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Faupel et al.

[11] **3,827,832**

[45] **Aug. 6, 1974**

[54] **MEANS FOR REDUCING FUEL DELIVERY OF FUEL INJECTION PUMPS IN THE LOW RPM RANGE**

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[51] **Int. Cl.** **F02m 59/34**

[58] **Field of Search** .... 417/289, 494, 293; 123/139 AD, 139 AM, 139 AY, 140 FG, 139 AL

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Assistant Examiner—Richard Sher
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[57] **ABSTRACT**

In a fuel injection pump in which the fuel quantities delivered for injection are controlled by bypassing one part of the fuel from the pump work chamber during the pressure strokes of the pump piston by a control edge of a slidable member that controls a bypass channel in an rpm-dependent manner, for reducing the delivered fuel quantities in the low rpm range at any load condition, said bypass channel is first opened by a throttle and subsequently opened by said control edge.

9 Claims, 8 Drawing Figures

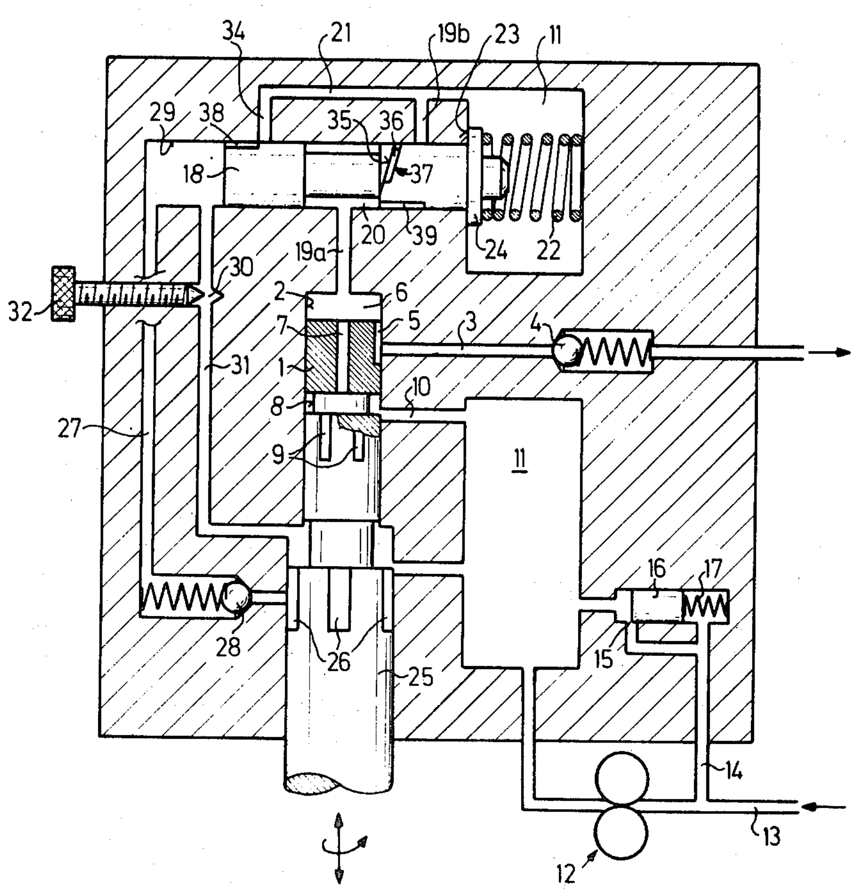

Fig. 1

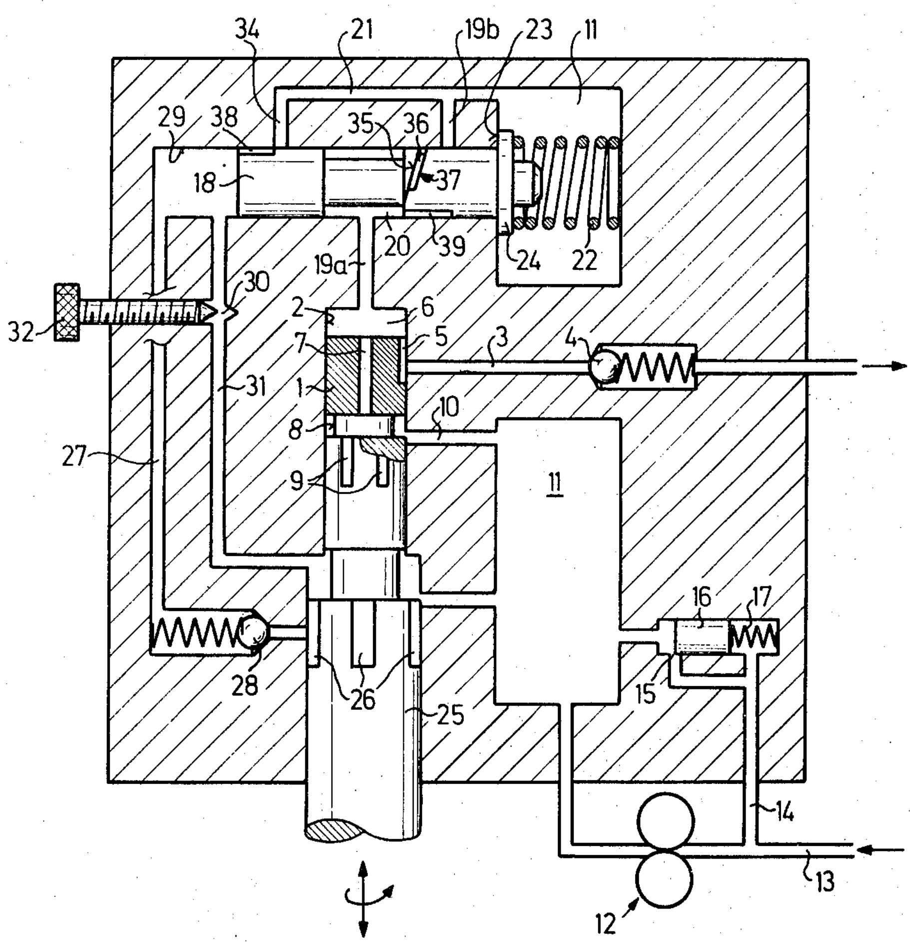
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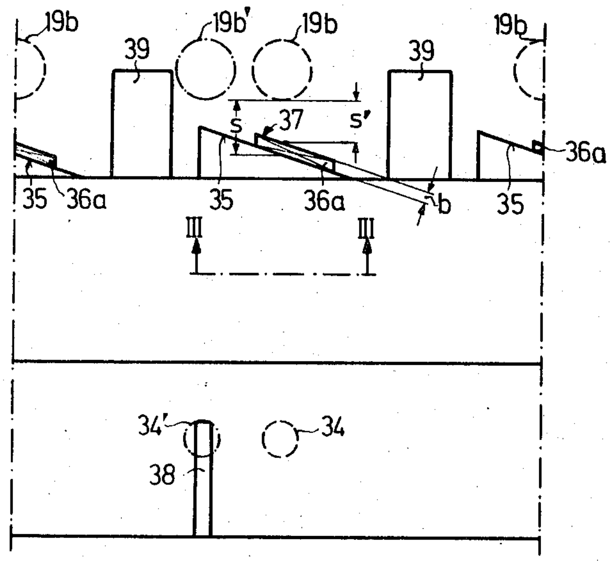
Fig. 2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19b'
19b
19b
39
39
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s'
36a
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36a
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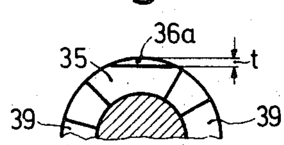
36a
b
35
III
III
34'
34
38

