

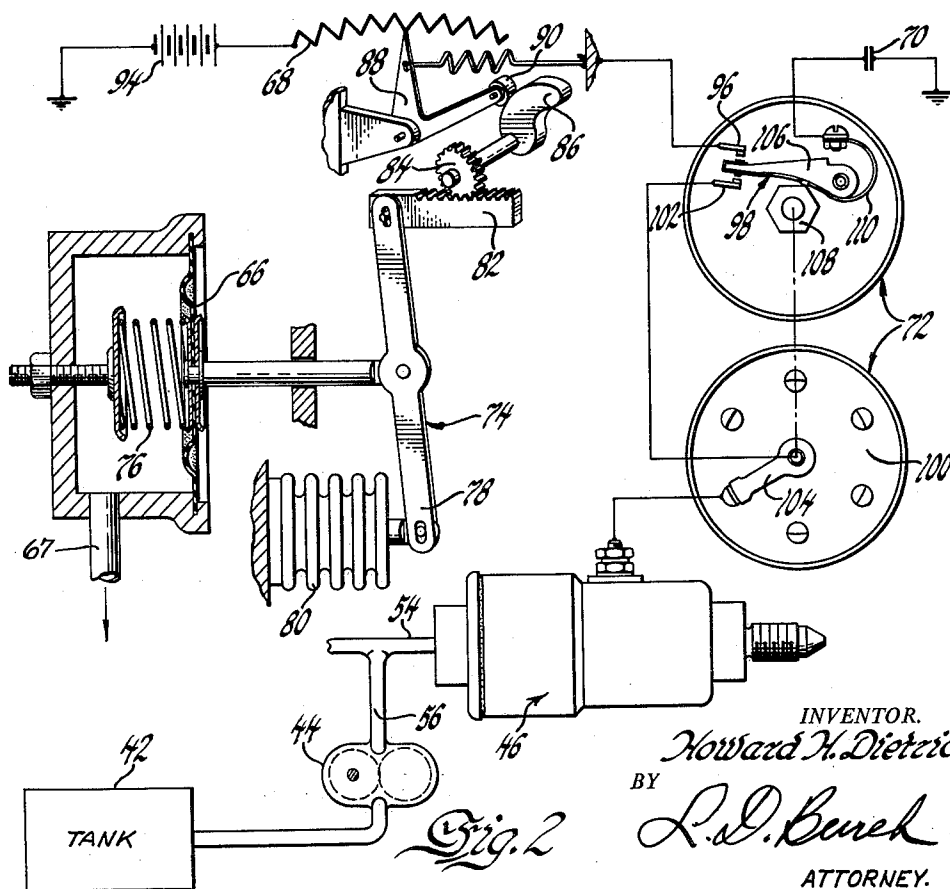
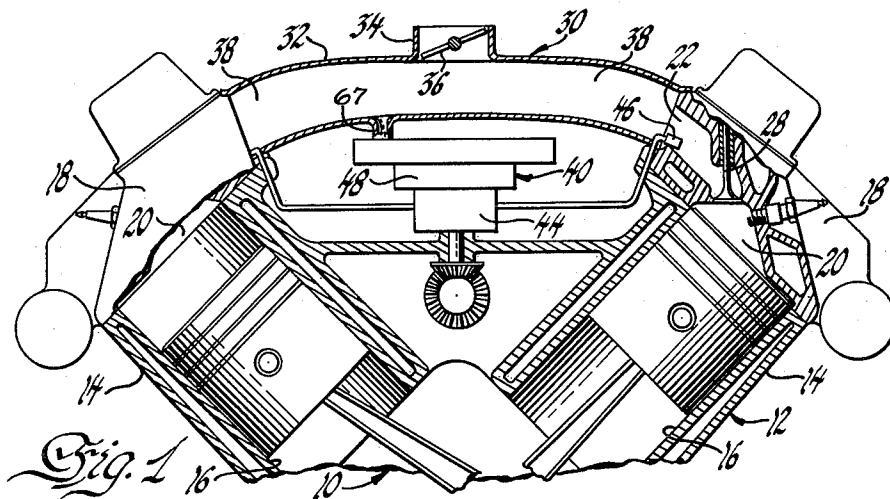
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H. H. DIETRICH
FUEL INJECTION SYSTEM

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2 Sheets-Sheet 1



INVENTOR.
Howard H. Dietrich
BY
L. D. Burek
ATTORNEY.

