

Aug. 24, 1954

B. G. PARSONS
FUEL INJECTION SYSTEM

2,687,123

Filed Dec. 5, 1950

2 Sheets-Sheet 1

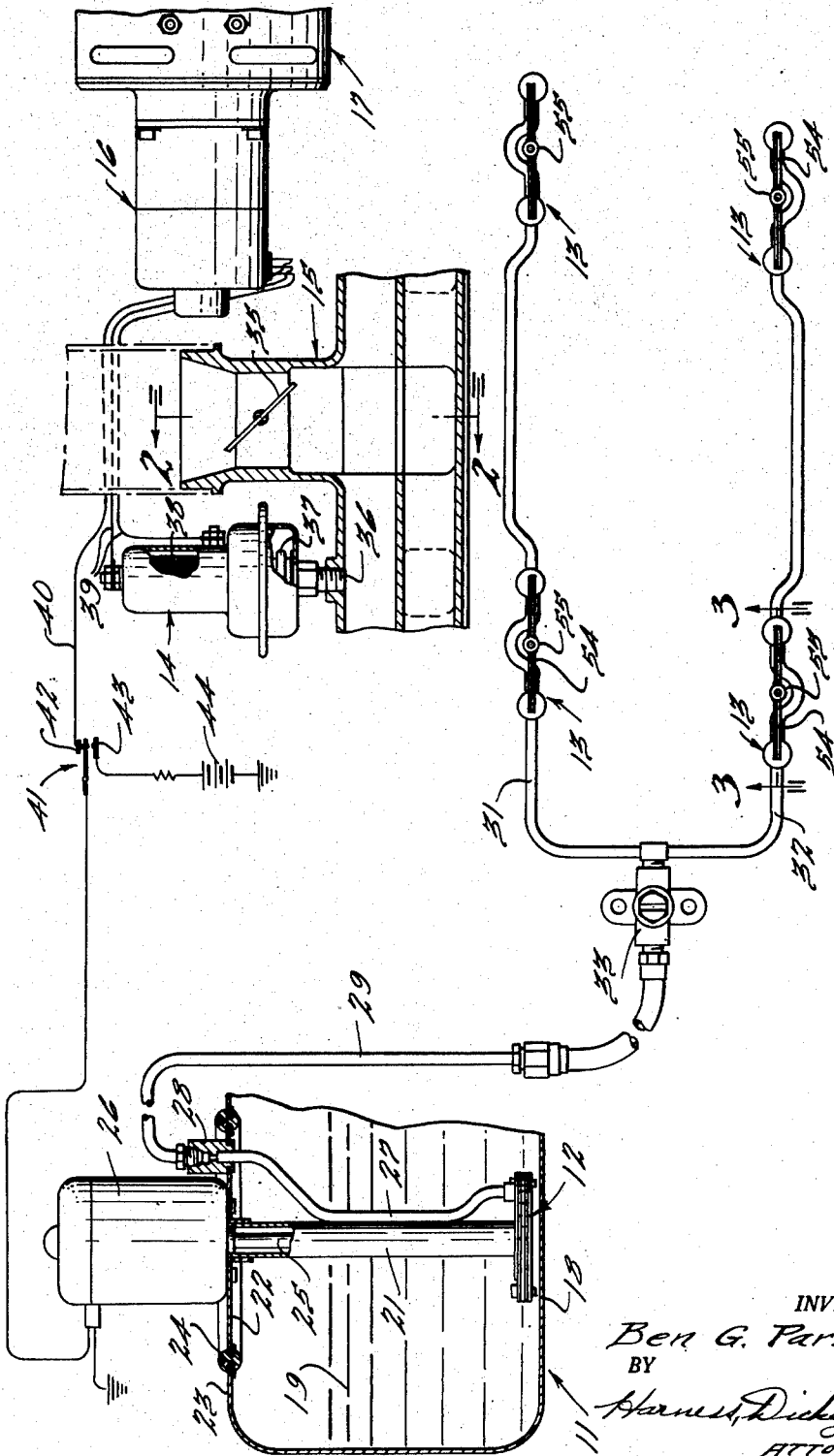


FIG. 1.

INVENTOR.

Ben G. Parsons
BY

Harriet Dickey & Pierce
ATTORNEYS.

