

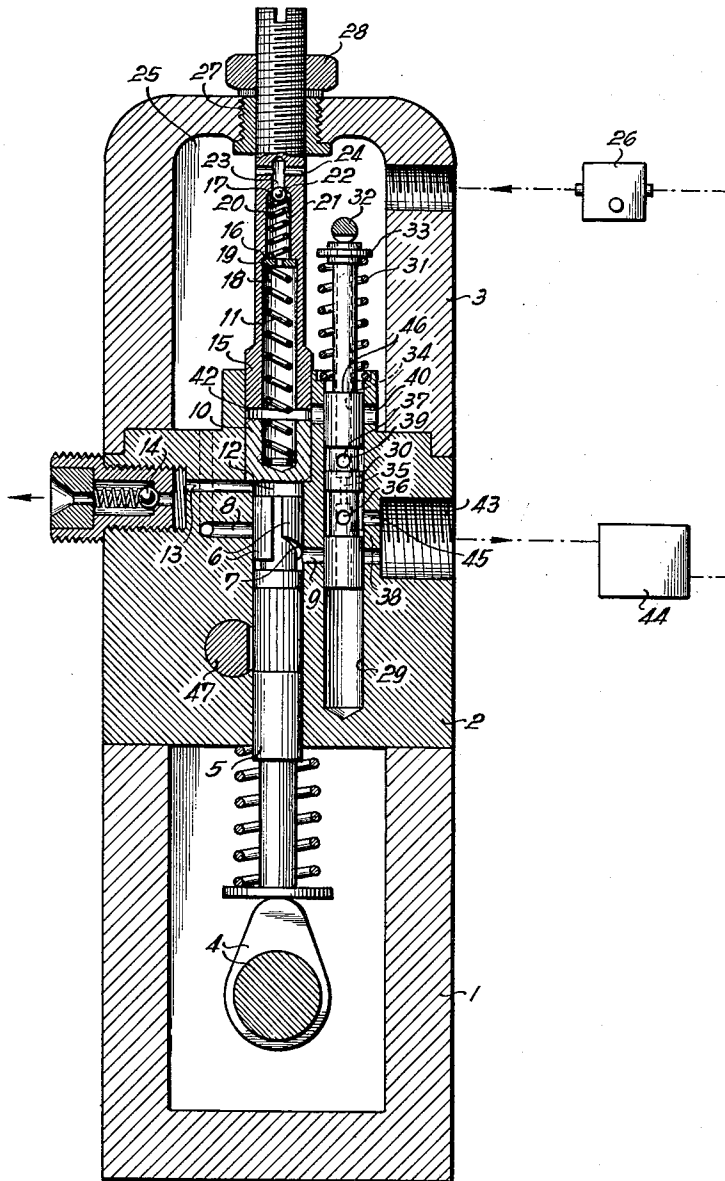
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INJECTION PUMP

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INJECTION PUMP

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The present invention relates to injection pumps for internal combustion engines.

With engines whose fuel is supplied by an injection pump, the injection pump is designed to deliver a certain maximum amount of fuel at full load. However, for starting purposes it is desirable to deliver to the engine an amount of fuel greater than that required under full load operating conditions, so that the engine may be easily started.

One of the objects of the present invention is to provide an injection pump with a means for automatically delivering to the engine, when the latter is being started, an amount of fuel greater than that received by the engine when the latter is operating at full load.

Another object of the present invention is to provide a fuel injection pump with a means for automatically decreasing, as the engine speed increases, the amount of fuel delivered from the pump to the engine.

A further object of the present invention is to provide a fuel injection pump with a convenient, easily operable adjusting means for adjusting the extent to which the amount of fuel, delivered from the pump to the engine, is changed with the automatic regulating means of the invention.

An additional object of the invention is to provide a structure which is capable of accomplishing the above objects and which at the same time is made up of simple and ruggedly constructed parts which are very reliable in operation and to which an easy access is provided for maintenance purposes.

