United States Patent [19]

Makino et al.

[11] **3,827,415**

[45] **Aug. 6, 1974**

[54] FUEL SUPPLY DEVICE FOR INTERNAL COMBUSTION ENGINES

[75] Inventors: **Takayuki Makino**, Okazaki; **Shinya Ishii; Rokuji Ohkubo**, both of Toyota, all of Japan

[73] Assignee: **Toyota Jidosha Kogyo Kabushiki Kaisha**, Toyota-shi, Japan

[22] Filed: **Oct. 7, 1971**

[21] Appl. No.: **187,298**

[30] **Foreign Application Priority Data**

Nov. 7, 1970 Japan 45-97562

[52] **U.S. Cl.** .... **123/119 R**, 123/139 AW, 123/DIG. 10

[51] **Int. Cl.** **F02m 7/00**, F02d 31/00

[58] **Field of Search** .... 123/DIG. 10, 119 R

[56] **References Cited**

UNITED STATES PATENTS

3,386,709	6/1968	Drayer	123/DIG. 10
3,598,096	8/1971	Timpner	123/DIG. 10
3,672,339	6/1972	Lazar	123/119 R

Primary Examiner—Wendell E. Burns
Attorney, Agent, or Firm—Stevens, Davis, Miller & Mosher

[57] **ABSTRACT**

A fuel supply device for internal combustion engines, comprising a rotating pulse generating means and a fluid calculating means having a pulse-width modulating means and a fuel injection means. The rotating pulse generating means comprises a pulse generator and a fluid element for shaping wave forms and utilizes liquid fuel as a medium to produce pulse signal conforming to the fuel injection timing in accordance with the number of engine revolution. The pulse-width modulating means comprises a variable liquid resistor adapted to throttle the pulse signal in conformity with the internal pressure in an intake manifold, and further comprises a fluid element for controlling pulse width which is set by the pulse signal and is reset by the throttled signal obtained from the variable liquid resistor. Thus, the pulse-width modulating means is adapted to modulate the pulse signal conforming to the fuel injection timing to provide a control pulse having a width which better corresponds with the fuel injection timing. The fuel injection means comprises a fluid element for fuel injection and supplies fuel to the downstream side of a throttle valve in the intake manifold in accordance with the control pulse signal having the modulated pulse width.