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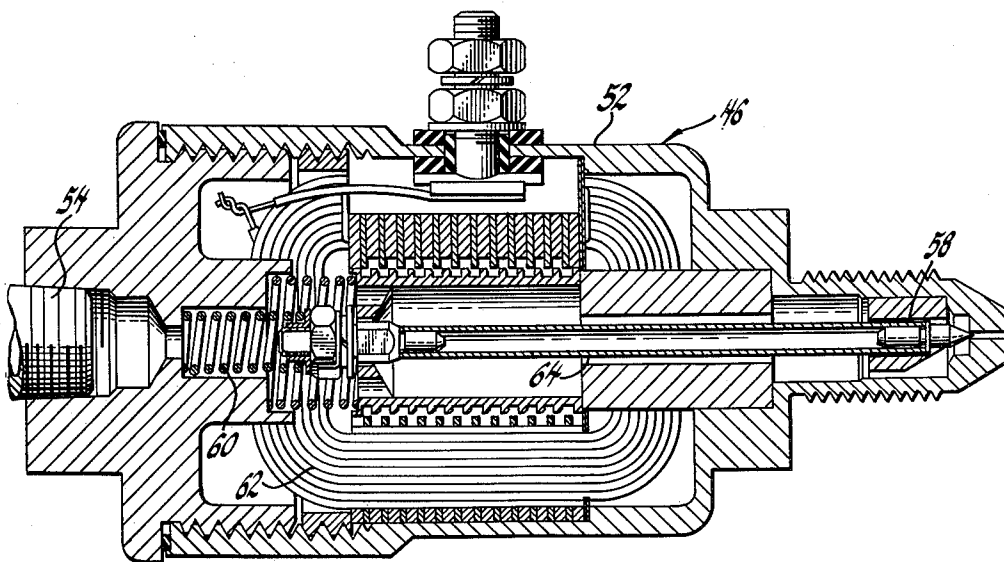
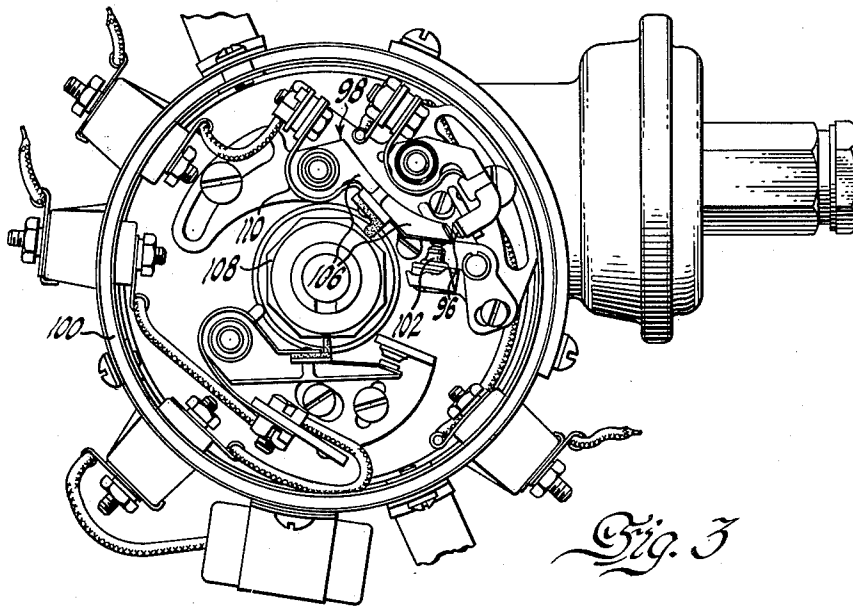


Fig. 4

INVENTOR.
Howard H. Dietrich
BY
L. D. Burch
ATTORNEY.

