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FUEL INJECTION PUMPS

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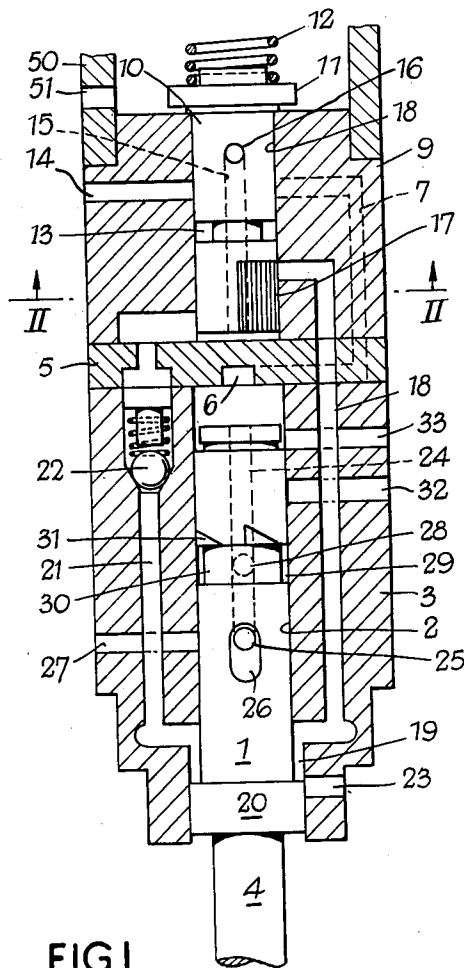


FIG. 1

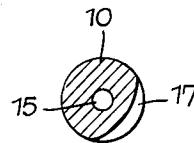


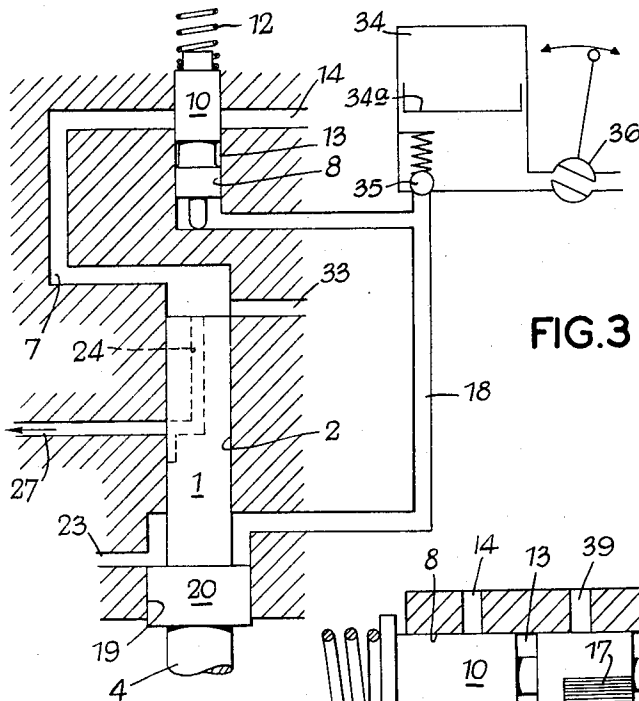
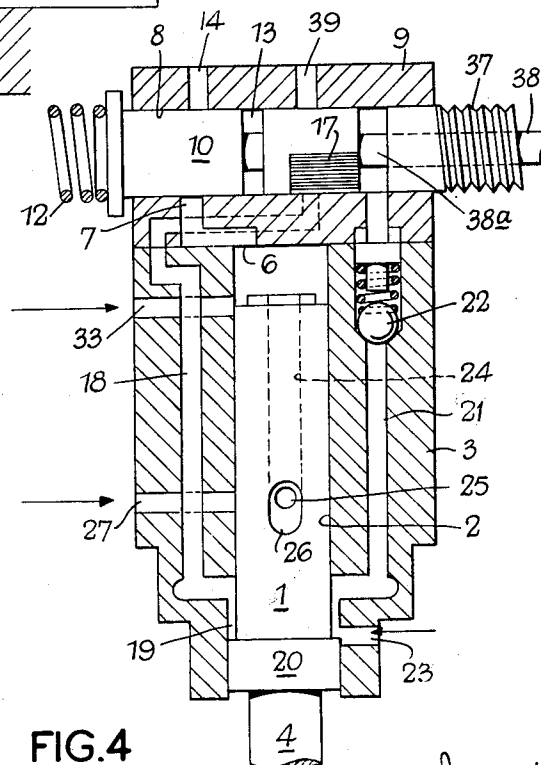
FIG. 2

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4 Sheets-Sheet 2

4 Sheets-Sheet 2



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FUEL INJECTION PUMPS

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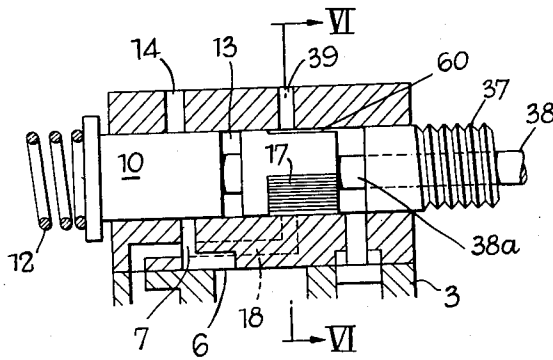