7 Claims, 7 Drawing Figures

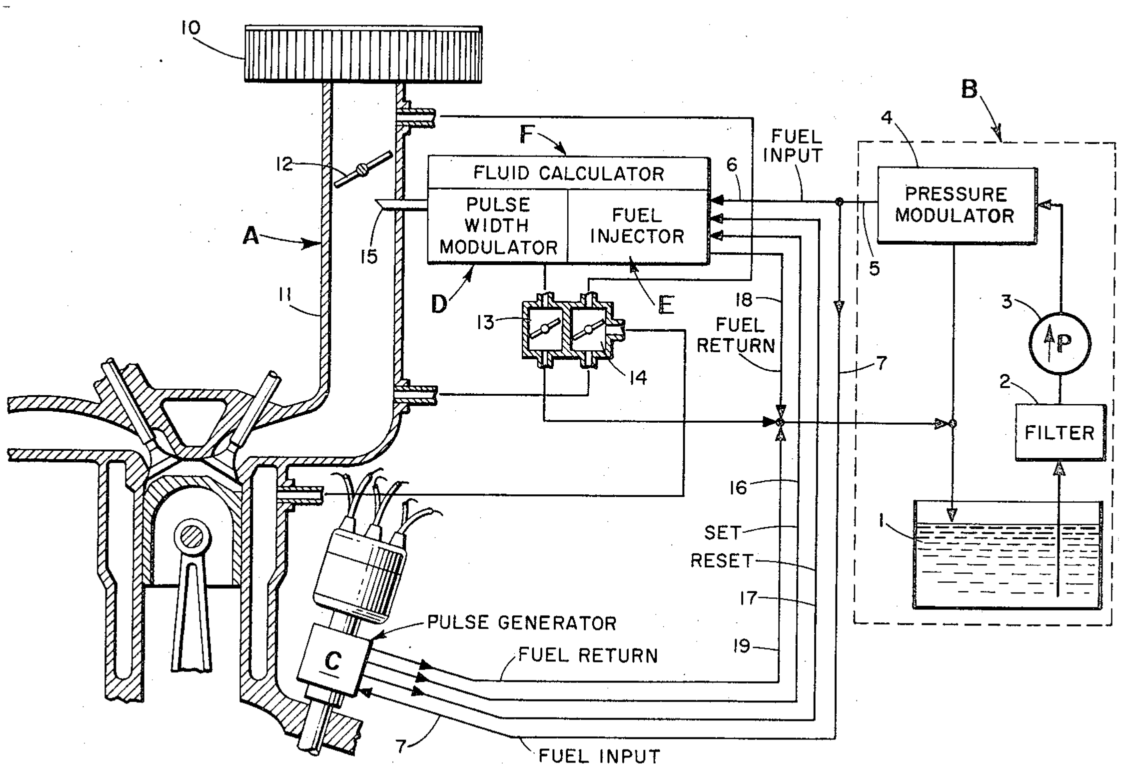


FIG. 1

