

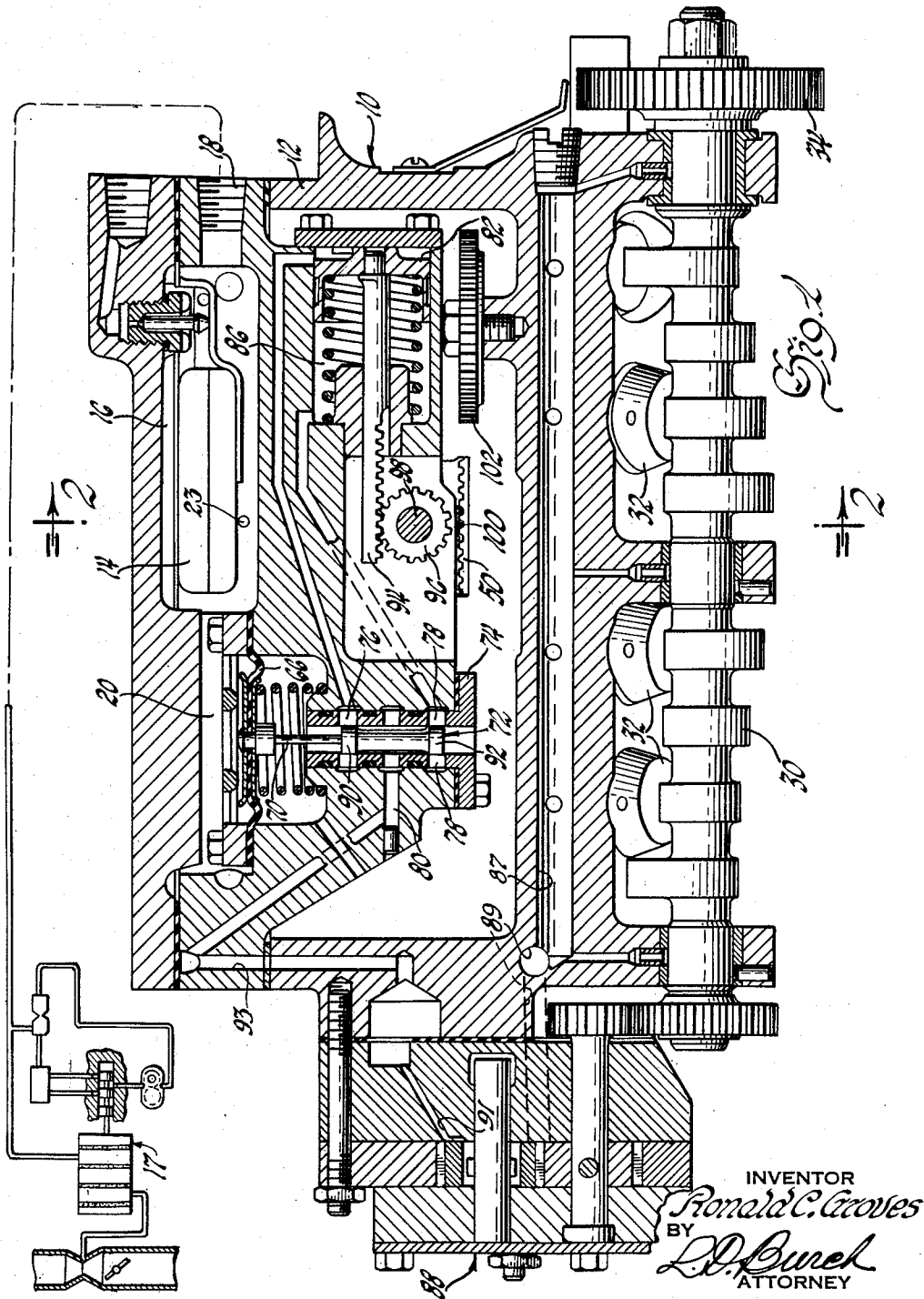
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R. C. GROVES
CHARGE FORMING MEANS

