

Nov. 17, 1964

L. F. MARTYN ET AL

3,157,173

FUEL INJECTION PUMPS

Filed June 29, 1962

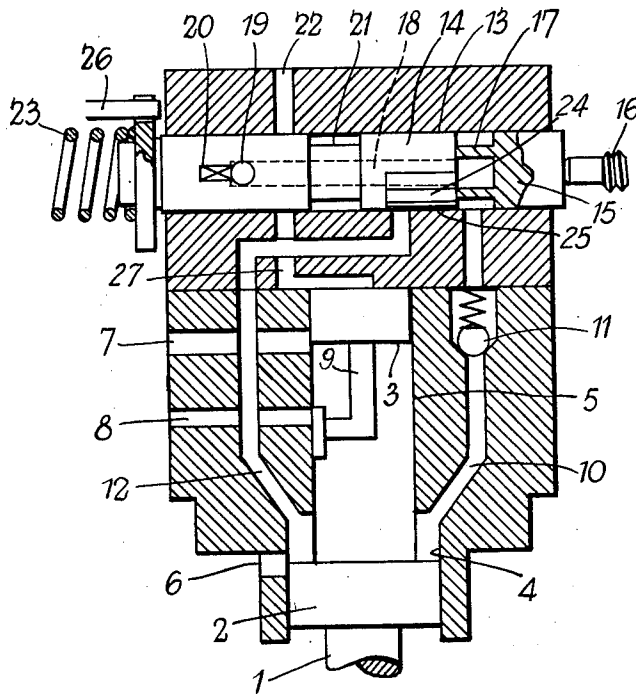


FIG. 1

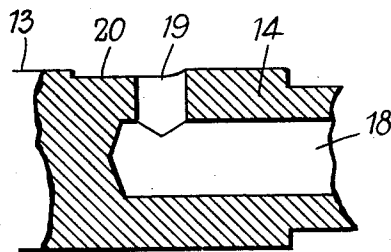


FIG. 2

Inventors
Laurence Frederic Martyn
Michael Pole
By Peck & Peck
ATTORNEYS

1

3,157,173

FUEL INJECTION PUMPS

Laurence Frederic Martyn, Walton-on-Thames, and Michael Pole, Southall, England, assignors to Mono-Cam Limited, London, England, a company of Great Britain

Filed June 29, 1962, Ser. No. 206,436

Claims priority, application Great Britain, June 29, 1961, 23,570

7 Claims. (Cl. 123-140)

This invention relates to fuel injection pumps for internal combustion engines particularly though not exclusively, compression-ignition engines. It is concerned with improvements in such pumps of the kind (hereinafter referred to as "the kind specified") comprising one or more piston and cylinder pumping assemblies in which the effective length of the delivery stroke of the or each piston is controlled by pressure-responsive governor means which is exposed during the injection stroke of a piston to a fuel pressure and which is arranged to move under the influence of said fuel pressure against the effect of spring means to place the cylinder in communication with the inlet side of the pump, the fuel tank or like low pressure region when the engine speed exceeds that for which the pump is set.

In the specification filed in respect of the co-pending application No. 8,763 dated February 15, 1960, now Patent No. 3,075,509, there is described a fuel injection pump of the kind specified in which the fuel pressure to which the governor means is exposed at the commencement of an injection stroke is a function of the period of time between the commencement of the injection stroke and the end of the immediately preceding injection stroke thereby ensuring that the fuel pressure to which the governor means is exposed is a function of the mean engine speed over a period of time longer than the injection period. This is achieved by forming the governor means as a substantially cylindrical valve body slidable in a sleeve and arranged to place the pumping cylinder in communication with the inlet side of the pump or like low pressure region at a predetermined displacement of the valve body relative to the sleeve. One end of the valve body is exposed to a volume of fuel displaced during a pumping stroke of the piston through a non-return valve to displace the valve body from a starting position and allowing the volume of fuel to leak away through a restriction to a low pressure region during the period between the end of the injection stroke and the commencement of the next injection stroke so that the valve body returns towards its starting position during this period of time under the influence of the spring means. The starting position to which the valve body has returned at the commencement of the next injection stroke and hence the distance through which the valve body requires to be displaced before placing the pumping cylinder in communication with the low pressure region is thus a function of the period of time between the commencement of the injection stroke and the end of the preceding injection stroke and hence a function of the engine speed. It will be appreciated that the pressure of the fuel to which the one end of the valve body is subjected to a function of the pressure of the spring means exerted on the valve body tending to return it to its starting position and hence is a function of the magnitude of the displacement of the valve body and is thus a function of the period of time between the end of an injection stroke and the commencement of the next injection stroke. Although the maximum displacement of the valve body is, in practice, only of the order of 2.5 mm., this can result in a difference of pressure exerted by the spring means between the two end positions of the valve body

