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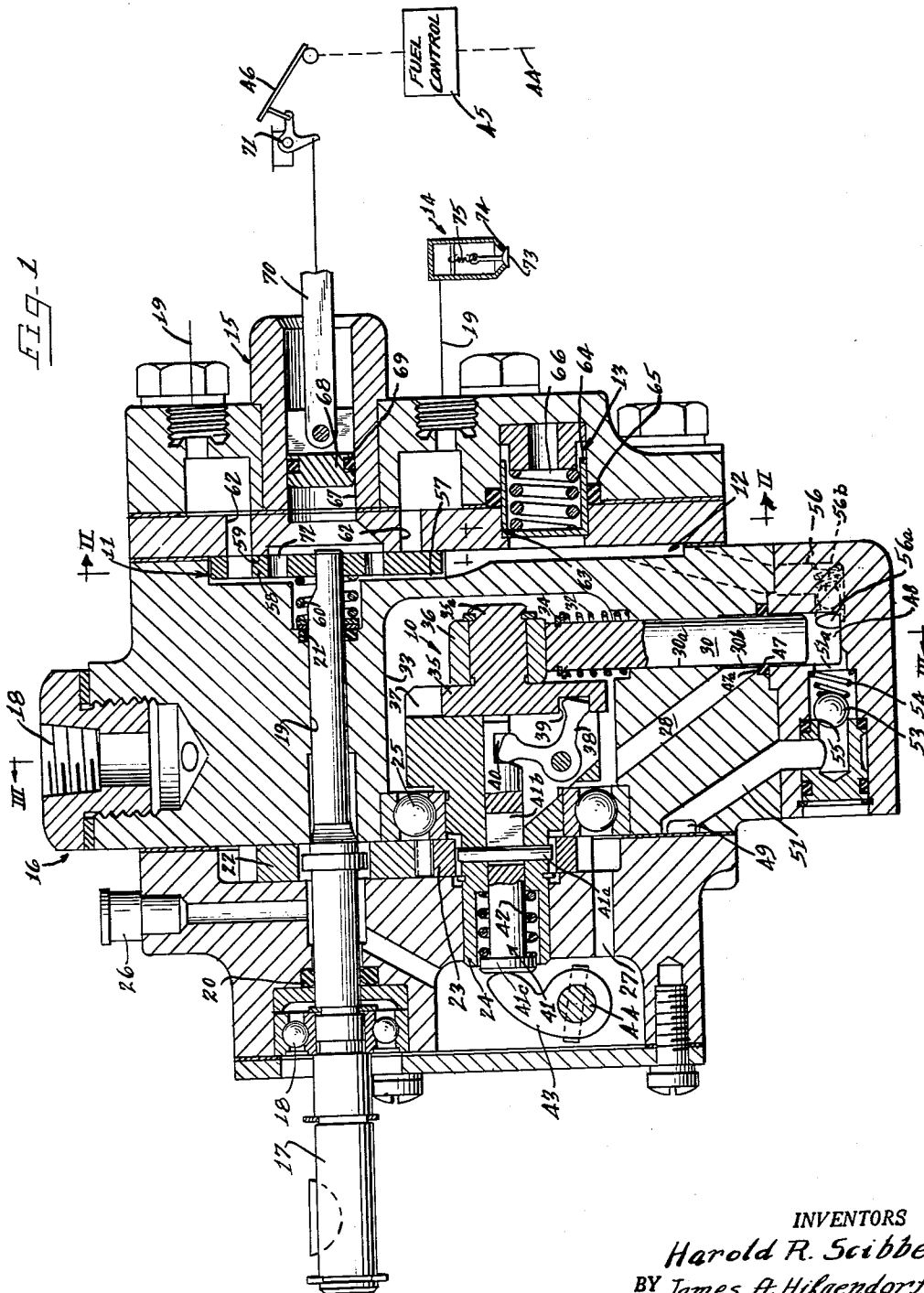
H. R. SCIBBE ET AL