Fig. 3


36a
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t
39
39

Fig. 4

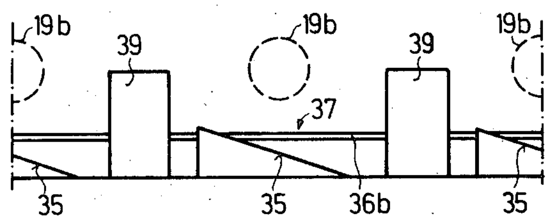


Fig. 5

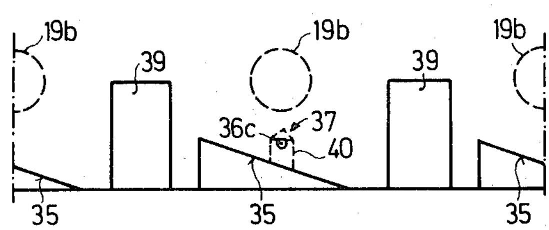


Fig. 6

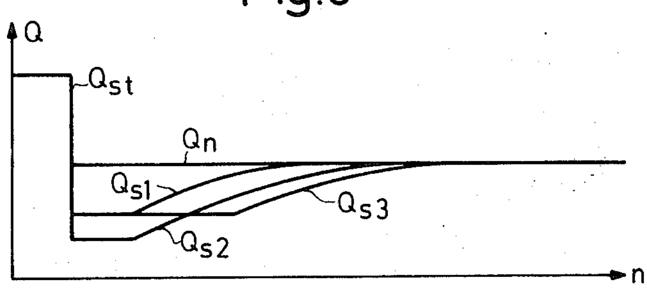
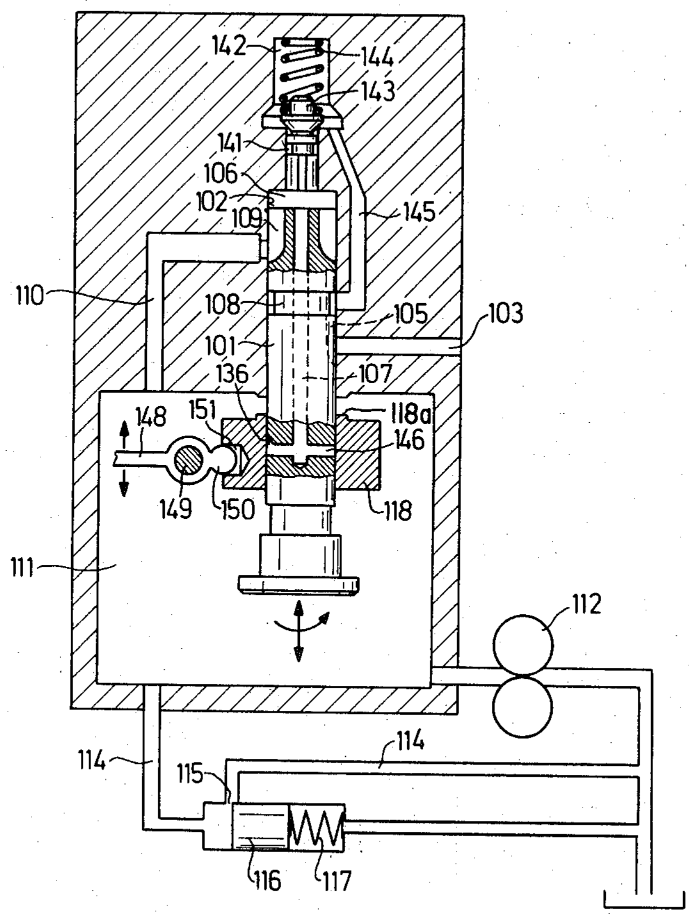


Fig. 7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106
102
109
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110
108
105
103
101
136
107
148
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118a
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118
111
112
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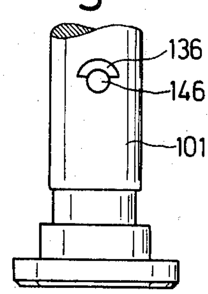
114
115
116
117

Fig. 8


136
146
101

MEANS FOR REDUCING FUEL DELIVERY OF FUEL INJECTION PUMPS IN THE LOW RPM RANGE

BACKGROUND OF THE INVENTION

This invention relates to a fuel injection pump for internal combustion engines and is of the type in which the delivered fuel quantities are altered as a function of the rpm. The delivered fuel quantities are determined by interrupting the fuel delivery at a certain, rpm-dependent moment during each pressure stroke of the pump piston by means of opening a bypass channel of the pump work chamber. The opening of the bypass channel is effected by a control edge of a fuel quantity regulating member, such as a regulator shuttle or a control sleeve.

In internal combustion engines the smoke generated in the low rpm range under full load conditions is caused by an imperfect combustion of the delivered fuel quantities. Accordingly, a number of attempts have already been made to adapt the fuel quantities to the actual requirements of the engine. In particular, a reduction of the injected fuel quantities in the low rpm range is sought after.

In a known fuel injection pump of the aforenoted type, such as disclosed, for example, in U.S. Pat. No. 3,620,648 (German Published Patent Application DOS 1,947,528), in addition to a first bypass channel, there is provided a second bypass channel which is opened by the regulator shuttle prior to opening the first bypass channel. As long as no fluid abutment is present, however, this second bypass channel is closed by a means provided on the pump piston before it could be opened by the regulator shuttle. As the fluid abutment increases, the second bypass channel is opened to an increasing degree (the "fluid abutment" will be defined and explained later). The control edge for controlling the second bypass channel is preceded by a further control point which is formed as a throttle. In the beginning stage of the fluid abutment a discharge may occur only through this last-named throttle and only upon a further displacement of the control plunger will the second bypass channel be fully opened. By means of such an arrangement the injected fuel quantities are reduced in the partial load range and in idling and there is further achieved a smooth transition from the unaffected full load range to the partial load range.

For an optimal operation of an internal combustion engine, it is, however, a requirement to inject at any load condition only that amount of fuel which is, in fact, required by the engine. Stated differently and as noted earlier, the injected fuel quantity has to be adapted to the actual requirements of the engine. This applies in particular to the low rpm range in which the vehicle engine operates for a substantial proportion of its entire operating period.

