May 23, 1967 C. KOSTER ETAL 3,320,893

REGULATED INJECTION PUMP

Filed May 11, 1966 2 Sheets-Sheet 1

FIG. 1

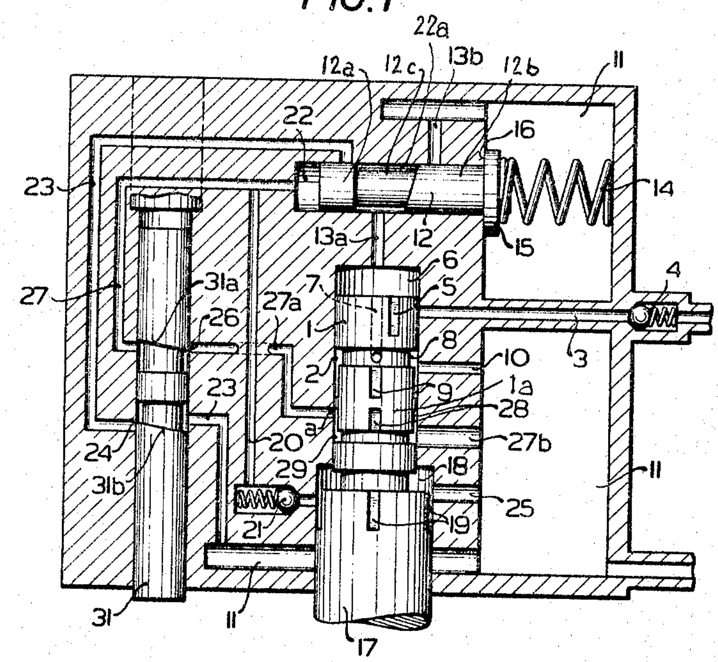

FIG. 2

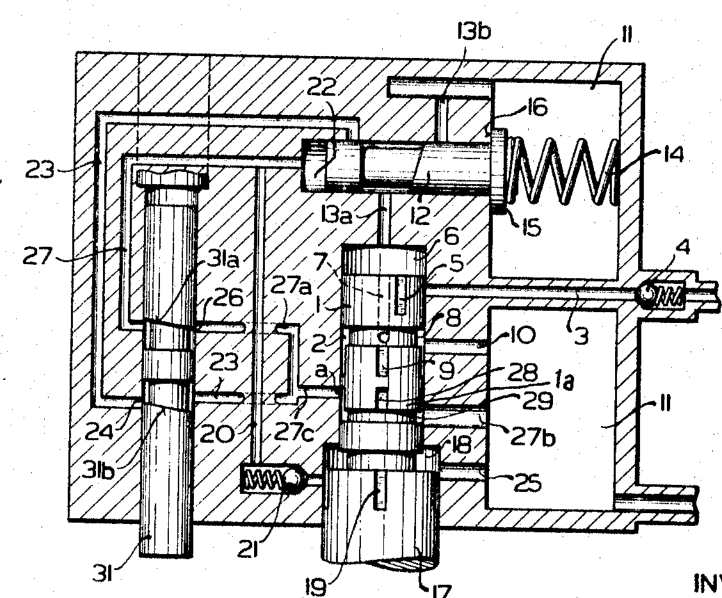

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FIG. 3

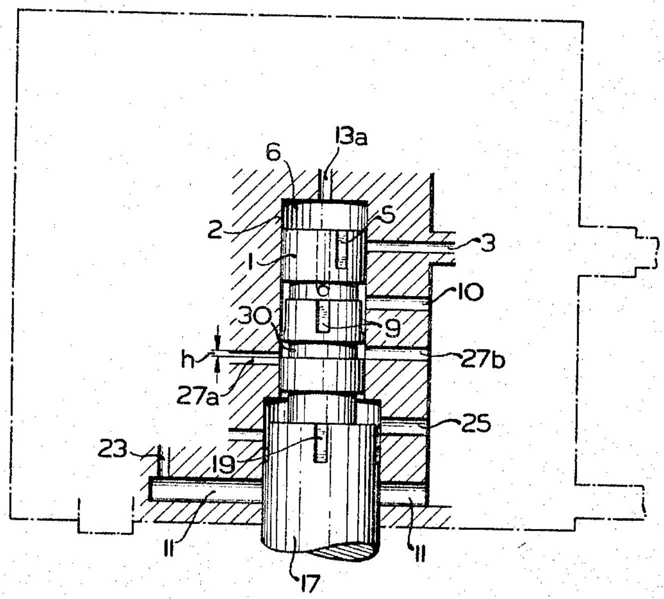
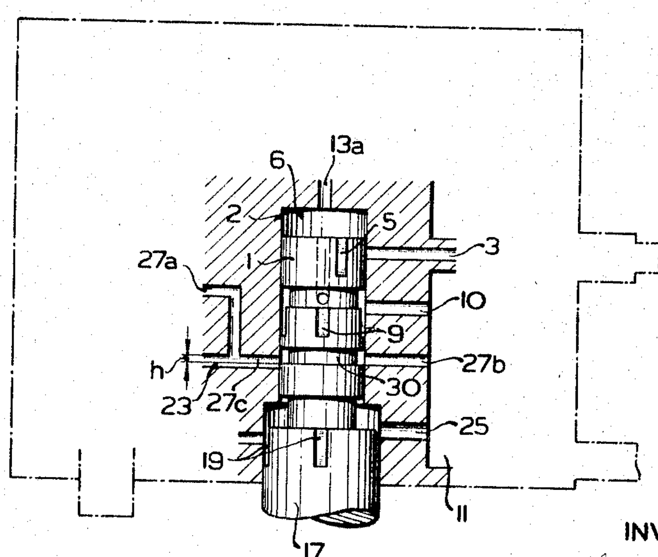


FIG. 4



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REGULATED INJECTION PUMP

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11 Claims. (Cl. 103—41)

The present invention relates to a regulated injection pump, and more particularly to a fuel injection pump whose output is regulated so that the amount of fuel flowing into a combustion motor does not rise in proportion to the increased speed of the combustion motor.

Fuel injection pumps are known whose output is regulated in accordance with the "liquid stop" principle. In pumps of this type, a control piston is provided in a control cylinder for relieving at the proper moment the pressure of the fuel pump. The control piston is operated by fuel flowing through a supply conduit to move to a relieving position, and is biased to return while pressing the fuel through a throttling conduit so that the return stroke is braked. At high speeds of the combustion engine and injection pump, the control piston cannot complete its return stroke, so that less fuel is injected by the injection pump whose pressure is relieved by the control piston after a shorter stroke.

In known injection pumps of this type, the time available for the return stroke of the control piston, is the time between the end of one injection stroke and the beginning of the next following injection stroke of the piston of the injection pump. If the spacing between the injections, determined by the number of outlets of the injection pump, is different, the return times of the control piston are correspondingly different. Therefore, the cross section of the throttling conduit, or of a throttle in the same, must be selected in accordance with the time intervals between the injections, if a constant amount of fuel is to be injected during each injection stroke. For greater time intervals, the free throttle cross section must be proportionally smaller, and for smaller time intervals proportionally greater.