3,079,904

FUEL DISTRIBUTOR WITH ACCELERATION ENRICHMENT

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2

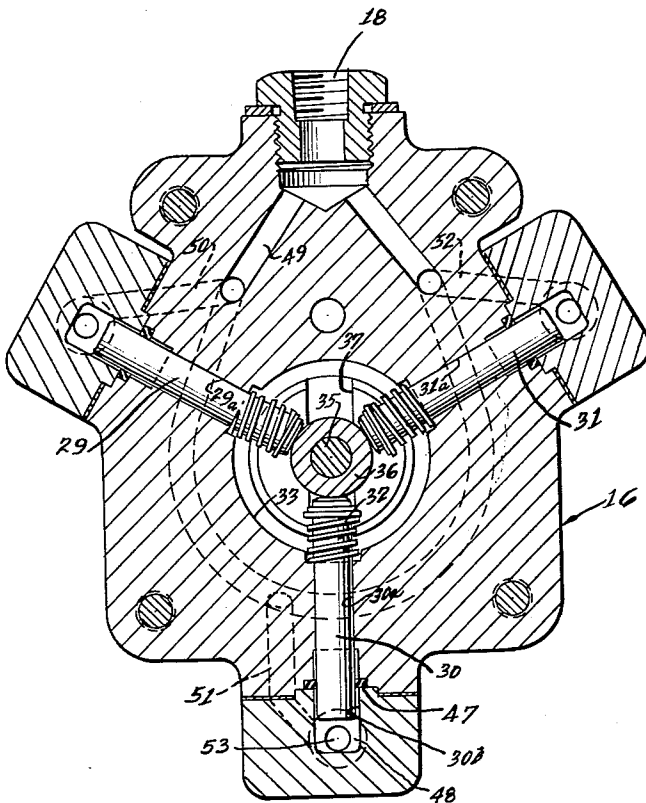
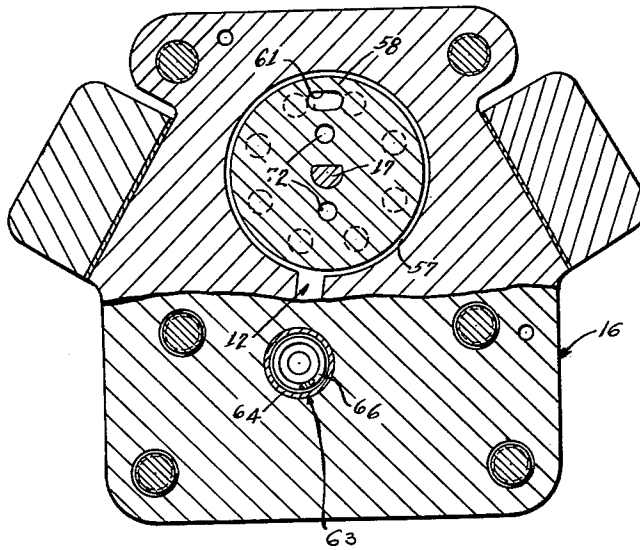


Fig 3

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3,079,904 FUEL DISTRIBUTOR WITH ACCELERATION ENRICHMENT

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This invention relates to a fuel injection system for high speed, four cycle, spark ignition internal combustion engines and is particularly concerned with a method and mechanism for increasing the fuel delivered to the engine during periods of acceleration.

In an embodiment of the invention fuel is delivered from a variable output metering pump such as that having a plurality of pistons operating at a variable stroke. The pump delivers to a distributor which provides for periodic releases of the fuel to lines leading to fuel injectors. In a conduit means between the pump and the distributor is connected an accumulator chamber which has a movable wall biased to discharge to the distributor for each fuel release and to accumulate fuel from the metering pump between releases. An acceleration enrichment chamber is also connected to communicate with the conduit means between the pump and accumulator and to be filled with fuel from the pump and be emptied to supply its fuel to the distributor for increasing the fuel delivered by the distributor during periods of acceleration of the engine. In automobile operation the enrichment chamber is connected to the accelerator pedal of the automobile to enrich the fuel delivery during acceleration.

It is a general object of the invention to provide an improved fuel delivery system for an engine supplied with fuel through injectors.

A further object of the invention is to provide an improved fuel injection system employing a pump having a pulsating output wherein the pulsations are smoothed and a uniform delivery of fuel to the engine is accomplished by delivering equal and uniform quantities of fuel to each engine cylinder for each release of a distributor which receives the delivery from the pump.