2

of several pounds per square inch. We have now found that the governing characteristics of the fuel injection pump of our prior proposal can be considerably improved by arranging for the fuel to which the one end of the valve body is exposed to leak away through a restriction which is only operative during that part of an injection stroke which occurs after the pumping cylinder has been placed in communication with the low pressure region and injection has ceased, thereby modifying the stroke of the valve body.

According to the present invention there is provided a fuel injection pump of the kind specified wherein the governor means comprises a substantially cylindrical valve body having one end arranged to be exposed to said fuel pressure and displaceable in a sleeve against the effect of the spring means to place the pumping cylinder in communication with the inlet side of the pump, the fuel tank or like low pressure region at a predetermined displacement of the valve body within the sleeve, a first restriction between said one end of the body and the low pressure region and operable during the period between the end of an injection stroke and the commencement of the next injection stroke to permit a restricted escape of fuel from said one end of the valve body and a second restriction between said one end of the valve body and the low pressure region and operable to permit a restricted escape of fuel from said one end of the valve body to the low pressure region during that part of an injection stroke which occurs after the pumping cylinder has been placed in communication with the inlet side of the pump and injection has ceased.

Reference is now made to the accompanying drawings which illustrate an embodiment of the present invention here given by way of example and in which:

FIG. 1 is a sectional elevation view, and

FIG. 2 is an enlarged view of a portion of FIG. 1.

In the embodiment illustrated a reciprocating rotating piston is indicated at 1, the means for achieving the reciprocating and rotary motion and which may include a cam follower mechanism not being shown. This piston 1 has an enlarged annular part 2 and a piston head portion 3, the enlarged part 2 co-operating with a cylindrical chamber 4 and the piston portion 3 sliding within a cylindrical chamber indicated at 5. A low pressure fuel inlet to cylindrical chamber 4 is shown at 6 and a low pressure fuel inlet to the cylindrical chamber 5 is shown at 7. The upper part of the cylindrical chamber 5 is in communication with an injection conduit 8 through a conduit indicated at 9 which extends axially of the piston 1 and then extends radially to terminate in a flat portion which communicates with the inner end of the injection conduit 8 when the piston 1 has attained the requisite position in its reciprocating and rotational motion. It will be understood that a separate conduit 8 is provided for each cylinder of the engine to which fuel is to be fed, the conduits 8 being equi-angularly disposed about the axis of the piston 1.

A path for fuel from the cylindrical chamber 4 is provided by a passage 10, this path including a non-return valve indicated at 11. A return path for fuel is provided by a passage 12, the passages 10 and 12 opening through the wall of a sleeve defining a cylindrical chamber 13 which is disposed with its axis transverse to the axis of cylindrical chamber 5. A governor member is provided by a cylindrical governor valve body 14 which is housed in sliding relationship in the cylindrical chamber 13. Located to the right hand side of the governor valve 14 (as seen in FIG. 1) is a terminating plug 15 the position of which is adjustable by screw 16 with respect to the lateral extent of the cylindrical chamber 13. The end of the plug 15 adjacent the governor valve 14 is formed with two lateral projections 17, the governor valve mem-

ber 14 bearing against these lateral projections 17 in the limiting inner or extreme right hand position of the governor valve body 14. The limiting inner end position of the valve body 14 is such that the passage 19 is always open to the space between the inner end of the valve body 14 and the plug 15 so that fuel is supplied to this space by the enlarged annular part 2 of the piston 1 on each injection stroke to displace the governor body 14 outwards.

The governor valve 14 has a central conduit 18 extending from its end adjacent the plug 15 to a cooperating radially extending orifice 19. The radially extending orifice 19 terminates in a flat 20 which has but slight clearance between its surface and the inner surface of the cylindrical chamber 13 and defines a restriction which is operative when the flat 20 clears the outer or left-hand end of the sleeve defining the chamber 13 to permit a restricted escape of fuel from the space at the inner end of the valve body 14. This portion of FIG. 1 is indicated in enlarged view in FIG. 2.

