

[54] **FUEL INJECTION SYSTEMS FOR
INTERNAL COMBUSTION ENGINES**

123/140 MC

[72] Inventor: **George Vincent Bloomfield,**
Coventry, England

[73] Assignee: **Brico Engineering Limited,** War-
wickshire, England

[22] Filed: **Nov. 10, 1970**

[21] Appl. No.: **88,416**

Related U.S. Application Data

[62] Division of Ser. No. 811,914, April 1, 1969, Pat. No.
3,596,640.

[30] **Foreign Application Priority Data**

April 5, 1968 Great Britain.....16,641/68

[52] U.S. Cl. 123/139 AW, 123/32 EA

[51] Int. Cl. F02m 51/00

[58] Field of Search.....123/32 AE, 32 EA, 139 AW,
140 AW,

[56]

References Cited

UNITED STATES PATENTS

2,856,910	10/1958	Goodridge	123/139 AW
3,272,187	9/1966	Westbrook et al.	123/32 EA
2,891,532	6/1959	Turlay	123/140 MC
2,899,948	8/1959	Groves	123/140 MC

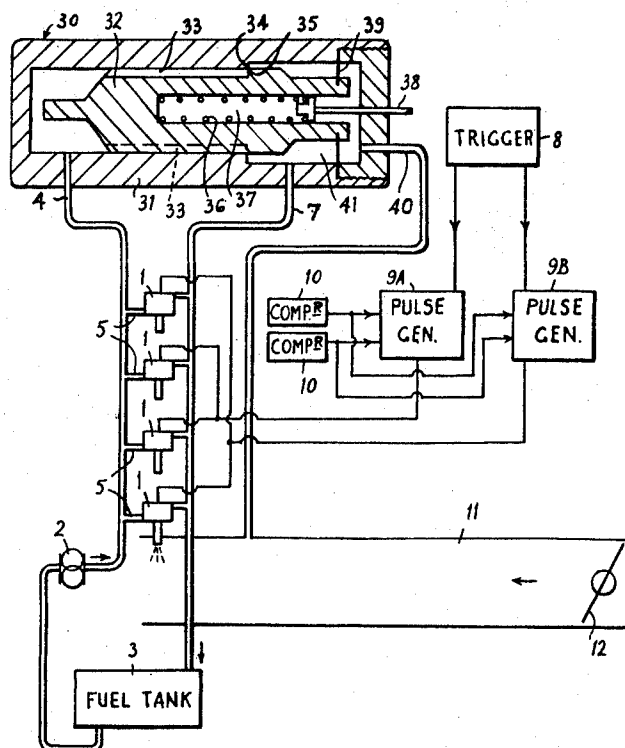
Primary Examiner—Laurence M. Goodridge
Attorney—Holcombe, Wetherill & Brisebois

[57]

ABSTRACT

Fuel from a fuel pressure source is injected by fuel injection valves into the induction passage of an engine and means are provided to vary the pressure of the fuel pressure source in accordance with the engine induction passage pressure, in the sense of reducing the fuel pressure when the induction passage pressure is reduced and vice versa.