2,902,989

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3 Sheets-Sheet 1



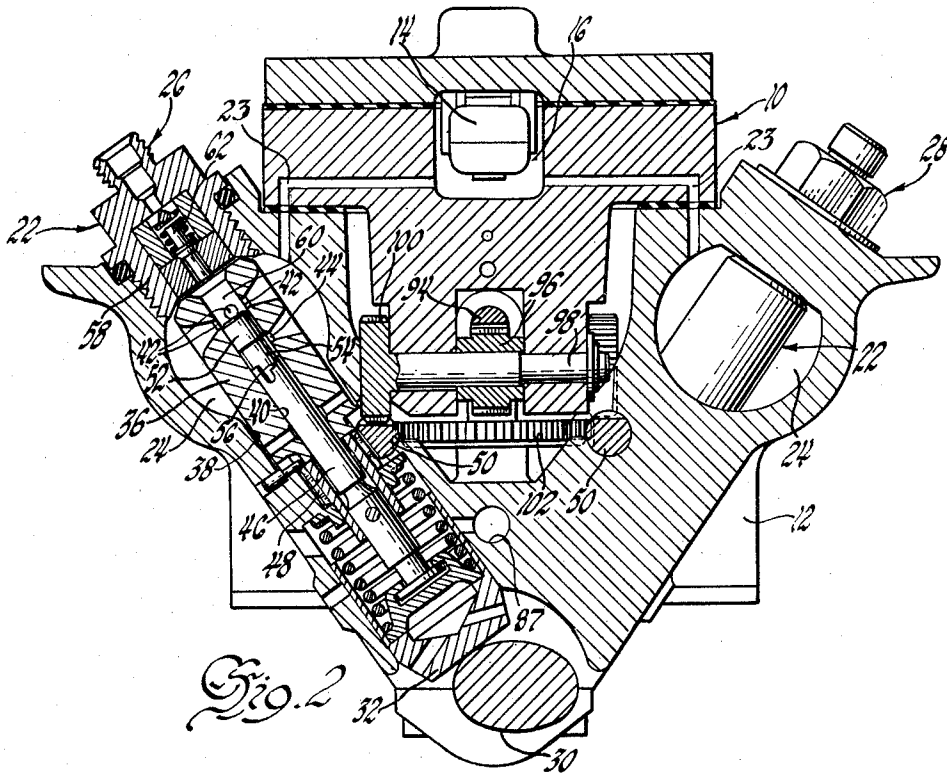
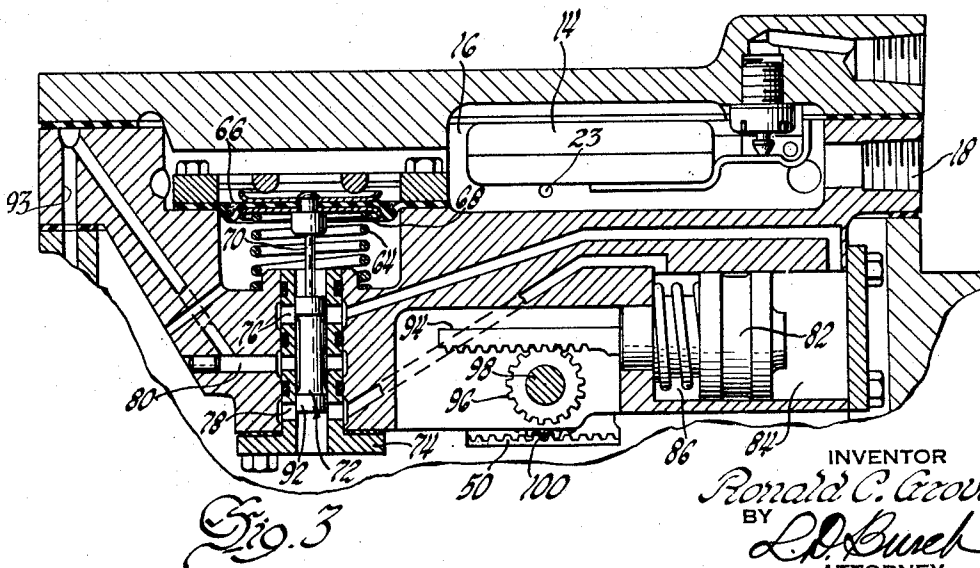