In a further known fuel injection pump of the above-described type, such as disclosed, for example, in U.S. Pat. No. 3,405,700 (German Published Patent Application DAS 1,526,500), the adaptation is achieved by angularly adjusting, by means of a sliding setting member which has a helically extending control edge for opening the bypass channel. The aforenoted setting member, in turn, is shifted by the rpm-dependent pressure in the suction chamber of the fuel injection pump. This displacement of the setting member is effected against the force of one or several springs of different rigidity. In this manner an rpm-dependent adaptation of the injected fuel quantities is achieved, whereby the accuracy of the adaptation depends upon the number of the springs and the possibilities of gradation regarding the stiffness of the springs. This type of adaptation, however, results in substantial additional costs.

OBJECT, SUMMARY AND ADVANTAGES OF THE INVENTION

It is an object of the invention to provide an improved fuel injection pump of the aforeoutlined type in which under any load condition an rpm-dependent adaptation of the injected fuel quantities is achieved in the low rpm range with simple means.

Briefly stated, according to the invention the bypass channel is first opened by a control means formed by a throttle and then opened by the conventional control edge of a sliding member. The throttle is provided either adjacent the mouth of the bypass channel on the component containing the latter or on the slidable regulator member adjacent the control edge.

The aforeoutlined arrangement has the substantial advantage that by means of an only slight structural change, the fuel quantities to be injected are decreased in the lowest rpm range to an extent dependent upon the design of the throttle. In case of a high rpm, the throttle exerts, by virtue of the more pronounced throttle effect, no substantial influence on the injected fuel quantities. In case of a low rpm, the decrease of the injected fuel quantities is stronger for partial load than for full load. In this manner the generation of smoke in the lower rpm range is avoided and there is achieved a quiet run of the internal combustion engine, particularly in the idling and in the partial load range.

The invention will be better understood, as well as further objects and advantages will become more apparent, from the ensuing specification of four exemplary embodiments taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a sectional schematic view of a first embodiment of the invention illustrating a distributor-type fuel injection pump in which the fuel quantity regulation is effected by the principle of "fuel abutment";

FIG. 2 is a development of the control edges of the fuel quantity regulator member according to the first embodiment of the invention;

FIG. 3 is a fragmentary cross-sectional view of one component illustrated in FIG. 1;

FIG. 4 is a development of the control edge of a regulator member according to the second embodiment of the invention finding application in a fuel injection pump according to FIG. 1;

FIG. 5 is a development of the control edge of a regulator member according to the third embodiment of the invention;

FIG. 6 is a diagram of the course of the injected fuel quantities per stroke as a function of the pump rpm for different throttle designs;

FIG. 7 is a simplified sectional view of a fourth embodiment of the invention finding application in a distributor-type fuel injection pump in which the fuel quantity regulation is effected by a control sleeve arranged on the pump piston and

FIG. 8 is a fragmentary elevational view of the pump piston illustrated in FIG. 7.

DESCRIPTION OF THE EMBODIMENTS

Turning now to FIG. 1, a pump piston 1 of a fuel injection pump operates in a cylinder 2 and is driven in such a manner by known means, not illustrated, that it executes a reciprocating axial motion and a rotary motion about its axis. The reciprocating motion serves for fuel delivery, while the roarty motion serves for fuel distribution. During the rotary motion, during the pressure strokes, fuel is admitted in sequence to the individual pressure conduits 3 (only one shown) which are arranged uniformly spaced about the cylinder 2. In each of the pressure conduits 3 there is situated a check valve 4. On the lateral surface of the piston 1 there is provided an axially parallel distributor groove 5 which, during each successive pressure stroke of the piston, connects the pump work chamber 6 with another pressure conduit 3. The pump work chamber 6 is supplied with fuel through a channel 7, an annular groove 8, one of longitudinal grooves 9 provided on the lateral surface of the piston 1, and a supply channel 10 which communicates with a suction chamber 11. The latter, in turn, is supplied with fuel by means of a fuel delivery pump 12 which may be a gear pump driven by the engine that is served by the fuel injection pump.

In order to maintain an rpm-dependent pressure in the suction chamber 11, the latter is connected with the suction channel 13 at the intake side of the delivery pump 12 by means of a channel 14 containing a throttle 15, the flow passage section of which is controlled by a piston plunger 16. The latter is, at one side, exposed to the fuel pressure which prevails in the suction chamber 11. As the rpm increases, the piston plunger 16 is displaced against the force of a return spring 17. As a result, the flow passage section of the throttle 15 is increased.