With the above objects in view the present invention mainly consists of an injection pump for an internal combustion engine, this pump including a pump housing formed in its interior with a cylindrical bore and having in the pump housing means which form therein a fuel chamber separate from the cylindrical bore. A pump piston is slidable in the cylindrical bore, and a reciprocating means engages the pump piston to reciprocate the same between bottom and top dead center positions. A free piston is slidably mounted in the cylindrical bore for free movement therein and faces the head end of the pump piston so that the pistons define between themselves a pump chamber formed by that part of the cylindrical bore which is located between the pistons. A limiting means forms part of the housing and limits movement of the free piston toward the pump piston. A first passage means communicates with the fuel chamber and with a part of the pump chamber distant from the free piston for supplying fuel to the interior of the pump chamber when the pump piston moves in its suction stroke toward its bottom dead center position. A second passage means leads to a cylinder of the engine and communicates with a part of the pump chamber adjacent the free piston for delivering fuel from the pump chamber to the engine cylinder. A third passage means communicates with the fuel chamber and with a part of the bore located at the side of the free piston opposite from the pump piston so that the free piston is located between the third passage

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means and the pump chamber. A passage control means is carried by the housing at the third passage means thereof for automatically opening the third passage means to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases until at low engine speeds the third passage means is closed and the free piston cannot move away from the pump piston, while at relatively higher engine speeds the free piston may move away from the pump piston, displacing fuel through the third passage means into the fuel chamber, to reduce the amount of fuel moved by the pump piston through the second passage means to the engine cylinder.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

Referring now to the drawing, which is a sectional elevational view through an injection pump constructed in accordance with the present invention and which shows schematically apparatus for delivering fuel to and removing fuel from the injection pump, it will be seen that the injection pump of the invention includes a pump housing made up of housing parts 1, 2, and 3, part 2 being a block which extends across the interior of the pump housing. A cam shaft 4 is rotatable within the housing part 1 and engages the bottom end of a pump piston 5 which is slidable within a cylindrical bore passing through the block 2. The end of piston 5 which engages the cam shaft 4 is enlarged, and a spring is located about piston 5 and abuts against the block 2 and the bottom enlarged end of piston 5 to maintain the latter against the cam shaft 4. Thus, this spring and the cam shaft 4 form a means for reciprocating the piston 5 in the cylindrical bore of the block 2 between the top and bottom dead center positions of piston 5, this piston 5 being shown in the drawing in its top dead center position.

The block 2 forms with part 3 of the pump housing a fuel chamber 25 to which fuel is supplied by a pump 26 which is driven by the engine so that the speed of the pump 26 varies directly with the speed of the engine. A passage means 8, in the form of a bore in the block 2, leads from fuel chamber 25 to the interior of the cylindrical bore in which the pump piston 5 reciprocates. Thus, when the pump piston 5 moves down to its bottom dead center, the bottom right end of bore 8, as viewed in the drawing, will become uncovered and fuel will flow into the cylinder of block 2 which houses the piston 5 ahead of this piston to be moved by piston 5 during its pressure stroke. The piston 5 is provided with a control surface 6 formed with a groove extending axially along piston 5 from its head end and communicating with an annular groove extending about the piston 5 and defined in part by the helical edge 7. The block 2 is formed with a passage 9 leading from the cylinder of block 2 which houses piston 5 to the threaded bore 43 from which a conduit leads to a fuel tank 44, this tank 44 communicating through a suitable conduit with the suction side of pump 26. Thus, fuel ahead of the piston 5 will be moved thereby until edge 7 uncovers passage 9, and then the remaining fuel will flow through the passage 9 back to the tank 44. The piston 5 is formed with axially extending teeth which mesh with a manually operable rack 47, so that the operator by pushing or pulling rack 47 regulates the angular position of piston 5 so as to control the moment in the stroke of piston 5 at which the return flow passage 9 is uncovered by edge 7.