FIG.5

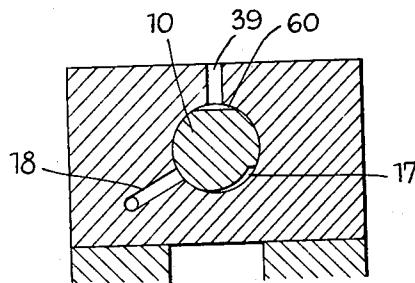


FIG.6

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4 Sheets-Sheet 4

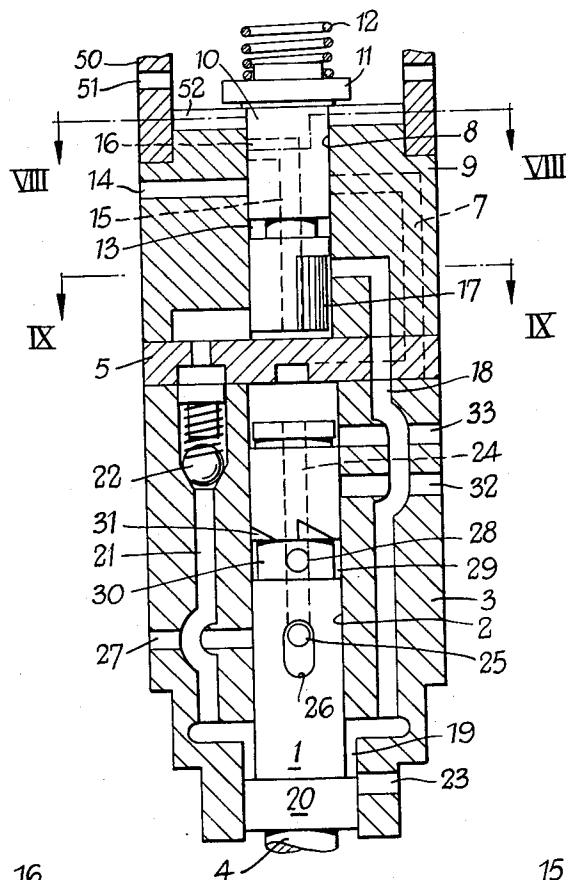


FIG. 7

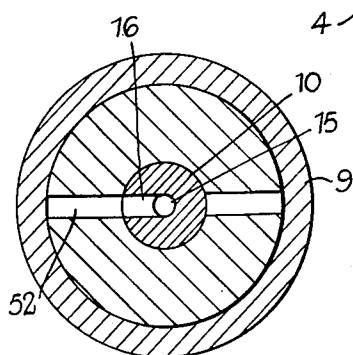


FIG. 8

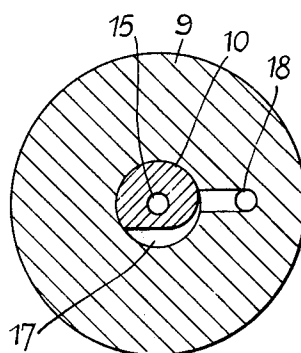


FIG. 9

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FUEL INJECTION PUMPS

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Claims priority, application Great Britain Feb. 24, 1959
17 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 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 fuel injection pumps of the kind specified the fuel pressure to which the governor means is exposed during the injection stroke of a piston is commonly built up from zero at the commencement of the injection stroke and hence is purely a function of the engine speed over the injection period which is a relatively short period of time, and which may not sufficiently accurately represent the engine speed over a longer period of time.

It is an object of the present invention to provide a fuel injection pump of the kind specified in which 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.

According to the present invention there is provided a fuel injection pump of the kind specified in which the governor means is exposed to a fuel pressure at the commencement of an injection stroke 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.

Preferably the governor means comprises a substantially cylindrical valve body exposed at one end to said fuel pressure and slidable within a sleeve against the effect of spring means, and a restriction is provided to control during said period of time the escape of fuel pressure built up at the end of an injection stroke to a region of lower pressure to provide at the end of said period of time said fuel pressure to which said governor means is exposed.

According to one embodiment of the invention said one end of the valve body communicates through the restriction with an enlargement of the cylinder in which an enlargement of the piston operates to generate fuel pressure and also communicates with the enlargement of the cylinder by way of a passage incorporating a non-return valve adapted to be open only on the injection stroke of the piston, the arrangement being such that the fuel pressure to which said one end of the valve body is exposed at the commencement of an injection stroke is a function of said period of time during which escape of fuel pressure from said one end of the valve body through the restriction is controlled and the position of the valve body within its sleeve at the commencement of an injection stroke is also a function of said period of time.

Preferably, the valve body is provided with an axial bore extending from said one end thereof to a radial bore arranged to communicate with the low pressure side of the pump at a selected position of the valve body

in the sleeve to limit the outward displacement of the valve body.

