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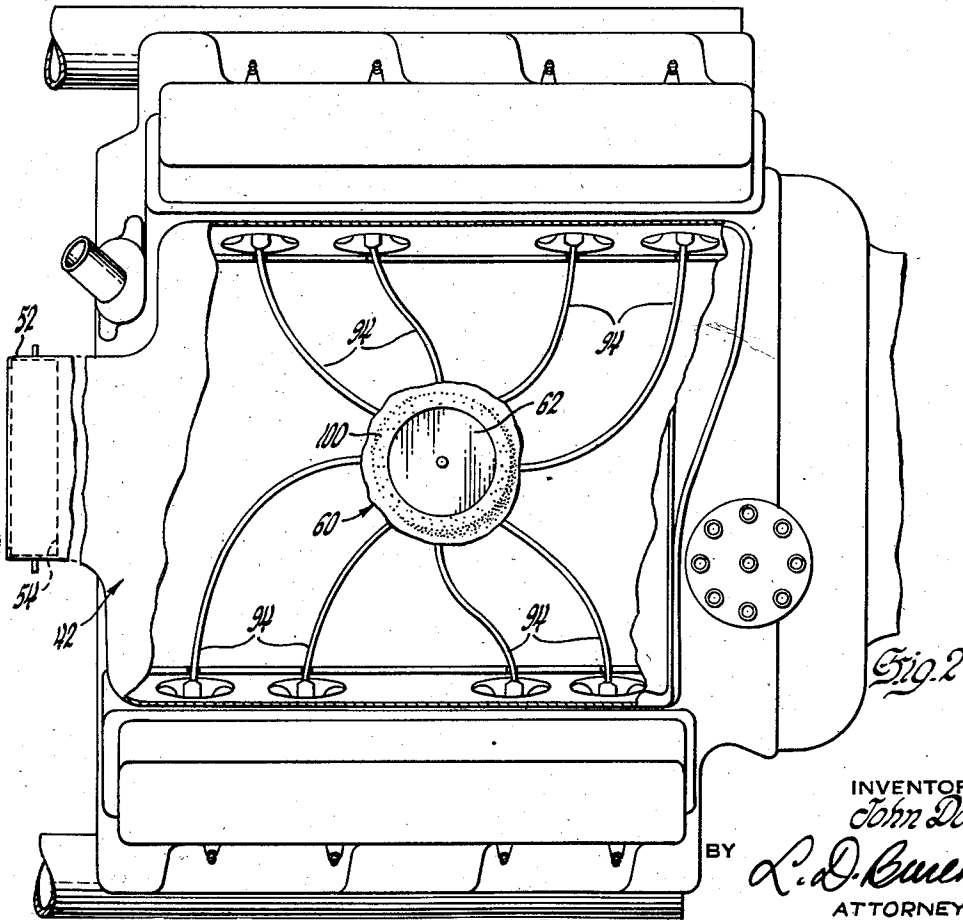
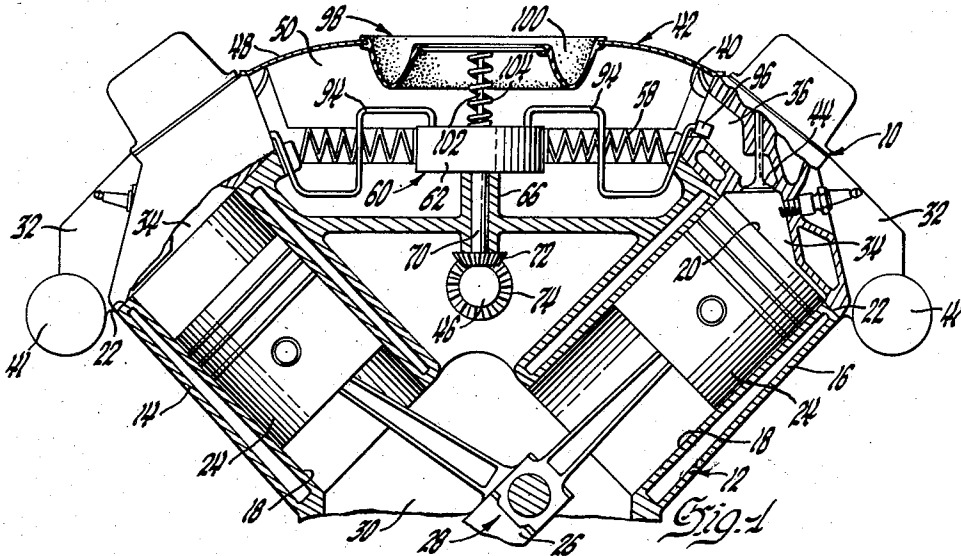
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2,890,690