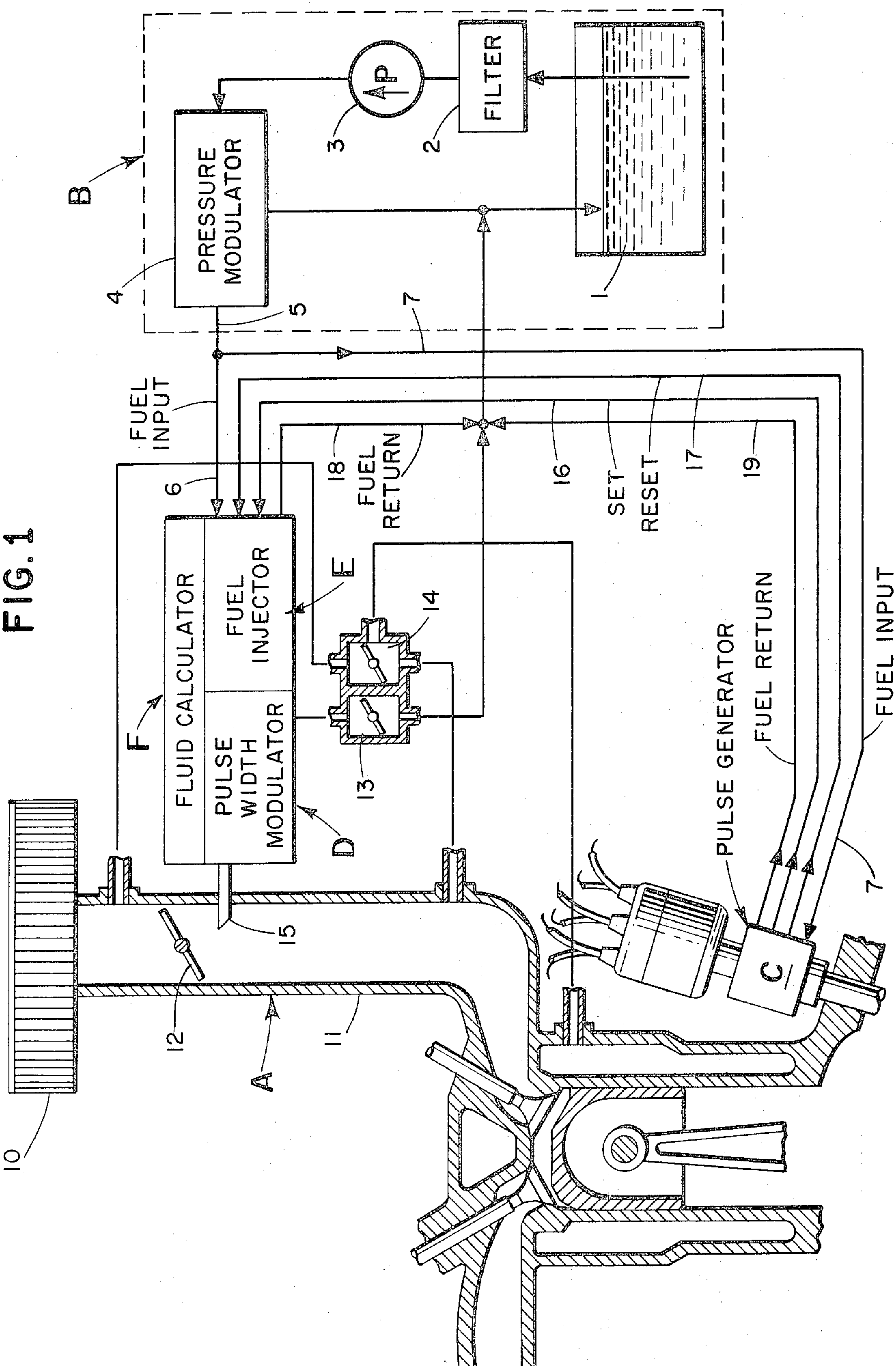
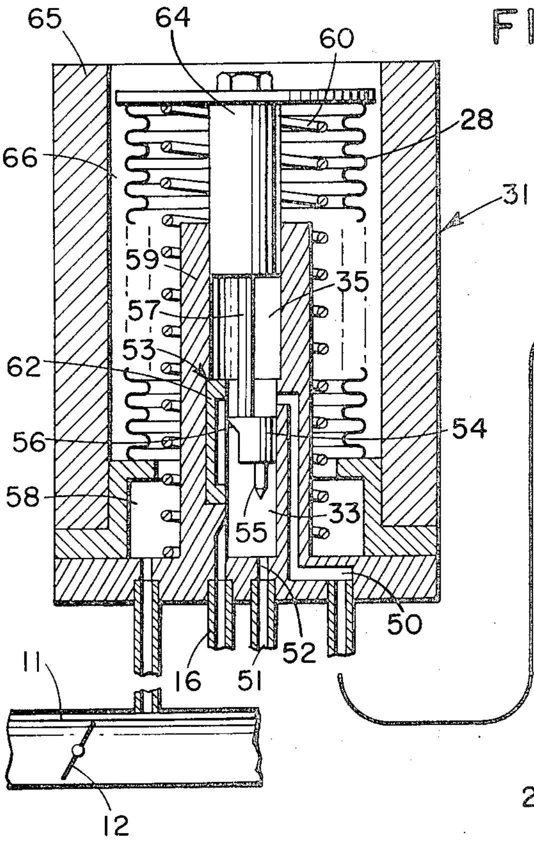