Desirably, means is provided for varying said selected position of the valve body by angular displacement thereof.

According to an alternative embodiment of the invention said one end of the valve body communicates with an enlargement of the cylinder in which operates an enlargement of the piston to generate a fuel pressure and, through a non-return valve, with a fuel pressure reservoir which, in turn, communicates with the low pressure side of the pump through the restriction, said non-return valve being arranged to open at the commencement of an injection stroke such that the fuel pressure to which said one end of the valve body is exposed at the commencement of an injection stroke is a function of said period of time during which escape of the fuel pressure in the fuel pressure reservoir is controlled by the restriction.

Some embodiments of the present invention will now be described by way of example, reference being made to the accompanying drawings in which:

FIG. 1 is a sectional view illustrating one embodiment, some parts being shown in elevation.

FIG. 2 is a sectional view of a valve body shown in FIG. 1 and taken on the line II-II of FIG. 1,

FIG. 3 is a diagrammatic view illustrating a second embodiment,

FIG. 4 is a view similar to FIG. 1 illustrating a further embodiment,

FIG. 5 is a fragmentary sectional view illustrating a modification of the arrangement of FIG. 4,

FIG. 6 is a section taken on the line VI-VI of FIG. 5,

FIG. 7 is a sectional view similar to FIG. 1 illustrating a modification,

FIG. 8 is a section taken on the line VIII-VIII of FIG. 7, and

FIG. 9 is a section taken on the line IX-IX of FIG. 7.

The fuel injection pump of the first embodiment is intended to deliver fuel to four engine cylinders and comprises a piston 1 slidable and rotatable in a cylinder 2 formed in a barrel 3. The piston 1 is carried on a shaft 4 which is connected to a diametrically extending arm (not shown) carrying cam profiles which co-operate with four rollers to lift the piston 1 against the influence of spring means (not shown) so that the as the shaft 4 and piston 1 are rotated by the engine, the co-operation of the cam profiles with the rollers causes the piston 1 to execute four injection strokes for each complete revolution thereof. The upper end of the cylinder 2 is substantially closed by a plate 5 having a port 6 through which the interior of the cylinder 2 communicates by way of passage 7 with a cylindrical bore 8 in a governor sleeve or body 9.

A cylindrical valve body 10 is slidably received in the bore 8 coaxially with the piston 1 and is provided with a head having lugs 11 whereby the angular position of the valve body 10 in the bore 8 may be manually adjusted from the exterior by means (not shown) and in a manner known per se. A spring 12 engages the head of the valve body 10 and is arranged to urge the latter towards its innermost position in the bore 8. The valve body 10 is provided with a reduced diameter portion intermediate its length to define with the wall of the bore 8 an annular chamber 13 arranged to place the passage 7 in communication with a spill passage 14 when the valve body 10 is displaced a predetermined distance from its innermost position in the bore 8. The valve body 10 is provided with an axial bore 15 which extends from its lower face to a radial bore 16 disposed towards the upper end of the valve body 10 and arranged when the valve body

10 has been displaced through the predetermined distance referred to, to communicate with the interior of a cup-shaped cap member 50 which closes the end of the governor sleeve 9 and which communicates with the low pressure region of the pump through one or more passages 51.

The lower end of the valve body 10 is clear of the lower end of the bore 8 when in its lowermost position and is cut-away at its periphery to define a part annular chamber 17 which is open to the lower end of the bore 8 and, over a range of angular positions of the valve body 10, to a passage 18 which communicates with an enlargement 19 of the lower end of the cylinder 2 in which an enlargement 20 of the piston 1 operates. The chamber 17 is shaped to be eccentric about the axis of the valve body 10 as can be more clearly seen in FIG. 2 so that the restriction it affords between the lower end of the bore 8 and the passage 18 may be varied by angularly adjusting the valve body 10 in the bore 8.

A passage 21 incorporating a non-return valve 22 extends between the lower end of the bore 8 and the enlargement 19 of the cylinder 2. An inlet passage 23 communicates with the lower end of the enlargement 19 so that during an injection stroke of the piston 1 the enlargement 20 of the piston 1, working in the enlargement 19 of the cylinder 2, pumps fuel to both passages 18 and 21, the valve 22 in the latter being arranged to open on an injection stroke.

The piston 1 is formed with an axial bore 24 which extends from the top of the piston to a radial bore 25 which opens into an elongated slot 26 in the surface of the piston 1 arranged to communicate with a delivery passage 27 during an injection stroke. It will be appreciated that although only one delivery passage 27 is illustrated, four such passages are provided spaced at 90° intervals around the axis of the piston 1 so that fuel may be delivered to each in turn during one revolution of the piston 1, each delivery passage 27 communicating with a separate engine cylinder. The axial bore 24 also communicates with a radial bore 28 which opens into an annular chamber 29 formed by a reduced diameter portion 30 of the piston 1 and which opens into helical grooves 31 formed in the wall of the piston 1 and corresponding in number to the number of engine cylinders. The helical grooves 31 are provided to control the spill for the associated engine cylinder at maximum engine load in known manner. This is achieved by so disposing the grooves 31 in relation to a spill passage 32 that at a selected point in the injection stroke for a given engine cylinder, the groove 31 associated with that engine cylinder opens into the passage 32 thereby causing injection to cease.