FUEL INJECTION SYSTEM

Filed May 31, 1955

3 Sheets-Sheet 1



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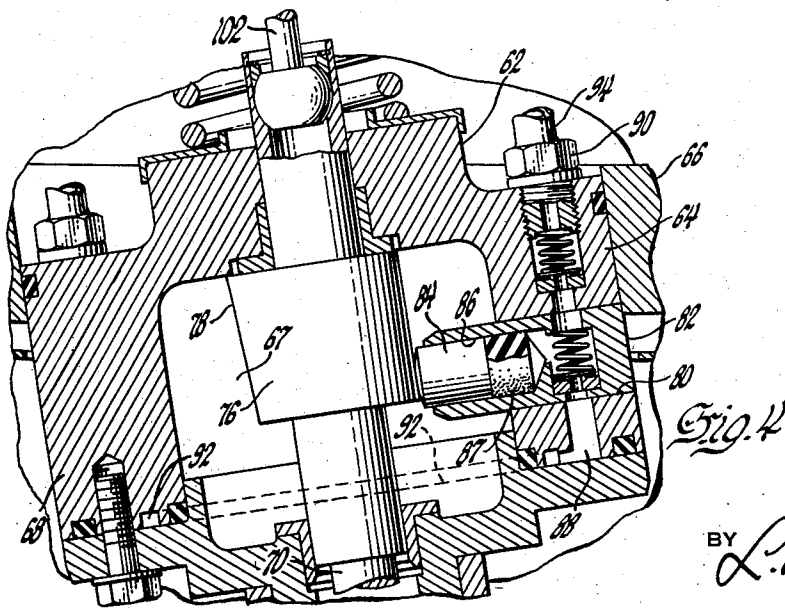
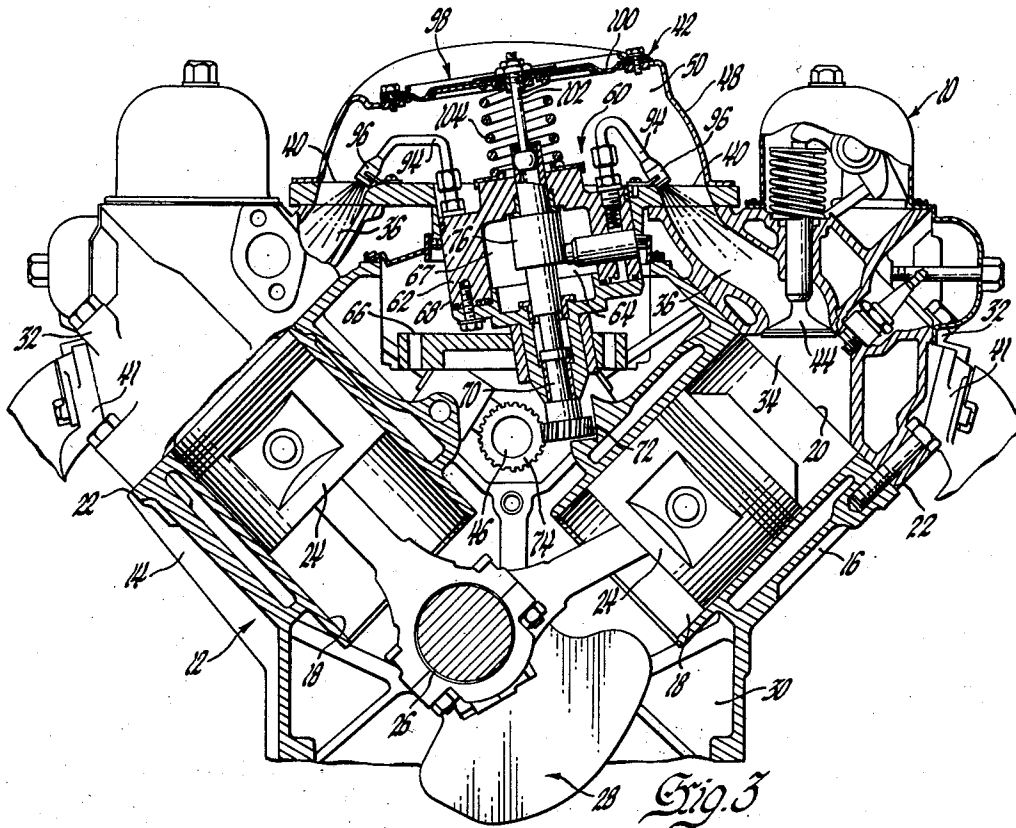
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FUEL INJECTION SYSTEM