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FUEL INJECTION SYSTEM

Howard H. Dietrich, Rochester, N.Y., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

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The present invention relates to internal combustion engines and more particularly to charge forming means therefor.

In the operation of an internal combustion engine of the so-called spark ignited variety a combustible charge of air and fuel is compressed in the combustion chambers and ignited. Although there are numerous ways in which this charge may be formed it is essential for maximum efficiency and performance, that the individual charges delivered to the cylinders be substantially identical both as to the volume and the proportions of air and fuel. In the past the most common method for forming and distributing the charge has been to employ a carburetor and an intake manifold. However, another method which has many advantages over the conventional carburetor is a fuel injection system which will inject metered quantities of fuel into the charge immediately adjacent the combustion chamber. Although such injection systems have numerous advantages they have not been employed on mass produced automotive engines for numerous reasons.

It is now proposed to provide a fuel injection system which is particularly adapted for use on an automotive engine. This system is not only simple and inexpensive but it is also reliable in operation and is adapted to accurately meter and distribute the fuel to the various cylinders of the engine. It is proposed to employ an energy storing reactance such as a condenser which will discharge the energy stored therein through an energy dissipating reactance such as a solenoid in a fuel valve. The solenoid actuated valve is preferably located in the injection nozzles and it is adapted to meter the fuel discharged from the nozzle and into the induction system in proportion to the amount of energy stored in the condenser and then dissipated in the solenoid. The means for charging the condenser with energy is responsive to the fuel demands of the engine and is adapted to regulate the amount of stored energy in proportion thereto. More particularly this charging means may include a suitable voltage source, a variable resistor and a pressure sensitive device responsive to the induction vacuum for varying the resistance in proportion to the vacuum. Thus the amount of stored energy and consequently the amount of injected fuel will be proportional to the combustible charge in the induction system.

In the drawings:

FIGURE 1 is a cross-sectional end view of an engine employing a fuel injection system embodying the present invention.

FIGURE 2 is a diagrammatic view of the fuel injection system employed in FIGURE 1.

FIGURE 3 is a top plan view of a distributor with the cap removed.

FIGURE 4 is a cross-sectional view of a fuel injection nozzle.

Referring to the drawings in more detail the present invention may be adapted for use on any suitable internal combustion engine 10. In the present instance this engine 10 is of the so-called V-type wherein a cylinder block 12 includes a pair of angularly disposed banks 14 of cylinders 16. Cylinder heads 18 are secured to the block 12 to extend along each of the banks 14 and close the upper ends of the cylinders 16 and form combustion

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chambers 20. Intake passages 22 may extend through the cylinder heads 18 to communicate with the combustion chambers 20 while intake valves 28 control the timing of the flow into the combustion chambers 20.

In order to supply a charge of air to the cylinders 16 an induction system 30 may be provided in the space between the two banks of cylinders 16. This induction system 30 includes an intake manifold 32 having an inlet 34 with a throttle valve 36 therein to control the volume of the charge. A plurality of induction passages 38 in the intake manifold 32 may communicate with the intake passages 22 in the cylinder heads 18.

In order to mix a metered quantity of fuel with the air in the induction system and form a combustible charge, a fuel injection system 40 may be provided which will positively inject metered quantities of fuel into the charges for said cylinders 16. This fuel injection system 40 includes a fuel storage tank 42, a fuel pump 44, a plurality of injection nozzles 46 and metering means 48 for controlling the amount of fuel discharged from the nozzles 46. Each of these nozzles 46 includes a housing 52 threaded into the intake manifold 32 so as to be mounted to spray fuel into an intake passage 22. A fitting 54 on the side of the housing 52 is adapted to be directly connected to the outlet of the pump 44 by a fuel line 56. A valve 58 is disposed in the discharge end of the nozzle 46 to control the flow of fuel therepast. A spring 60 biases this valve 58 tightly closed so as to normally prevent any fuel flowing therepast. A solenoid 62 is contained in the housing 52 and is operatively interconnected to the valve stem 64. The solenoid 62, when energized, is effective to compress the spring 60 and open the valve 58. This will allow the fuel to flow therethrough and be injected into the charge in the induction system 30. The amount of metered fuel which is discharged from the nozzle 46 and into the charge is controlled by the time that the nozzle 46 is opened. This period is, in turn, controlled by the amount of energy dissipated in the solenoid 62.