The piston 1 is shown in FIG. 1 at the commencement of an injection stroke and it will be seen that in this position the upper end of the cylinder 2 communicates with a fuel inlet passage 33 which is blanked off by the piston 1 during the injection stroke.

The operation of the arrangement described is as follows: As the piston 1 commences its injection stroke fuel is pumped to the appropriate engine cylinder from the top of the cylinder 2, through axial and radial bores 24 and 25 and the delivery passage 27. At the same time fuel is pumped up the passages 18 and 21 to the lower end of the bore 8 and when the fuel pressure to which the lower end of the valve body 10 is exposed reaches a predetermined value the latter is moved against the spring 12 through a sufficient distance to place the top of the cylinder 2 in communication with the spill passage 14 through the annular chamber 13 and injection ceases. At the same time the radial bore 16 in the valve body 10 communicates with the interior of the cap member 50 so that the valve body 10 does not move further during completion of the injection stroke. At the end of the injection stroke the piston 1 commences its suction stroke and the non-return valve 22 closes and the pressure in the passage 18 is reduced. The valve body 10 starts to return to its lowermost position under the influence of

the spring 12 so that the radial bore 16 therein no longer communicates with the low pressure side of the pump. The lower end of the valve body 10 is however subjected to a fuel pressure, the valve 22 being closed, and this fuel pressure can only slowly escape to the passage 18 through the restriction afforded by the chamber 17, this controlled escape occurring until the commencement of the next injection stroke. At the commencement of the next injection stroke the lower end of the piston 10 will still be subjected to a residual fuel pressure which is a function of the period of time between the end of the preceding injection stroke and the commencement of the next injection stroke during which time the controlled escape of fuel pressure occurs. The position of the valve body 10 in the bore 8 will correspondingly depend upon this period of time. Thus if the engine is running at a speed greater than that for which it is set by the angular position of the valve body 10, the period of time referred to will be shorter than that corresponding to the desired speed. Hence the residual fuel pressure will be greater, the valve body 10 will have returned to a lesser extent into the bore and spill will occur earlier in the injection stroke thereby reducing the speed of the engine and bringing it back to the desired value.

It will be appreciated that the time interval between injection strokes is usually appreciable compared to the injection period and that the arrangement described responds to the mean of variations in engine speed taken over a period of time longer than the injection period.

The second embodiment illustrated diagrammatically in FIG. 3 is very similar to that described with reference to FIGS. 1 and 2 although many details are omitted from the drawing and like reference numerals are used to denote like parts where appropriate. This embodiment need only be briefly described. In this case the passage 21 and non-return valve 22 are omitted together with the chamber 17, the passage 18 opens into the bottom of the bore 8 and the valve member 10 has a projection 10a on its lower face to prevent it closing the passage 18. The axial bore 15 and radial bore 16 in the valve body 10 are also omitted, a suitable stop (not shown) being provided to limit further upward motion of the valve body 10 when the upper end of the cylinder 2 has been placed in communication with the spill passage 14 by way of the passage 7 and the annular chamber 13. In this embodiment the passage 18 also communicates with a fuel pressure store or accumulator 34 by way of a non-return valve 35 which opens on an injection stroke of the piston 1. The accumulator 34 communicates with the low pressure region of the pump through a restriction provided by a valve 36 the setting of which controls the speed for which the engine is set. The accumulator 34 may take any suitable form and may for example include a piston 34a which acts on the fuel in the accumulator and may be adjusted to control the pressure of the fuel therein.

The operation of this arrangement is briefly as follows: At the end of an injection stroke of the piston 1 the valve body 10 will be raised to the spill position, the valve 35 will be open and the fuel pressure in the accumulator 34 will be the same as that to which the lower end of the valve body 10 is exposed. As the piston 1 commences its suction stroke the valve 35 closes and the valve body 10 returns to its innermost position in the bore 8. During the period of time which then elapses until the commencement of the next injection stroke, the fuel pressure in the accumulator 34 escapes through the restriction afforded by the valve 36 to leave a residual pressure at the commencement of the next injection stroke. When the latter commences the valve 35 is opened and this residual pressure is applied to the lower end of the valve body 10. Thus if the engine speed is greater than that for which the engine is set, the period of time referred to will be correspondingly shorter and hence the residual pressure will be correspondingly greater so that after the commencement of the next injection stroke a

5

shorter period of time will elapse before the fuel pressure has built up sufficiently to lift the valve body 10 and hence spill will occur earlier and the engine speed will be reduced.

Conversely, if the engine speed is too low, the period of time referred to will be longer and the residual pressure available at the commencement of the next injection stroke will be lower, so that the piston 1 will travel a longer period on its injection stroke before spill occurs and hence the engine speed will be increased.

