

Sept. 19, 1961

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FUEL INJECTION APPARATUS

3,000,369

Filed Nov. 23, 1959

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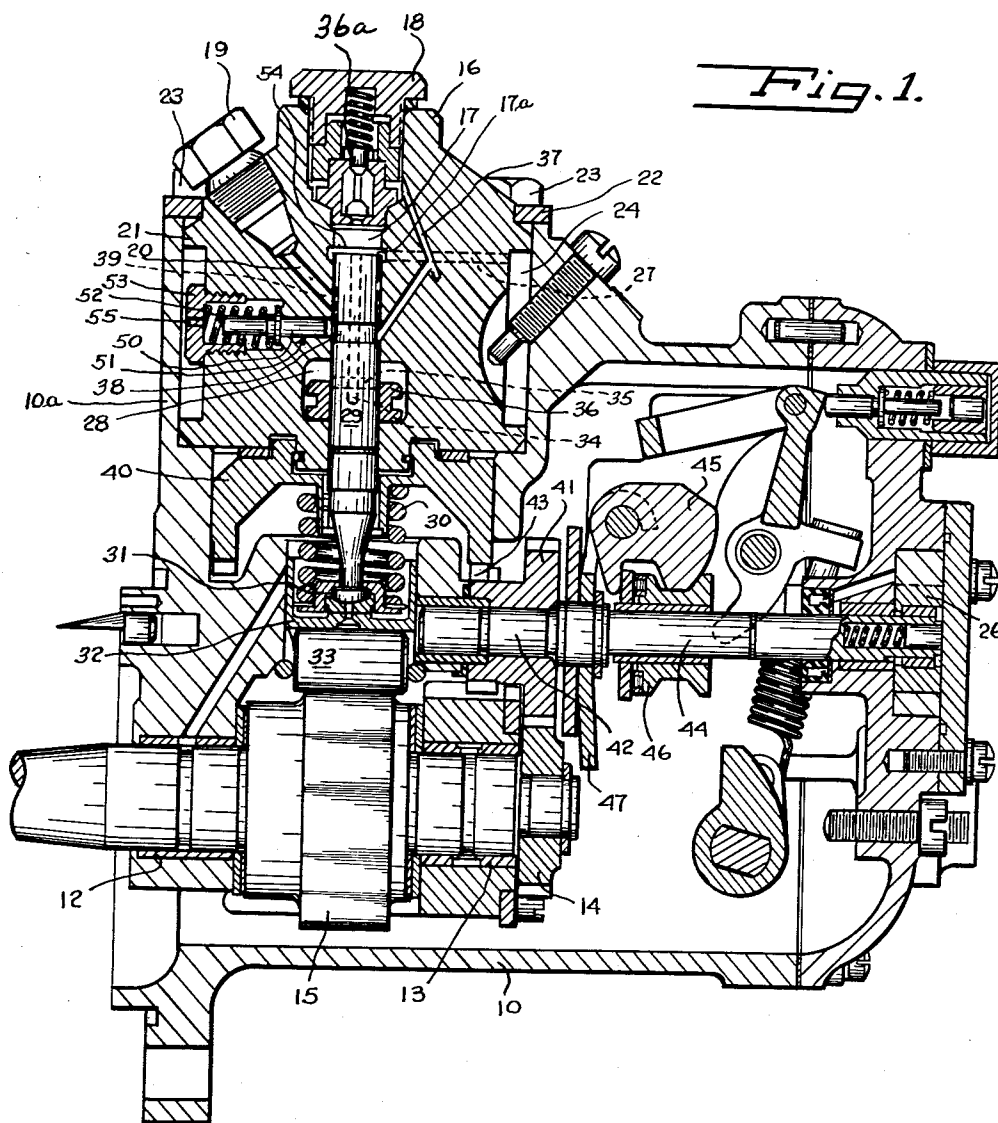


Fig. 1.