For the quantity control of the fuel delivered by the piston 1 to the engine during the pressure strokes, there is provided a regulator shuttle 18. The latter controls a bypass channel 19*a*, 19*b* by controlling in an annular space 20 communication between the bypass channel portion 19*a* and the bypass channel portion 19*b*. The bypass channel 19*a*, 19*b* leads from the pump work chamber 6 to the suction chamber 11. The bypass channel portion 19*a* is in continuous communication with the annular chamber 20 in every position of the regulator shuttle 18. The bypass channel portion 19*b* is connected with the suction chamber 11 through a channel 21. A regulator spring 22 seeks to maintain the regulator shuttle 18 in its position of rest which is determined by the cooperation of a solid fixed abutment 23 forming part of the pump housing and a collar 24 affixed to the regulator shuttle 18. In this position of rest the latter maintains the bypass channel portion 19*b* closed.

For the purpose of moving the regulator shuttle 18 away from its above-described position of rest, there is provided an auxiliary piston 25 which operates synchronously with the piston 1 and which is preferably formed as a stepped piston portion of the piston 1. The auxiliary piston 25 displaces fuel from its cylinder through longitudinal grooves 26 arranged on the lateral face of the piston 25 and a channel 27 which contains a check valve 28 and which opens into a cylinder 29 accommodating the regulator shuttle 18. Thus, by virtue of the fuel pressure generated immediately to the left of the regulator shuttle 18 by the auxiliary piston 25, the regulator shuttle 18 is displaced towards the right against the force of the spring 22, whereby hydraulic communication is established between the bypass portions 19*a* and 19*b*.

During the period between two pressure strokes of the piston 25, the regulator shuttle 18 returns to its position of rest, driven thereinto by the spring 22. During this return motion the regulator shuttle 18 displaces one portion of the fuel present in the cylinder 29 through a channel 31 in which there is disposed a regulator throttle 30 braking the return motion of the control shuttle 18. The free flow passage section of the regulator throttle 30 is adjustable by a throttle needle 32 or the like. At a given flow passage section above a determined pump speed (that is, engine rpm), a fluid abutment appears which means that the regulator shuttle 18 does no longer return to its fixed position of rest at the end of its return motion. Stated differently, the starting and terminal point of the reciprocating motion of the regulator shuttle 18 will be spaced from its fixed position of rest and will shift to the right (towards the spring 22) as the rpm further increases. In this manner the fuel quantity which is delivered during each pressure stroke of the pump piston to the fuel injection nozzles through the pressure conduits is decreased.

If the throttle 30 is widened, for example, during full load or partial load, then the initial and terminal point of the reciprocating motion of the control shuttle 18 shifts in an opposite direction (that is, towards the left) until the control shuttle 18 again engages the abutment 23. If, on the contrary, the flow passage section of the throttle 30 is decreased corresponding to a lower partial load or zero load, then the starting and terminal point of the reciprocating motion of the control shuttle 18 travels correspondingly faster in the direction of the regulator spring 22. The maximum excursion of the control shuttle 18 is obtained when the latter opens with its trailing edge a bypass channel 34 which directs the residual fuel quantity displaced by the piston 25 into the suction chamber 11.

The annular chamber 20 is bounded by a control edge 35 adjacent which there is disposed a control means 37 constituted by a throttle 36 by means of which, in the working position of the control shuttle 18, the channel 19*b* is opened earlier than it is by the control edge 35. Thus, when viewed in the direction of shuttle travel caused by the fuel pressure in the cylinder 29, the throttle 36 is disposed immediately downstream of the control edge 35. In this manner, even before the control edge 35 reaches the channel 19*b*, fuel is already drained from the pump work chamber, whereby the entire injected fuel quantity is decreased. The faster the opening step occurs as the rpm increases, the stronger will be the throttle effect, so that in case of a high rpm, it is substantially only the control edge 35 which determines the moment of opening the channel 19*b*.

In order to obtain an excess fuel quantity for starting the engine, the control shuttle 18 has at its land portion which is remote from the regulator spring 22, a longitudinal groove (starting groove) 38 which, when the control shuttle 18 is rotated by means not shown, establishes hydraulic communication between the cylinder 29 and the bypass channel 34. In this manner, during the phase of engine start, the fuel delivered by the auxiliary pump 25 flows through the channels 34, 21 into the suction chamber **11** without displacing the regulator **18**. Thus, in this operational condition the throttle **36** is inoperative. In this embodiment, the throttle **36** is, with regard to the starting groove **38**, so positioned adjacent the control edge **35** that in the rpm range which immediately follows the starting phase, the bypass channel portion **19***b* is not opened prematurely.