The embodiment illustrated in FIG. 4 is similar in many respects to that illustrated in FIG. 1 and like references are used to denote like parts. In this case, however, the valve body 10 is slidable in the bore 8 of the governor sleeve or body 9 in a direction normal to the axis of the piston 1. The lower or right-hand end of the bore 8 is closed by a threaded plug 37 which is adjustably screwed into the pump housing (not shown) and which has a control rod 38 extending axially therethrough into the chamber defined between the inner end of the valve body 10 and the plug 37, the rod 38 providing an abutment 38a normally limiting the extent to which the valve body 10 can enter into the bore 8. The plug 37 and control rod 38 are normally maintained in a substantially constant relative position by means of a spring (not shown) and manually operable means (not shown) is provided for moving the control rod 38 axially relative to the plug 37 against the effect of this spring to withdraw the control rod 38 and reduce the extent by which it projects into the chamber between the inner end of the valve body 10 and the plug 37.

It will be noted that in this embodiment the annular chamber 29, the reduced diameter portion 30 of the piston 1, the helical grooves 31, spill passage 32, and the radial bore 28 in the piston 1 are no longer required. Additionally the plate 5 of the embodiment of FIG. 1 is not required, the port 6 and passage 7 being entirely formed in the governor or body 9. Furthermore the axial passage 15 and the radial bore 16 in the valve body 10 are omitted, the chamber at the lower end of the valve body 10 being opened to the low pressure side of the pump, when the valve body 10 has been displaced against the spring 12 by a predetermined amount, by a spill passage 39 provided in the governor sleeve or body 9. As can be seen in FIG. 4, the relative dispositions of the spill passage 39 and the inner end of the valve body 10 correspond substantially with the relative dispositions of the spill passage 14 and the annular chamber 13.

It will be appreciated that in this embodiment adjustment of the plug 37 controls the normal position of the abutment 38a and hence the innermost position attainable by the valve body 10 in the bore 8. Thus by adjusting the plug 37 the distance through which the valve body 10 moves from its innermost position before the chamber 13 is open to the spill passage 14 is controlled and this provides a control for the maximum engine load. When the engine is to be started the control rod 38 is withdrawn to allow the valve body 10 to move further into the bore 8 and hence increase the amount of fuel supplied to the engine. Once the engine is running the control rod 38 is returned to the position shown in FIG. 4.

It will be appreciated that the embodiment described with reference to FIG. 4 provides a governing effect in substantially the same manner as that described with reference to FIG. 1. It will be further appreciated that the pump described with reference to FIG. 4 is simpler and more economic to produce than that described with reference to FIG. 1 and is also more compact.

The arrangement described with reference to FIG. 4 may be modified in the manner shown in FIGS. 5 and 6 by forming the valve body 10 with a flat 60 on the side opposite to that of the chamber 17. The flat 60 extends for an axial length sufficient to place the inner end of the valve body 10 in communication with the spill passage 39 at a selected angular position of the valve body 10 in

6

which the passage 18 is closed as can be seen in FIG. 6. The flat 60 is dimensioned to ensure that such communication is relatively restricted so that at the low pumping speeds which occur when the engine is started, the low pressure to which the inner end of the valve body is exposed escapes through the space left by the flat 60 through the spill passage 39 to the low pressure side of the pump and the valve body 10 tends to remain in its inner position and excess fuel is supplied to the engine for starting purposes. As the engine speed increases, the fuel pressure to which the inner end of the valve body 10 is exposed increases to a value such that it can only escape to a relatively limited extent through the space left by the flat 60 and the valve body 10 tends to be displaced to limit the amount of fuel supplied to the engine. This arrangement prevents overloading of the engine and ensures an automatic supply of excess fuel to the engine for starting purposes so that although the adjustable plug 37 and the control rod 38 are provided, there is no longer any necessity of providing means for withdrawing the control rod 38 for starting purposes. This avoids the danger of an operator leaving the control rod 38 in its withdrawn position.

It will be appreciated that when the valve body 10 is angularly adjusted to select an engine speed, the chamber 17 is placed in communication with the passage 18 and the flat 60 is displaced relative to the spill passage 39 to render it ineffective.

In the embodiments described with reference to FIGS. 4, 5 and 6, the spill passage 39 limits the outward displacement of the valve body 10. In the embodiment described with reference to FIG. 4 the same effect may be achieved without the spill passage 39 by providing an axial bore 15 and a radial bore 16 in the valve body 10 as in the embodiment described with reference to FIG. 1.

This may also be done in the embodiment described with reference to FIGS. 5 and 6 but in this case a spill passage corresponding to the spill passage 39 must still be provided to co-operate with the flat 60.

The fuel injection pump illustrated in FIGS. 7, 8 and 9 is a modification of that described with reference to FIG. 1. The pump is shown set for low engine speeds and like reference numerals are used to denote like part. The fuel injection pump of this example is, however, modified in that the upper end of the governor sleeve 9 is formed with a radial slot 52 which for ease of machining is part of a diametral slot. The slot 52 is arranged with its axis in the plane containing the axis of the radial bore 16 of the valve body 10 when the angular position of the latter corresponds to the setting for low engine speeds. The arrangement is such that the bore 16 will communicate with the slot 52, and hence with the interior of the cap member 50, when the valve body 10 is raised or moves outwardly in the bore 8 through a predetermined amount relative to its innermost position. The effect of this is to limit the outward movement of the valve body 10. The setting for low engine speeds is that shown in the accompanying drawings in which the restriction afforded by the chamber 17 is a maximum.