A further object of the invention is to provide a mechanism for enriching the fuel delivered to an engine during acceleration periods by storing fuel delivered from the pump and selectively delivering this stored fuel to the distributor such as during acceleration.

A further object of the invention is to provide an improved acceleration enrichment mechanism for a fuel injector system which enhances the response of the engine without adding to the flow rate as controlled by a variable displacement pump and therefore without sacrifice to the general fuel economy.

A still further object of the invention is to provide a pump and distributor for delivering fuel to an injector supplied engine with an accumulator between the pump and distributor which has a complete discharge for each release of fuel by the distributor and which is constructed so that air or fuel vapor can be readily purged and are not trapped in the accumulator to detract from its operation.

Other objects and advantages will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiment thereof in the specification, claims and drawings, in which:

FIGURE 1 is a sectional view taken through the center of a fuel supplying mechanism in accordance with the principles of the present invention, for delivering fuel to an injector supplied engine;

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FIGURE 2 is a vertical sectional line taken substantially along line II—II of FIGURE 1; and

FIGURE 3 is a vertical sectional view taken substantially along line III—III of FIGURE 1.

As shown on the drawings:

FIGURE 1 illustrates a mechanism having a pump 10 with a variable delivery for pumping fuel. The fuel flows to a distributor 11 which at intermittent periodic intervals releases the pumped fuel to individual fuel injectors 14 which supply an internal combustion engine. The fuel flows from the pump to the distributor through a conduit means 12 and communicating with the conduit means is an accumulator 13 which collects the fuel from the pump between distributor releases and completely discharges its collected fuel during the periods of distributor release.

Also communicating with the conduit means 12 is an enrichment device 15 which is filled with fuel from the metering pump 10 and selectively discharges this fuel to the distributor 11 when the engine is accelerated.

The metering pump 10 and distributor 11 are incorporated in a unit housing 16 made up of parts which are suitably clamped together such as by cap screws or bolts with the parts having gaskets therebetween. These parts need not be described in detail inasmuch as their construction will be apparent from the drawings and the entity may be generally referred to as the housing 16. The housing is adapted to be suitably mounted on an engine to be driven thereby such as by being connected to the timing shaft. The mechanism has a distributor shaft 17 which is driven at one half the speed of an engine to which fuel is delivered so that in a four cycle engine the distributor 11 will release fuel once for one injection per four stroke cycle of the typical multicylinder engine.

Fuel is received through a line connected to a fuel intake opening 18 in the housing 16 and usually fuel being delivered to the apparatus from a fuel tank by a supply pump so that the intake 18 will receive pressurized fuel. The distributor is connected to individual fuel lines 19a which lead to the injectors 14.

The metering pump 10 is driven from the distributor shaft 17 which is supported in the housing 16 in a ball bearing assembly 18 and a cylindrical bearing surface 19. A circular sealing ring 20 is positioned around the shaft in the housing to prevent the escape of lubricant and a ring 21 is also positioned around the shaft to prevent the escape of fuel from the distributor 11, as will later be described.

The pump 10 is driven by a gear 22 on the shaft 17 driving a gear 23 pinned to the pump shaft 24 which is supported in a ball bearing assembly 25.

The ratio of the gear 22 on the shaft 17 to the gear 23 on the pump shaft is preferably one which cannot be expressed exactly in whole numbers, such as 23/30 or 30/23; 25/28 or 28/25; 20/33 or 33/20. Inasmuch as the pump is a piston type, such fractional gear ratios will preclude the possibility of any one piston consistently delivering fuel through the same port of the distributor and hence to the same engine cylinder. If small differences exist between the pistons, piston chambers, piston stroke links or seals of the pumping element a slight inequality of fuel delivery may occur between pistons and this will not consistently result in the inequality being reflected in the fuel delivered to one or more engine cylinders but will move through the sequential injections to all of the cylinders. For example, engine failures due to consistently lean mixtures on one cylinder of the engine are prevented. While excessively rich or lean injections could occur due to manufacturing differences, these conditions will move through all of the cylinders of the multicylinder engine,

The bearing 25 for the pump shaft 24 and the pump pistons are lubricated through a lubrication connection 26 in the housing and lubricant flows through suitable passages through a passage 27 to the bearing 25 and through passages such as 28 leading to the individual pump pistons and their seals. Lubricant is also delivered to the hollow chamber 33 which contains the mechanism for driving the pump pistons.