For the purpose of completely interrupting fuel delivery during the operation of the fuel injection pump, the regulator shuttle **18** has at its land portion oriented towards the regulator spring **22**, a longitudinal groove **39** (cutoff groove) which, upon proper angular displacement of the regulator shuttle **18**, establishes communication, in a manner known by itself and therefore not shown here, between the annular chamber **20** and the bypass channel portion **19***b*. As a result, the entire delivered fuel is directed through the channel **21** into the suction chamber **11**, thus bypassing the pressure conduits **3**.

Turning now to FIG. **2**, there is shown a development of the regulator shuttle **18** with the cutoff groove **39**, the starting groove **38**, as well as the throttle **36** constituting the control means **37**. The throttle **36** is constituted by a ground portion **36***a* extending parallel to the control edge **35** and axially bounded thereby. The ground portion **36***a* has a width *b* and a depth *t*, as illustrated in FIG. **3**. Instead of the ground planar portion 36a shown in section in FIG. **3**, the throttle **36** may be of any other shape; for example, it may be of annular configuration. It is apparent from FIG. **2** that in the absence of the throttle **36***a* the regulator shuttle **18** would start to open the bypass channel portion **19***b* only after a shuttle stroke *s*, while in the presence of the throttle **36** such opening already starts after a shorter shuttle stroke *s*'.

As the fluid abutment increases (that is, it travels to the right as viewed in FIG. **1**), the stroke *s*' decreases and thus there is also a decrease in the width of the sealing piston land between the bypass channel portion **19***b* and the annular chamber **20**. The thus appearing leakage losses in the lower rpm range reduce the injected fuel quantities, so that under partial load conditions there will be a stronger adaptation of the fuel quantities than in case of full load and, in particular, there is attained a "silent" idling of the engine.

FIG. **6** illustrates schematically how the throttle **36** affects the injection quantity Q at different rpm's. The curve formed of curve portions Q_{st} and Q_n corresponds to a regulator shuttle without a throttle; the curve portion Q_{st} illustrates the excess fuel quantity for starting. Dependent upon the size and shape of the throttle **36**, there are obtained different curve portions such as Q_{s1}, Q_{s2}, Q_{s3} adjoining the curve portion Q_{st}. The curve portion Q_{s3} is obtained from the curve Q_{s1} if, for example, in the throttle **36***a* the depth *t* of the ground portion is increased. Q_{s2} is obtained from the curve Q_{s1} if, for example, in the throttle **36***a* the width *b* of the ground portion is enlarged.

The throttle **36** may be formed as an annular groove **36***b* which is in communication in a tangential direction through the cutoff groove **39** with the annular chamber **20** as shown in the developed illustration of FIG. **4**.

FIG. **5** shows a development of a regulator shuttle wherein adjacent the control edge **35** there is provided a throttle in the form of a radial bore **36***c* which effects communication with the annular chamber **20** through an axial bore **40**.

In FIG. **7** there is schematically illustrated a fuel injection pump in which the injected fuel quantity is determined by means of a control sleeve. In a cylinder **102** provided in the housing of a fuel injection pump there operates a pump piston **101** which is driven by known and therefore not illustrated means in such a manner that it executes an axial reciprocating motion and a rotary motion about its axis. The reciprocating motion serves for fuel delivery, while the rotary motion serves for fuel distribution. As a result of the rotary motion, during the pressure strokes, fuel is admitted sequentially to the individual pressure conduits **103** which are arranged uniformly spaced about the cylinder **102**. Each pressure conduit **103** leads to a non-illustrated fuel injection valve of the internal combustion engine. The number of the pressure conduits **103** is equal to that of the cylinders of the internal combustion engine which is served by the fuel injection pump. In the cylinder **102** the pump piston **101** bounds a pump work chamber **106** which during the suction stroke of the pump piston is supplied with fuel from the suction chamber **111** through longitudinal grooves **109** provided in the lateral face of pump piston **101** and a supply channel **110**. The longitudinal grooves **109** are equal in number to that of the pressure conduits **103** and merge into the pump work chamber **106**.

From the pump work chamber **106** there extends a bore **141** which merges into a compartment **142**. The mouth of the bore **141** is formed as a valve seat and is closable by a valve body **143** which is loaded by a spring **144** accommodated in the compartment **142**. From the latter there extends a conduit **145** which merges into the cylinder **102** in a plane situated between the entry of the supply channel **110** and the entry of the pressure conduits **103** into the cylinder **102**.