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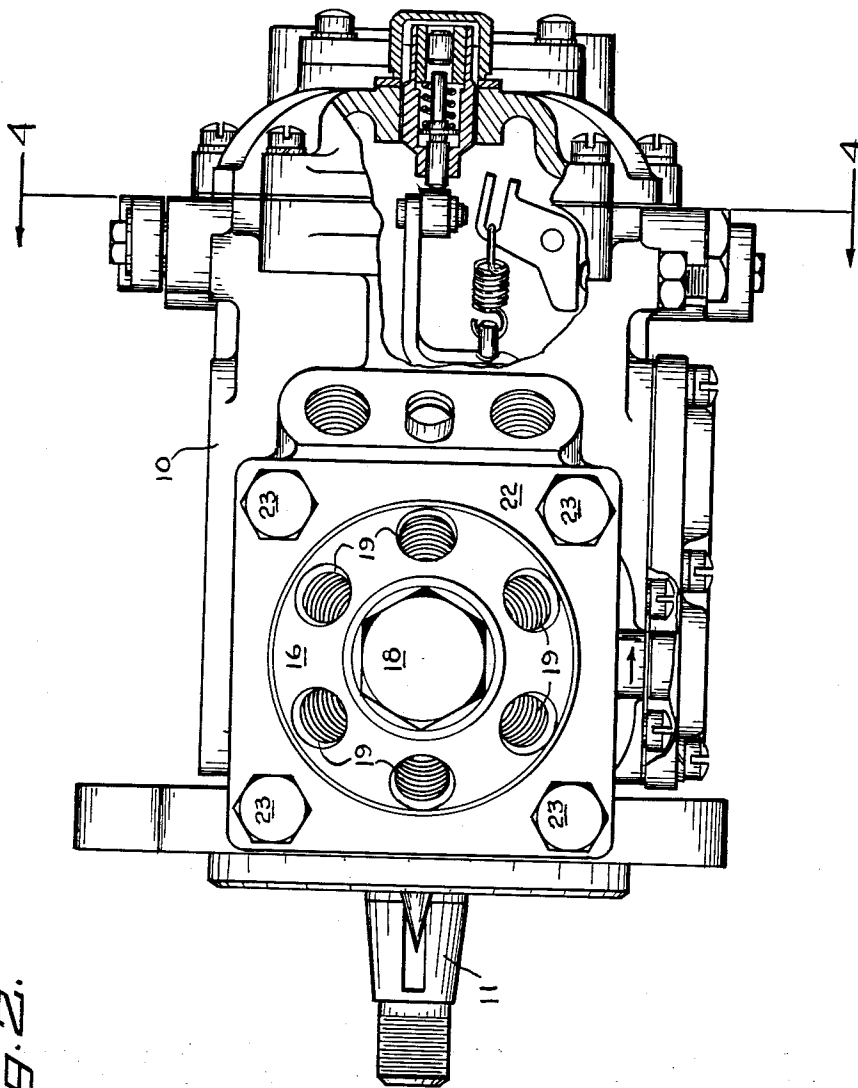


Fig. 2.