Aug. 24, 1954

B. G. PARSONS
FUEL INJECTION SYSTEM

2,687,123

Filed Dec. 5, 1950

2 Sheets-Sheet 2

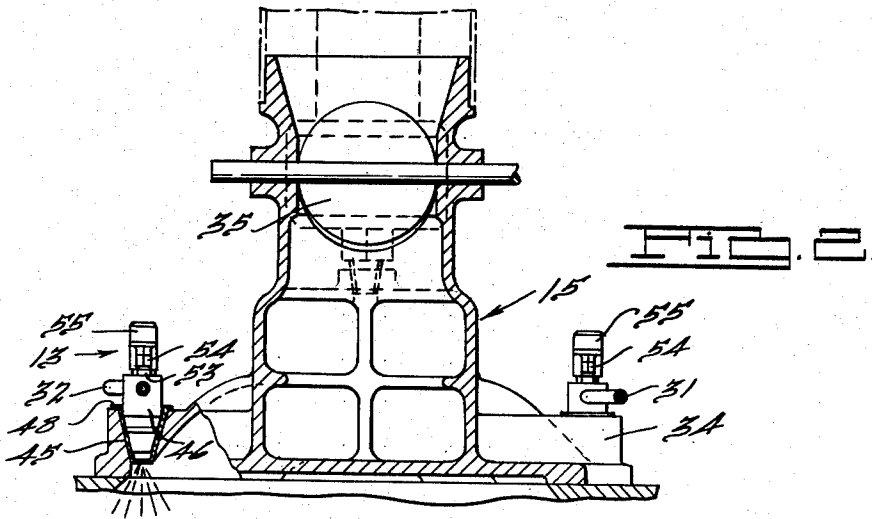


FIG. 4.

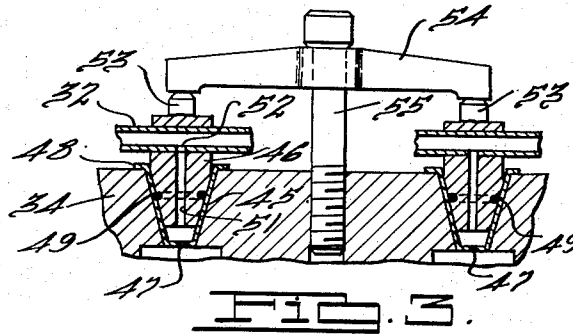
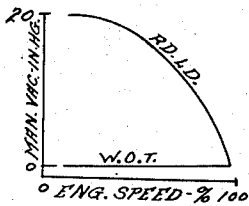


FIG. 6.

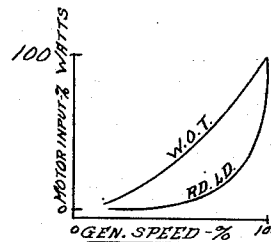
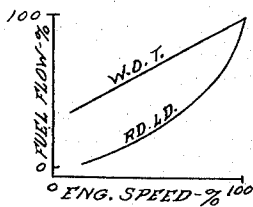


FIG. 5.

INVENTOR.

Ben G. Parsons.

BY

Harness, Dickey & Pierce
ATTORNEYS.

UNITED STATES PATENT OFFICE

2,687,123

FUEL INJECTION SYSTEM

Ben G. Parsons, Grosse Pointe, Mich., assignor
to Fuelcharger Corporation, Wayne, Mich., a
corporation of Michigan

Application December 5, 1950, Serial No. 199,325

7 Claims. (Cl. 123—140)

1

This invention relates to fuel injection systems, and more particularly to a positive pressure fuel feeding, distributing and mixture control system especially adapted for use with spark ignition internal combustion engines, in which liquid fuel and air are supplied to each cylinder through an injection nozzle and an inlet port respectively.

It is an object of this invention to provide an improved fuel injection system as described, in which the richness of the mixture supplied to the cylinders will be automatically controlled to suit the varying load requirements of the engine. More particularly, it is an object to provide an improved fuel injection system in which the richness of mixture is a continuous function of and will be controlled simultaneously by both the intake manifold pressure of the engine and by the engine speed.

It is another object to provide an improved fuel supply system of the indicated character in which the liquid fuel will be supplied to the injector nozzles by means of a variable speed pump, and in which the pump speed will be a continuous function of two coordinated values, these values being created at separate stations and being automatically coordinated by the pump motor.