The metering means for regulating the amount of energy fed to the solenoid 62 includes a pressure sensitive device 66, a variable resistance 68, a condenser 70 and switch means 72. The pressure sensitive device may be a diaphragm 66 exposed to the vacuum in the induction system 30 through a conduit 67 connecting with manifold 32. The diaphragm 66 is connected to the center of a walking beam 74 and a spring 76 exerts a biasing force thereon to oppose the force from the vacuum. One end 78 of the beam 74 is pivoted about an adjustable fulcrum provided by a temperature responsive bellows 80. The opposite end of the beam 74 is interconnected with a longitudinally reciprocating rack 82. A pinion 84 meshes with the rack 82 and is adapted for rotating a cam 86. It will be seen that as a result of the opposed force of the spring 76 and the vacuum for any given vacuum, the cam 86 will assume some predetermined fixed position. A bell crank 88 carried a roller 90 on one end that rides on the cam 86 while the opposite end is adapted to vary the resistance of a variable resistance 68. One side of the resistance is connected to a voltage source such as a battery 94 while the opposite side is interconnected with one of the contacts 96 in the switch means 72. The switch means 72 includes a double-throw, make and break switch 98 and a rotary distributor 100. One contact 96 in the switch 98 is connected to the resistor 68 while the other contact 102 is connected to the rotor 104 in the distributor 100. The arm 106 in the switch 98 is actuated by a multi-lobed cam 108 and a spring 110 that is connected to one side of the condenser 70 which has the opposite side thereof grounded. The contacts 102 in the distributor 100 are connected to the various solenoids 62 in the nozzle 46.

When the arm in the switch 98 is in the upper position this switch will interconnect the battery 94 and variable resistance 68 with the condenser 70 and allow the condenser 70 to be charged thereby. The amount of energy in this charge will be determined by the position of the amount of effective resistance of the resistor 68 which is controlled by the intake manifold vacuum. When the arm 106 in the switch 98 is moved to the opposite position, the condenser 70 will then discharge through the other contact 102, the distributor 100 and the solenoid 62 in one of the fuel injection nozzles 46. The time the valve 58 remains open and therefore the amount of fuel injected may be determined by the amount of energy dissipated in the solenoid 62.

The claims:

1. A fuel injection system for an internal combustion engine comprising energy storage means, means responsive to the fuel demands of said engine operatively interconnected with said energy storage means for charging said energy storage means proportional to said fuel demands, fuel means operatively interconnected with said energy storage means and adapted to discharge metered fuel into the charge for said engine, said fuel means being adapted to dissipate said energy and to meter said metered fuel in proportion thereto.

2. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said fuel injection system comprising energy storage means, means responsive to the vacuum in said induction system operatively interconnected with said energy storage means for charging said energy storage means with energy in proportion to said vacuum, fuel means operatively interconnected with said energy storage means and adapted to discharge metered fuel into the charge in said induction system, said fuel means being adapted to dissipate said energy and to meter said discharged fuel in proportion thereto.

3. A fuel injection system for an internal combustion engine, said system comprising means responsive to the fuel demands of said engine, an energy storing reactance interconnected with said means to be charged thereby with energy in proportion to said fuel demands, an energy dissipating reactance operatively interconnected with said first reactance, fuel means operatively interconnected with said second reactance and adapted to inject fuel into the charge for said engine in proportion to the amount of said energy.

4. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said fuel injection system comprising an energy storing reactance, means responsive to the vacuum in said induction system operatively interconnected with said energy storing reactance for charging said reactance with energy in proportion to said vacuum, fuel means operatively interconnected with said energy storing reactance and adapted to discharge fuel into the charge in said induction system, said fuel means being adapted to dissipate said energy and to meter said discharged fuel in proportion thereto.