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3 Sheets-Sheet 2



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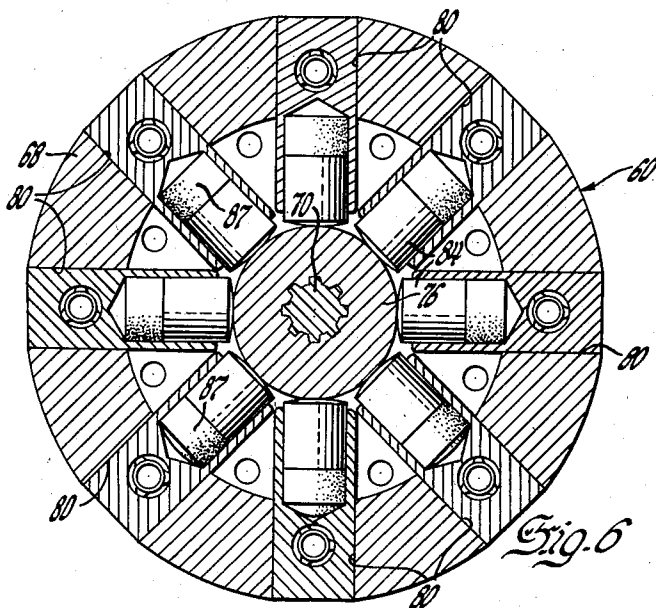
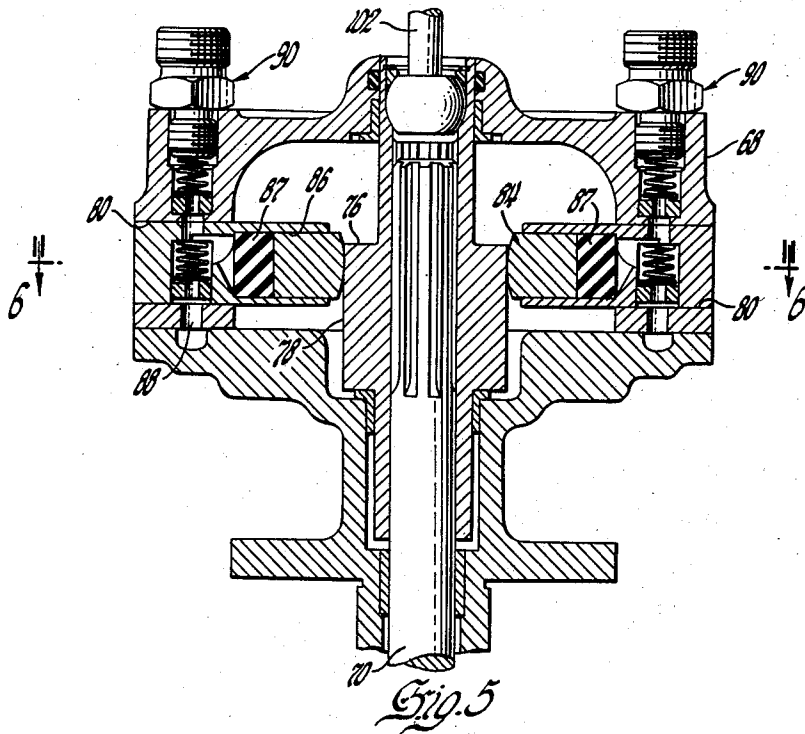
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3 Sheets-Sheet 3



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2,890,690

FUEL INJECTION SYSTEM

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5 Claims. (Cl. 123—119)

The present invention relates to internal combustion engines of the so-called spark ignited type and more particularly to fuel injection systems therefor.

In the operation of an internal combustion engine of the so-called spark ignited variety, a combustible charge of air and fuel is formed. The charge is then compressed in a cylinder and ignited. This charge may be formed by a carburetor and distributed to the cylinders by an intake manifold. However, this results in a poor volumetric efficiency and uneven fuel distribution. As a result numerous attempts have been made to devise a practical fuel injection system that will discharge the fuel into the air adjacent the cylinders. The systems devised to date have been expensive. In addition, although these systems may provide the desired fuel rates at one or two operating conditions they have been unable to properly meter the correct amount of fuel over a wide range of engine operating conditions. Consequently, the use of fuel injection systems has been largely confined to engines for use in racing cars and aircraft which for a majority of the time operate at one or two throttle settings.