The governor valve 14 has a reduced diameter portion 21 and a spill passage 22 is formed in the block in which the cylindrical chamber 13 is provided. A return spring 23 biases the governor valve 14 towards the limiting right hand inner position and the lateral projections 17 of the plug 15. A cut-away portion 24 is provided in the cylindrical wall of the governor valve 14 at the inner end thereof to form a restriction between this cut-away portion 24 of the governor valve and the opposed part 25 of the cylindrical chamber 13, this restriction being, in cross-section, defined by a circular arc part of the wall of the chamber 13, i.e. 25, and by the wall of the cut-away portion 24 which is eccentric with respect to the axis of the valve body 14 so that the restriction afforded by the cut-away portion 24 is dependent upon the angular adjustment of the governor valve 14, the conduit 12 opening to the circular arc part 25 of the chamber 13. A lever 26 is provided for adjusting the rotational setting of the governor valve 14 in the cylindrical chamber 13. A conduit 27 extends from the upper part of cylindrical chamber 5, and opens into the chamber 13 at location such as to be placed in communication with the spill passage 22 by the reduced diameter portion 21 of the valve body 14 when the latter assumes a predetermined position within the chamber 13. The flat 20 is so located in relation to the reduced diameter portion 21 and the passages 22 and 27 so as to clear the end of the sleeve defining the chamber 13 and permit a restricted escape of fuel from the inner end of the valve body 14 only after the pumping cylinder 5 is placed in communication with the spill passage 22.

In operation fuel from a low pressure gallery is fed via inlet 7 to the upper part of cylindrical chamber 5 and via inlet 6 to the cylindrical chamber 4. With upward reciprocatory motion of the piston 1, after closure of the inlet port 7, the fuel above piston head portion 3 is subjected to pressure and is injected via the conduit 9 to the injection conduit 8 and thence to the respective engine cylinder in dependence upon the angular position of the piston 1. The upward movement of the piston 1 also causes the fuel inlet 6 to be covered by the enlarged annular part 2 and the fuel in the cylindrical chamber 4 is thence pumped up via the conduit 10 to the space in the chamber 13 at the inner end of the valve body 14 to displace the latter outwardly against the spring 23, the ball valve 11 only lifting from its seat during an injection stroke.

At a predetermined position of the governor valve 14 in the chamber 13, the pumping cylinder 5 is placed in communication with the spill passage 22 and injection ceases. After injection ceases and during the remainder of the pumping stroke fuel continues to be displaced from the chamber 4 to the space at the inner end of the valve body 14 and the latter continues its outward displacement to cause the flat 20 to clear the end of the sleeve defining

the chamber 13 and allowing a restricted escape of fuel from the inner end of the valve body through the passages 18 and 19 and the flat 20 to the low pressure side and thereby modifying the stroke of the valve body 14 after the termination of injection, the valve body 14 continuing its outward displacement throughout the injection stroke.

During the period between the end of the injection stroke of the piston 1 and the commencement of the next injection stroke, the valve 11 closes the passage 19 and fuel leaks away from the space at the inner end of the valve body 14 through the restriction afforded by the cut-away portion 24 and the passage 12 so that the governor body 14 returns towards its inner end position under the influence of the spring 23 and, at the commencement of the next injection stroke, has returned to a position in the chamber 13 which is a function of the period of time between the commencement of the injection stroke and the end of the immediately preceding injection stroke and hence of the engine speed. The pressure of the fuel in the space at the inner end of the valve body 14 is thus also a function of the period of time referred to and hence of the engine speed. Thus, if the engine speed is greater than that for which it is set, the period of time referred to will be less than it should be, the valve body 14 will have returned a shorter distance towards its innermost position than it should have and the valve body 14 will have a shorter outward displacement before the reduced diameter portion 21 places the pumping cylinder 5 in communication with the spill passage 22 and hence a lesser quantity of fuel will be injected into the engine cylinder.

The provision of the restricted escape of fuel by way of the flat 20 which is operative after injection has ceased until the end of the injection stroke, imparts a means of controlling the governing characteristics. With no escape of fuel, the amplitude of the valve motion is constant under all governing conditions so the zone of operation of the valve changes with engine load. Under such conditions, however, the governing is isochronous. It has been found that the restricted leak provides a means of controlling the speed range or run-out of the governor between full load and no load acceptable to the majority of applications without altering the amplitude of the valve by more than 5%. When a change of engine load occurs the displacement/time diagram of the valve changes its zone during the period of change of speed, but remains substantially unaltered in characteristic in whatever zone it is working.