In particular, it is an object to provide such a system wherein one of these values is created by the instantaneous manifold pressure, and the other by the rotary engine speed.

It is a further object to provide an improved injector nozzle especially adapted for use with the above described fuel injector system, and which is extremely easy to assemble and disassemble. More particularly, it is an object to provide such a nozzle which is of a two-piece threadless construction and which may be quickly removed from its operative position for cleaning or replacing.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a schematic view of the improved fuel injection system, partly in cross-section and showing the construction and cooperation of the elements;

Fig. 2 is a cross-sectional view taken along the line 2—2 of Fig. 1 and showing the positioning of the injector nozzles in the engine head;

Fig. 3 is a cross-sectional view taken along the line 3—3 of Fig. 1 and showing the construction of the injector nozzles as well as their mounting in the engine head; and

Figs. 4, 5, and 6 are plotted graphs or charts

2

illustrating the performance characteristics of the improved fuel injection system.

The fuel injection system of this invention is especially adapted for use in engine installations of the spark ignition internal combustion type wherein liquid fuel is supplied directly to the cylinders by positive pressure means and injected through a nozzle or atomizer, the air being drawn into the cylinders through intake valves adjacent the nozzles. It will be understood, however, that the principles of this invention are equally applicable to other types of internal combustion engines. The system comprises in general a fuel supply source 11, a pump 12 which forces the fuel through a series of injector nozzles 13, a device 14 which is sensitive to the pressure within intake manifold 15, and a generator 16 which controls the pump speed and is in turn controlled both by the pressure-sensitive device 14 and by the speed of engine 17 to which it has a driving connection. The fuel supply source 11 comprises a fuel tank 18 containing liquid fuel 19. The pump 12 may be of any conventional type, and in the illustrated embodiment is shown as comprising a turbine type of pump mounted within the lower portion of the fuel supply tank 18. The pump is supported by a tubular column member 21 extending upwardly therefrom and suspended in turn from a plate 22. This plate is preferably secured in flush relation with the upper wall 23 of the fuel supply tank by means of a seal strip 24. The pump rotor shaft 25 is concentrically mounted within tubular column 21 and is driven by a motor 26 mounted above plate 22. It will be understood, however, that other types of mounting means may be employed for the motor and pump and in particular that, if desirable, the motor could be mounted within the fuel supply tank itself.

The discharge end of pump 12 has a riser 27 leading upwardly therefrom through the tank to a connecting piece 28. Fuel supply line 29 leads from the connecting piece to the distributing lines 31 and 32 through an adjustable idle speed valve control 33. Injector nozzles 13 are mounted at spaced intervals along the distributing lines 31 and 32 and are supported within engine head 34, as best seen in Figs. 2 and 4. It will be observed that in the illustrated embodiment there does not appear a distributor element in fuel supply line 29 or in the distributing lines 31 and 32 in order to intermittently supply fuel to the various nozzles. This arrangement is especially adapted for the conventional high speed internal combustion engine wherein the combustion cycle

is so brief as to nullify the usefulness of such a distributor. It will be understood, however, that the principles of this invention would be equally effective in a system containing such a distributor in the line.

The purpose of the novel control means for the fuel injection system is in general to supply a richer air-fuel mixture to the engine when its power needs are greater—namely, when the throttle 35 is opened and also when the speed of the engine 17 is increased. Since wider throttle openings result in decreased intake manifold vacuum, the richness of the mixture should be in inverse proportion to the degree of vacuum, and in direct proportion to engine speed. The generator 16 which supplies the power for pump motor 26 is utilized to achieve the above-described results. Motor 26 is preferably of a conventional D. C. type, the speed of which is proportional to armature current. The generator 16 is also of a conventional D. C. type, the output current being proportional to both the armature speed and the field current. As stated previously, the armature of generator 16 is driven directly from the engine 17 by means (not shown) such as a belt drive. The field circuit of generator 16 is controlled by pressure-responsive device 14. This device is connected directly to the intake manifold 15 by a nipple 36 and has a pressure-responsive element 37 therein such as a bellows or diaphragm which controls a variable rheostat 38 in the generator field circuit so that the resistance in the field circuit increases as the manifold vacuum increases. Since devices having these elements are known in the art, unit 14 is not shown in detail in the drawings, but such a pressure-responsive device is described in detail in my copending application No. 335, filed January 2, 1948, now Patent 2,576,694, issued November 27, 1951. Lead lines 33 connect the pressure-responsive rheostat to the generator field circuit. The output of the generator is carried by a line 40 having a starting switch 41 therein to the pump motor 26. The starting switch 41 may be of a conventional two-way type having a terminal 42 connected to line 40 and a starting terminal 43 connected directly to a battery 44, so that the pump may be operated for priming purposes upon starting the engine. If desired, a thermostatic switch (not shown) may be inserted in the line leading to battery 44 in order to prevent the priming operation except when the engine is cold.