It is now proposed to provide a fuel injection system which is not only economical to manufacture but which will also be simple and reliable in operation. The injection system will employ a fuel pump and a control mechanism adapted to meter the output of this pump to insure the correct amount of fuel for all engine operating conditions. The present pump is a positive displacement one having separate cells with each of the cells having a separate outlet that is adapted to discharge fuel into a charge for one cylinder. Thus the pump will be able to deliver separate or individual quantities of fuel to each of the various cylinders. The control mechanism includes means for sensing the volume of air drawn into the engine. This is accomplished by forming an air box through which any air entering the engine must flow. If a throttle valve controls the flow of air into the air box, an intake vacuum will be formed therein. Thus the control mechanism may include a diaphragm having one side exposed to the atmosphere and the other side exposed to vacuum. The diaphragm is in turn connected to the fuel pump so that as the air pressure inside of the box varies, the diaphragm will actuate the pump and thereby vary the pump output in proportion to the air flow.

In the three sheets of drawings:

Figure 1 is a cross sectional view of an engine diagrammatically illustrating the present invention.

Figure 2 is a plan view of the engine in Figure 1 with portions thereof being broken away.

Figure 3 is a cross sectional view of an engine employing a fuel injection system embodying the present invention.

Figure 4 is a cross sectional view on an enlarged scale of the pump employed in this system.

Figure 5 is a cross sectional view similar to Figure 2.

Figure 6 is a cross sectional view of the pump taken substantially along the plane of line 6—6 in Figure 5.

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Referring to the drawings in more detail, the present invention may be adapted for installation on any suitable internal combustion engine 10. In the present instance this engine 10 is of the so-called V-type having a cylinder block 12 with a pair of angularly disposed cylinder banks 14 and 16. Each bank 14 and 16 may include a plurality of cylinders 18 having the lower ends thereof opening into the crankcase while the upper ends form openings 20 in the plane faces 22 on the sides of the block 12. A piston 24 may be reciprocally disposed in each of these cylinders 18 and drivingly connected to the throws 26 of a crankshaft 28 rotatably mounted in the crankcase 30.

Cylinder heads 32 may be secured to the plane faces 22 formed by the cylinder banks for closing the cylinders 18. These heads 32 may include a plurality of cavities 34 each of which is positioned to register with an opening 20 formed by the cylinders 18. Thus these cavities 34 will cooperate with the upper ends of the pistons 24 to form combustion chambers.

Intake and exhaust passages 36 may extend transversely through the heads 32 so as to form intake ports 40 and exhaust ports on the opposite sides of the heads 32. The exhaust ports may be disposed on the outsides of the engine for discharging the exhaust gases into exhaust manifolds 41. These manifolds 41 may in turn collect the gases and direct them into an exhaust system which discharges them into the atmosphere. The intake ports 40 may be on the inside of the heads 32 so as to communicate with the induction system 42. Intake valves 44 may be disposed in the inner ends of the passages 36 for controlling the flow of gases into the combustion chambers. Similar exhaust valves may be provided for controlling the exit of the gases. These valves are actuated by a camshaft 46 driven from the crankshaft 28 at one-half engine speed.

The induction system 42 may include an air box 48 that is disposed in the space between the cylinder banks 14 and 16 so as to form a chamber 50 that communicates with the various intake passages 36. This box 48 may include an intake 52 that projects toward the front of the engine 10. A throttle valve 54 disposed in this intake 52 may control the flow of air into the chamber 50. It should be noted that a filter element 58 may be disposed in the chamber 50 to divide chamber 50 into a pair of compartments with the intake 52 communicating with one compartment and the intake 36 communicating with the other.

In order to form a combustible charge, a fuel supply system 60 may be provided for mixing fuel with the air. In the present instance this supply system 60 includes a pump 62 that communicates with a source of fuel. The pump 62 includes a housing 64 mounted on a support 66 extending between the cylinder banks 14 and 16. The present housing 64 includes a substantially cylindrical opening that extends axially upwardly from the lower end thereof to form a chamber 67 and a housing wall 68. A driveshaft 70 may project from the lower end of the housing 64 so that a gear 72 thereon will mesh with a gear 74 on the camshaft 46. Thus the driveshaft 70 will be driven at camshaft speed or one-half engine speed. A variable lift cam 76 may be provided on the upper end of the driveshaft 70 so as to be driven thereby. The present cam 76 is axially movable on the driveshaft 70. Since the profile 78 of this cam 76 may vary in an axial direction, movement of the cam 76 in an axial direction will cause the effective lift thereof to vary.