Another disadvantage of known injection pumps of this type is that the throttling conduit communicates with the cylinder of the auxiliary pump which operates the control piston, which has an influence on the movements of the control piston due to the negative pressure occurring in the cylinder of the auxiliary pump during its suction stroke. Another disadvantage of known injection pumps of this type is that a very small free cross section of the throttling conduit is required for braking the return stroke of the control piston sufficiently so that the throttling conduit may become slogged by impurities contained in the fuel.

It is one object of the present invention to overcome these disadvantages of known regulated injection pumps, and to provide a regulated injection pump which is inexpensively manufactured and reliably operates.

Another object of the invention is to provide an automatically regulated injection pump whose throttling conduit has such a free cross section that it is not likely to be clogged by impurities contained in the operating liquid.

Another object of the invention is to provide an automatically regulated injection pump with a control piston whose return stroke is short and constant, irrespective of different intervals between successive injections of fuel into the cylinders of a combustion engine.

With these objects in view, the present invention relates to an automatically regulated injection pump which comprises main pump means having an inlet, at least one

delivery conduit, and a relief conduit; a control cylinder member located in the relief conduit and having an outlet conduit and a throttling conduit; a control piston member located in the control cylinder member, either the control cylinder member or the control piston member being biassed to move in one direction to a position closing the outlet and relief conduits of the main pump means; and auxiliary pump means operating in synchronism with the main pump means.