FILTER
P
PRESSURE MODULATOR
B
1
2
3
4
5
7
FUEL INPUT
6
18
FUEL RETURN
16
SET
RESET
17
19
FLUID CALCULATOR
FUEL INJECTOR
PULSE WIDTH MODULATOR
E
F
D
14
13
15
PULSE GENERATOR
FUEL RETURN
FUEL INPUT
C
7
10
12
11
A

FIG. 4A



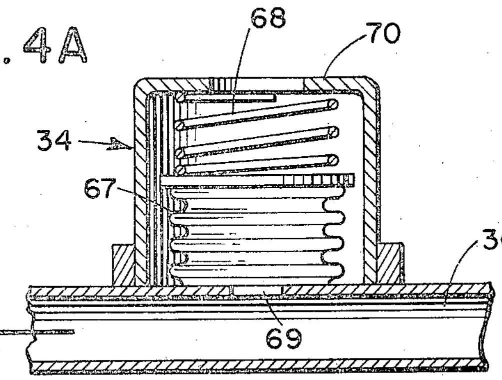


FIG. 2

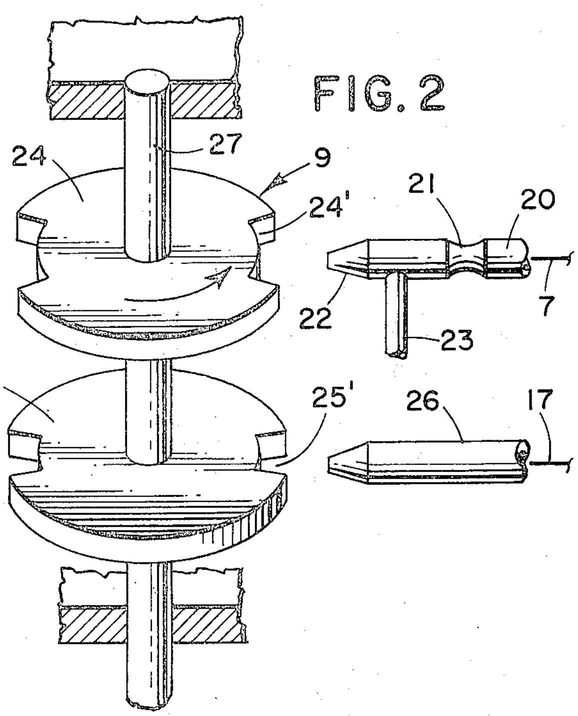


FIG. 4B

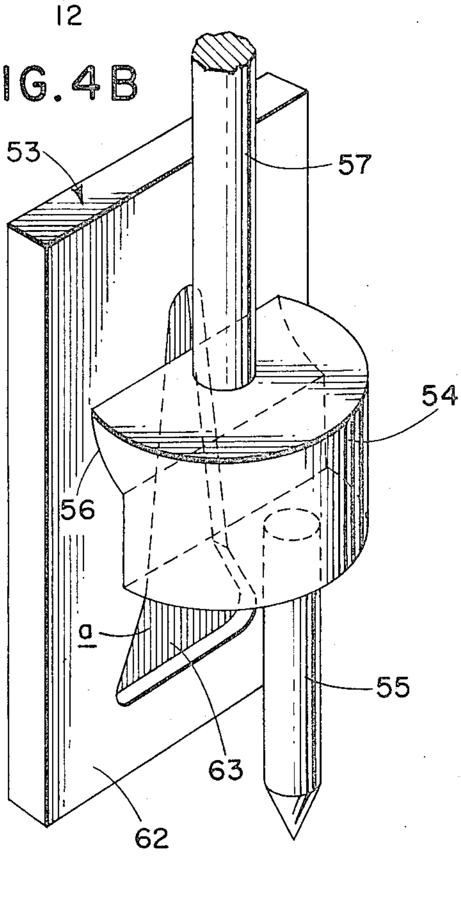
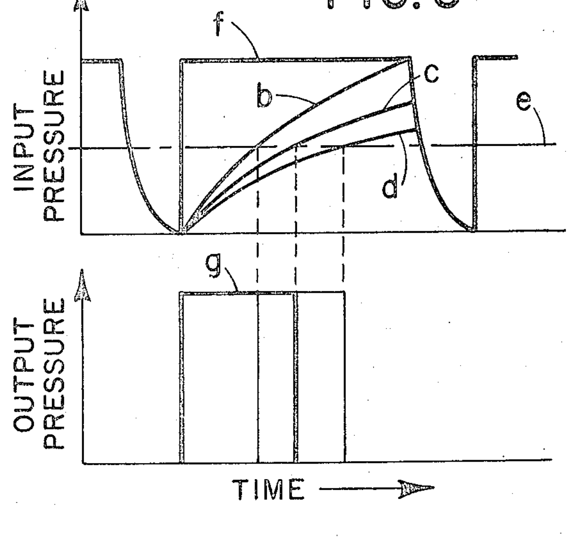