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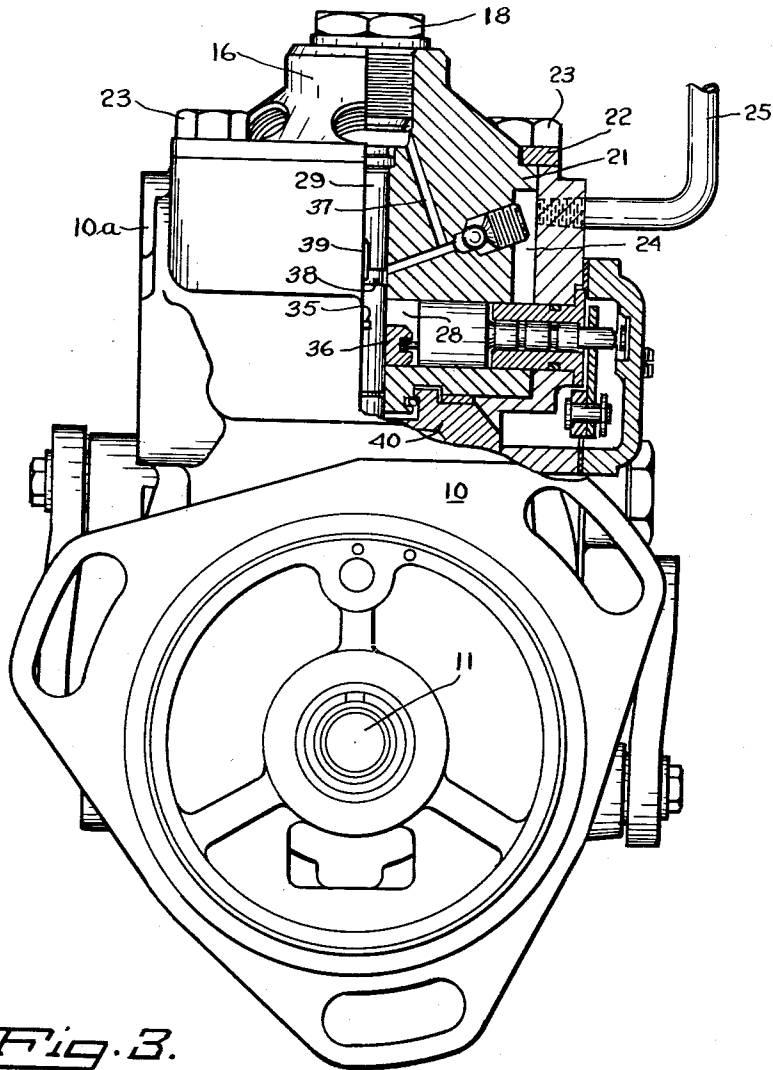
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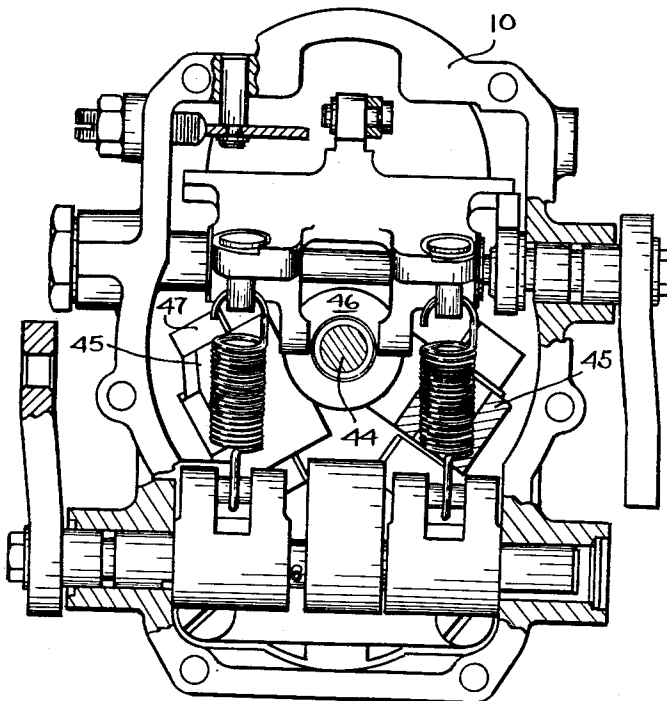
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Filed Nov. 23, 1959

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Fig. 4.



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3,000,369

FUEL INJECTION APPARATUS

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Filed Nov. 23, 1959, Ser. No. 854,807

7 Claims. (Cl. 123-139)

This invention relates to fuel injection apparatus for internal combustion engines and has particular reference to a new and improved form of fuel injection pump in which the timing of injection by the pump will be varied according to pump speed.

An object of the invention is to provide a new and improved fuel injection pump having variable injection timing means and whereby the timing of injection by the pump will be automatically varied according to pump speed without any external timing device.

Another object of the invention is to provide a new and improved device of the type set forth wherein the injection timing means is relatively simple and economical in construction and assembly and yet efficient in operation.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings, wherein the preferred form of the invention has been given by way of illustration only.

Referring to the drawings:

FIG. 1 is a longitudinal sectional view of a fuel injection pump embodying the invention;

FIG. 2 is a top or plan view of the apparatus shown in FIG. 1, partly in section;

FIG. 3 is a sectional view taken on line 3-3 of FIG. 2, looking in the direction of the arrows; and

FIG. 4 is a sectional view taken on line 4-4 of FIG. 2, looking in the direction of the arrows.

Referring more particularly to the drawings wherein similar reference characters designate corresponding parts throughout, the apparatus shown embodying the invention comprises a housing or casing 10 in which the drive shaft or cam shaft designated generally at 11 is journaled in the bearings 12 and 13, and which drive shaft is adapted to be operatively connected to the engine and to be driven thereby.

On the end of the drive shaft 11 is secured the spur gear 14 which is adapted to be rotated upon rotation of the drive shaft.

The drive shaft 11 is provided with a cam portion 15 having cam lobes, the number of which depends upon the speed at which the pump is to be driven, for example, when the drive shaft 11 is connected to a four-cycle engine and adapted to operate at one half engine speed, the number of cam lobes on the cam 15 is equal to the number of pump outlets and where the drive shaft 11 is adapted to be driven at engine speed, the cam is provided with one half the number of lobes as the pump has outlets.