Supply conduit means connect the auxiliary pump means with the control cylinder member so that fluid is pumped into the cylinder member for moving the biassed member, preferably the control piston member, opposite to the action of a biassing spring for first opening the relief conduit and for then connecting the supply conduit means with the outlet conduit. When the relief conduit is opened, the injection stroke of the main piston is terminated, and when the outlet conduit is opened, the biassing spring starts the return of the biassed control piston member.

The supply conduit means has a check valve blocking flow into the auxiliary pump means so that the fluid, preferably a liquid fuel, is pressed through the throttling conduit by the biassed control piston member whereby at high speeds, the biassed control piston member cannot complete its return stroke so that the output of the main pump means is reduced.

In accordance with the present invention, control valve means are located in the throttling conduit for opening the same during the suction stroke of the main piston for timed periods shorter than the intervals between successive injection strokes of the main piston so that the biassed control piston member returns only during such shorter time periods. The control valve means operates in timed relation with the main piston, and is preferably formed by a portion of the same provided with suitable recesses for establishing communication between two portions of the throttling conduit during a part of the suction stroke of the main piston of the injection pump.

In one embodiment of the invention, the outlet conduit of the control cylinder communicates with a suction chamber containing fuel and communicating with the inlet of the auxiliary pump means. In another embodiment of the invention, the outlet conduit is connected with the throttling conduit, and is opened and closed by the control valve means together with the same for time periods shorter than the intervals between successive injection strokes of the main piston.

In accordance with the preferred embodiment of the invention, the throttling conduit has a first portion opening into the cylinder of the main pump means, and a second portion connecting this cylinder with the suction chamber from which fuel is sucked by the main pump and auxiliary pump. The main piston is provided with an annular recess and circumferentially spaced axially extending grooves which establish communication between the two portions of the throttling conduit in angularly turned positions of the main piston which are required for distributing the fuel into a plurality of delivery conduits respectively communicating with different cylinders of the combustion engine.

In another embodiment of the invention, in which no angular turning movement of the main piston is required, only an annular groove in the main piston is provided for connecting the first and second portions of the throttling conduit during a part of the suction stroke of the main piston. In either construction, the outlet conduit of the control cylinder may be connected with the first throttling conduit portion, or directly with the suction chamber.

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 fragmentary schematic sectional view illustrating one embodiment of the invention;

FIG. 2 is a fragmentary schematic sectional view illustrating another embodiment of the invention;

FIG. 3 is a fragmentary schematic sectional view illustrating a modified part of the embodiment of FIG. 1, parts illustrated in FIG. 1 being omitted for the sake of simplicity; and

FIG. 4 is a fragmentary schematic sectional view illustrating a modified part of the embodiment of FIG. 2, parts illustrated in FIG. 2 being omitted for the sake of simplicity.

Referring now to the drawing, and more particularly to FIG. 1, a supporting body has a main cylinder **2** in which a main piston **1** is mounted for reciprocating axial movement, and for angular displacement about its axis. During the turning movement, piston **1** acts as distributor, and successively supplies fuel during its pressure strokes to a plurality of angularly spaced delivery conduits **3**, of which only one is shown. Each delivery conduit has a check valve **4** and communicates with one cylinder of a combustion engine. An axially extending groove **5** is formed in the cylindrical surface of main piston **1** which during each pressure stroke of piston **1** connects one of the delivery conduits **3** with the cylinder chamber **6**. Liquid fuel is sucked from a suction chamber **11** into the inlet **10** and flows through an annular recess **8** and a duct **7** into cylinder chamber **6** during the downward suction stroke of main piston **1**. In the angularly turned positions of main piston **1**, different angularly spaced axially extending grooves **9** communicate with inlet **10** to connect the same with the annular recess **8**. Liquid fuel is supplied by a pump, not shown, into suction chamber **11**. The supporting body is formed with a control cylinder **22** which is located between two portions **13***a* and **13***b* of a relief conduit which connects cylinder chamber **6** with suction chamber **11**. A control piston **12** is located in control cylinder **22** and has two end portions **12***a* and **12***b*, and an intermediate portion **12***c* forming an annular chamber **22***a* in control cylinder **22** by which relief conduit portions **13***a* and **13***b* are connected when control piston **12** is moved toward the right against the action of a spring **14** abutting a flange **15** of control piston **12**. Spring **14** biasses control piston **12** to assume the illustrated position in which flange **15** abuts a surface **16** of the support body. In this position, relief conduit portions **13***a* and **13***b* are separated by piston end portion **12***b*, and piston end portion **12***a* closes an outlet conduit **23** which is connected to suction chamber **11**. A throttling conduit **27** is connected to a chamber formed in control cylinder **22** by piston portion **12***a*, and a supply conduit **20** is connected with the working chamber of a cylinder **18** of an auxiliary pump which includes a piston **17** mounted in cylinder **18** for axial reciprocation and angular turning movement together with main piston **1** with which piston **17** is rigidly connected. Auxiliary piston **17** has a plurality of angularly spaced axially extending grooves **19** successively communicating with the ends of supply conduit **20** in the turned positions of piston **17**, and also communicating with an inlet **25** which connects cylinder **18** with suction chamber **11**.