Assuming that, for a given set of conditions, the valve body 10 will move inwardly between injection strokes by a predetermined amount, under the influence of the spring 12 against the fuel pressure to which its lower end is exposed, it will be seen that by providing the slot 52 the valve body 10 will move nearer its innermost position than it would in the absence of the slot 52 so that it requires a longer time during an injection stroke for the chamber 13 to place the passage 7 in communication with the spill passage 14 and hence a greater injection of fuel is achieved.

When the valve body 10 is turned through 90° (in the anti-clockwise direction as seen in FIGS. 2 and 3) to the position for high engine speed in which the chamber 17 affords the minimum restriction, the slot 52 is inopera-

tive and the valve body 10 must move further out of the bore 8 before the radial bore 16 communicates with the interior of the cap member 50.

It will be understood that, if desired, the slot 52 may be so disposed as to be rendered operative at the setting of the valve body 10 for high engine speeds and inoperative at the setting for low engine speeds.

It will be further understood that, if desired, a progressive modification of the governing characteristics of the pump according to the angular disposition of the valve body 10 may be achieved by providing instead of the slot 52 a helical groove in the wall of the bore 8 so that the point in the displacement of the valve body 10 at which the radial bore 16 communicates with the helical groove is determined by the angular position of the valve body 10, the helical groove communicating with the low pressure region through the interior of the cap member 50. The same result may be achieved by forming a helical groove around the valve body 10 with the radial bore 16 opening into such a groove and a radial spill passage being provided in the governor sleeve 9 at such a location that the point in the displacement of the valve body 10 at which the helical groove communicates with the radial spill passage is determined by the angular position of the valve body.

It will be appreciated that, in the example described with reference to FIG. 7, the angular position of the valve body 10 in the bore 8 controls the speed for which the engine is set and the limit of the outward movement of the valve body and hence the position from which the valve body commences to move inwardly at the end of an injection stroke under the influence of the spring 12 and against the effect of the fuel pressure to which its one end is exposed.

The piston 1 in the above examples may, with advantage, be provided with means operative upon rotation of the piston in a direction opposite to that intended to maintain a fuel inlet port such as the port opening into the cylinder 2 from the passage 33 in communication with the upper or operative end of the piston 1 during the effective part of an injection stroke to prevent fuel injection taking place.

What I claim is:

1. A fuel injection pump for an internal combustion engine comprising a cylinder, a piston reciprocable by said engine in said cylinder to provide a pumping assembly having a pumping stroke during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected into said engine cylinder, a first fuel inlet opening to said cylinder at a location such as to be blanked off by said piston during at least a part of a pumping stroke of said piston to define the commencement of the effective period of injection of fuel to said engine cylinder by said piston, an auxiliary cylinder, an auxiliary piston reciprocable by said engine in said auxiliary cylinder, a second fuel inlet opening to said auxiliary cylinder at a location such as to be blanked-off by said auxiliary piston during a pumping of said pumping assembly, a sleeve, a cylindrical governor body slidable in said sleeve from an end position and disposed with the axis thereof normal to that of the piston of the pumping assembly, spring means opposing displacement of said governor body in said sleeve from said end position, a first passage extending between said auxiliary cylinder and the interior of said sleeve to expose one end of said governor body to the fuel pressure generated by said auxiliary piston as a function of engine speed to tend to displace said governor body from said end position, non-return valve means disposed in said first passage to prevent the escape of fuel from the interior of said sleeve through said first passage to said auxiliary cylinder during a suction stroke of said pumping assembly, a second passage extending from said cylinder of the pumping assembly to open to the interior of said sleeve at a location where it is blanked-off by said governor body when in

said end position, a third passage opening from the interior of said sleeve at a location where it is blanked-off by said governor body when in said end position, a reduced diameter neck-portion on said governor body intermediate the length thereof arranged to place said third and second passages in communication with each other upon said governor body being displaced from said end position by a predetermined distance to define the end of said injection period, a fourth passage extending from the interior of said sleeve to said auxiliary cylinder and a cut-away portion of said governor body providing restricted communication between said fourth passage and said one end of said governor body to permit a restricted escape of said generated fuel pressure during the period between the end of an injection stroke and the commencement of the next injection stroke.

2. A fuel injection pump according to claim 1 wherein adjustable abutment is provided in co-operative relationship with said one end of said governor body to control said end position of said governor body.

3. A fuel injection pump according to claim 2 wherein said abutment comprises a plug adjustable relative to said sleeve, a rod extending through said plug for engagement with said governor body in said end position and a control spring operable to retain said plug and said rod in a substantially constant relative position.