The restriction afforded by the flat 20 controls the rate of rise of the fuel to which the inner end of the valve body is exposed after injection has ceased and thus controls the difference between no load speed and full load speed.

What we claim is:

1. A fuel injection pump for an internal combustion engine comprising a housing, a cylinder within said housing, a piston reciprocable within said cylinder by said engine to form a pumping assembly having a pumping stroke of the piston during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected to said engine cylinder, an enlargement of said pumping cylinder providing an auxiliary cylinder, an enlargement of said piston reciprocable in said auxiliary cylinder by said engine, a first fuel inlet passage opening into said pumping cylinder at a location blanked-off by said pumping piston during a pumping stroke to define the commencement of the period of injection of fuel to said engine cylinder and opening to the exterior of said housing for connection to a low pressure fuel supply, a second fuel inlet passage opening into said auxiliary cylinder at a location blanked-off by said auxiliary piston during a pumping stroke to generate a fuel pressure in said auxiliary cylinder as a function of engine speed and opening to the exterior of said housing for connection to said low pres-

5

sure fuel supply, a governor sleeve in said housing, a first pressure transmitting passage extending between said auxiliary cylinder and said sleeve to transmit said generated fuel pressure to said sleeve, a non-return valve in said first pressure transmitting passage to prevent escape of said generated fuel pressure from said sleeve through said first pressure transmitting passage to said auxiliary cylinder during a suction stroke of said pumping piston, a second pressure transmitting passage extending from said sleeve to said auxiliary cylinder to permit the escape of said generated fuel pressure from said sleeve during the period of time between the end of a pumping stroke of said pumping piston and the commencement of the next succeeding pumping stroke of said pumping piston, a first restriction associated with said second pressure transmitting passage to control the escape of said generated fuel pressure from said sleeve during said period of time whereby the fuel pressure in said sleeve at the commencement of the next succeeding pumping stroke of said pumping piston is a function of said period of time, a third pressure transmitting passage opening to said sleeve, a fourth pressure transmitting passage extending from said pumping cylinder and opening to the interior of said sleeve at a first location, a fifth passage communicating with the exterior of said housing and opening to the interior of said sleeve, a governor valve body displaceable in said sleeve away from an end position under the influence of said generated fuel pressure and operable to place said fourth and fifth passages in communication with each other upon displacement beyond a first predetermined distance from said end position to terminate injection and to place said third passage in communication with the exterior of said housing upon displacement beyond a second predetermined distance from said end position to permit escape of said generated fuel pressure, said second predetermined distance being greater than said first predetermined distance, a second restriction associated with said third passage to restrict the escape of said generated fuel pressure through said third passage and spring means opposing displacement of said valve body from said one end position and operable to move said valve body during said period of time to a starting position at the commencement of said next succeeding pumping stroke which starting position is a function of said period of time.

2. A fuel injection pump for an internal combustion engine comprising a housing, a cylinder within said housing, a piston reciprocable within said cylinder by said engine to form a pumping assembly having a pumping stroke of the piston during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected to said engine cylinder, an enlargement of said pumping cylinder providing an auxiliary cylinder, an enlargement of said piston reciprocable in said auxiliary cylinder by said engine, a first fuel inlet passage opening into said pumping cylinder at a location blanked-off by said pumping piston during a pumping stroke to define the commencement of the period of injection of fuel to said engine cylinder and opening to the exterior of said housing for connection to a low pressure fuel supply, a second fuel inlet passage opening into said auxiliary cylinder at a location blanked-off by said auxiliary piston during a pumping stroke to generate a fuel pressure in said auxiliary cylinder and opening to the exterior of said housing for connection to said low pressure fuel supply, a governor sleeve in said housing communicating at one end with the exterior of said housing for connection to said low pressure fuel supply, a first pressure transmitting passage extending between said auxiliary cylinder and the other end of said sleeve opposite to said one end to transmit said generated fuel pressure to said sleeve, a non-return valve in said first pressure transmitting passage to prevent escape of said generated fuel pressure from said