A check valve **21** in supply conduit **20** blocks flow of fluid into cylinder **18**, but permits auxiliary piston **17** to pump fuel from suction chamber **25** through check valve **21** and supply conduit **20** into control cylinder **22**. The grooves **19** communicate with inlet **25** before piston **17** has reached its lower dead center position, and establish communication between cylinder **18** and supply conduit **20** during the upward working stroke of auxiliary piston **17**.

The supporting body has a cylindrical bore in which a throttle member **31** is mounted for manual turning movement. Throttling member **31** has two throttling portions **31***a* and **31***b* with slanted surfaces which form throttling constrictions in throttling conduit **27** and outlet conduit **23** at throttling points **26** and **24**. The free open cross section of conduits **27** and **23** can be adjusted by turning of throttle member **31**.

Throttling conduit **27** has a first conduit portion **27***a* and a second conduit portion **27***b* which are connected by a portion of main cyclinder **2**. Conduit portion **27***b* communicates with suction chamber **11**.

A portion **1***a* of main piston **1** serves as control valve controlling the flow between throttling conduit portions **27***a* and **27***b*. The surface of piston portion **1***a* has a plurality of angularly spaced axially extending control grooves **28** which communicate with an annular recess **29**. The port *a* of throttling conduit portion **27***a* cooperates with different grooves **28** in angularly turned positions of main piston **1** with piston portion **1***a*. During the reciprocating strokes of main piston **1**, the annular recess **29** does not reach port *a*, and does not communicate with throttling conduit portion **27***a*. Throttling conduit portion **27***b* communicates with annular recess **29** during the axial movement of main piston **1**.

During each downward suction stroke of main piston **1**, one of the grooves **28** and annular recess **29** connect throttling conduit portions **27***a* and **27***b*, and thereby connect control cylinder **22** with suction chamber **11** during a part of the downward suction stroke of main piston **1**, and consequently for a time period which is shorter than the time required for the downward suction stroke of main piston **1**, or than the time period between two successive pressure strokes of main piston **1**.

Main piston **1** and main cyclinder **2** constitute a main pump which supplies fuel from suction chamber **11** through delivery conduit **3** to the cylinders of a combustion engine, not shown.

Cylinder **18** and piston **17** constitute an auxiliary pump for operating the control piston **12**.

Piston portion **1***a* with grooves **28** and annular recess **29** constitutes a control valve controlling the flow through throttling conduit **27**. It is evident that main piston **1**, control valve piston portion **1***a*, and auxiliary piston **17** are connected to each other for synchronous operation.

The piston means **1**, **1***a*, **17** is reciprocated and angularly displaced in a well known manner conventional in fuel injection pumps of this type. For example, a rotary cam may act on piston **17**, and the angular displacement may be obtained by a stationary lug engaging a helical cam groove in piston **17**.

During each upward pressure stroke, fuel previously sucked into cylinder chamber **6** through conduits **10**, **8**, **7**, is discharged through groove **5** and one of the delivery conduits **3** into a cylinder of the combustion engine. At the same time, fuel is discharged by piston **17** from cylinder **18** through a groove **19**, check valve **21** and supply conduit **20** into the chamber of control cylinder **22** located on the left of control piston **12** so that the same is moved to the right as viewed in the drawing against the action of spring **14** until the edge of control piston portion **12***b* passes relief conduit portion **13***b* whereby relief conduit **13***a*, **13***b* is connected by the annular chamber **12***c*, and the pressure in working chamber **6** of main cylinder **2** is relieved, so that the discharge through delivery conduit **3** is terminated.