4. A fuel injection pump for an internal combustion engine comprising a cylinder, a piston reciprocable by said engine in said cylinder to provide a pumping assembly having a pumping stroke during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected into said engine cylinder, a first fuel inlet opening to said cylinder at a location such as to be blanked off by said piston during at least a part of a pumping stroke of said piston to define the commencement of the effective period of injection of fuel to said engine cylinder by said piston, an auxiliary cylinder, an auxiliary piston reciprocable by said engine in said auxiliary cylinder, a second fuel inlet opening to said auxiliary cylinder at a location such as to be blanked-off by said auxiliary piston during a pumping stroke of said pumping assembly, a sleeve, a cylindrical governor body disposed co-axially with the piston of the pumping assembly and slidable in said sleeve from an end position, spring means opposing displacement of said governor body in said sleeve from said end position, a first passage extending between said auxiliary cylinder and the interior of said sleeve to expose one end of said governor body to the fuel pressure generated by said auxiliary piston and cylinder as a function of engine speed to tend to displace said governor body from said end position, non-return valve means disposed in said first passage to prevent the escape of fuel from the interior of said sleeve to said auxiliary cylinder during a suction stroke of said pumping assembly, a second passage extending from said cylinder of the pumping assembly to open to the interior of said sleeve at a location where it is blanked-off by said governor body when in said end position, a third passage opening from the interior of said sleeve at a location where it is blanked-off by said governor body when in said end position, a reduced diameter neck-portion on said governor body intermediate the length thereof arranged to place said third and second passages in communication with each other upon said governor body being displaced from said end position by a predetermined distance to define the end of said injection period, a fourth passage opening to the interior of said sleeve for communication with a low pressure fuel supply and a cut-away portion of said governor body providing restricted communication between said fourth passage and said one end of said governor body.

5. A fuel injection pump for an internal combustion engine comprising a cylinder, a piston reciprocable by said engine in said cylinder to provide a pumping as-

9
 assembly having a pumping stroke during at least a part of which fuel is injected into an engine cylinder and a suction stroke during which no fuel is injected into said engine cylinder, a first fuel inlet opening to said cylinder at a location such as to be blanked off by said piston during at least a part of a pumping stroke of said piston to define the commencement of the effective period of injection of fuel to said engine cylinder by said piston, an auxiliary cylinder, an auxiliary piston reciprocable by said engine in said auxiliary cylinder, a second fuel inlet opening to said auxiliary cylinder at a location such as to be blanked-off by said auxiliary piston during a pumping stroke of said pumping assembly, a sleeve, a cylindrical governor body slidable in said sleeve from an end position, spring means opposing displacement of said governor body in said sleeve from said end position, a first passage extending between said auxiliary cylinder and the interior of said sleeve to expose one end of said governor body to the fuel pressure generated by said auxiliary piston and cylinder as a function of engine speed to tend to displace said governor body from said end position, non-return valve means disposed in said first passage to prevent the escape of fuel from the interior of said sleeve to said auxiliary cylinder during a suction stroke of said pumping assembly, a second passage extending from said cylinder of the pumping assembly to open to the interior of said sleeve at a location where it is blanked-off by said governor body when in said end position, a third passage opening from the interior of said sleeve at a location where it is blanked-off by said governor body when in said end position, a reduced diameter neck-portion on said governor body intermediate the length thereof arranged to place said third and second passages in communication with each other upon said governor body being displaced from said end position by a predetermined distance to define the end of said injection period, a fourth passage extending from said auxiliary cylinder and opening to the interior of said sleeve and a cut-away portion of said governor body providing restricted communication between said fourth passage and said one end of said governor body.

6. A fuel injection pump for an internal combustion engine comprising a cylinder, a piston reciprocable by said engine in said cylinder to provide 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 into said engine cylinder, a first fuel inlet opening to said pumping cylinder at a location blanked-off by said piston during a pumping stroke to define the commencement of the period of injection of fuel into said engine cylinder, said period of injection commencing at the same point in each pumping stroke of said piston, a sleeve, a first passage extending from said cylinder to said sleeve, a second passage extending from said sleeve for communication with a low pressure fuel supply, a cylindrical governor body displaceable in said sleeve from an end position in which said governor body prevents communication between said first and second passages, said governor body having a reduced diameter portion whereby said first and second passages are placed in communication upon displacement of said governor body from said end position by a predetermined distance to terminate said injection period, a restriction afforded by a part-annular chamber defined between a cut-away portion of said governor body and the wall of said sleeve, spring means tending to oppose displacement of said governor body in said sleeve, fuel pressure generating means driven by said engine and communicating with said sleeve to expose one end of said governor body to a fuel pressure, at least during an injection stroke, the magnitude of which fuel pressure is a function of engine speed, non-return valve means interposed between said fuel pressure generating means and said

sleeve preventing flow of fuel from said sleeve to said fuel pressure generating means and a third passage opening to said part-annular chamber for connection to said low pressure fuel supply to permit a restricted escape of fuel from said one end of the governor body to said low pressure supply.

7. A fuel injection pump according to claim 6 wherein said governor body is angularly adjustable in said sleeve to vary restrictive effect of said part-annular chamber.