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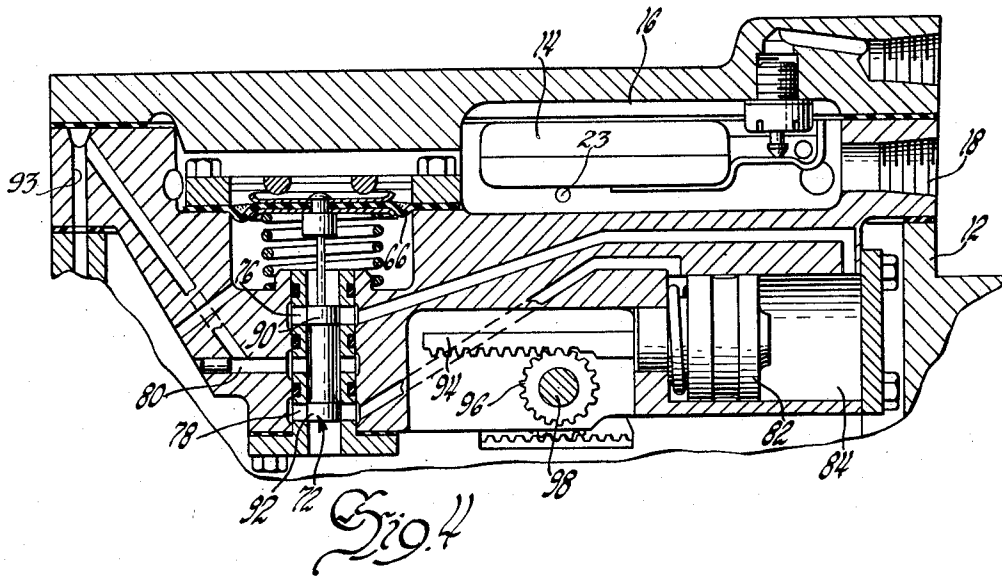
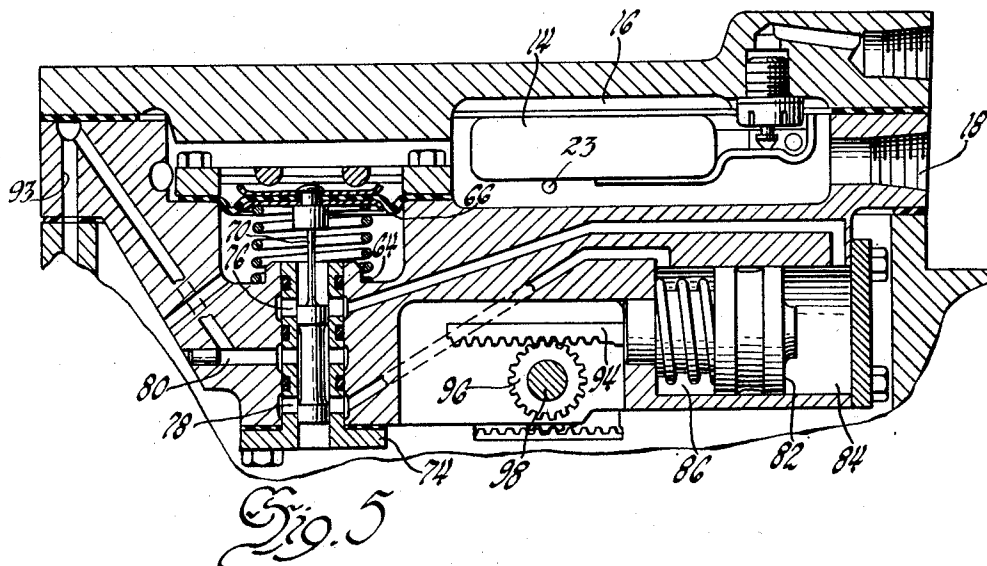
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CHARGE FORMING MEANS

