with axial groove 11 formed in the piston rod so that fluid in the bore portion located above the intermediate bore portion 7, as viewed in the drawing engages the top face of the piston 9.

At its top end, as viewed in the drawing, the piston rod portion 8 fixedly carries an annular collar 12 against which the top end of a coil spring 13 abuts, this coil spring being coiled about the piston rod 8 and abutting with its bottom end against a shoulder 14 which is located between the intermediate bore portion 7 and the enlarged elongated bore end portion 16 located immediately above the bore portion 7. Thus, the spring 13 urges the piston 9 upwardly to the raised position shown in the drawing. In this position the annular collar 12 is located against a plug 15 which is located in a fluid-tight manner within the bore portion 16 and which is restrained against upward movement by the snap ring 17, shown in the drawing, within an annular groove formed partly in the plug 15 and partly in the inner surface of the distributor 4 which includes the elongated bore portion 16.

The piston 9 in its position illustrated in the drawing separates the bottom end portion 18 of the bore of the distributor from the intermediate bore portion 7. The bore portions 16, 7 and 18 form a chamber within the fluid guiding member formed by the distributor 4 in which the intermediate bore portion 7 meets the bore portion or chamber end portion 18 along an inlet edge 35, and the end portion 18 of this chamber communicates with a discharge conduit portion 19 extending radially with respect to the axis of the distributor 4 and located in the same plane as the bores 6. During rotation of the distributor 4, the discharge conduit portion 19 thereof communicates successively with the several fuel feeding bores 6 to supply fuel thereto, as will be apparent from the description which follows.

In accordance with the present invention the volume

of the chamber end portion 18 is greater than the volume of the piston 9 by an amount which is just great enough to provide unrestricted fluid flow from bore portion 7 through chamber 18 to conduit portion 19 when the piston 9 is located within the chamber 18. As a particular example, the chamber 18 may have a diameter which is approximately 0.5 mm. greater than that of the piston 9, and the axial length of the chamber 18 is approximately 0.4 mm. longer than the axial length of the piston 9.

In another horizontal plane located above that in which the bores 6 and conduit portion 19 are located four inlet conduit portions 20 are formed in the distributor 4 and are spaced from each other by 90° and extend radially from the axis of the distributor 4. As the distributor 4 rotates about its axis, the several inlet conduit portions 20 communicate successively with a pump discharge conduit in the form of a bore 21 formed in the housing 1 and located in the same plane as the several inlet conduit portions 20. In the position of the parts shown in the drawings, one of the bores 20 is shown in registry with the pump discharge bore 21, and the discharge conduit portion 19 is shown in registry with one of the fuel feeding bores 6. The conduit 21 leads from a cylindrical pump chamber 22 which forms the upper end portion of an elongated cylindrical bore portion 23 forming part of a pump structure accommodated in the housing 1. The pump piston 24 slides within the elongated bore 23, while a supply bore 25 is provided for supplying fuel to the bore 23 from any suitable source.

The bottom end portion of the piston 24 is formed with an elongated annular groove and has an enlarged bottom head end, the elongated end portion of reduced cross section of the piston 24 extending slidably through an annular ring 26 which rests on the bottom head end of the piston 24 as indicated in the drawing. A coil spring 27 is coiled about piston 24, is located in an enlarged chamber of the housing 1, and presses at its bottom end against the ring 26 and at its top end against the top surface of the chamber so that the spring 27 in cooperation with the ring 26 urges the piston 24 downwardly, as viewed in the drawing. Thus, the spring 27 serves to maintain the bottom end of the piston 24 in constant engagement with the top end of a follower 28, 29 which includes a cylindrical portion 28 slidable within a cylindrical bore which communicates with the chamber in which spring 27 is located, and a roller 29 turnably carried by the member 28 and engaging the cams of the cam disc 3.

The parts of the pump are shown in that position which they take when they are at the end of the pressure stroke of the pump. In this position the pump piston 24, which is formed adjacent its top end with an annular groove 32, which is in constant communication with the chamber 22 through the axial groove 33 extending along the piston 24 between its top end and the groove 32, is located with its groove 32 in slightly overlapping relation with the supply conduit 25 so that the piston 9 which is placed only under the supply pressure in the conduit 25 may be moved to the illustrated position by the spring 13. During the succeeding suction stroke of the pump the bore 25 is closed by the portion of piston 24 above groove 32 while during the last part of the suction stroke and during the first part of the pressure stroke the top end of the piston becomes located beneath the uppermost part of the left end of bore 25, as viewed in the drawing, so that the chamber 22 becomes filled with fuel. Then, during the succeeding pressure stroke the conduit 25 is again closed by the piston and the pump piston pushes the fluid trapped between itself and the piston 9 along the discharge conduit 21 through one of the inlet conduits 20 which is aligned with conduit 21 and into the chamber portion 16 downwardly along the intermediate bore portion 7 against the top face of the piston 9. The great pressure in the fuel at this time causes the fuel to lower the piston 9, from the rest position thereof as viewed in the drawing, against the action of the spring 13, until the piston 9 is located in its maximum discharge position completely out of the intermediate bore portion 7 and completely within the chamber end portion 18 so that the fuel then flows through the clearance about piston 9 in chamber 18 to the conduit 19 and from the latter along one of the fuel feeding bores 6. In this maximum discharge position of the piston 9 the upper or controlling edge 34 thereof will be located slightly below the inlet edge 35 of the chamber end portion 18 and the bottom face 36 of the piston will engage the bottom face 37 of the chamber end portion 18. In the specific construction shown in the drawing, the bottom face 37 forms therefore limiting means for limiting the movement of the piston 9 to its maximum discharge position. The fuel supply pressure ends as soon as the annular groove 32 of the piston 24 overlaps the conduit 25. This process repeats itself four times during one revolution of the drive shaft 2 so that a four cylinder engine may be served with the above described structure.

