

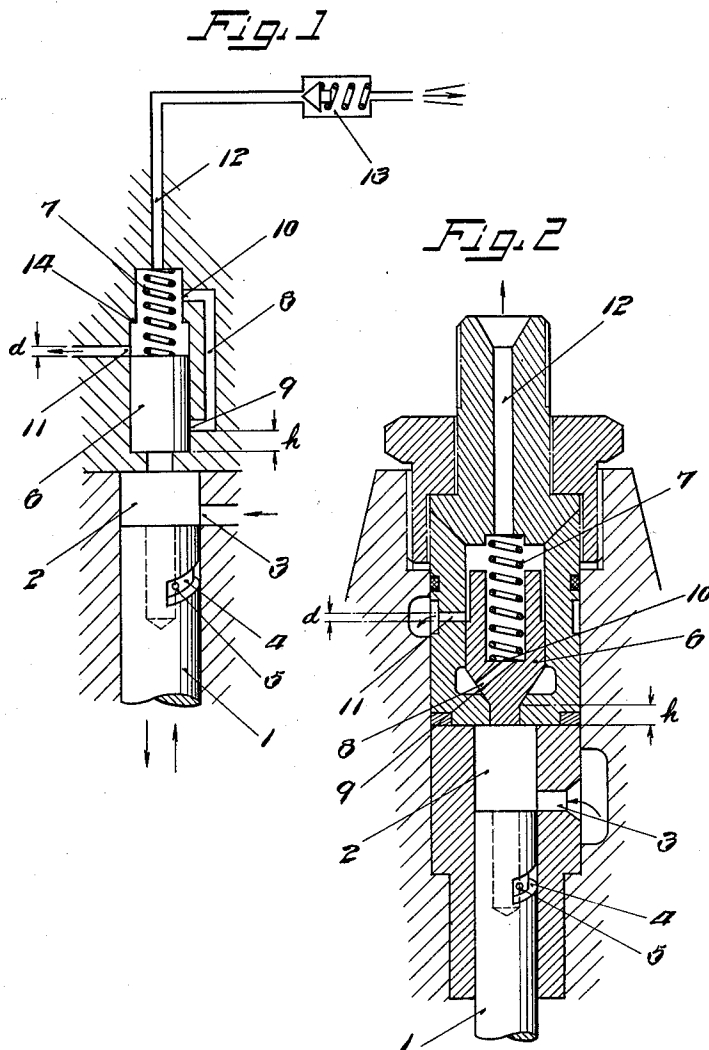
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FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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3,135,209 FUEL INJECTION PUMP FOR INTERNAL COMBUSTION ENGINES

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The present invention relates to a fuel injection pump 10
for internal combustion engines, especially high speed
small engines.

In general, a fuel injection pump of this kind is pro-
vided as delivery valve with a non-return valve or a pres- 15
sure reducing valve to cut off injection of fuel definitely
and exactly.

For high speed small internal combustion engines, how-
ever, the fuel injection pump of the above mentioned type
can not be always suitable for the undermentioned rea-
sons:

(1) In the fuel injection pump of this type it is difficult
from functional points of view to diminish the minimum
injection quantity.

(2) If the volume of the delivery (or reducing) valve
chamber is decreased in order to diminish the minimum 25
injection quantity, there would be produced cavitation due
to action of the reducing valve, resulting in an irregular
injection at each delivery of the pump.

(3) If the volume of the reducing valve chamber is de-
creased and returning quantity of fuel due to the reducing 30
valve is diminished, in order to diminish the minimum
injection quantity, there would occur an undesired second-
ary injection and residual pressure in the high pressure
piping would arise, whereby cut-off of injection would be
made indefinite.

Furthermore, irregular injection of fuel is not inherent
in a fuel injection pump for small type engines, but due to
unequalness and vibration in fuel quantity remaining after
completion of each injection between a fuel nozzle and the 40
delivery valve of a fuel injection pump. The irregular in-
jection mentioned above is a serious defect of the fuel
injection pump of this kind.

The primary object of this invention is, therefore, to
provide a fuel injection pump for internal combustion
engines which enables one to decrease the minimum in-
jection quantity of the pump without being accompanied
by any irregular injection and to cut off injection of fuel
definitely and exactly. In order to attain this object, in
the fuel injection pump of this invention, fuel remaining
after completion of each injection is led between the de-
livery valve and a fuel nozzle into a space communicating
with the space between said valve and nozzle whereby the
residual pressure of said fuel is reduced so rapidly as to be
maintained constant, and in addition the vibration in the
fuel line is removed.