As shown in FIGURES 1 and 3, the pump is provided with three radially extending pistons 29, 30 and 31 slidably supported in radially bored cylinders 29a, 30a and 31a in the housing 16. An odd number of pistons are provided and a greater number may be employed if desired retaining an odd number. The pistons are movable radially outwardly in a discharge stroke and radially inwardly in an intake stroke and are urged inwardly by springs such as 32 surrounding the inner ends of the pistons and seated in annular recesses in the wall of the chamber 31. Split snap rings 34 seat in annular grooves in the pistons to hold washers against which the springs engage. Inasmuch as the construction of each piston is the same, the arrangement of the piston 30 only need be described in detail.

The pistons are driven by a head 35 eccentrically carried at the lower end of the pump shaft 24. The head 35 rotatably supports a roller 36 which is rotatably mounted on a stud 35a on the head and the roller 36 rolls on the stud to reduce friction between the roller and pistons.

The head 35 is carried in a radially extending supporting slot 37 on the shaft 24 and its eccentricity with respect to the axis of the shaft is controllable by a bell crank 38 supported on the shaft. The lower arm of the bell crank is held in a recess 39 in the head 35 and the upper arm of the bell crank 39 is received in a recess 40 in a plunger 41 coaxially carried in the hollow center of the pump shaft 24. A cross pin 41a extends across through an axially elongated slot 41b in the plunger 41 and the pin 41a is mounted in the shaft 24. This pin 41a also functions to lock the gear 23 to the pump shaft. A spring 42 in an axially extending recess in the end of the shaft 24 engages the underside of an enlarged head 41c of the plunger 41 to urge it to the left, as shown in FIGURE 1. This tends to move the head 35 to increase the eccentricity thereof and increase the pump delivery. The action of the spring 42 is resisted by an arm 43 bearing on the upper end of the head of the plunger 41 and mounted on a shaft 44. The shaft 44 is connected to the fuel control mechanism shown schematically at 45.

The fuel control mechanism 45 will determine the displacement and output of the metering pump 10 and is operated in accordance with various factors of engine conditions such as the intake manifold pressure and engine temperature. A manual input signal is also provided by an accelerator shown schematically at 46.

Each of the pump plungers are sealed by an O-ring 47 in an annular groove 47a in the housing. The width of the groove in an axial direction is greater than the cross sectional diameter of the O-ring. The inner diameter of the elastic O-ring is slightly greater than the diameter of the piston 30 and the outer diameter of the O-ring is slightly greater than the diameter of the base of the groove 47a. When assembled, the radial compression of the outer diameter of the elastic O-ring forces the inner diameter of the ring to contact the cylindrical piston surface. Dimensions of the O-ring, O-ring groove, and piston are so designed that contact of the inner diameter of the O-ring with the piston is sufficient to seal against the fluid fuel pressure but light enough to prevent excessive friction during reciprocation of the piston within the seal. The cylindrical bore or cylinder 30a in which the piston slides is relieved at its outer end so as to be of a slightly larger size than the inner end to thereby prevent scratching of the piston at the location where the piston slides through the O-ring 47. This insures that the piston will retain its finish at that location and not wear the

O-ring but retain a good seal. Lubricant enters the cylinder 30a behind the O-ring seal.

As shown in FIGURES 1 and 3, the fuel enters the intake 18 of the housing and flows through a passage 49 that forms a loop. Off this loop are branch passages 50, 51 and 52 for supplying pumping chambers 48 at the end of the pump pistons. Fuel intake into the pump pistons. Fuel intake into the pump chambers 48 flows through an intake port 51a past a check valve having a ball check 53 held by a spring 54 against a seat 55 so as to close the intake passage when the pump piston moves outwardly. Flow out of the pumping chamber 48 is through a port 56a past a ball check valve 56b which closes during the intake stroke of the piston. The ball valves 53 and 56b may also be rubber disc check valves.