The above described structure of the invention effects a compromise between two conflicting requirements. On the one hand, it has been found that the smaller the volume of chamber portion 18 the greater is the precision in the volume of fuel fed to each cylinder, and on the other hand, it is essential to immediately release the pressure in the fuel after it is metered in order to prevent such a high pressure in the fuel that it will continue to flow to the cylinders and thus supply more than the metered amount of fuel. With the structure of the invention, on the one hand, the piston 9 has such a size, that the fuel pressure drops sufficiently between the piston 9 and the internal combustion engine when at the end of the injection the piston 9 returns to the shown position thus preventing any additional fuel from flowing to the cylinders, and, on the other hand, the volume of the chamber 18 is only slightly larger than that of the piston 9 that greater accuracy in the volume of the metered fuel for each of the cylinders of the engine is maintained. The cross section and axial sizes of the bore end portion 18 are larger than the cross section and axial sizes of the piston 9 by an amount which is only great enough to assure unrestricted fuel flow during the fuel feeding process.

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.

While the invention has been illustrated and described as embodied in fluid control for 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, a fluid guiding member formed with an inlet conduit portion, a discharge conduit portion and with a chamber communicating with said inlet and discharge conduit portions, said chamber including an elongated bore portion and a chamber end portion communicating exclusively with said bore portion and with said discharge conduit portion, said bore portion and said chamber end portion meeting along an inlet edge; and a piston in the form

of a solid body having a controlling edge and a cross section equal to that of said bore portion slidably mounted in the latter for limited sliding movement from a rest position in said bore portion to a maximum discharge position in said chamber end portion with said controlling edge of said piston slightly spaced from said inlet edge, and from said chamber end portion back into said bore portion, said piston having a volume which is smaller than that of said chamber end portion only by a small amount sufficient to provide unrestricted fluid flow from said bore portion through said chamber end portion to said discharge conduit portion when said piston is in said maximum discharge position in said chamber end portion, whereby when said piston is in said maximum discharge position the flow of discharged fluid will be substantially uniform due to the slight spacing of said controlling edge from said inlet edge and whereby after discharge return of said piston to said rest position thereof will create suction in said chamber end portion reducing the pressure in said discharge conduit portion.

2. In an injection pump, in combination, a fluid guiding member formed with an inlet conduit portion, a discharge conduit portion, and with a chamber having an inlet portion communicating with said inlet conduit portion, said chamber including an elongated bore portion and a chamber end portion communicating exclusively with said bore portion and with said discharge conduit portion, said bore portion and said chamber end portion meeting along an inlet edge; a piston in the form of a solid body having a controlling edge and a cross section equal to that of said bore portion slidably mounted in the latter for limited sliding movement from a rest position in said bore portion to a maximum discharge position in said chamber end portion with said controlling edge of said piston slightly spaced from said inlet edge, and from said chamber end portion back into said bore portion, said piston having an axial length and cross section both of which are smaller than the length and cross section of said chamber end portion only by a small amount sufficient to provide unrestricted fluid flow from said bore portion through said chamber end portion to said discharge conduit portion when said piston is in said chamber end portion; and spring means in said chamber inlet portion and outside said end portion thereof operatively connected to said piston for urging the same to said rest position within said bore portion to cut off communication between said inlet and discharge conduit portions.