6

sleeve through said first pressure transmitting passage to said auxiliary cylinder during a suction stroke of said pumping piston, a second pressure transmitting passage extending from said other end of said sleeve to said auxiliary cylinder to permit the escape of said generated fuel pressure from said sleeve during the period of time between the end of a pumping stroke of said piston and the commencement of the next succeeding pumping stroke of said pumping piston, a first restriction associated with said second pressure transmitting passage to control the escape of said generated fuel pressure from said sleeve during said period of time whereby the fuel pressure at said other end of said sleeve at the commencement of said next succeeding pumping stroke of said pumping piston is a function of said period of time, a third pressure transmitting passage extending from said pumping cylinder and opening to the interior of said sleeve at a first location intermediate the length thereof, a fourth passage communicating with the exterior of said housing and opening to the interior of said sleeve at a second location intermediate the length thereof, a governor valve body disposed in said sleeve with one end exposed to said generated fuel pressure and displaceable away from said other end of said sleeve under the influence of said generated fuel pressure, a cut-away portion intermediate the length of said valve body operable to place said third and fourth passages in communication to terminate injection upon a first predetermined displacement of said valve body away from said other end of said sleeve, a second restriction defined between said valve body and the wall of said sleeve and permanently in communication with said one end of said valve body and operable upon a second predetermined displacement of said valve body away from said other end of said sleeve to place said one end of said valve body in communication with said one end of said sleeve to permit a restricted escape of said generated fuel pressure, said second predetermined displacement being greater than said first predetermined displacement and spring means opposing displacement of said valve body under the influence of said generated fuel pressure to move said valve body during said period of time to a starting position at the commencement of said next succeeding pumping stroke which starting position is a function of said period of time.

3. A fuel injection pump according to claim 2 wherein said first restriction is defined between a further cut-away portion of said valve body at said one end thereof and the wall of said sleeve.

4. A fuel injection pump according to claim 3 wherein said further cut-away portion is so shaped in relation to the wall of said sleeve that the restriction afforded thereby is variable by angular adjustment of said sleeve.

5. A fuel injection pump according to claim 2 wherein said valve body is displaceable in a direction normal to the direction of reciprocation of said pumping piston.

6. A fuel injection pump for an internal combustion engine comprising a housing, a cylinder within said housing, a piston reciprocable within said cylinder by said engine to form a pumping assembly having a pumping stroke of the piston during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected to said engine cylinder, an enlargement of said pumping cylinder providing an auxiliary cylinder, an enlargement of said piston reciprocable in said auxiliary cylinder by said engine, a first fuel inlet passage opening into said pumping cylinder at a location blanked-off by said pumping piston during a pumping stroke to define the commencement of the period of injection of fuel to said engine cylinder and opening to the exterior of said housing for connection to a low pressure fuel supply, a second fuel inlet passage opening into said auxiliary cylinder at a location blanked-off by said auxiliary piston during a pumping stroke to generate a fuel pressure in said auxiliary cylinder and

opening to the exterior of said housing for connection to said low pressure fuel supply, a governor sleeve in said housing communicating at one end with the exterior of said housing for connection to said low pressure fuel supply, a first pressure transmitting passage extending between said auxiliary cylinder and the other end of said sleeve opposite to said one end to transmit said generated fuel pressure to said sleeve, a non-return valve in said first pressure transmitting passage to prevent escape of said generated fuel pressure from said sleeve through said first pressure transmitting passage to said auxiliary cylinder during a suction stroke of said pumping piston, a second pressure transmitting passage extending from said other end of said sleeve to said auxiliary cylinder to permit the escape of said generated fuel pressure from said sleeve during the period of time between the end of a pumping stroke of said piston and the commencement of the next succeeding pumping stroke of said pumping piston, a first restriction associated with said second pressure transmitting passage to control the escape of said generated fuel pressure from said sleeve during said period of time whereby the fuel pressure at said other end of said sleeve at the commencement of said next succeeding pumping stroke of said pumping piston is a function of said period of time, a third pressure transmitting passage extending from said pumping cylinder and opening to the interior of said sleeve at a first location intermediate the length thereof, a fourth passage communicating with the exterior of said housing and opening to the interior of said sleeve at a second location intermediate the length thereof, a cylindrical valve body disposed in said sleeve with one end exposed to said generated fuel pressure and displaceable away from said other end of said sleeve, a reduced diameter portion intermediate the length of said valve body defining with the wall of said sleeve an annular chamber operable to place said third and fourth passages in communication to terminate injection upon a first predetermined displacement of said valve body away from said other end of said sleeve, a radial bore in said valve body opening to the side wall thereof, an axial bore in said valve body extending from said one end thereof to said radial bore, a flat formed on the side wall of the body in communication with said radial bore and defining, with the wall of said sleeve, a second restriction operable upon a second predetermined displacement of said valve body away from said other end of said sleeve to place said one end of said valve body in communication with said one end of said sleeve to permit a restricted escape of said generated fuel pressure, said second predetermined displacement being greater than said first predetermined displacement and spring means opposing displacement of said valve body under the influence of said generated fuel pressure to move said valve body during said period of time to a starting position at the commencement of said next succeeding pumping stroke which starting position is a function of said period of time.