A free piston 10 is mounted for free sliding movement in the same bore of block 2 which houses the piston

5, and this bore has a larger cross section at the part thereof which houses the free piston 10 so that the block 2 is provided with a shoulder forming a limiting means which limits the movement of the free piston 10 toward the pump piston 5, these pistons forming between themselves a pump chamber 12 which is in communication with a discharge passage means 13 communicating with pump chamber 12 at a part thereof adjacent the free piston 10. Thus, fuel in the chamber 12 will be moved, during the pressure stroke of piston 5 and before passage 9 is uncovered, through the passage means 13 and through a non-return valve 14 to an engine cylinder. A spring 11 engages the free piston 10 and urges the latter to its illustrated position where it is located against the shoulder and is nearest to the pump piston 5.

As the pump piston 5 moves in its pressure stroke the fuel in pump chamber 12 tends to move free piston 10 against the influence of spring 11 away from pump piston 5, and this latter movement of free piston 10 is limited by an elongated stop member 15 extending into the bore of block 2 which houses the free piston 10. The housing part 3 is formed in its top wall with a threaded bore which threadedly carries a tubular member 27 formed in its interior with threads in threaded engagement with outer threads on the top end portion of stop member 15 which extends through the member 27 to the exterior of the pump, the top free end of the stop member 15 being provided with a slot to receive a screw driver or the like so that the operator may turn stop member 15 to adjust the distance between the stop member and the free piston 10 when the latter is in the position shown in the drawing so as to regulate the extent to which the free piston 10 can move away from the pump piston 5, a stop nut 28 being in threaded engagement with the member 15 and engaging member 27 to lock stop member 15 in its adjusted position. The member 15 makes a fairly tight fit with the bore of block 2 which houses the free piston 10 so that there can be no leakage past the stop member 15 into or out of the block 2.

The elongated stop member 15 is formed in its interior with an axially extending bore having a portion 18 of relatively large cross section into which spring 11 extends, an intermediate portion 21 of a smaller cross section than portion 18 and forming a shoulder 16 therewith, and a top portion 23 smaller in cross section than portion 21 and forming a shoulder 17 therewith, the stop member 15 being provided with a cross bore 24 communicating with bore portion 23 and fuel chamber 25. A plate 19 formed with a central aperture is located against shoulder 16, and spring 11 abuts against the bottom face of plate 19, a spring 20 abutting against the top face of plate 19, extending along bore portion 21, and urging a ball valve member 22 against shoulder 17 to close bore portion 23, elements 17, 22, and 21 forming a non-return valve means allowing fuel to flow from chamber 25 into chamber 42, between stop 15 and free piston 10, when the pressure on the downstream side of ball valve 22 is less than the fuel pressure in chamber 25 by an amount greater than the force of spring 20.

The block 2 is further formed with an elongated bore 29 parallel to pump piston 25, and an elongated control member 30, forming a passage control means as will be pointed out below, is slidable within the bore 29. A spring 31 is located about an upper portion of member 30, abuts with its bottom end against block 2, and engages with its top end a washer 33 or the like fixed to the control member 30 so that the spring 31 urges the control member 30 upwardly, as viewed in the drawing, to the position shown in the drawing where the control member 30 engages a stop 32 fixed in the housing of the pump and limiting the upper movement of control member 30. This control member 30 is formed with an axially extending bore 34 having inter-

mediate its ends a throttling portion 35 of reduced cross section; and it will be seen that the stop member 32 is cut away at that portion thereof which overlies the top end of bore 34 so that this bore is in free communication with chamber 25 at all times. The control member 30 is further formed with a pair of cross bores 36 and 37 respectively located on opposite sides of the bore portion 35 and respectively leading into annular grooves 38 and 39 formed in the control member 30.

A passage means 40 is formed in the block 2, extends across the bore 29, communicates with the bore which houses free piston 10 and stop 15, and communicates with the fuel chamber 25, the chamber 42, on the side of free piston 10 opposite from pump piston 5, thus communicating with passage means 40. The return flow passage 9 also is intersected by the bore 29, and a further bore 45 is formed in the block 2 and provides communication between bore 29 and the opening 43 which leads to tank 44.