Thereupon control piston portion **12***a* opens the port of outlet conduit **23**, relieving the pressure in cylinder **22**, so that spring **14** urges control piston **12** to move in a return stroke toward the left as viewed in the drawing. Since check valve **21** closes supply conduit **20**, the fuel is discharged from control cylinder **22** through the throttling conduit 27 so that the return stroke of control piston 12 is slowed down and braked.

The return strokes of control piston 12 take place during the suction strokes of pistons 1 and 17. At normal speeds, the time afforded by the suction strokes of pistons 1 and 17 is sufficient to permti a return of control piston 12 to its end position shown in FIG. 1 under the action of spring 14 and against the braking force exerted by throttling conduit 27 and particularly by the throttle 26. However, above a certain high speed, the so-called "liquid stop" effect takes place, and control piston 12 cannot complete its return stroke before pistons 1 and 17 have started the pressure strokes which cause movement of control piston 12 toward the right since piston 17 pumps fuel through supply conduit 20 into control cylinder 22 before control piston 12 has completed its return stroke. Since control piston 12 travels now a shorter distance to open the relief conduit portion 13*b*, the full pressure stroke of main piston 1 is not used, and a smaller amount of fuel is pumped through the respective delivery conduit 3.

Since throttling conduit portion 27*b* communicates with suction chamber 11, and the end portion 12*b* of control piston member 12 is partly located in suction chamber 11 and subjected to the same pressure, the pressure in throttling conduit 27 between throttling point 26 and suction chamber 11, and the pressure acting on control piston 12, are equal, and have no influence on the movements of control piston 12 and on the regulation of the pump.

During the movement of control piston 12 under the action of spring 14 to the left as viewed in the drawing, fuel can be discharged through throttling conduit 27 only when piston portion 1*a* is in such a position that port *a* of throttling conduit portion 27*a* communicates with one of the grooves 28. The ports of throttling conduit portion 27*a*, 27*b*, the grooves 28, and the annular recess 29 are designed so that throttling conduit portions 27*a* and 27*b* are connected to each other only during part of the downward suction stroke of main piston 1. Consequently, fuel in the chamber of control cylinder 22 can be pressed through throttling conduit 27 into suction chamber 11 only during a time period which is shorter than the time interval between two successive pressure strokes of main piston 1 and auxiliary piston 17. Due to the turning movement of piston 1, grooves 28 are angularly displaced, and the communication between throttling conduit portions 27*a* and 27*b* is interrupted before control piston 12 can complete its return stroke so that the effect of throttle 31*a*, 26 is increased.

In the embodiment of FIG. 2, outlet conduit 23 is not connected to suction chamber 11, but to a portion 27*c* of throttling conduit portion 27*a* so that the time during which fuel can be discharged through outlet conduit 23 from control cylinder 22 is also reduced. Port *a* of conduit portion 27*c* cooperates with grooves 28 as described with reference to conduit portion 27*a* in the embodiment of FIG. 1.

In the embodiment of FIG. 3, which has the same construction as the embodiment of FIG. 1 so that outlet conduit 23 communicates with suction chamber 11, the axial grooves 28 are omitted, and an annular recess 30 in the main piston 1 connects throttling conduit portions 27*a* and 27*b* in certain positions of main piston 1 for a comparatively short period of time. The connection is established when main piston 1 is in its lower dead center position, and is interrupted when piston 1 has moved the distance *h* to a position in which the lower edge of annular recess 30 passes the upper edge of the port of throttling conduit portion 27*a*. This construction of the control valve for throttling conduit 27 is not only suitable for injection pumps in which the main piston not only reciprocated, but also turns to perform a distributing function, but is also applicable to pumps in which the main piston reciprocates without turning.

The embodiment of FIG. 4 is different from the embodiment of FIG. 3 inasmuch as both throttling conduit 27*a*, and outlet conduit 23 are connected by conduit portion 27*c* with main cylinder 2 and controlled by the annular recess 30 during reciprocation of main piston 1. As in the embodiment of FIG. 2, the time during which outlet conduit 23 connects control cylinder 22 with suction chamber 11 is thus shortened as compared with the embodiment of FIGS. 1 and 3.