The pump piston **101** has an annular groove **108** which communicates with a longitudinal distributor groove **105** provided on the lateral face of the pump piston **101**. For each pressure stroke of the pump piston **101** a different pressure conduit **103** is connected with the conduit **145** through the distributor groove **105**. The latter can be connected with one of the pressure conduits **103** only if the longitudinal grooves **109** are not in communication with the supply conduit **110**.

The pump piston **101** has an axial blind bore **107** which at one end communicates with the pump work chamber **106** and at the other end is intersected by a radially extending throughgoing bore **146**. In the zone of the latter there is disposed a control sleeve **118** which is slidably mounted in a fluid-tight manner on the piston **101**. Dependent upon the position of the control sleeve **118**, during the pressure strokes of the pump piston the bore **146** is opened by the upper edge **118***a* of the control sleeve **118** at an earlier or later moment so that a certain variable residual quantity of the delivered fuel may flow into the suction chamber **111** from the pump work chamber **106** through the bores **107, 146**. In case the control sleeve **118** is set in such a manner that the bore **146** is not uncovered at all during the pressure strokes of the pump piston **101**, then the entire fuel quantity delivered by the pump piston (excessive fuel quantity for engine start) will be directed into the pressure conduits **103**. The displacement of the control sleeve **118** is effected by a lever **148** which is pivotable about a stationary point **149** and has a nose **150** which projects into a depression **151** provided in the control sleeve **118.** The lever **148** is displaceable as a function of load and rpm by means not shown.

In order to obtain in the suction chamber **111** an rpm-dependent pressure, the fuel supply is effected — in the same manner as described in connection with the first embodiment in FIG. **1** — through a pump **112** while the pressure of the suction chamber is regulated by means of a piston **116** which is loaded by a spring **117** and which controls a throttle **115** situated in a return channel **114.**

According to the invention, in the fuel injection pump illustrated in FIG. **7,** there is provided on the piston **101,** immediately adjacent the opening of the bore **146,** a ground portion which constitutes a throttle **136.** In this manner, during each pressure stroke of the piston **110** the pump work chamber is first discharged through the throttle **136** and then, after an additional axial displacement of the pump piston **101,** it is discharged through the bore **146.** Thus, there is obtained, in a manner similar to that already discussed in connection with the type of pump shown in FIG. **1,** an adaptation of the fuel injection quantities as a function of the rpm, particularly in the low rpm range.

Turning now to FIG. **8** there is shown an elevational view of that side of the pump piston **101** which contains the throttle **136** and the outlet plane of the bore **146.** In this embodiment the plane of the ground portion **136** is at an angle with respect to the longitudinal axis of the pump piston **101;** it is to be understood that the throttle may be formed as a ground portion which is parallel to the longitudinal axis of the pump piston. Further, the throttle may also be provided on the inner lateral face of the control sleeve **118** in the vicinity of the upper control edge. This solution, however, involves more complex machining. The arrangement and formation of the throttle described in connection with FIGS. **4** and **5** may also be adapted in case of the piston illustrated in FIG. **8.**

It is thus seen that in fuel injection pumps in which the injected quantities are controlled by sliding elements which regulate a bypass, there is achieved in the low rpm range for any load a reduction of the injected fuel quantities by providing a throttle at a particular location by simple means. The course of the injected fuel quantity as a function of the rpm is determined by the particular shape of the throttle. At higher rpm's there may be obtained, however, the original level of injection since, as the rpm increases, the fuel quantities which pass through the throttle are decreased.

What is claimed is:

1. In a fuel injection pump of the known type that has (a) a reciprocating pump piston, (b) a pump work chamber bounded by said pump piston, (c) pressure conduit means through which fuel is forced from said pump work chamber by said pump piston during its pressure strokes, (d) a bypass channel leading from said pump work chamber, (e) a slidable fuel quantity regulator member having control edge means for opening said bypass channel at an rpm-dependent moment during said pressure strokes for interrupting fuel delivery to said pressure conduit means during a portion of each pressure stroke by causing fuel to escape from said pump work chamber through said bypass channel and (f) means for displacing said fuel quantity regulator member to an rpm-dependent extent, the improvement comprising a throttle in the surface of said regulator member between said control edge means and said bypass channel when viewed in the direction of the relative opening motion of said fuel quantity regulator member and at least partially contiguous to said control edge means; during the relative opening motion between said bypass channel and said fuel quantity regulator member said bypass channel being opened first through said throttle and subsequently by said control edge means.

2. An improvement as defined in claim **1,** wherein said throttle is constituted by a recessed ground portion extending parallel to and being axially bounded by said control edge means.

3. An improvement as defined in claim **1,** wherein said throttle is constituted by a bore through which said bypass channel is opened prior to being opened by said control edge means during said relative motion.