FIG. 5



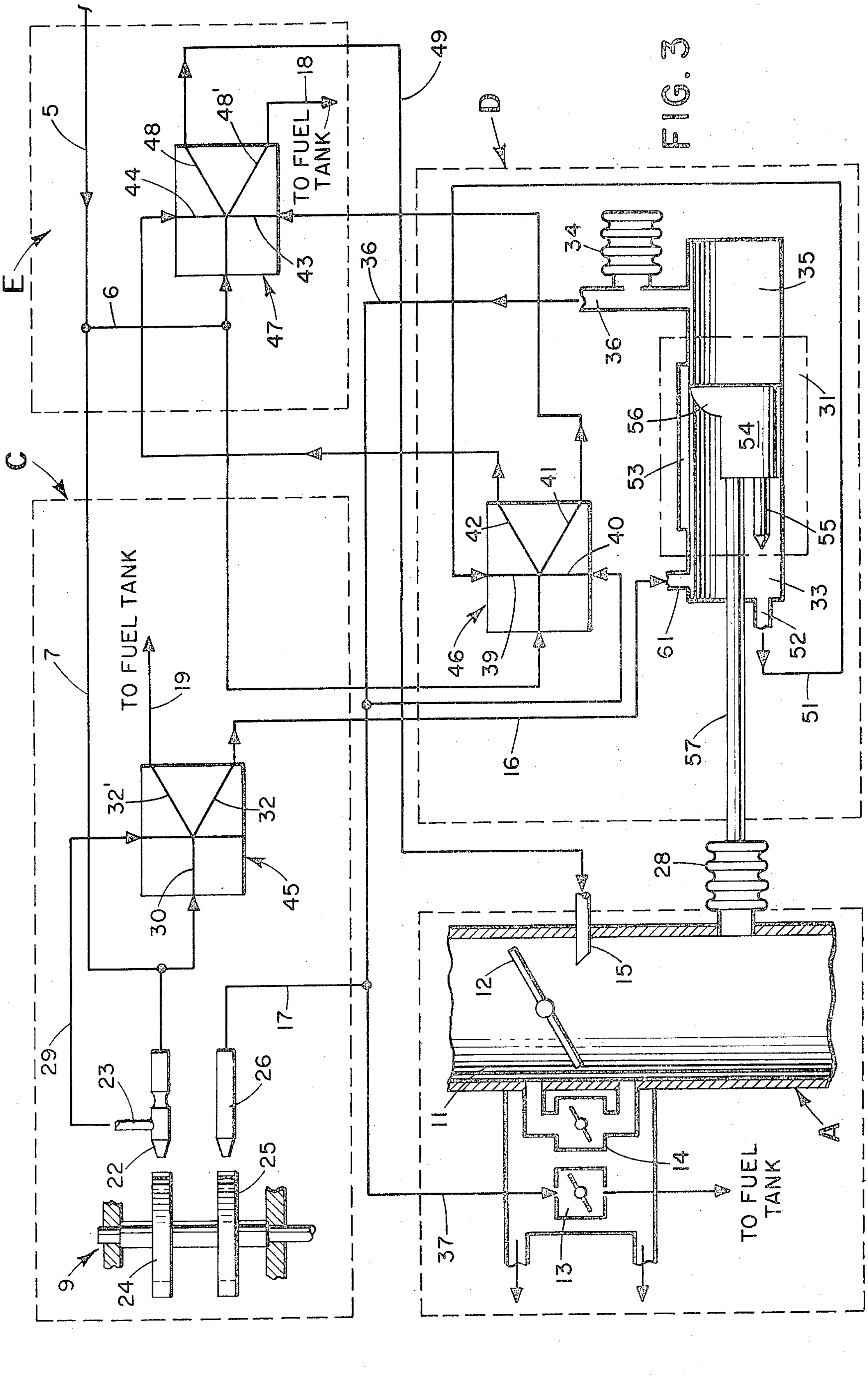