The advantage of the control valve means according to the invention which shortens the time during which fuel can be discharged from control cylinder 22, and thereby the length of the strokes of control piston 12, is particularly that the free cross section of throttle 31*a*, 26 in the embodiments of FIGS. 1 and 3, and also of throttle 31*b*, 24 in the embodiments of FIGS. 2 and 4, can be made greater for the same high speed at which the return stroke of control piston 12 is shortened. The same amount of liquid can be discharged from control cylinder 22 and a wider open throttle during a shorter time afforded by the control valve constituted by main piston portion 1*a* as through a more constricted throttle in a throttling conduit 27 which is opened during the entire suction stroke of pistons 1 and 17. The wider open throttles according to the invention, are less expensively manufactured to wider tolerances, and are less subject to clogging by impurities contained in the fuel. According to the prior art, the throttling conduit is connected to cylinder 18 of the main piston, so that the suction produced by piston 17 influences the return stroke of control piston 12, which is undesirable.

The time required for the return stroke of control piston 12 can be determined by suitably constructing the axial grooves 28, and the port *a* of throttling conduit 27 in main cylinder 2. The opening time of the throttling conduit can be made so short that piston portions 1*a* having different numbers of grooves 28 can be used. The number of grooves 28 corresponds to the number of cylinders of the combustion engine which is supplied with fuel by the main pump 1, 2, 5, 6 through delivery conduit 3. A considerable reduction of the manufacturing cost is obtained by using the entire device without adaptation and changes for different combustion engines having different numbers of cylinders, after replacement of the piston means, 1, 1*a*, 17 for a piston means provided with the proper number of axially extending grooves.

Another advantage of the invention resides in that the return stroke of the control piston remains the same even for pumps for combustion engines with a non-uniform ignition sequence in which injections take place after turning of the distributing main piston through different angular distances.

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 regulated injection pumps differing from the types described above.

While the invention has been illustrated and described as embodied in an automatically regulated injection pump in which a fluid is discharged through a throttling conduit for a time shorter than the interval between two successive injection strokes of a fuel pump piston, 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. Regulated injection pump comprising, in combina-

tion, main pump means having an inlet, at least one delivery conduit, and a relief conduit, and including a reciprocable main piston; a control cylinder member located in said relief conduit and having a throttling conduit and an outlet conduit opening into said throttling conduit; a control piston member located in said control cylinder member, one of said members being biassed to move in one direction to a position closing said outlet and relief conduits; auxiliary pump means operating in synchronism with said main pump means and having an inlet for a fluid; supply conduit means connecting said auxiliary pump means with said control cylinder member so that said auxiliary pump means pumps the fluid through said supply conduit means into said cylinder member for moving said biassed member opposite to said one direction for first opening said relief conduit and for then connecting said supply conduit means with said outlet conduit, said supply conduit means having a check valve blocking flow into said auxiliary pump means so that the fluid is pressed through said throttling conduit by said biassed member returning in said one direction whereby at high speeds the output of said main pump means is reduced; and control valve means operating in timed relation with said main piston, and being located in said throttling conduit downstream of said outlet conduit for opening said outlet and throttling conduits during the suction strokes of said main piston for the same time periods which are shorter than the intervals between successive pump strokes of said main piston whereby said biassed member returns in said one direction only during said shorter time periods.

2. An injection pump according to claim **1** wherein said main pump means has a main cylinder in which said main piston is mounted for reciprocation; wherein said throttling conduit has two conduit portions communicating with said main cylinder; and wherein said main piston has a control portion recessed to provide communication between said conduit portions through said main cylinder during suction strokes of said main piston for time periods shorter than the time required for a suction stroke of said main piston.

3. An injection pump according to claim **1** wherein said main pump means has a main cylinder in which said main piston is mounted for reciprocation; wherein said throttling conduit has two conduit portions communicating with said main cylinder; and wherein said main piston has a control portion recessed to provide communication between said conduit portions through said main cylinder during suction strokes of said main piston for time periods shorter than the time required for a suction stroke of said main piston.

4. An injection pump according to claim **1** wherein said main pump means has a main cylinder in which said main piston is mounted for reciprocation; wherein said throttling conduit has two conduit portions communicating with said main cylinder; wherein said main piston has a control portion recessed to provide communication between said conduit portions through said main cylinder during suction strokes of said main piston for time periods shorter than the time required for a suction stroke of said main piston; and wherein said recessed control portion has a plurality of angularly spaced axially extending grooves, and an annular recess communicating with said grooves, said grooves respectively cooperating with one of said conduit portions in angularly turned positions of said main piston and control portion, and said annular recess cooperating with the other conduit portion of said throttling conduit.