7. A fuel injection pump for an internal combustion engine comprising a housing, a cylinder within said housing, a piston reciprocable within said cylinder by said engine to form a pumping assembly having a pumping stroke of the piston during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected to said engine cylinder, an enlargement of said pumping cylinder providing an auxiliary cylinder, an enlargement of said piston reciprocable in said auxiliary cylinder by said engine, a first fuel inlet passage opening into said pumping cylinder at a location blanked-off by said pumping piston during a pumping stroke to define the commencement of the period of injection of fuel to said engine cylinder and opening to the exterior of said housing for connection to a low pressure fuel supply, a second fuel inlet passage

opening into said auxiliary cylinder at a location blanked-off by said auxiliary piston during a pumping stroke to generate a fuel pressure in said auxiliary cylinder and opening to the exterior of said housing for connection to said low pressure fuel supply, a governor sleeve in said housing communicating at one end with the exterior of said housing for connection to said low pressure fuel supply, a first pressure transmitting passage extending between said auxiliary cylinder and the other end of said sleeve opposite to said one end to transmit said generated fuel pressure to said sleeve, a non-return valve in said first pressure transmitting passage to prevent escape of said generated fuel pressure from said sleeve through said first pressure transmitting passage to said auxiliary cylinder during a suction stroke of said pumping piston, a second pressure transmitting passage extending from said auxiliary cylinder and opening to the interior of said sleeve, a third pressure transmitting passage extending from said pumping cylinder and opening to the interior of said sleeve at a first location intermediate the length thereof, a fourth passage communicating with the exterior of said housing and opening to the interior of said sleeve at a second location intermediate the length thereof, a cylindrical valve body disposed in said sleeve with one end exposed to said generated fuel pressure and displaceable away from said other end of said sleeve in a direction normal to the direction of reciprocation of said pumping plunger, a reduced diameter portion intermediate the length of said valve body defining with the wall of said sleeve an annular chamber operable to place said third and fourth passages in communication to terminate injection upon a first predetermined displacement of said valve body away from said other end of said sleeve, a cut-away portion at said one end of said valve body defining with the wall of said sleeve a first restriction placing said second passage in communication with said other end of said sleeve to permit the restricted escape of said generated fuel pressure through said second passage during the period of time between the end of a pumping stroke of the pumping piston and the commencement of the next succeeding pumping stroke of said pumping piston whereby the fuel pressure at said other end of said sleeve at the commencement of said next succeeding pumping stroke is a function of said period of time, a radial bore in said valve body opening to the side wall thereof, an axial bore in said valve body extending from said one end thereof to said radial bore, a flat formed on the side wall of the body and communicating with said radial bore and defining, with the wall of said sleeve, a second restriction operable upon a second predetermined displacement of said valve body away from said other end of said sleeve to place said one end of said valve body in communication with said one end of said sleeve to permit a restricted escape of said generated fuel pressure, said second predetermined displacement being greater than said first predetermined displacement and spring means opposing displacement of said valve body under the influence of said generated fuel pressure to move said valve body during said period of time to a starting position at the commencement of said next succeeding pumping stroke which starting position is a function of said period of time.

References Cited in the file of this patent

UNITED STATES PATENTS

3,027,843	Raibaud	Apr. 3, 1962
3,044,404	Bessiere	July 17, 1962
3,075,509	Friedlander	Jan. 29, 1963
3,079,862	Raibaud	Mar. 5, 1963

FOREIGN PATENTS

1,185,828	France	Feb. 16, 1959
1,234,133	France	May 16, 1960