Delivery from the pumping chamber 48 is through a passage 56 leading up into a chamber 57 in which is located a distributor plate 58. The passage 56 and the chamber 57 constitute the conduit means leading from the pump discharge to the distributor.

It is to be noted that the pumping chamber receives fluid through the port 51a and delivers fluid through the port 56a. These ports and the passageways connected thereto are arranged so that fluid flow through the pumping chamber 48 is in an upward direction thus facilitating the escape flow of fluid vapor and entrained air through the chamber. All of the fluid passages in the pump are designed to prevent the trapping of fuel vapor or entrained air in the pumping elements. This makes the pump self-purging of vapor and air and greatly reduces the number of pump revolutions required to purge a vapor locked pump.

As shown in FIGURES 1 and 2, a distributor plate 58 has a flat smooth undersurface which sealingly slides against a surface 59 in the chamber 57 and is held downwardly by a spring 60 and is driven by the shaft 17. Below the distributor plate 58 in the stationary housing part are a series of evenly spaced circumferentially arranged relief ports 62 which conduct fuel each time an elongated port 61 in the distributor plate 58 passes over them. This intermittently at even intervals relieves the fluid fuel from the distributor chamber 57 and the fuel sequentially flows out through the lines 19 to the individual injectors 14.

The accumulator 13 which is in communication with the conduit means 12 between the pump and distributor has an expansible chamber in the form of a cylinder 63 in which is located a piston 64. The piston is spring loaded by a spring 66 which urges the piston 64 in a direction to discharge the fuel from the chamber 63. An annular piston seal 65 surrounds the piston.

The spring 66 has a natural frequency greater than the accumulator exciting frequency, namely the opening and closing of the successive distributor ports. The accumulator thus empties itself for each release of the distributor.

The accumulator 13 is located below the distributor chamber and in a position so that air or fuel vapor cannot be trapped. The cylinder 63 is shown in a horizontal position below the distributor.

Also in communication with the distributor chamber 57, or in other words, in communication with the conduit means 12 between the pump and distributor, is an accelerator chamber shown in the form of an elongated cylinder 67. The chamber 67 communicates with the distributor chamber 57 through openings 72 through the distributor plate. Within the chamber 67 is a piston 68 having a piston ring 69. The piston is mounted on a piston rod 70 suitably connected to a bell crank 71 which in turn is connected to the accelerator 46.

Movements of the accelerator pedal 46 to decelerate allow the chamber 67 to fill from fuel delivered by the pump 10. As the accelerator 46 is moved in an accelerating direction, the piston 68 will force fuel out of the chamber 67 through the openings 72 which will cause the distributor to deliver an increased quantity of fuel to the engine. The distributor plate 58 is held down against its

smooth surface 59 by a coil spring 60 and the flow of fuel through the passages 72 has no effect on the normal operation of the distributor.

The use of this accelerator chamber 67 enhances the response of the engine to movements of the accelerator pedal 46 without adding to the flow rate through the variable displacement pump 10. This therefore occurs without sacrifice to the general fuel economy. It is also to be noted that as the accelerator is released, the variable chamber 67 provides an escape chamber for the fuel in the distributor thereby enhancing the rapid cut-off of fuel supplied to the engine as the accelerator is released to prevent delivering an over enriched fuel mixture to the engine and consequent smoking and increase in smog effects.

The accelerator cylinder 67 is preferably slightly smaller in diameter than the accumulator cylinder 63 but the piston 68 has a greater axial movement than the accumulator piston 64.

While the fuel injection nozzles may be of various designs, the nozzle 14 is shown schematically as including an injection opening 74 against which seats a valve member 73 held against the opening by a tension spring 75. The tension spring 75 is such that it opens at a lower fuel pressure than that required to depress the accumulator spring 66. Thus with the accumulator discharge pressure being greater than the injector nozzle opening pressure, the injector will open as soon as the distributor 11 releases the fuel and will stay open during the time the accumulator piston 64 is emptying the accumulator chamber and during the time the distributor ports are in alignment.