5. In an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, a fuel injection system comprising an energy storing reactance, means responsive to the vacuum in said induction system operatively interconnected with said energy storing reactance for charging said reactance with energy in proportion to said vacuum, a plurality of fuel means for injecting fuel into the charges for said cylinders and means for individually interconnecting said energy storing reactance with said fuel means sequentially with the operation of said cylinders, said fuel means including energy dissipating means effective to meter said fuel in proportion to said energy.

6. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system

comprising a source of fuel under pressure, a solenoid actuated nozzle for injecting fuel into said induction system, a condenser adapted to discharge through said solenoid and open said valve, means responsive to the fuel demands of said engine for charging said condenser in proportion to said fuel demands, and means for discharging said condenser through said solenoid to retain said valve open in proportion to said fuel demands.

7. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said fuel injection system comprising a condenser, means responsive to the vacuum in said induction system operatively interconnected with said condenser for charging said condenser in proportion to said vacuum, fuel means operatively interconnected with said condenser and adapted to discharge metered fuel into the charge in said induction system, said fuel means including an inductance adapted to dissipate said charge and to cause said fuel means to discharge said metered fuel in proportion to said charge.

8. The combination of claim 6 wherein said first means comprises a variable resistance and a pressure sensitive device responsive to the induction vacuum to vary said resistance in proportion thereto to thereby control the rate of charging of said condenser.

9. A fuel injection system for an internal combustion engine having an induction system for charging said cylinders, said injection system comprising a source of fuel under pressure, a plurality of nozzles interconnected with said source for injecting said fuel into the charges for said cylinders, a solenoid actuated valve in each of said nozzles for controlling the volume of fuel discharged from said nozzle, a condenser, means responsive to the fuel demands of said engine for charging said condenser in proportion thereto, means for sequentially interconnecting said condenser individually with said solenoid actuated valves for discharging said condenser through said solenoid to retain said valve open in proportion to said fuel requirements.

10. A fuel injection system for an internal combustion engine having an induction system for charging said cylinders, said injection system comprising a source of fuel under pressure, a plurality of nozzles interconnected with said source for injecting said fuel into the charges for said cylinders, a solenoid actuated valve in each of said nozzles for controlling the volume of fuel discharged from said nozzle, a condenser, means including a variable resistor for charging said condenser, a pressure sensitive device responsive to the vacuum in said induction system and effective to vary said resistor to insure said condenser being charged in proportion to said vacuum, a distributor for sequentially interconnecting said condenser with the individual solenoid actuated valves for discharging said condenser through said solenoids to retain said valves open in proportion to the amount of said charge.

11. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said injection system comprising an energy storing reactance, means including a variable resistance for charging said reactance, means responsive to the vacuum in said induction system and effective to vary said resistance, a plurality of injector nozzles adapted to inject fuel into the charge in said induction system, means for sequentially interconnecting said energy storing reactance with each of said nozzles for discharging said energy storing reactance through said nozzles, said nozzles being adapted to dissipate said energy and being effective to meter said fuel in proportion to said energy.

12. A fuel injection system for an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, said fuel injection system comprising a fuel pump, a plurality of injector nozzles interconnected with said pump and disposed in said induction system for injecting fuel therinto, each of said nozzles including a solenoid actuated valve for con-

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trolling the amount of said fuel, a condenser, means for charging said condenser in proportion to the fuel demands of said engine, said means including a variable resistor and a pressure sensitive device responsive to the vacuum in said induction system for varying said resistor and thus the amount of charge in said condenser in proportion to said vacuum, a distributor driven in timed relation to said engine for interconnecting said condenser individually with said solenoids for retaining said valves open in proportion to said charge for metering said fuel in proportion thereto.

13. In an internal combustion engine having a plurality of cylinders and an induction system for charging said cylinders, a fuel injection system comprising a fuel pump, a plurality of injector nozzles interconnected with said

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pump and disposed in said induction system for injecting fuel thereinto, a pressure sensitive device responsive to the vacuum in said induction system and connected to the center of a walking beam, a thermostat connected to one end of said beam, the opposite end of said beam being adapted to actuate a variable resistance, switch means for charging a condenser through said resistance and discharging said condenser through one of said injector nozzles.

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