8. A fuel injection pump according to claim 7 wherein said governor body is formed with lugs for angularly displacing said governor body.

9. A fuel injection pump according to claim 7 including a spill passage extending from said sleeve for communication with said low pressure fuel supply and a flat formed on said governor body to place said one end of said governor body in communication with said spill passage at a selected angular position of said governor body corresponding to the setting for low engine speed.

10. A fuel injection pump according to claim 9 wherein said flat is formed at a location diametrically opposite to said cut-away portion of said governor body.

11. 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 into said engine cylinder, an enlargement of said pumping cylinder providing an auxiliary cylinder, an enlargement of said piston providing an auxiliary piston reciprocable in said auxiliary cylinder by the engine, a first fuel inlet passage opening into said pumping cylinder at a location blanked-off by said 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 the housing for connection to said low pressure fuel supply, a governor passage formed in and opening to the exterior of said housing a cap member attached to said housing to define therewith a chamber into which said governor passage opens, a governor body displaceable within said governor passage from one end position, spring means opposing displacement of said governor body from said one end position, a first pressure transmitting passage extending between said auxiliary cylinder and said governor passage to expose one end of said governor body to said generated fuel pressure, non-return valve means disposed in said first pressure transmitting passage to prevent escape of said generated fuel pressure from said one end of said governor body to said auxiliary cylinder, a cut-away portion on said governor body defining with the wall of said governor passage a part-annular chamber communicating with said one end of said governor body and providing a restriction, a second pressure transmitting passage extending from said part-annular chamber to said auxiliary cylinder to permit the restricted escape of fluid pressure from said one end of said governor body to said auxiliary cylinder during a suction stroke of said pumping assembly, a third pressure transmitting passage extending from the pumping cylinder to open in said governor sleeve at a location such as to be closed by said governor body when in said end position, a fourth passage communicating with the exterior of said housing and opening to the interior of said governor passage at a location such as to be normally closed by said governor body when in said end position, and

11

a reduced diameter portion on said governor body at a location to place said third and fourth passages in communication with each other when said governor body is displaced from said end position by a predetermined distance.

12. A fuel injection pump according to claim 11 wherein said governor body is formed with an axial bore communicating with said one end of said governor body and a radial bore extending between said axial bore and the exterior of said governor body to open into said chamber when said governor body is displaced a further predetermined distance from said one end position.

13. A fuel injection pump according to claim 12 wherein said governor body is angularly adjustable in said governor passage and said housing is formed with a slot open to said governor passage and said chamber whereby the magnitude of said further predetermined distance is variable by varying the angular position of said governor body in said governor passage.

14. A fuel injection pump according to claim 11 wherein said governor body is disposed co-axially with said piston.

15. A fuel injection pump according to claim 11 wherein said governor body is disposed with its axis normal to that of said piston.

16. A fuel injection pump according to claim 11 wherein the piston is rotatable in said cylinder of said pumping assembly and is formed with an axial bore extending from one end of the piston and a radial bore opening to the exterior of the piston intermediate the length thereof and communicating with said axial bore and a plurality of injection passages opening to the interior of said pumping cylinder at equiangularly disposed locations so as to be placed sequentially in communication with said radial bore during successive pumping strokes of said piston, said injection passages opening to the exterior of said housing for communication with separate engine cylinders.

17. A fuel injection pump for an internal combustion engine comprising a cylinder, a piston reciprocable by said engine in said cylinder to provide 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 into said engine cylinder, a first fuel inlet opening to said pumping cylinder at a location blanked-off by said piston during a pumping stroke to define the

12

commencement of the period of injection of fuel into said engine cylinder, said period of injection commencing at the same point in each pumping stroke of said piston, a sleeve, a first passage extending from said cylinder to said sleeve, a second passage extending from said sleeve for communication with a low pressure fuel supply, a cylindrical governor body displaceable in said sleeve from an end position in which said governor body prevents communication between said first and second passages, said governor body having a reduced diameter portion whereby said first and second passages are placed in communication upon displacement of said governor body from said end position by a predetermined distance to terminate said injection period, a restriction afforded by a part-annular chamber defined between a cut-away portion of said governor body and the wall of said sleeve, spring means tending to oppose displacement of said governor body in said sleeve, fuel pressure generating means driven by said engine and communicating with said sleeve to expose one end of said governor body to a fuel pressure, at least during an injection stroke, the magnitude of which fuel pressure is a function of engine speed, non-return valve means interposed between said fuel pressure generating means and said sleeve preventing flow of fuel from said sleeve to said fuel pressure generating means, a third passage opening to said part-annular chamber for connection to said low pressure fuel supply to permit a restricted escape of fuel from said one end of the governor body to said low pressure supply, a fourth passages extending from the interior of said sleeve for communication with said low pressure supply and a fifth passage formed in said governor body extending from said one end thereof to open to the exterior thereof at a location closed by said sleeve when said governor body is in said end position and communicating with said fourth passage when said governor body is displaced by a predetermined distance from said end position to limit displacement of said governor body from said end position by said predetermined distance.

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