6 Claims, 2 Drawing Figures



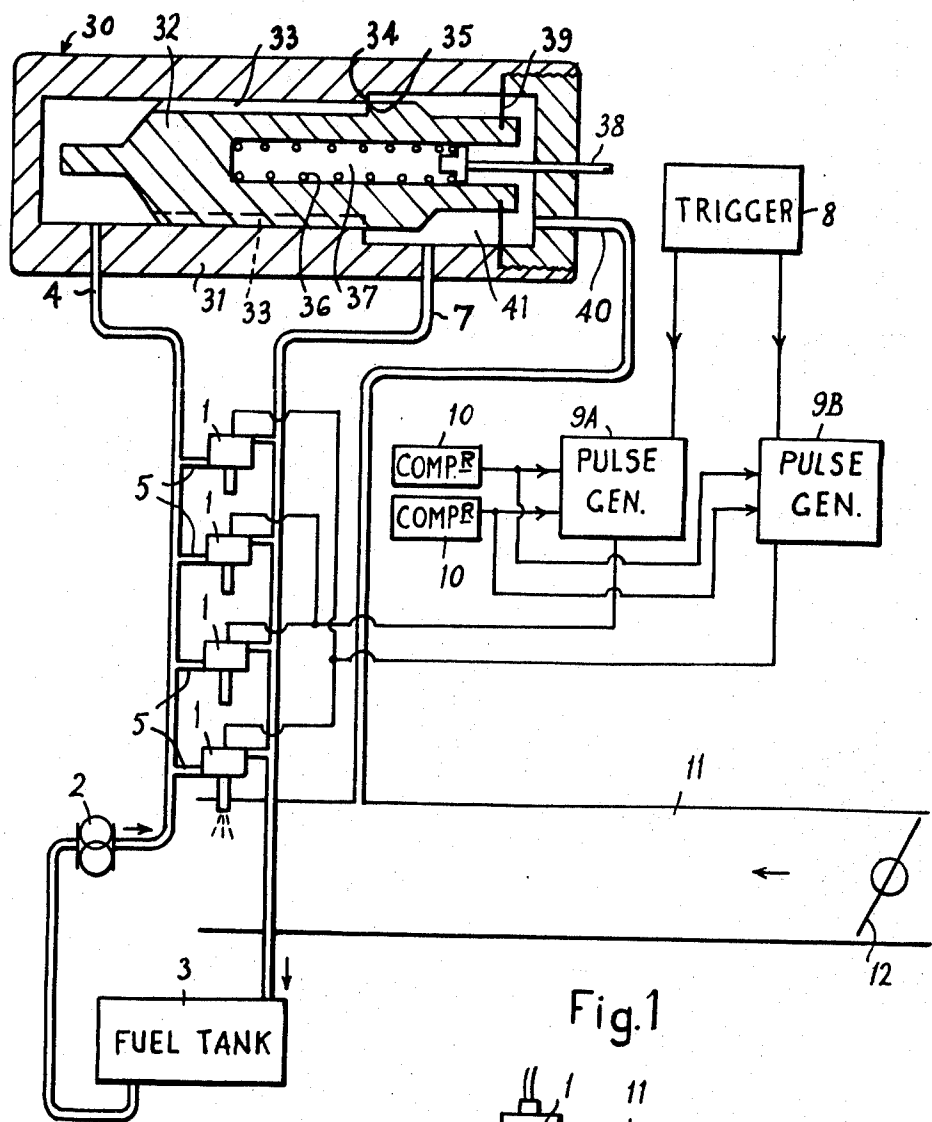


Fig.1

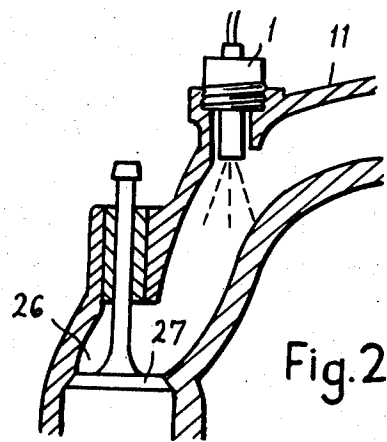


Fig.2

FUEL INJECTION SYSTEMS FOR INTERNAL COMBUSTION ENGINES

This application is a division of my prior application Ser. No. 811,914, filed Apr. 1, 1969 now U.S. Pat. No. 3,596,640.

This invention relates to fuel injection systems for internal combustion engines, of the kind in which fuel is fed to an engine through one or more electrically-operated fuel injection valves or injectors which are opened intermittently.

According to this invention, there is provided a fuel injection system of the kind described, wherein fuel is injected by the or each valve into an induction passage of the engine and the or each valve is supplied from a fuel pressure source, and there is provided means to vary the pressure of the fuel pressure source in accordance with the engine induction passage pressure, in the sense of reducing the fuel pressure when the induction passage pressure is reduced, and vice versa.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a simplified diagram of one embodiment of a fuel injection system according to the invention; and

FIG. 2 is a view of part of an induction passage of an engine.

Referring to FIG. 1, a fuel injection system is shown as applied to a four-cylinder internal combustion engine, having one fuel injection valve or injector 1 for each cylinder. Fuel from a fuel tank 3 is fed by a fuel pump 2 to a common fuel supply rail 4 and the injectors 1 are each connected by a supply line 5 to the fuel rail 4. Excess fuel from each injector is returned to the fuel tank 3 through the return rail 7. A pressure relief valve 30 which will be described in detail later is connected between the common fuel supply rail 4 and the return rail 7 and controls the fuel pressure in the common rail 4.

Each fuel injector 1 is opened intermittently by electrical pulses generated in the pulse generators 9A and 9B. Each pulse is initiated by the closing of a trigger switch device 8 driven from the engine and which operates once per engine cycle for each cylinder. The trigger switch 8 is connected to the pulse generators 9A and 9B each of which controls two fuel injectors 1. The duration of each pulse fed to an injector is controlled by the pulse generators under the control of voltages fed to the pulse generators from computer circuits 10. One voltage may, for example, be a function of the engine manifold pressure and rotational speed, and the other voltage may be a function of ambient temperature and the engine cooling water temperature. Thus for any given set of operating conditions the pulse duration, and consequently the time which a fuel injector 1 is open, will be the same. The pulse generators and the computer circuits may be constructed as described in U.S. Pat. specification No. 3272187, and the injectors as in U. S. Pat. specification No. 3247833.