In the upper portion 10a of the casing or housing 10 is provided the pump head 16 which fits into a recess in said housing portion 10a.

The pump head 16 has the bore 17 therethrough, the outer end of which is closed by a threaded plug or the like 18 and the pump head 16 is provided with the outlets 19, one of which is provided for each engine cylinder or combustion chamber of the engine and which outlets 19 are connected to the bore 17 by the ducts or passages 20.

The pump head or hydraulic head 16 has the peripheral flange 21 which is engaged by member 22 which, through bolts 23, locks hydraulic head 16 in the casing 10a.

The pump head 16 is provided with an annular or

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peripheral recess or groove 24 adjacent the periphery of the pump head, which together with the adjacent wall of the housing 10a, forms a sump to which fuel is supplied through pipe 25 extending out of the casing 10a and which is adapted to be connected to a suitable source of fuel such as by a pipe line, not shown, to fuel supply pump 26, which may be of the impeller type, gear or vane type, as desired or, if desired an external fuel supply pump could be employed.

Fuel is supplied to the pump bore 17 from sump 24 by means of fill ports or ducts 27 which may be of any suitable number.

Fill ports or ducts 27 connect sump 24 with bore 17 at which point bore 17 is provided with peripheral groove or slot 17a, which slot or groove is positioned at a point where it will be passed by the top edge of the plunger 29 during the pumping or delivery stroke of the plunger.

Intermediate the ends of bore 17 is provided the spill sump 28 which is connected by a fuel passage, not shown, to sump 24.

The plunger or pumping and distributing member 29 is mounted for reciprocation and rotation in bore 17 and said member is adapted to be urged on its pumping stroke by means of the lobes on cam 15 and on its filling or suction stroke by means of spring 30, which has one end engaging spring seat 31 for retaining the end of the member 29 in engagement with tappet 32. Tappet roller 33 is provided between cam 15 and tappet 32.

The lobes on cam 15 force the pumping and distributing member 29 upward on its pumping and distributing stroke and spring 32 effects the return or suction stroke of said member 29.

Member 29 has the axial bore or passage 34 which communicates with the upper end of said member and at its lower end communicates with radial spill port 35 which is adapted to spill into sump 28 and sleeve 36 controls the spilling of fuel through said port 35 into said sump 28 to thereby control the quantity of fuel delivered by the pump.

In bore 17 is provided the fuel delivery or discharge valve 36a which is adapted to be opened by fuel under pressure and fuel passing through said valve passes through fuel passage or duct 37 to annular groove 38 which communicates with distributing slot 39 on member 29. The distributing slot 39 is adapted to communicate successively with each outlet passage 20 upon rotation of member 29 to thereby distribute fuel to each of the outlets 19 in succession.

In order that the member 29 may be rotated, simultaneous with the reciprocation thereof, a face gear 40 is provided surrounding the lower end of member 29 and said face gear 40 is connected to member 29 by pins or other suitable means for operatively connecting said face gear 40 with said member 29.

Face gear 40 is adapted to be rotated upon rotation of drive shaft 11 and spur gear 14 through the pinion 41, which meshes with gear 14 and which is connected to shaft 42 on which is positioned gear 43 which, in turn, meshes with face gear 40. Shaft 42 is also utilized for driving supply pump 26 and the governor shaft 44 as will be seen from FIG. 1.

The governor arrangement shown is of the centrifugal type and is generally of the type shown in Patent 2,518,448 wherein the governor is adapted to be actuated through the centrifugal force of governor weights 45 upon the rotation of governor shaft 44, and which weights are adapted to actuate governor sleeve 46 along governor shaft 44 and, as the governor sleeve 46 is mechanically connected to spill sleeve 36, through linkage not shown, movement of said sleeve 46 will effect movement or adjustment of said spill sleeve 36.

The governor weights 45 are pivotally mounted on a spider and three such weights are preferably provided, and the spider 47 is keyed to shaft 44 by suitable means whereby rotation of the shaft effects rotation of the weights.

The arrangement for providing variable injection timing consists generally of a spring loaded piston 50 inserted in the high pressure injection circuit and operated by hydraulic pressure.

The piston 50 is provided in bore 51 communicating with bore 17 and is held in normal position by means of spring 52 positioned within threaded cap 53.

The operation of the pump, except for the injection timing means, is set forth in said Patent 2,518,448.