The injector nozzles 13 are preferably mounted within openings (not designated) in the engine head adjacent their corresponding cylinders. As best see in Figs. 2 and 3, each nozzle comprises a shell portion 45 inserted within the cylinder head opening and a body portion 46 fitting within the shell portion and connected to the distributing line. The shell portion 45 and its corresponding opening may be tapered if desired and has an orifice 47 designed to disperse and atomize the fuel as it is forced therethrough, the upper edge of the shell being provided with a peripheral flange 48 which rests upon the top of the engine head. The body 46 is held in sealed relation with the shell 45 by means of O-ring 49, and the body is provided with an axial bore 51 extending therethrough and aligned with an aperture 52 in the distributing line, the latter passing transversely through the upper portion of the body. A boss 53 projects upwardly from the body, and a pair of injector nozzles may be clamped in operative position by a clamping bar 54 drawn downwardly against the bosses by a bolt 55 threaded into the

head. It will therefore be seen that the nozzles are exceedingly easy to take apart and clean, since it is only necessary to loosen clamp 54, lift the nozzle from its seat (the line 32 being of resilient construction), and slip the shell 45 from the body to clean the orifice 47.

In operation of the fuel supply system, assuming an initial condition in which the motor is shut off, the system will be started for priming purposes by moving switch 41 against starting contact 43 so as to connect pump motor 26 directly to the battery 44. In vehicular installations, the starting switch 41 may be actuated by means (not shown) simultaneously with the engine starting switch when the ignition switch is on. Once the engine is started the switch 41 may be moved to contact 42 and the pump motor 26 supplied with power by generator 16.

The performance of the system under various conditions may perhaps best be illustrated with reference to the plotted graphs of Figs. 4, 5 and 6. Fig. 4 illustrates the variation of manifold vacuum with engine speed for two extreme conditions—namely, a wide open throttle (W. O. T.) condition and for a road load (Rd. Ld.) condition in which the throttle is only opened sufficiently to overcome the frictional resistance to a vehicle. It will be seen from this figure that for road load throttle settings the manifold vacuum will be a maximum at low engine speeds and will decrease gradually, and then more rapidly, with increase in engine speed. With a wide open throttle, the manifold vacuum will be practically zero at low engine speeds and will increase only very slightly as the engine speed increases. Keeping in mind these engine characteristics, it will be understood that at low engine speeds with road load throttle settings the armature rotation of generator 16 will be relatively slow, and the rheostat setting of pressure-responsive device 14 will be such as to insert maximum resistance in the generator field circuit. These combined actions will result in a minimum amount of power output from the generator, and the pump motor 26 will thus be driven at a low speed, delivering a minimum amount of fuel to the injector nozzles 13. Upon increase in engine speed the generator armature will be driven at a faster rate, thus supplying more power to the pump motor and increasing the fuel flow. If the increase in engine speed is accomplished with road load throttle settings, that is, with minimum acceleration, the manifold vacuum and therefore the field resistance will decrease gradually, and then more rapidly, thus likewise acting to increase the fuel flow. At a low engine speed with wide open throttle, the manifold vacuum is negligible and the low field resistance in the generator will result in substantial fuel delivery. If the engine speed increase is accompanied by a wide open throttle, the resultant increase in armature rotational speed will still further increase the generator output and the resultant fuel flow.

It is important to note at this point that the novel principles of this invention present a great improvement over systems where the fuel delivery rate is made to vary with manifold pressure alone, since in systems of the latter type there would be no increase in fuel flow if the engine speed were increased with a wide open throttle.