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3 Claims. (Cl. 123—140)

The present invention relates to charge forming means for an internal combustion engine and more particularly to a servo unit for simultaneously controlling a plurality of individual injector pumps.

It has been found desirable to form the combustible charge for a multicylinder internal combustion engine of the spark ignited variety by individually injecting metered fuel directly in to the cylinders or into the induction system adjacent to the cylinders. In order to obtain maximum efficiency or performance from such an engine, the fuel must be metered in exact proportions to the air flow and each of the charges must receive substantially identical increments of the metered fuel. In the fuel injection systems employed heretofore there has been a considerable amount of difficulty in obtaining this objective of uniform distribution.

It is now proposed to provide a fuel injection control unit which is adapted to receive metered quantities of fuel and to distribute and inject substantially identical quantities of fuel into each of the individual cylinders.

More particularly, this unit includes an inlet chamber that receives metered fuel and supplies this fuel to separate injector pumps for each of the engine cylinders. These injector pumps are controlled by a pressure responsive means that is responsive to the fuel pressure in the chamber and is effective to adjust the injector pumps to maintain the pressure constant. Thus the injectors will be pumping the fuel at the same rate it is leaving the metering system.

In the three sheets of drawings:

Figure 1 is a cross-sectional view of a servo control unit embodying the present invention.

Figure 2 is a transverse cross-sectional view taken substantially along the plane of line 2—2 in Figure 1.

Figures 3, 4 and 5 are fragmentary cross-sectional views similar to Figure 1 but showing the parts in different operating positions.

Referring to the drawings in more detail, the present invention is embodied in a servo control unit 10 which is particularly adapted for use in a V-type engine having a pair of angularly disposed banks of cylinders with an upwardly opening space therebetween. The servo control unit 10 includes a housing 12 adapted to be mounted on the front end of the cylinder block in the space between the two banks of cylinders. The housing 12 includes a float 14 controlled vent chamber 16 having an inlet 18, a diaphragm chamber 20 interconnected with the vent chamber 16 and a plurality of injectors 22 that are connected to the diaphragm chamber 20 through conduits 23 by a fuel manifold 24. The injectors 22 are arranged in two banks 26, 28 similar to the engine cylinders. There is preferably a separate injector 22 for each of the engine cylinders for pumping the metered fuel through suitable nozzles located in either the intake passages or cylinders.

The inlet 18 to the vent chamber 16 is adapted to be interconnected with a fuel metering system such as disclosed in copending application Serial No. 555,820, Fuel Injection System filed December 28, 1955 in the name

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of Ronald C. Groves. This system includes a diaphragm unit responsive to the amount of induction air flow and fuel flow and effective to maintain the two in some predetermined proportions. Thus the chamber 16 will receive fuel in quantities that are metered in proportion to the amount of air entering the engine.

A pump camshaft 30 extends the length of the housing 12 at the intersection of the two banks 26, 28 so that the cam followers 32 on the ends of injectors 22 may be driven therefrom. The pump camshaft 30 is driven from the engine camshaft by gearing 34 that will insure the injectors being actuated in timed relation to the charging of the cylinders.

Each of the injectors 22 includes a bushing 36 that is secured in a passage 38 forming one of the banks 26 or 28. The bushing 36 includes an axial passage 40 with a group of upper ports 42 disposed in a plane normal to the axis of the passage 40 and a lower port 44 that is located some specific distance below the plane of the upper ports 42. A plunger 46 is reciprocally disposed in the axial passage 40. The lower end of the plunger 46 includes a follower 32 that rides on a cam to be driven thereby. A pinion 48 on the plunger 46 engages a control rack 50 so that the angular position of the plunger 46 will be set by the axial position of the rack 50. The upper end of the plunger 46 includes a head 52 that is separated from the main body by an undercut 54 that forms a helical shoulder 56 on the main body of the plunger 46. The upper end of the passage 40 is closed by a cap 58 to form a discharge chamber 60. The cap 58 includes a pressure responsive check valve 62 that interconnects the discharge chamber 60 with the injector lines and injector nozzles. A drilled passage through the plunger 46 interconnects the undercut 54 with the discharge chamber 60.