A plurality of passages 80 may extend through the housing wall 68 so as to be radially disposed about the cam 76. A separate cell 82 of the pump 62 may be disposed in each of these passages 80. Each of the present cells 82 include a plunger 84 that is reciprocally dis-

posed in a cylinder 86. The outer end of the plunger 84 may ride on the cam periphery 78 while the inner end engages a resilient member 87. Thus as the cam 76 rotates, the plunger 84 will be reciprocally driven in the cylinder 86 so as to cause the resilient member 87 to expand and compress. When the plunger 84 is thus moved, fuel may be drawn in through an inlet passage 88 and forced out through an outlet 90. The intake passages 88 may communicate with an annular fuel manifold 92 interconnected with a source of fuel while each of the outlets 90 is connected to a tube 94 provided with a discharge nozzle 96 which is disposed in an intake passage 36. Thus rotation of the cam 76 will cause each cell 82 to discharge a separate quantity of fuel into an intake passage 36 adjacent an intake valve 44. It is apparent that the volume or quantity of fuel so discharged will depend upon the effective lift of the cam 76.

Since the amount of fuel required for each piston stroke will vary depending upon the engine operating conditions, control means 98 may be provided for metering the amount of fuel discharged from the pump 62. By employing a positive displacement pump which is driven by the engine, the volume of fuel passing through the pump 62 will be a function of engine speed. The air flowing through the air box 48 will create a vacuum therein which will be an index of the volume of air entering the engine 10. Accordingly, a pressure responsive device such as a diaphragm 100 may be provided in the air box 48 for sensing the air pressure therein. The diaphragm 100 may form one wall of the air box 48 so that one side will be exposed to the atmospheric pressure while the other side will be exposed to the vacuum present in the air box 48. This diaphragm 100 may be connected to the cam 76 by means of a rod 102 so that movement of the diaphragm 100 will move the cam 76 in an axial direction. If a spring 104 opposes the unbalance produced by the air pressure on the diaphragm 100 for any given vacuum, the spring 104 and diaphragm 100 will cause the cam 76 to assume some predetermined position. If the contour of the cam profile 78 is correctly shaped at that setting the pump 62 will cause the correct amount of fuel to be discharged from the nozzles 96.

When the engine 10 is running with the throttle valve in the closed or nearly closed position, the engine will be lightly loaded and the fuel required for each piston stroke will be smallest. Under such circumstances the vacuum present in the air box will be a maximum. The atmospheric air pressure will thus move the diaphragm downwardly and compress the spring. When the diaphragm is in this lower position the cam will also be in its lower position. The plungers will then engage the upper portion of the cam profile. Since the fuel required for each stroke of a piston will be a minimum, the lift of the cam at the upper end is a minimum. Thus as the camshaft 46 rotates the driveshaft 70 and the cam 76 mounted thereon will result in each of the cells 82 causing a separate quantity of fuel to be discharged through the nozzles 96 into the air flowing through the intake passages 88 into the cylinders.

As the throttle valve 54 moves towards the open position, the intake vacuum will decrease and the volume of the air flowing into the engine 10 will increase. Consequently, the amount of fuel required for each piston stroke will increase. However, it should be noted that as the intake vacuum decreases, the spring 104 will expand and raise the cam 76 so as to cause the plungers 84 to engage a lower portion of the cam profile 78. Thus the lift of the cam 76 may increase towards the lower end thereof so that the strokes of the plungers 84 will increase with a decrease in the vacuum. This in turn will increase the volume of fuel discharged from the nozzles 96. It is therefore apparent that the cam profile 78 may be shaped so as to insure the desired amount of fuel for all intake vacuums. It may thus be

seen that the diaphragm 100 and spring 104 will maintain the cam 76 properly positioned at all times and thereby insure the desired air-fuel ratio being delivered to the cylinders during all engine operating conditions.