5. An injection pump according to claim **1** wherein said main pump means includes a main cylinder in which said main piston is mounted for axial reciprocation and angular turning movement; wherein said throttling conduit includes two conduit portions respectively communicating with said main cylinder; and wherein said control valve means include a control portion of said main piston having a plurality of angularly spaced axially extending grooves cooperating with one of said conduit portions, and an annular recess communicating with said grooves and cooperating with the other conduit portion of said throttling conduit for connecting said conduit portions for time periods shorter than the suction strokes of said main piston.

6. An injection pump according to claim **1** wherein said main pump means includes a main cylinder in which said main piston is mounted for axial reciprocation and angular turning movement; wherein said throttling conduit includes two conduit portions respectively communicating with said main cylinder; and wherein said control valve means include a control portion of said main piston having an annular recess cooperating with said conduit portions for opening said throttling conduit for time periods shorter than the suction stroke of said main piston.

7. An injection pump according to claim **6** and including a suction chamber for a fuel; and wherein said throttling conduit has one end communicating with said control cylinder and another end connected with said suction chamber, said control valve means being located between said ends; and comprising a manually adjustable throttling means having two throttles respectively located in said outlet conduit and in said throttling conduit and being operable for varying the free cross sections of said throttling and outlet conduit.

8. An injection pump according to claim **1** and including a suction chamber adapted to contain fuel, and wherein said inlets of said main pump means and auxiliary pump means, and said relief conduit communicate with said suction chamber.

9. An injection pump according to claim **1** and including a suction chamber for a fuel; and wherein said throttling conduit has one end communicating with said control cylinder and another end connected with said suction chamber, said control valve means being located between said ends; and comprising a manually adjustable throttling means having two throttles respectively located in said outlet conduit and in said throttling conduit and being operable for varying the free cross sections of said throttling and outlet conduits.

10. An injection pump according to claim **1** and including a suction chamber for a fuel; wherein said throttling conduit has one end communicating with said control cylinder and another end connected with said suction chamber, said control valve means being located between said ends, comprising a manually adjustable throttling means having two throttles respectively located in said outlet conduit and in said throttling conduit and being operable for varying the free cross sections of said throttling and outlet conduits; wherein said main pump means has a main cylinder in which said main piston is mounted for reciprocation; wherein said throttling conduit has two conduit portions between said ends communicating with said main cylinder; wherein said main piston has a control portion constituting said control valve means and being recessed to provide communication between said conduit portions through said main cylinder during suction strokes of said main piston for time periods shorter than the time required for a suction stroke of said main piston; and wherein said recessed control portion has a plurality of angularly spaced axially extending grooves, and an annular recess communicating with said grooves, said grooves respectively cooperating with one of said conduit portions in angularly turned positions of said main piston and control portion, and said annular recess cooperating with the other conduit portion of said throttling conduit.

11. Regulated injection pump comprising, in combination, main pump means having an inlet, at least one delivery conduit, and a relief conduit, and including a reciprocable main piston; means forming a suction chamber for a fuel; a control cylinder member located in said relief conduit and having an outlet conduit and a throttling conduit, said throttling conduit having one end communicating with said control cylinder and another end connected with said suction chamber; a control piston member located in said control cylinder member, one of said members being biassed to move in one direction to a position closing said outlet and relief conduits; auxiliary pump means operating in synchronism with said main pump means and having an inlet for a fluid; supply conduit means connecting said auxiliary pump means with said control cylinder member so that said auxiliary pump means pumps the fluid through said supply conduit means into said cylinder member for moving said biassed member opposite to said one direction for first opening said relief conduit and for then connecting said supply conduit means with said outlet conduit, said supply conduit means having a check valve blocking flow into said auxiliary pump means so that the fluid is pressed through said throttling conduit by said biassed member returning in said one direction whereby at high speeds the output of said main pump means is reduced; control valve means operating in timed relation with said main piston, and

being located in said throttling conduit between said ends of the same for opening the same during the suction strokes of said main piston for time periods shorter than the intervals between successive pump strokes of said main piston whereby said biassed member returns in said one direction only during said shorter time periods; and manually adjustable throttling means having two throttles respectively located in said outlet conduit and in said throttling conduit and being operable for varying the free cross sections of said throttling and outlet conduits.

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