As the cam rotates and drives the plunger 46 upward the fuel in the chamber 60 will be discharged through all of the ports 42 and back into the fuel manifold 24 until the head 52 of the plunger 46 covers the top ports 42 and forces fuel downwardly through the drilled passage into the space between the head 52 and the helical shoulder 56 formed on the plunger body by the undercut 54. When this shoulder 56 closes the lower ports 44, the fuel will be forced to flow through the outlet valve 62 at the top of the chamber 60 and along the injector lines and out of the nozzles. This is the start of the injection stroke and it will continue until the upper ports 42 are uncovered by the undercut 54. When this point is reached the valve 62 will close and fuel will flow downwardly through the drilled passage and through the ports 42 into the fuel manifold 24. It may thus be seen that the effective length of the stroke will be determined by the distance between the point where the helical edge 56 covers the lower port 44 and the point at which the undercut 54 exposes the upper ports 42. This distance is determined by the angular position of the plunger 46 as determined by the control racks 50.

One wall of the diaphragm chamber 20 is formed by a flexible spring 64 biased diaphragm 66. The diaphragm 66 includes a rigid backing plate 68 having a shaft 70 depending downwardly therefrom. The lower end of this shaft 70 carries a valve 72 that is slidably disposed in a servo valve housing 74 having an upper outlet port 76 and a lower outlet port 78 with a servo fluid inlet 80 disposed therebetween. A cylinder with a servo piston 82 slidably disposed therein has one end 84 connected to the upper port 76 and the other end 86 connected to the lower port 78. The inlet 80 is interconnected with a source of servo fluid under pressure; for example, the engine lubrication system of which a conduit 87 is a part. Although the lubricant will be under pressure, the pressure varies over a considerable range. Accordingly, it has been found

desirable to employ a servo booster pump 88 having an inlet conduit 89 communicating with lubricant conduit 87. Pump 88 is driven from the pump camshaft 30 to maintain the servo fluid under sufficient pressure to insure a fast acting system. Pump 88 includes an output passage 91 which through conduit 93 supplies inlet 80 of valve 72 with fluid under pressure. The valve 72 includes a reduced center portion and a pair of enlarged heads 90, 92 that are positioned to simultaneously register with both outlet ports 76, 78 and close them.

The servo piston 82 includes a rack 94 having teeth that engage a pinion 96 on a transverse shaft 98. One end of the shaft 98 includes a pinion 100 that engages one of the control racks 50 for driving it in an axial direction. A horizontal gear 102 engages both of the control racks 50 so as to insure their working in unison.

The operation of this unit may be summarized briefly as follows:

The fuel metering system will deliver metered fuel to the inlet 18. When this fuel is flowing at a high rate and the system is in a stable condition the metered fuel will be flowing from the vent chamber 16 to the injectors 22 at the same rate the injectors 22 are pumping fuel. Thus the fuel pressure in the diaphragm chamber 20 will be constant and the force on the diaphragm 66 will balance the force of the spring 64. Thus the enlarged heads 90, 92 on the opposite ends of the servo valve 72 will block both outlet ports 76, 78 and lock the piston 82 in a fixed position in the right end of the cylinder. See Figure 1.

In the event the load on the engine changes and the fuel metering system supplies the metered fuel to the float chamber 16 at a lower rate than the injectors 22 are pumping fuel, the pressure in the diaphragm chamber 20 will decrease. When this occurs the spring 64 will force the diaphragm 66 and the servo valve 72 to rise to the position shown in Figure 3. The enlarged heads 90, 92 will then uncover the upper and lower outlet ports 76, 78 and allow the servo fluid to flow through the upper port 76 and into the chamber 84 on the right side of the servo piston 82 and force it to move to the left. The servo fluid trapped on the opposite side of the piston 82 will be drained through the lower outlet port 78. Movement of the piston 82 to the left will cause the rack 94 to drive the pinion 96 and thereby move the control racks 50. This will rotate the plungers 46 and thus adjust the individual injectors 22 to lower the rate at which they are pumping fuel. This motion of the piston 82 will continue until the injectors 22 pumping rate matches the rate the metered fuel is entering the chamber 16. When a balance fuel flow is established the fuel pressure in the diaphragm chamber 20 will increase and force the servo valve 72 downwardly until the enlarged heads 90, 92 close both of the ports 76, 78 in the servo valve. This will lock the servo piston 82 and also the control racks 50 in position.