3. In an injection pump, in combination, a housing formed with an elongated cylindrical bore, with a plurality of fuel feeding bores distributed about and extending in a plane radially from the axis of said cylindrical bore, and communicating with the latter for feeding fuel to the several cylinders of an engine, and with a pump discharge bore also communicating with said cylindrical bore; an elongated cylindrical distributor rotatably mounted in said cylindrical bore in slidable engagement with said housing, said distributor being formed in its interior with an elongated stepped bore having an intermediate bore portion of a smaller cross section than the end portions of said stepped bore, and said distributor being formed with a radial bore in said plane communicating with one of said stepped bore end portions and communicating successively with said feeding bores during rotation of said distributor, said intermediate bore portion meeting said one end portion of said stepped bore along an inlet edge and said one end portion communicating only with said intermediate bore portion and said radial bore in said distributor, the latter also being formed with a plurality of inlet bore portions equal to the number of feeding bores, communicating with the other of the stepped bore end portions, and communicating successively with said pump discharge bore during rotation of said distributor; a piston in the form of a solid body having a controlling edge and being slidably mounted in said intermediate bore portion of said distributor for limited movement from a rest position in said intermediate bore portion to a maximum discharge position in said one end portion of said stepped bore with said controlling edge of said piston slightly spaced from said inlet edge, and from the latter back into said intermediate bore portion of said distributor, said piston having an axial length and cross section both of which are smaller than the length and cross section of said one end portion of said stepped bore by an amount sufficient to provide unrestricted flow when said piston is in said one end portion of said stepped bore; spring means in said other end portion of said stepped bore engaging said piston for urging the same to a rest position in said intermediate bore portion; distributor drive means operatively connected to said distributor for rotating the latter.

4. In an injection pump, in combination, a fluid guiding member formed with at least one inlet conduit portion communicating with a single pump discharge bore, a discharge conduit portion communicating with a plurality of fuel feeding bores, and with a chamber communicating with said inlet conduit portion and said discharge conduit portion, said chamber including an elongated bore portion and a chamber end portion communicating exclusively with said bore portion and with said discharge conduit portion, said bore portion and said chamber end portion meeting along an inlet edge; and a piston in the form of a solid body having a controlling edge and a cross section equal to that of said bore portion slidably mounted in the latter for limited movement from a rest position said bore portion to a maximum discharge position in said chamber end portion with said controlling edge of said piston slightly spaced from said inlet edge, and from said chamber end portion back into said bore portion, said piston having a volume which is smaller than that of said chamber end portion only by a small amount sufficient to provide unrestricted fluid flow from said bore portion through said chamber end portion to said discharge conduit portion when said piston is in said chamber end portion, whereby when said piston is in said maximum discharge position the flow of discharged fluid will be substantially uniform due to the slight spacing of said controlling edge from said inlet edge and whereby after discharge return of said piston to said rest position thereof will create suction in said chamber end portion reducing the pressure in said discharge conduit portion.

5. In an injection pump, in combination, a fluid guiding member formed with an inlet conduit portion, a discharge conduit portion and with a chamber communicating with said inlet and discharge conduit portions, said chamber including an elongated bore portion and a chamber end portion communicating exclusively with said bore portion and with said discharge conduit portion, said bore portion and said chamber end portion meeting along an inlet edge; a valve piston in the form of a solid body having a controlling edge and a cross-section equal to that of said bore portion slidably mounted in the latter for limited sliding movement from a rest position in said bore portion to a maximum discharge position in said chamber end portion and from said maximum discharge position back to said rest position; and limiting means for limiting the movement of said piston into said chamber end portion so that the controlling edge of said piston is only slightly spaced from said inlet edge when said piston is in said maximum discharge position and, said piston having a volume which is smaller than that of said chamber end portion only by a small amount sufficient to provide unrestricted flow from said bore portion between said spaced edges through said chamber end portion to said discharge conduit portion when said piston is in said maximum discharge position thereof, whereby when said piston is in said maximum discharge position the flow of discharged fluid will be substantially uniform due to the slight spacing of said controlling edge from

said inlet edge and whereby after discharge return of said piston to said rest position thereof will create suction in said chamber end portion reducing the pressure in said discharge conduit portion.

6. In an injection pump, in combination, a fluid guiding member formed with an inlet conduit portion, a discharge conduit portion and with a chamber having an inlet portion communicating with said inlet conduit portion, said chamber including an elongated bore portion and a chamber end portion communicating exclusively with said bore portion and with said discharge conduit portion, said bore portion and said chamber end portion meeting along an inlet edge; a valve piston in the form of a solid body having a controlling edge and a cross-section equal to that of said bore portion slidably mounted in the latter for limited sliding movement from a rest position in said bore portion to a maximum discharge position in said chamber end portion and from said maximum discharge position back to said rest position; limiting means for limiting the movement of said piston into said chamber end portion so that the controlling edge of said piston is only slightly spaced from said inlet edge when said piston is in said maximum dicharge position and, said piston having a volume which is smaller than that of said chamber end portion only by a small amount sufficient to provide unrestricted flow from said bore portion between said spaced edges through said chamber end portion to said discharge conduit portion when said piston

is in said maximum discharge position thereof; and spring means in said chamber inlet portion and outside said end portion thereof and operatively connected to said piston for urging the same to said rest position, whereby when said piston is in said maximum discharge position the flow of discharged fluid will be substantially uniform due to the slight spacing of said controlling edge from said inlet edge and whereby after discharge return of said piston to said rest position thereof will create suction in said chamber end portion reducing the pressure in said discharge conduit portion.

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