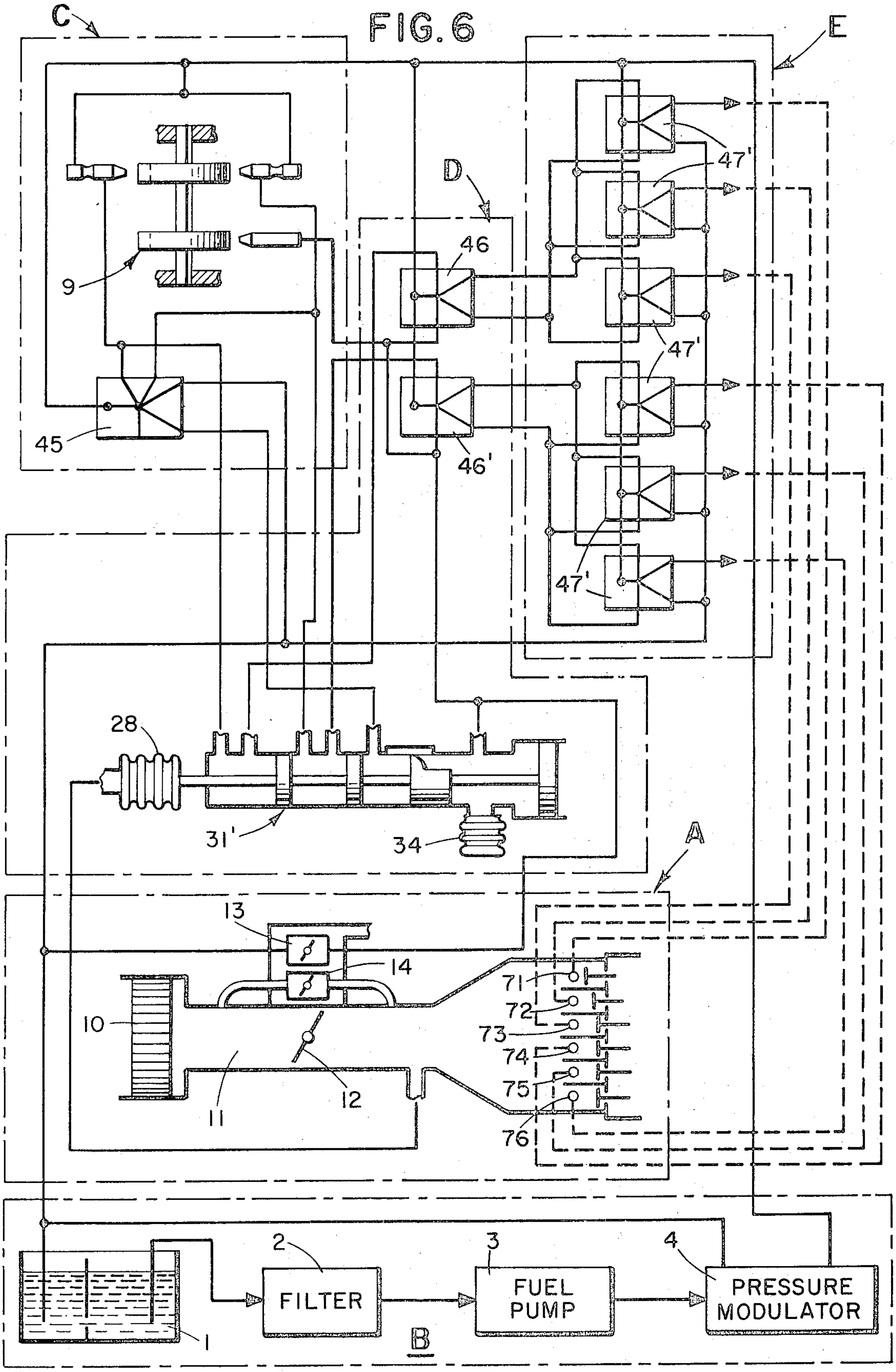