When the engine is started up, the control member 30 is located in the position illustrated in the drawing. At the very low speeds of the engine, when it is starting, the fuel supply pump 26 supplies such a small amount of fuel to the fuel chamber 25, that the throttled portion 35 of the bore 34 does not cause the pressure in the fuel chamber 25 to increase by an amount sufficient to cause the control member 30 to move downwardly, as viewed in the drawing, against the influence of the spring 31. At this time the passage 9 as well as the passage 40 are closed by the control member 30 which extends across these passages in the manner shown in the drawing. The chambers 18 and 21 of stop member 15 as well as the chamber 42 are filled with fuel which is supplied to these chambers from chamber 25 through the non-return valve 22. As long as control member 30 closes passage 40 the free piston 10 cannot move into the chamber 42 from the position shown in the drawing since fuel cannot be displaced from chamber 42 through the passage 40. Whatever fuel is lost from chamber 42 by leakage at this time is immediately made up by fuel flowing into the chamber 42 through the valve 22. Thus, at the time when the engine is started the piston pump 5 must supply a full measure of fuel to the engine, since with the control member 30 in the illustrated position both passage 40 and passage 9 are closed and the fuel supplied through inlet 8 to the pump chamber is necessarily moved to the passage 13 during the entire pressure stroke of the piston pump. Therefore, at the low starting speeds of the engine a relatively large amount of fuel is supplied thereto. This large supply of fuel is in many cases desirable and of great advantage for starting purposes. The fuel which flows through the passage 34 in control member 30, and thus through the throttled portion 35 thereof, flows through the cross bore 36 into the annular groove 38 and from the latter through the bore 45 into the opening 43 from where the fuel flows back to the tank 44.

As soon as the engine speed has increased substantially above the starting speed thereof, the pressure of the fuel in chamber 25 increases. This pressure increases because the fuel supply pump 26, driven by the engine, also increases in speed and delivers a greater amount of fuel to the chamber 45 within a given period of time so that the result is that the chamber 25 receives fuel at a rate which is greater than the greatest possible rate of flow of fuel through the throttled portion 35 of the bore 34. As a result of the increase in pressure in chamber 25 the control member 30 begins to move downwardly, as viewed in the drawing, against the influence of the spring 31 at least through a distance sufficient to cause the edge 46 of control member 30 to uncover passage 40 at least partly and thus control the extent of flow of fuel there-through from chamber 42 to chamber 25. At the same

time the downward movement of control member 31 causes the annular groove 38 to overlap passage 9 and open the latter to the discharge opening 43. The position of control member 30 is thus dependent on the speed of the engine.

At this time the pressure produced on the fuel in pump chamber 12 by piston 5, during the pressure stroke of the latter, causes the free piston 10 to move into the chamber 42 until the free piston 10 engages the stop 15, and in this way the free piston 10 displaces fuel from chamber 42 through passage 40 into the chamber 25. The supply of fuel to the cylinder of the engine thus starts at this time only after the free piston 10 has engaged the stop 15 and ends when the edge 7 of the piston 5 uncovers the return flow passage 9. Therefore, the maximum amount of fuel delivered to the engine during its normal operation, after the starting period, is determined by the position of stop 15. The best possible position of stop 15 may be determined by test for each engine, and the lock nut 28 maintains stop 15 in its adjusted position.

A change in the fuel supplied during operation, and therefore a change in the output of the engine, is obtained by turning the pump piston through shifting of the rack 47. Thus, in accordance with the angular position of piston 5 the edge 7 will uncover the return flow passage 9 at a predetermined moment during the pressure stroke of the piston.

Inasmuch as the fuel supply pump 26 supplies to the chamber 25 more fuel than is ever taken from the chamber 25 during normal operation of the engine, the pressure in the chamber 25 increases during such operation. During such an increase in pressure the control member 30 is moved further against the influence of spring 31 until the annular groove 39 overlaps the opening 45 so that the excess amount of fuel supplied to chamber 25 from the fuel supply pump 26 may freely flow back to the tank 44 without first passing through the throttled portion 35 of the bore 34.