Fig. 5 illustrates the variation of power input to motor 26 with increase in generator speed, both for road load and the wide open throttle conditions. It will be seen from this figure that with a wide open throttle the power input will increase

at a steadier rate than with road load throttle settings. Fig. 6 illustrates the variation in fuel flow to the injector nozzles with engine speed increase for road load and wide open throttle conditions. It will be obvious from the foregoing discussion that at low engine speeds the fuel flow will be substantially greater with a wide open throttle (low manifold vacuum) than with a road load throttle setting. Since there is a steady decrease in manifold vacuum with increasing engine speeds at road load throttle (see Fig. 5) the fuel flow will increase more rapidly with engine speed increase at this type of throttle setting than it will with a wide open throttle. This difference in fuel flow increase rate is made apparent by the plotted curves of Fig. 6. It will therefore be seen that a fuel injection system is provided which takes into account both manifold vacuum and engine speed in controlling the mixture richness, and which is capable of an infinite amount of delivery rates depending upon the instantaneous engine conditions.

While it will be apparent that the preferred embodiment of the invention herein disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

I claim:

1. In combination with an internal combustion engine of the fuel injection type, a pump for delivering fuel to the injection system, a variable speed motor for driving said pump, a generator driven by said engine and operatively connected to said motor, and a pressure-responsive rheostat connected to the intake manifold of said engine, said rheostat being in the circuit of said generator, whereby the output of said generator is a function of both the engine speed and the intake manifold pressure.

2. In combination with an internal combustion engine, a pump for supplying fuel under positive pressure to said engine, a motor of a variable speed type for driving said pump, a generator connected to said motor for supplying power thereto, the armature of said generator being driven at a speed directly proportional to said engine, a rheostat in the field circuit of said generator, and a pressure-responsive element connected to the intake manifold of said engine and controlling the setting of said rheostat, whereby the output of said generator increases with an increase in engine speed or with a decrease in manifold vacuum.

3. In combination with an internal combustion engine of a type having a positive pressure fuel supply system, a pump for supplying fuel to said system under positive pressure, a variable speed electric motor having a driving connection with said pump, a source of electric power for said motor, a connecting element between said engine and said power source for varying the power output of said source in direct proportion to engine speed, and a second connecting element between said power source and the intake manifold of said engine for varying the output of said power source in inverse proportion to the manifold vacuum, the effects of said first and second connecting elements being continuously and simultane-

ously integrated by said power source, whereby the power supply to said motor will depend upon the combined effects of these connecting elements.

4. In an internal combustion engine of the type having a positive pressure fuel supply system, a pump for supplying fuel to said system, a variable speed electric motor for driving said pump, a generator having an armature driven at a speed directly proportional to the speed of said engine, a rheostat in the field circuit of said generator, a pressure-responsive element connected to the intake manifold of said engine and controlling the setting of said rheostat so as to increase the generator output when the manifold vacuum decreases, a power supply line leading from said generator to said motor, a two-way starting switch in said power supply line, and a separate power source for said motor, said starting switch being movable between a starting position in which said motor is connected to said separate power source and a running position in which said motor is connected to said generator.

5. In combination with an internal-combustion engine of the fuel injection type, a pump for delivering fuel to the fuel injection system, an electrical circuit including a variable speed pump motor and generator therefor, the generator being driven by said engine, and electrical control means responsive to the intake manifold pressure of said engine, said control means being connected in said circuit, whereby the speed of said pump motor is a function of both the engine speed and the intake manifold pressure.

6. In combination with an internal-combustion engine of the fuel injection type, a pump for delivering fuel to the injection system, a variable speed motor for driving said pump, a generator driven by said engine and connected to said motor for supplying power thereto, and control means responsive to intake manifold pressure of said engine and electrically connected to said generator, whereby the output of said generator is a function of both the engine speed and the intake manifold pressure.

7. In combination with an internal-combustion engine of the fuel injection type, a pump for delivering fuel to the fuel injection system, an electrical circuit including a variable speed pump motor and generator therefor driven by said engine, and a pressure-responsive rheostat controlled by the intake manifold of said engine and connected in said circuit, whereby the speed of said pump motor is a function of both the engine speed and the intake manifold pressure.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,557,206	Kettering	Oct. 13, 1925
1,684,073	Rotter	Sept. 11, 1928
1,826,535	Thomas	Oct. 6, 1931
1,912,057	Bagnulo	May 30, 1933
2,308,746	Flint	Jan. 19, 1943
2,313,264	Reggio	Mar. 9, 1943
2,341,257	Wunsch	Feb. 8, 1944
2,435,902	Reggio	Feb. 10, 1948