As a brief summary of operation, the power or distributor shaft 17 is driven from the engine to provide a fuel release for each fuel intake stroke of the engine, and through the gears 22 and 23 drives the pump 10. The delivery of the pump is varied by the arm 43 pushing down on the plunger 41 which determines the eccentricity of the head 35 and the stroke of the pump pistons 29, 30 and 31. Fuel flows in through the intake 18 past the intake check valve 53 on the intake stroke of the piston 30 and a check valve 56b, FIGURE 1, closes off the delivery passage 56. On the delivery stroke of the piston fuel flows through the passage 56 to the distributor chamber 57. As the distributor plate 58 rotates quantities of fuel are intermittently released as the port 61 successively aligns itself with the ports 62. The accumulator chamber 63 receives fuel between port releases and discharges during the release periods. The acceleration enrichment chamber 67 will fill with fuel from the pump and when the accelerator 46 is depressed an enrichment quantity of fuel will be discharged by the piston 68 into the distributor chamber 57 to be delivered to the individual injectors 14.

Thus it will be seen that we have provided an improved pump and distributor arrangement incorporating a fuel enrichment system which meets the objectives and advantages above set forth. The arrangement lends itself to a compact unit device capable of continued operation without adjustment. Fuel enrichment is simply and easily accomplished to improve the performance of the engine without adversely affecting normal operation or affecting the fuel economy.

The multiple piston metering and pressure generating pump has an advantage in freedom from high speed limitations that are placed on a single piston injection pump that must reciprocate through one stroke for each cylinder of a multi-cylinder engine. The metering pump with a rotary distributor has considerable manufacturing advantages over types heretofore used requiring individual pistons, cylinders, valves and passages all of which must be precisely matched to maintain distribution equality for each cylinder of a multicylinder engine.

It will be understood that while the distributor usually is employed to accomplish one fuel release and one injection per four stroke cycle it may also be used to provide two injections per four stroke cycle. This method of distribution halves the large fuel quantities required per

cycle and precludes the necessity for larger metering pump components.

The drawings and specification present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

We claim as our invention:

1. A fuel supply mechanism for an engine fuel injection system comprising a variable delivery fuel pump, a distributor connected to receive fuel from the pump for distributing the fuel to fuel injectors, a fuel conduit means connected between the pump and distributor for the flow of fuel from the pump to the distributor, an expansible enrichment chamber communicating with said fuel conduit means for filling with fuel from the pump, and means operable during operation of the supply mechanism selectively discharging fuel from said expansible enrichment chamber back into said conduit means for temporarily increasing the fuel quantity delivered to the injectors.

2. A fuel supply mechanism for an engine fuel injection system comprising a variable delivery fuel pump, a distributor connected to receive fuel from the pump for distributing the fuel to fuel injectors, a fuel conduit means connected between the pump and distributor for the flow of fuel from the pump to the distributor, an expansible enrichment chamber communicating with said fuel conduit means for filling with fuel from the pump, means for selectively discharging fuel from said expansible enrichment chamber back into said conduit means for temporarily increasing the fuel quantity delivered to the injectors, and an accelerator control for expanding and contracting said enrichment chamber to fill with fuel from the pump or to temporarily increase the fuel quantity delivered to the injectors.

3. A fuel supply mechanism for an engine fuel injection system comprising pump means having a discharge for delivering fuel, a distributor having an intake connected to said pump discharge to receive fuel from the pump and to deliver fuel to individual nozzles in measured quantities, acceleration enrichment means connected between said pump discharge and said distributor intake to selectively deliver an additional acceleration quantity of fuel, and means for positively operating said enrichment means at selected times during operation of the system.

4. A fuel supply mechanism for an engine fuel injection system comprising a fuel distribution means for delivering fuel in measured quantities to fuel injectors including a fuel pump with a delivery passage, an enrichment chamber communicating with the pump delivery passage and being filled with fuel from the pump, and means for selectively immediately discharging fuel accumulated in said chamber back into said delivery passage for enriching the flow of fuel from the pump at a freely selected time.

5. In a fuel supply mechanism for an engine fuel injection system having a fuel supply pump with a discharge and a fuel distributor connected to the pump discharge and having outlets for connecting to individual fuel distribution points for distributing fuel from the pump, the improvement of an auxiliary fuel supply means connected to the distributor for immediately and positively selectively supplying additional fuel for selective periods of engine operation.