The operation of the injection timing means is as follows:

On the injection stroke, the plunger or pumping and distributing member 29 moves upward. When the top edge of the plunger passes the upper edge of groove 54, pressure is developed forcing the delivery valve 36a from its seat and fuel flows through passage 37 to the groove 38 on the plunger 29 and then to the distributor slot 39 and out through one of the outlets 20 to its respective engine cylinder.

Piston 50 is closely fitted in its bore 51 to prevent leakage, but yet permit free movement and the load of spring 52 is such as to permit piston 50 to move due to fuel pressure before the engine nozzles are opened by fuel pressure.

Cap 53 holds the spring and piston in place and seals the cavity for bore 51.

Cap 53 has the orifice 55 which controls the flow of fluid out of the spring cavity, thereby controlling the travel of piston 50 and, due to this orifice effect and the time differential, the piston 50 is displaced a greater amount at low speeds than at high speeds. Displacement of piston 50 effectively varies the beginning of injection of fuel at the nozzles and, because there will be more displacement at low speeds than at high speeds, there will also be more delay in the beginning of injection at low speeds and, in effect, retarding the timing of injection.

At high speeds there would be less displacement of piston 50, therefore, less delay and less retard to the timing. This then would vary the timing of injection automatically with a change in the speed of the pump.

The injection stroke normally is ended when the spill port 35 is opened by the metering edge on the sleeve 36. With the present device, when fuel is spilled into the spill sump, the delivery valve will seat and then the spring 51 will force piston 50 back to its initial position and the fuel under piston 50 in the piston bore 53 will be returned to the high pressure circuit and delivered to the engine. It will thus be seen that this device does not take fuel from the system, but rather merely permits a delay in its delivery time.

From the foregoing, it will be seen that I have provided new and improved means for obtaining all of the objects and advantages of the invention.

I claim:

1. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and fuel injection timing passage means communicating with said fuel distributing means for allowing the passage of fuel from said fuel distributing member for automatically varying the timing of injection

upon changes in speed of operation of said pumping and distributing member.

2. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and fuel injection timing passage means communicating with said fuel distributing means for allowing the passage of fuel from said fuel distributing member for automatically varying the timing of injection upon changes in speed of operation of said pumping and distributing member, said means for controlling the passage of fuel through said fuel injection timing passage means and comprising a spring loaded piston with said piston being adapted to compress said spring by hydraulic pressure effected by the delivery of fuel.

3. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and fuel injection timing passage means communicating with said fuel distributing means for allowing the passage of fuel from said fuel distributing member for automatically varying the timing of injection upon changes in speed of operation of said pumping and distributing member, said means for controlling the passage of fuel through said fuel injection timing passage means and comprising a bore and a spring loaded piston in said bore with said spring being compressed by said piston when said piston is subjected to the pressure of fuel.

4. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and means communicating with said fuel distributing means for automatically varying the timing of injection upon changes in speed of operation of said pumping and distributing member, said means comprising a displacement piston communicating with the fuel distributing system of said fuel injection pump with said displacement piston being displaced by the pressure of fuel distributed by said pump successively upon each pumping stroke of said pump.

5. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and means communicating with said fuel distributing means for automatically varying the timing

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of injection upon changes in speed of operation of said pumping and distributing member, said means comprising a displacement piston communicating with the delivery pressure circuit of said pump and a restriction controlling the flow of fuel from said displacement piston.

6. In a device of the character described, a housing having a bore, a pumping and distributing member in said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and means communicating with said fuel distributing means for automatically varying the timing of injection upon changes in speed of operation of said pumping and distributing member, said means comprising a passage from said bore to said passage means for supplying fuel to said bore and means for controlling the passage of fuel through said passage from said bore to said passage means for supplying fuel to said bore.

7. In a device of the character described, a housing having a bore, a pumping and distributing member in

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said bore, a plurality of outlets communicating with said bore and adapted to deliver fuel to each of a plurality of combustion chambers successively, passage means for supplying fuel to said bore from a suitable source of fuel, means for effecting reciprocation and rotation of said pumping and distributing member for pumping and distributing fuel to each of said outlets successively, fuel distributing means on said pumping and distributing member and means communicating with said fuel distributing means for automatically varying the timing of injection upon changes in speed of operation of said pumping and distributing member, said means comprising a passage from said bore to said passage means for supplying fuel to said bore and means for controlling the passage of fuel through said passage from said bore to said passage means for supplying fuel to said bore, said means for controlling the flow of fuel comprising a displacement piston and a restricted orifice controlling the flow of fuel from said displacement piston.

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