As mentioned above, the fuel pressure in the fuel supply rail 4 is controlled by a relief valve 30. This valve comprises a valve body 31 defining a cavity in which is slidably arranged a valve member 32 having splines 33 which engage with the walls of the body 31. A shoulder 34 in the body cooperates with a shoulder 35 on the valve member, at the end of the splines, to form a metering throat and so control the amount of

fuel passing between the supply rail 4 and return rail 7. A spring 36 is located in a cavity 37 in the valve member 32 and is provided with a threaded adjuster member 38 which is threaded in the wall of the valve body 31, to adjust the force of the spring acting on the valve member 32. The valve member 32 is also attached to a diaphragm 39 extending between this member and the valve body 31. One side of the diaphragm is subjected to the pressure in the induction passage 11 downstream of the throttle valve 12, by means of the conduit 40. The other side of the diaphragm is subjected to the fuel pressure in the space 41 communicating with the return rail 7.

The relief valve 30 is so arranged that upon an increase of the engine induction passage pressure, the diaphragm is urged by the increase in pressure applied through conduit 40 acting in conjunction with the force of spring 36, in the sense of closing the metering throat between shoulders 34 and 35, thereby increasing the fuel pressure in the supply rail 4. Conversely, a decrease in the induction passage pressure causes the valve 30 to pass more fuel and thereby decrease the fuel pressure in the supply rail 4.

In this way the pressure in the common fuel supply rail 4 is increased when the induction passage pressure is relatively high and is reduced when the induction passage pressure is relatively low, whereby the pressure difference causing the fuel to flow through each injection valve orifice is maintained more nearly constant.

Referring to FIG. 2, part of the induction passage 11 of the engine is shown in order to indicate that the fuel injection valves 1, of which there are in this case one per cylinder, are so located with respect to the cylinders so that the fuel is injected directly into the induction port 26 of each cylinder, to be drawn into the cylinder on opening of the inlet valve 27.

It will be appreciated that the number of pulse generators may be varied, from a single unit upwards, depending on the number of cylinders of the engine, but preferably the fuel injectors of the engine are divided into a number of groups, each controlled by a separate pulse generator.

It will be understood that the fuel injection system herein described may be applied to engines having more or less than four cylinders.

I claim:

1. In a fuel injection system for an internal combustion engine wherein fuel is fed to the engine through one or more electrically-operated fuel injection valves, and including a pulse generator which produces pulses of a duration depending on one or more parameters of engine operation for intermittently energizing the valve or valves to open to pass fuel, means for triggering the pulse generator in timed relation to the engine operating cycle, means for feeding one or more control signals varying as a function of a parameter of engine operation, including a control signal dependent on induction passage pressure, to the pulse generator in order to control the duration of the energizing pulses fed to open the injection valve or valves, and wherein the fuel is injected by the or each valve into an induction passage of the engine and the or each valve is supplied from a fuel pressure source, the improvement which consists in maintaining a substantially constant fuel pressure difference across the fuel injection valve

3

or valves by providing means to vary the pressure of the fuel pressure source in accordance with the engine induction passage pressure, in the sense of reducing the fuel pressure when the induction passage pressure is reduced and vice versa.

2. A system as claimed in claim 1, in which the fuel is fed from a fuel tank to a fuel supply line connected to each injection valve and a return line is connected from each injection valve, by means of which excess fuel can be returned to the fuel tank, wherein a pressure-operated valve is connected between the fuel supply line and the fuel return line, said valve being controlled in accordance with the pressure existing in the induction passage of the engine.

3. A system as claimed in claim 2, including a connection from the induction passage downstream of the throttle valve of the engine and leading to said pressure-operated valve.

4. A system as claimed in claim 3, in which the pressure-operated valve comprises a diaphragm having one

4

side exposed to induction passage pressure, and the arrangement is such that an increase in the induction passage pressure tends to close the valve, and vice versa.

5. A system as claimed in claim 4, in which the other side of the diaphragm is subjected to the pressure in the fuel return line.

6. A system as claimed in claim 5, comprising a valve body, a splined valve member arranged within the valve body and having a shoulder which cooperates with a shoulder on the valve body to form a fuel metering throat, a spring acting on said valve body, a diaphragm extending between the valve member and the valve body, a connection from the fuel return line to the valve body at the other side of the diaphragm and one end of the valve member, and a connection from the fuel supply line to the valve body at the other end of the valve member.

* * * * *

25

30

35

40

45

50

55

60

65