Other features and objects of this invention will be-
come more apparent from the following description and
accompanying drawing which shows two embodiments of
the fuel injection pump of this invention and in which

FIG. 1 is a schematic sectional view of a fuel injection
pump embodying this invention, shown mainly for ex-
plaining the fundamental idea of this invention, and

FIG. 2 is a longitudinal sectional view of another em-
bodiment of a fuel injection pump embodying this inven-
tion.

Referring to FIGS. 1 and 2, the plunger 1 of the fuel
injection pump being fitted slidably and reciprocating in
the pump cylinder or sleeve 2 in a well known manner is
to be driven by a cam member (not shown) keyed to a
rotating shaft. The cylinder 2 is provided in its wall with
a suction passage or port 3 for fuel through which fuel is
delivered into the cylinder from a fuel feed pump (not

shown). The plunger 1 is provided on its circumference
with a fuel delivery regulating groove 4 of a well known
shape and in its body with a central longitudinal relief
bore or passage 5 of a well known shape communicating
with said groove 4 to relieve the cylinder 2 ahead of the
plunger 1 by communicating the suction 3 through the
passage 5 to the forward end of the plunger. In the head
portion of the cylinder constituting a valve chest for a
slide valve or delivery valve being fitted slidably in the
head portion in alignment with the plunger, the valve
body 6 is seated oil-tightly with its cylindrical projection
and a portion of its conical part under action of a coil
compression spring 7 loading said body, when the plunger
1 is positioned at its lower dead point, as shown in FIGS.
1 and 2. In FIG. 2 the slide valve body 6 is provided with
an inclined oil passage 8 (in FIG. 1, this passage 8 is
shown as bored in the head portion of the cylinder) pass-
ing through the valve body wall and having an inlet port
9 and an outlet port 10. In the wall of the valve chest an
oil pressure reducing passage 11 running perpendicularly
to the axial direction of the plunger and an oil injection
passage 12 to communicate with a fuel nozzle 13 (in FIG.
1) are bored.

In order to close and open the pressure reducing pas-
sage 11 timely by the slide valve body 6 before the com-
munication between the chamber of the cylinder 2 and
the injection passage 12 is established and after this com-
munication is interrupted by the slide valve body 6, re-
spectively, the inside width or diameter d of the passage
11 is so dimensioned that it is smaller than distance h
of lift of the slide valve body 6 at the end of which
the passage 8 begins to communicate with the chamber
of the cylinder 2 to let the fuel pass therethrough. The
shoulder 14 in the head portion shown in FIG. 1 serves as
stopper for the slide valve body 6 to prevent the outlet
port 10 in the wall of the head portion from being closed
by the valve body 6.

When the plunger 1 is positioned at its lower dead
point as shown in FIGS. 1 and 2, fuel is delivered into
the chamber of the cylinder 2 through the suction pas-
sage 3 from a feed pump not shown in the drawing.
When the plunger 1 begins its upward, i.e., working stroke
and lifts up to close the suction passage 3, the fuel begins
to be compressed and to lift up the slide valve body 6
against force of the compression spring 7. When the
plunger 6 continues to move upward, it displaces the slide
valve body 6 through the compressed fuel till the valve
body 6 is lifted up and separated from its seat in the
valve chest, resulting in communication of the passage 8
with the chamber of the cylinder 2, whereby the com-
pressed fuel flows through said passage 8 from the cyl-
inder chamber into the injection passage 12, from which
the fuel flows into the injection nozzle 13, as known in
the art. Because the inside width or diameter d of the
passage 11 is dimensioned as mentioned above, this
passage 11 is closed oil-tightly by the slide valve body 6
during delivery of fuel into the passage 12.

When the plunger 1 is lifted up further till its cir-
cumferential groove 4 communicates with the suction
passage 3, fuel pressure in the chamber of the cylinder
2 is lowered down suddenly, so that the fuel delivery ends
immediately and at the same time the slide valve body 6
is lowered down by force of the compression spring 7 as
well as by high pressure of the fuel remaining in the
injection passage 12, till at first it interrupts communi-
cation between the injection passage 12 and the chamber
of the cylinder 2 (that is, it closes the inlet port 9 shown
in FIG. 1) and then it opens the port of the oil pressure
reducing passage 11, through which surplus of the high
pressure fuel remaining in the injection passage 12 flows
to return to a low pressure place of the pump assembly,