6. A fuel supply mechanism for an engine fuel injection system comprising a fuel supply pump with a discharge, a fuel distributor connected to the pump discharge and having outlets for connecting to individual fuel distribution points for distributing fuel from the pump, auxiliary fuel supply means connected to the distributor for supplying additional fuel, and means for in-

stantaneously selectively operating said auxiliary fuel supply means for furnishing enrichment fuel to an engine for selective periods of engine operation.

7. In a fuel supply mechanism for an engine fuel injection system having a fuel supply pump with a discharge and a fuel distributor connected to the pump discharge and having outlets for connecting to individual fuel distribution points for distributing fuel from the pump, the improvement of an acceleration enrichment fuel supply means connected to the distributor, a speed control member for an engine movable in an accelerating direction and a decelerating direction for a manual input signal to increase or decrease the speed of the engine, and means connecting the speed control member to said enrichment fuel supply means for operating the enrichment means to increase the delivery of fuel to the engine when accelerating.

8. A fuel supply mechanism for an engine fuel injection system comprising a variable delivery fuel pump, a distributor to receive fuel from the pump for periodically releasing fuel from the pump to injector nozzles, a fuel conduit means connecting between the pump and distributor for the flow of fuel, an accumulator chamber communicating with said conduit means and having a yieldable wall accommodating the flow of fuel into the chamber between distributor releases, means biasing said wall to completely discharge said accumulator chamber with each release from the distributor, an expansible enrichment chamber communicating with said conduit means for filling with fuel from the pump, and means for selectively discharging fuel from said expansible enrichment chamber back into said conduit means for temporarily increasing the fuel quantity delivered to the injectors.

9. A fuel supply mechanism for an engine fuel injection system comprising a variable delivery fuel pump, a distributor connected to receive fuel from the pump for distributing the fuel to fuel injectors, a fuel conduit means connected between the pump and distributor for the flow of fuel from the pump to the distributor, a cylindrical accumulator chamber communicating with said conduit means and having an accumulator piston in said chamber, a spring biasing the piston to discharge from the chamber having a natural frequency greater than the frequency of the distributor to fully discharge the accumulator chamber with each release of the distributor, a cylindrical enrichment chamber communicating with said conduit means and having a piston in said enrichment chamber, said enrichment chamber being of a smaller diameter than said accumulator chamber, and an enrichment piston in said enrichment chamber having a stroke greater than the stroke of the accumulator piston

and selectively operable to increase the fuel delivered by the distributor.

10. A fuel supply mechanism for an engine fuel injection system comprising a variable delivery fuel pump, a distributor connected to receive fuel from the pump for distributing the fuel to fuel injectors, a fuel conduit means connected between the pump and distributor for the flow of fuel from the pump to the distributor, a cylindrical accumulator chamber communicating with said conduit means and having an accumulator piston in said chamber, a spring biasing the piston to discharge from the chamber having a natural frequency greater than the frequency of the distributor to fully discharge the accumulator chamber with each release of the distributor, a cylindrical enrichment chamber communicating with said conduit means and having a piston in said enrichment chamber, an enrichment piston in said enrichment chamber, and an accelerator connected to said enrichment piston for selectively operating the piston to increase the fuel delivery by the distributor during acceleration periods and decrease the fuel delivered by the distributor during deceleration periods.

11. A fuel supply mechanism for an engine fuel injection system comprising a fuel pump, a distributor connected to receive fuel from the pump for releasing fuel from the pump to fuel injectors at periodic intervals, a fuel conduit means connected between the pump and distributor for the flow of fuel from the pump to the distributor, and means connected to said fuel conduit means for receiving fuel from the conduit means during deceleration periods to reduce the fuel quantity delivered by the distributor to the injectors.

12. The method of providing for acceleration fuel enrichment in a fuel injection system having a variable output pump connected to deliver to a distributor which comprises accumulating a quantity of fuel delivered by the pump for the distributor and returning the accumulated fuel to the distributor during periods of acceleration of the engine.

13. The method of providing for acceleration fuel enrichment in a fuel injection system having a variable output pump connected to deliver to a distributor which comprises accumulating a quantity of fuel delivered by the pump for the distributor and selectively returning the accumulated fuel to the distributor at selected times.

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