What is claimed is:

1. An induction system for an engine having a plurality of cylinders, said induction system comprising an air manifold forming a chamber, a throttle valve forming an intake for said manifold for controlling the quantity of air entering said chamber, an inlet for each cylinder for interconnecting said cylinder with said chamber for delivering a charge of air to said cylinder, a fuel pump disposed within said chamber and having an axially movable cam with the lift thereof varying in an axial direction and being rotatably driven by said engine, said pump having a separate cell for each of said cylinders, each of said cells including a plunger driven by said cam and an outlet for discharging a quantity of fuel into a charge delivered by an inlet to one of said cylinders during the period when said air is flowing into said cylinder, each of said cells including inlet and outlet valves insuring fuel flow only in the direction of the associated cylinder, a diaphragm disposed in said chamber and responsive to the absolute pressure in said chamber, means interconnecting said diaphragm and said cam, and a spring acting on said diaphragm to increase the output of each cell, atmospheric pressure acting on said diaphragm against the force of the absolute pressure in said chamber and the spring to urge said cam to a position decreasing the output of said fuel pump.

2. An engine comprising a plurality of cylinders, an air manifold, a separate inlet passage for each cylinder for interconnecting said cylinder with said manifold, a throttle valve for controlling the quantity of air flowing through said manifold into said cylinders, a camshaft for opening and closing valves for controlling the flow of gases into and out of said cylinders, a variable lift cam disposed in said manifold and driven from said camshaft, a separate pump for each of said cylinders, said pumps being radially disposed about said cam, each of said pumps including a plunger that engages said cam and an outlet disposed in one of said inlet passages for discharging a quantity of fuel into one of said inlet passages, a diaphragm in said air manifold for sensing the pressure difference inside and outside of said manifold, means interconnecting said diaphragm and cam, and a spring biasing said cam to increase the fuel output of each pump as said pressure difference decreases.

3. An engine comprising a plurality of cylinders, an air manifold forming a chamber therein, an inlet passage for each cylinder for interconnecting said cylinder with said chamber, a throttle valve for controlling the quantity of air entering said chamber, an intake valve disposed in said inlet passage for controlling the flowing of air from said chamber into said cylinders, a camshaft for opening and closing said intake valves, a fuel pump having an axially movable cam rotatably driven by said engine with the lift thereof varying in an axial direction, said pump including a separate cell for each of said cylinders, each of said cells including a plunger driven by said cam and having an outlet discharging a quantity of fuel into said inlet passage adjacent said inlet valve, axial movement of said cam being adapted to vary the output of each plunger, a diaphragm disposed in said chamber and responsive to air pressures inside and outside of said chamber, means interconnecting said diaphragm and said cam, and a spring biasing said cam to increase pump output as the absolute pressure in said chamber increases.

4. An engine comprising a plurality of cylinders, an air manifold forming a chamber therein, an inlet passage for each cylinder for interconnecting said cylinder with said chamber, a throttle valve for controlling the quantity of air entering said chamber, an intake valve disposed in said inlet passages for controlling the flowing of air from said chamber into said cylinders; a camshaft for

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opening and closing said intake valves, a fuel pump having an axially movable cam rotatably driven by said engine with the lift thereof varying in an axial direction, said pump including a separate cell for each of said cylinders, each of said cells including a plunger driven by said cam and having an outlet discharging a quantity of fuel into said inlet passage adjacent said inlet valve, axial movement of said cam being adapted to vary the output of each plunger, each of said cells including inlet and outlet valves insuring fuel flow only in the direction of the inlet passage inlet valve, a diaphragm disposed in said chamber and responsive to air pressures inside and outside of said chamber, means interconnecting said diaphragm and said cam, and a spring biasing said cam to increase pump output as the absolute pressure in said chamber increases.

5. An induction system for an engine having a plurality of cylinders, said induction system comprising an air manifold forming a common air chamber for said cylinders, a throttle valve for controlling the quantity of air entering said chamber, an induction passage for each cylinder interconnecting the cylinders with said common air chamber, a variable capacity fuel pump

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adapted to meter identical but individual charges of fuel to each induction passage, the number of said individual charges being proportional to engine speed, a diaphragm mounted in the common air chamber, means interconnecting said diaphragm and pump, atmospheric pressure acting on said diaphragm to increase the quantity of each individual charge, the absolute pressure in said chamber acting on said diaphragm to oppose the force of atmospheric pressure, and a spring element disposed in said chamber and biasing said diaphragm against the force of atmospheric pressure to increase the quantity of each individual fuel charge.

References Cited in the file of this patent

UNITED STATES PATENTS

1,662,040	Lee	Mar. 6, 1928
2,008,143	Mock	July 16, 1935
2,563,939	Kishline	Aug. 14, 1951
2,636,439	Mashinter	Apr. 28, 1953
2,725,861	Leibing	Dec. 6, 1955

FOREIGN PATENTS

616,721	Great Britain	Jan. 26, 1949
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