such as the chamber in the cylinder 2 or a fuel tank for the pump (not shown). It is self-evident that during the above mentioned downward movement of the slide valve body 6, the downward stroke of the plunger 1 begins timely.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. A fuel injection pump for an internal combustion engine comprising a pump cylinder including first and second portions in internal communication, a suction portion connected into said first portion intermediate the length thereof, an injection passage connected to said second portion adjacent an end thereof opposite from said first portion, a reciprocable plunger having groove means on the surface thereof defining a fuel passage for communicating the pressure end of said first portion with said suction passage, a delivery valve slidably fitted in said second portion, by-pass passage means connected between said delivery valve and said second portion for communicating said first portion of said cylinder with said injection passage, means to bias said delivery valve body in a direction toward the end of said second portion which is adjacent said first portion to close the communication between said first and second portions, a pressure relief passage connected into said second portion intermediate its length at a location to be uncovered by said valve body and to communicate said pressure relief passage with said injection passage and relieve the pressure thereof when said biasing means is effective to move said valve body toward the end of said second portion which is adjacent said first portion, said by-pass passage means being closed by said valve body when said biasing means is effective to move said delivery valve body toward the end of said second portion which is adjacent said first portion, said plunger, when movable in a first direction, being effective to close said suction passage and to build up delivery pressure in the end of said first portion adjacent said second portion and to force said delivery valve body in an opposite direction and against said biasing means, said delivery valve being effective first to close said pressure relief passage and thereafter to cause said by-pass means to communicate the pressure end of said first portion with said injection passage, said plunger groove means being effective thereafter to relieve the pressure in said first portion by communicating the end thereof with said suction line and said delivery valve being effective to be moved by said biasing means to first disconnect said by-pass means from communicating with said injection conduit and said first portion and to thereafter uncover said pressure relief passage to connect said injection passage to said pressure relief passage.

2. A fuel injection pump according to claim 1, wherein said by-pass passage means includes a passage defined in said cylinder and terminating in an opening at each end of said second portion.

3. A fuel injection pump according to claim 1, wherein said by-pass passage means includes a by-pass passage defined in said valve body providing communication in said second portion with opposite sides thereof, said cylinder including a passage surrounding one end of said by-pass passage communicating said by-pass passage with said first portion and to said injection passage when said valve body is moved against said biasing means.

4. A fuel injection pump for internal combustion engines comprising a cylinder including first and second portions interconnected by a narrow neck passage portion, an injection passage connected to the end of said second

portion removed from said first portion, a suction line connected to said first portion intermediate the length thereof, a plunger reciprocable in said first portion having groove means defined intermediate the length thereof adapted to uncover said suction line and relieve pressure from the end of said first portion which is adjacent said second portion, means connected to said plunger to reciprocate said plunger, a delivery valve slidably fitted in said second portion, means connected to said delivery valve to bias said delivery valve toward an end of said second portion adjacent said first portion, a relief passage connected into said second portion at a location to be uncovered by said delivery valve when said biasing means is effective to force said delivery valve toward said first portion, a by-pass line connected into said second portion at a first location adjacent the connection to said injection conduit and at a second location intermediate the length of said second portion, the dimensions of said pressure relief line and said by-pass conduit first and second connections being such that the pressure established between said first and second portions by movement of said plunger causes movement of said delivery valve to first close said relief passage and thereafter open said by-pass to communicate said first portion with said injection passage, the relieving of pressure by communicating said groove means with said suction lines causing said delivery valve under the influence of said biasing means to first close said bypass passage and thereafter open said relief line.

5. A fuel injection pump for internal combustion engines comprising a cylinder having first and second portions in internal communication through a relatively narrow connecting neck, a plunger having groove means defined intermediate the length thereof for communicating one end of said plunger with said groove means, said plunger being slidable in said first portion, means to reciprocate said plunger, a valve body slidably fitted in said second portion, said second portion including a narrow neck portion communicating with said first portion and an annular chamber defined adjacent said narrow neck portion, means to bias said valve body in a direction to cause the end thereof to close said narrow neck portion, a by-pass passage defined through said valve body connected into said annular area at one end and to the opposite end of said second portion at the opposite end, a pressure relief passage connected to said second portion at a location uncovered by said valve body when said valve body is biased in a direction to close the neck between said first and second portions, an injection portion connected into said second portion adjacent the end thereof removed from said first portion, said valve body being movable upon increase of fluid pressure in said first portion against said biasing means to first close said pressure relief passage and to thereafter effect communication of said first portion through said by-pass to said injection line, said valve body being movable by said biasing means upon decrease in pressure to first close said by-pass line and thereafter open said relief passage.

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