In the event the metering system is supplying fuel to the float chamber 16 at a faster rate than the injectors 22 are pumping it to the cylinders, the fuel pressure in the diaphragm chamber 20 will increase and force the diaphragm 66 and the servo valve 72 downwardly to the position shown in Figure 5. The heads 90, 92 will uncover the ports 76, 78 and the servo fluid will flow through the lower port 78 and into the chamber 86 on the left side of the piston 82 and force the piston 82 to move to the right. The servo fluid in front of the piston 82 will be drained through the upper port 76 in the servo valve 72. Movement of the piston 82 to the right causes the rack 94 to drive the pinion 96 and move the control racks 50 to increase the rate at which the injectors 22 are pumping fuel. This motion of the servo piston 82 will continue until the injectors 22 are pumping fuel at the same rate the metering system is delivering it to the chamber 16. When the fuel flows are matched the fuel pressure in the diaphragm chamber 20 will decrease to balance the force of the spring 64. When this condition is established the enlarged heads 90, 92 on the servo valve will again close

both ports 76, 78 and lock the servo piston 82 in a fixed position.

It is to be understood that, although the invention has been described with specific reference to a particular embodiment thereof, it is not to be so limited since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

I claim:

1. An injector control unit for a multi-cylinder engine, said unit including a separate variable capacity injector pump for each engine cylinder, a fuel inlet chamber adapted to receive metered fuel responsive to engine demand, a diaphragm in said chamber, one side of said diaphragm being responsive to the pressure of the metered fuel in said chamber, the other side of said diaphragm being open to atmosphere, a valve member operatively connected to said diaphragm, said valve including inlet and outlet means, a source of control fluid under pressure connected to the valve inlet, a servo mechanism operatively connected to each of said injector pumps to vary the capacity thereof, conduit means connecting the valve outlet means to said servo whereby changes in said metered fuel pressure cause the diaphragm controlled valve to admit said control fluid to the servo to vary the capacity of said pumps.

2. An injector control unit for a multi-cylinder engine, said unit including a separate variable capacity injector pump for each engine cylinder, a fuel inlet chamber adapted to receive metered fuel responsive to engine demand, a diaphragm in said chamber, one side of said diaphragm being responsive to the pressure of the metered fuel in said chamber, the other side of said diaphragm being open to atmosphere, a valve member operatively connected to said diaphragm, said valve including an inlet and a pair of outlets, a source of control fluid under pressure connected to the valve inlet, a servo mechanism operatively connected to each of said injector pumps to vary the capacity thereof, said mechanism including a piston member slidably mounted in a cylinder, conduit means respectively connecting each valve outlet to the cylinder on opposite sides of the piston whereby changes in said metered fuel pressure cause the diaphragm controlled valve to admit said control fluid to one side or the other of said piston to vary the capacity of said pumps.

3. An injector control unit for a multi-cylinder engine, said unit including a separate variable capacity injector pump for each engine cylinder, a fuel inlet chamber adapted to receive metered fuel responsive to engine demand, passage means communicating said chamber with said pumps, a diaphragm in said chamber, one side of said diaphragm being responsive to the pressure of the metered fuel in said chamber, the other side of said diaphragm being open to atmosphere, a valve member operatively connected to said diaphragm, said valve including an inlet and a pair of outlets, a source of control fluid under pressure connected to the valve inlet, a servo mechanism operatively connected to each of said injector pumps to vary the capacity thereof, said mechanism including a piston member slidably mounted in a cylinder, conduit means respectively connecting each valve outlet to the cylinder on opposite sides of the piston, said valve blocking the outlets during conditions of constant engine demand, changes in said metered fuel pressure reflecting changes in engine demand causing the diaphragm controlled valve to admit said control fluid to one of said outlets and opening the other of said outlets to exhaust.

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