4. An improvement as defined in claim **3,** wherein said bore constituting said throttle is provided in said fuel quantity regulator member, said bore having a first open end disposed at said control edge means and a second open end situated downstream of said control edge means when viewed in the direction of the relative opening motion of said fuel quantity regulator member.

5. An improvement as defined in claim **1,** including

A. a regulator shuttle constituting said fuel quantity regulator member,

B. an auxiliary piston operating synchronously with said pump piston,

C. first channel means containing hydraulic liquid and leading from said auxiliary piston to said regulator shuttle for causing the latter to execute forward strokes in response to the pressure strokes of said auxiliary piston,

D. means exerting a return force on said regulator shuttle for causing the latter to execute return strokes during the suction strokes of said auxiliary piston,

E. second channel means leading from said regulator shuttle, said second channel means carrying at least part of the hydraulic liquid displaced by said regulator shuttle during its return strokes,

F. an adjustable restriction disposed in said second channel means to brake said regulator shuttle during its return strokes; beyond an engine rpm determined by the setting of said adjustable restriction the braking effect of said hydraulic liquid in said second channel means causes the appearance of a fluid abutment preventing said regulator shuttle to return, during its reciprocating motion, into its original position of rest,

G. an axially parallel shutoff groove provided in the lateral face of said regulator shuttle, said shut-off groove, when aligned with said bypass channel by virtue of rotating said regulator shuttle into a predetermined angular position maintains communication between said pump work chamber and said bypass channel in any position of said regulator shuttle and

H. an annular groove provided on said regulator shuttle downstream of said control edge means when viewed in the direction of the pressure strokes of said regulator shuttle, said annular groove constituting said throttle and continuously communicating with said bypass channel through said axially parallel shutoff groove.

6. An improvement as defined in claim 1, including

A. a regulator shuttle constituting said fuel quantity regulator member,
B. an auxiliary piston operating synchronously with said pump piston,
C. first channel means containing hydraulic liquid and leading from said auxiliary piston to said regulator shuttle for causing the latter to execute forward strokes in response to the pressure strokes of said auxiliary piston,
D. means exerting a return force on said regulator shuttle for causing the latter to execute return strokes during the suction strokes of said auxiliary piston,
E. second channel means leading from said regulator shuttle, said second channel means carrying at least part of the hydraulic liquid displaced by said regulator shuttle during its return strokes,
F. an adjustable restriction disposed in said second channel means to brake said regulator shuttle during its return strokes; beyond an engine rpm determined by the setting of said adjustable restriction the braking effect of said hydraulic liquid in said second channel means causes the appearance of a fluid abutment preventing said regulator shuttle to return, during its reciprocating motion, into its original position of rest,
G. a recessed portion provided on said regulator shuttle downstream of said control edge means when viewed in the direction of the pressure strokes of said regulator shuttle, said recessed portion constituting said throttle,
H. an additional bypass channel extending from said first channel means and being normally closed by said regulator shuttle,
I. an axially parallel groove provided in the lateral face of said regulator shuttle, said groove, when aligned with said additional bypass channel by virtue of rotating said regulator shuttle into a predetermined angular position, maintains communication between said first channel means and said additional bypass channel to cause a discharge of the hydraulic liquid pressurized by said auxiliary piston for effecting the injection of excess fuel quantities for starting a cold engine; said control edge means and said recessed portion on said regulator shuttle being out of alignment with said bypass channel at any position of said regulator shuttle when said groove is in alignment with said additional bypass channel.

7. In a fuel injection pump of the known type that has (a) a reciprocating pump piston, (b) a pump work chamber bounded by said pump piston, (c) pressure conduit means through which fuel is forced from said pump work chamber by said pump piston during its pressure strokes, (d) a bypass channel leading from said pump work chamber, (e) a slidable fuel quantity regulator member having control edge means for opening said bypass channel at an rpm-dependent moment during said pressure strokes for interrupting fuel delivery to said pressure conduit means during a portion of each pressure stroke by causing fuel to escape from said pump work chamber through said bypass channel and (f) means for displacing said fuel quantity regulator member to an rpm-dependent extent, the improvement comprising a throttle formed contiguous with an opening end of said bypass channel; during the relative opening motion between said bypass channel and said fuel quantity regulator member said bypass channel being opened first through said throttle and subsequently by said control edge means.

8. An improvement as defined in claim 7 including a component that contains at least part of said bypass channel, said throttle being situated on said component upstream of said bypass channel when viewed in the direction of the relative opening motion of said fuel quantity regulator member.

9. An improvement as defined in claim 8 wherein said throttle is constituted by a recessed ground portion bounding said bypass channel.

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