It is possible to connect a distributor to the injection pump illustrated in the drawing, so that this pump can be used to supply fuel to a multi-cylinder engine.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of injection pumps differing from the types described above.

While the invention has been illustrated and described as embodied in automatically controlled injection pumps, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An injection pump for an internal combustion engine, comprising, in combination, a pump housing formed in its interior with a cylindrical bore; means in said pump housing forming therein a fuel chamber separate from said cylindrical bore, said fuel chamber being adapted to be supplied with fuel by a fuel supply means which supplies fuel at a rate proportional to the speed of an engine to which the injection pump is adapted to be operatively connected; a pump piston slidable in said cylindrical bore; reciprocating means engaging said pump piston to reciprocate the same between bottom and top dead center positions; a free piston slidably mounted in said cylindrical bore for free movement therein and facing the head end

of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said cylindrical bore located between said pistons; limiting means forming part of said housing and limiting movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber; and passage control means carried by said housing at said third passage means thereof and adapted to cooperate with said fuel supply means for automatically opening said third passage means, when the injection pump is connected to an engine, to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases until at low engine speeds said third passage means is closed and said free piston cannot move away from said pump piston while at relatively higher engine speeds said free piston may move away from said pump piston, displacing fuel through said third passage means into said fuel chamber, to reduce the amount of fuel moved by said pump piston through said second passage means to the engine cylinder.

2. An injection pump for an internal combustion engine, comprising, in combination, a pump housing formed in its interior with a cylindrical bore; means in said pump housing forming therein a fuel chamber separate from said cylindrical bore, said fuel chamber being adapted to be supplied with fuel by a fuel supply means which supplies fuel at a rate proportional to the speed of an engine to which the injection pump is adapted to be operatively connected; a pump piston slidable in said cylindrical bore; reciprocating means engaging said pump piston to reciprocate the same between bottom and top dead center positions; a free piston slidably mounted in said cylindrical bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said cylindrical bore located between said pistons; limiting means forming part of said housing and limiting movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chambers; passage control means carried by said housing at said third passage means thereof and adapted to cooperate with said fuel supply means for automatically opening said third passage means, when the injection pump is connected to an engine, to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases until at low engine speeds said third passage means is closed and said free piston cannot move away from said pump piston while at relatively higher engine speeds said free piston may move away from said pump piston, displacing fuel

through said third passage means into said fuel chamber, to reduce the amount of fuel moved by said pump piston through said second passage means to the engine cylinder; and stop means carried by said housing and located in said bore at the side of said free piston opposite from said pump piston to limit movement of said free piston away from said pump piston.

3. An injection pump for an internal combustion engine, comprising, in combination, a pump housing formed in its interior with a cylindrical bore; means in said pump housing forming therein a fuel chamber separate from said cylindrical bore, said fuel chamber being adapted to be supplied with fuel by a fuel supply means which supplies fuel at a rate proportional to the speed of an engine to which the injection pump is adapted to be operatively connected; a pump piston slidable in said cylindrical bore; reciprocating means engaging said pump piston to reciprocate the same between bottom and top dead center positions; a free piston slidably mounted in said cylindrical bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said cylindrical bore located between said pistons; limiting means forming part of said housing and limiting movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber; passage control means carried by said housing at said third passage means thereof and adapted to cooperate with said fuel supply means for automatically opening said third passage means, when the injection pump is connected to an engine, to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases until at low engine speeds said third passage means is closed and said free piston cannot move away from said pump piston while at relatively higher engine speeds said free piston may move away from said pump piston, displacing fuel through said third passage means into said fuel chamber, to reduce the amount of fuel moved by said pump piston through said second passage means to the engine cylinder; stop means carried by said housing and located in said bore at the side of said free piston opposite from said pump piston to limit movement of said free piston away from said pump piston; and adjusting means operatively connected to said stop means for adjusting the position of the latter in said cylindrical bore so as to regulate the extent to which said free piston may be moved away from said pump piston.

4. A device for controlling the feeding of fuel to an internal combustion engine comprising, in combination, an injection pump housing formed in its interior with a pair of elongated bores; means in said pump housing forming therein a fuel chamber separate from one of said bores; a pump piston slidable in said one bore; reciprocating means engaging said pump piston to reciprocate the same in said one bore between bottom and top dead center positions; a free piston slidable in said one bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said one bore located between said pistons; limiting means forming part of said housing and limiting the movement of said free piston toward said pump piston; first passage means com-

municating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said one bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber; said third passage means extending across and being intersected by the other of said bores; an elongated control member slidable in said other bore for movement to and from a position extending across and closing said third passage means; said control member having a transverse surface communicating with said fuel chamber to be acted on by fuel under pressure in said chamber so that the fuel under pressure tends to move said control member from its position closing said third passage means; spring means engaging said control member and urging the same to its position closing said third passage means; and a fuel supply pump communicating with said fuel chamber and adapted to be connected to an engine to be driven thereby so that when said fuel supply pump and said injection pump are operatively connected to an engine, as the engine speed increases the fuel supply pump tends to deliver an increasing amount of fuel to said fuel chamber to increase the pressure therein and move said control member against the influence of said spring means away from its closed position, whereby said third passage means is opened to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases.

5. A device for controlling the feeding of fuel to an internal combustion engine comprising, in combination, an injection pump housing formed in its interior with a pair of elongated bores; means in said pump housing forming therein a fuel chamber separate from one of said bores; a pump piston slidable in said one bore; reciprocating means engaging said pump piston to reciprocate the same in said one bore between bottom and top dead center positions; a free piston slidable in said one bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said one bore located between said pistons; limiting means forming part of said housing and limiting the movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said one bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber; said third passage means extending across and being intersected by the other of said bores; an elongated control member slidable in said other bore for movement to and from a position extending across and closing said third passage means; said control member having a transverse surface communicating with said fuel chamber to be acted on by fuel under pressure in said chamber so that the fuel under pressure tends to move said control member from its position closing said third passage means; spring means engaging said control member and urging the same to its position closing

said third passage means; a fuel supply pump communicating with said fuel chamber and adapted to be connected to an engine to be driven thereby so that as the engine speed increases the fuel supply pump tends to deliver an increasing amount of fuel to said fuel chamber to increase the pressure therein and move said control member against the influence of said spring means away from its closed position, whereby said third passage means is opened to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases; and fourth passage means leading from said fuel chamber back to said fuel supply pump and having a throttling portion of reduced cross section which is small enough to allow the fuel to flow freely back toward the fuel supply pump, when the latter and said injection pump are operatively connected to an engine, only at engine speeds which are lower than the idling speed of the engine.

6. A device for controlling the feeding of fuel to an internal combustion engine comprising, in combination, an injection pump housing formed in its interior with a pair of elongated bores; means in said pump housing forming therein a fuel chamber separate from one of said bores; a pump piston slidable in said one bore; reciprocating means engaging said pump piston to reciprocate the same in said one bore between bottom and top dead center positions; a free piston slidable in said one bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said one bore located between said pistons; limiting means forming part of said housing and limiting the movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said one bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber, said third passage means extending across and being intersected by the other of said bores; an elongated control member slidable in said other bore for movement to and from a position extending across and closing said third passage means, said control member having a transverse surface communicating with said fuel chamber to be acted on by fuel under pressure in said chamber so that the fuel under pressure tends to move said control member from its position closing said third passage means; spring means engaging said control member and urging the same to its position closing said third passage means; a fuel supply pump communicating with said fuel chamber and adapted to be connected to an engine to be driven thereby so that as the engine speed increases the fuel supply pump tends to deliver an increasing amount of fuel to said fuel chamber to increase the pressure therein and move said control member against the influence of said spring means away from its closed position, whereby said third passage means is opened to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases; and fourth passage means leading from said fuel chamber back to said fuel supply pump and having a throttling portion of reduced cross section which is small enough to allow the fuel to flow freely back toward the fuel supply pump, when the latter and said injection pump are operatively connected to an engine, only at engine speeds which are lower than the idling speed of the engine, said fourth passage means having a first portion communicating with said other bore and

a second portion extending along the interior of said elongated control member, and said throttling portion of said fourth passage means being located within said control member.

7. An injection pump for an internal combustion engine, comprising, in combination, a pump housing formed in its interior with a cylindrical bore; means in said pump housing forming therein a fuel chamber separate from said cylindrical bore, said fuel chamber being adapted to be supplied with fuel by a fuel supply means which supplies fuel at a rate proportional to the speed of an engine to which the injection pump is adapted to be operatively connected; a pump piston slidable in said cylindrical bore; reciprocating means engaging said pump piston to reciprocate the same between bottom and top dead center positions; a free piston slidably mounted in said cylindrical bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said cylindrical bore located between said pistons; limiting means forming part of said housing and limiting movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber; fourth passage means communicating with the interior of said fuel chamber and with said part of said bore located at the side of said free piston opposite from said pump piston; pressure-operated non-return valve means located in said fourth passage means for allowing fuel to flow from said fuel chamber along said fourth passage means into said bore whenever the difference in pressures on opposite sides of said non-return valve opens the latter; and passage control means carried by said housing at said third passage means thereof and adapted to cooperate with said fuel supply means for automatically opening said third passage means, when the injection pump is connected to an engine, to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases until at low engine speeds said third passage means is closed and said free piston cannot move away from said pump piston while at relatively higher engine speeds said free piston may move away from said pump piston, displacing fuel through said third passage means into said fuel chamber, to reduce the amount of fuel moved by said pump piston through said second passage means to the engine cylinder.

8. A device for controlling the feeding of fuel to an internal combustion engine comprising, in combination, an injection pump housing formed in its interior with a pair of elongated bores; means in said pump housing forming therein a fuel chamber separate from one of said bores; a pump piston slidable in said one bore; reciprocating means engaging said pump piston to reciprocate the same in said one bore between bottom and top dead center positions; a free piston slidable in said one bore for free movement therein and facing the head end of said pump piston so that said pistons define between themselves a pump chamber formed by that part of said one bore located between said pistons; limiting means forming part of said housing and limiting the movement of said free piston toward said pump piston; first passage means communicating with said fuel chamber and with a part of said pump chamber distant from said free piston

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for supplying fuel to the interior of said pump chamber when said pump piston moves in its suction stroke toward its bottom dead center position; second passage means adapted to lead to a cylinder of an engine and communicating with a part of said pump chamber adjacent said free piston for delivering fuel from said pump chamber and adapted to convey the fuel to the engine cylinder; third passage means communicating with said fuel chamber and with a part of said one bore located at the side of said free piston opposite from said pump piston so that said free piston is located between said third passage means and said pump chamber, said third passage means extending across and being intersected by the other of said bores; an elongated control member slidable in said other bore for movement to and from a position extending across and closing said third passage means, said control member having a transverse surface communicating with said fuel chamber to be acted on by fuel under pressure in said chamber so that the fuel under pressure tends to move said control member from its position clos-

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ing said third passage means; spring means engaging said control member and urging the same to its position closing said third passage means; a fuel supply pump communicating with said fuel chamber and adapted to be connected to an engine to be driven thereby so that as the engine speed increases the fuel supply pump tends to deliver an increasing amount of fuel to said fuel chamber to increase the pressure therein and move said control member against the influence of said spring means away from its closed position, whereby said third passage means is opened to an increasing extent as the engine speed increases and to a decreasing extent as the engine speed decreases; and fourth passage means leading from said one bore back to said fuel supply pump, extending across said other bore, and said control member having a portion extending across and closing said fourth passage means when said control member closes said third passage means.

No references cited.