FIG. 3

FIG. 6


C
E
D
47'
46
9
47'
45
46'
47'
28
31'
34
A
13
14
71
72
10
73
74
75
12
11
76
2
3
4
FILTER
FUEL
PUMP
PRESSURE
MODULATOR
1
B

FUEL SUPPLY DEVICE FOR INTERNAL COMBUSTION ENGINES

BACKGROUND OF THE INVENTION

This invention relates to a fuel supply device for use with carburetors of internal combustion engines of automobiles or the like in which fuel is supplied at an optimum air fuel ratio conforming to the operating condition of the engine. More particularly, it relates to a fuel supply device in which the fuel injection timing and injection duration are appropriately controlled in accordance with the operating condition of the engine.

Conventional fuel supply devices for automobile engines are of the type wherein the amount of fuel introduced into the engine is due to the difference between the pressure in the fuel chamber and the negative pressure produced in the Venturi fuel nozzle by the velocity of air flow. In supply devices of the type described above, however, the Venturi negative pressure is influenced by environmental conditions such as temperature and atmospheric pressure as well as by the number of engine revolutions, thus causing a discrepancy between the fuel injection amount required by the engine and the amount of fuel actually injected. Consequently, it is difficult to obtain the optimum air fuel ratio for given environmental and engine loading conditions.

In addition to fuel supply devices utilizing the Venturi negative pressure, an injection type fuel supply device has been proposed in which the amount of fuel to be supplied is electrically controlled by employing the manifold negative pressure and the number of engine revolutions as the engine loading signal to obtain the characteristic values indicating the operating conditions of the engine, thus injecting fuel into air intermittently or continuously. However, as such a device utilizes a medium other than fuel, for example electricity or air, for calculating the characteristic values indicating the operating conditions of the engine, a separate energy source for providing such a medium is required. Moreover, the detecting and control mechanism for adjusting the fuel amount to the operating conditions of the engine are complicated.

SUMMARY OF THE INVENTION

The object of this invention is to control the amount of fuel supplied to an engine in accordance with its operating characteristics by simple calculations having a high degree of accuracy and to simplify the construction of the calculating mechanism without using any other medium than fuel.

In fuel supply devices of the type in which fuel is injected into the intake air in an intake pipe by calculating and controlling the number of engine revolutions and the engine load, the above-described object is attained by the provision of a rotating pulse generating means utilizing liquid fuel as a medium for generating a fluid pulse signal which is in synchronism with the number of engine revolutions per unit time and a fluid calculating means adapted to perform multiplication by replacing the internal pressure in an intake manifold by the liquid resistance of liquid fuel so that the pulse duration of the fluid pulse signal is changed, thus controlling the amount of fuel to be injected in accordance with the width of the pulse signal.

In another aspect of the invention, the rotating pulse generating means comprises a pulse generator for producing a pulse signal conforming to the fuel injection timing by detecting the number of engine revolutions per unit time, and a fluid element for shaping wave forms. The fluid calculating means comprises a variable liquid resistor provided with a throttle portion for changing the area of a liquid fuel passage in accordance with the internal pressure of the intake manifold, a fluid element for controlling pulse width which is set by the pulse signal and is reset by the throttled signal obtained from the variable liquid resistor in order to change the pulse width, and a fluid element for fuel injection which is controlled by the output signal of the pulse-width control fluid element to inject fuel into the intake manifold, thus determining the pulse width from the relationship between the set signal and reset signal at the pulse-width control fluid element.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 illustrates schematically the fuel supply device according to this invention;

FIG. 2 illustrates schematically a rotating pulse generating means to be used in the device according to this invention;

FIG. 3 is a circuit diagram of an embodiment of the device according to this invention;

FIGS. 4A and 4B illustrate in different views an example of the pulse-width modulating means to be used in the device of this invention;

FIG. 5 is a diagram showing the relationship between the input and output pressures and time in the pulse-width modulating means; and

FIG. 6 is a connection diagram of the control circuit in a six cylinder engine in which the device of this invention is applied.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1, the fuel supply device comprises a liquid fuel supply means B, a rotating pulse generating means C and a fluid calculating means F having a pulse-width modulating means D and a fuel distribution and injection means E in combination with an intake manifold assembly A. The intake manifold assembly A comprises a throttle valve 12 installed within an intake manifold 11 downstream of an air cleaner 10. The amount of air is changed by displacing the throttle valve 12 in conformity with the engine output. The liquid fuel supply means B comprises a filter 2, a fuel pump 3, a pressure modulator 4 which are all connected in series on a conduit 5 extending from a fuel tank 1. The conduit 5 is branched into two directions; a conduit 6 directed to the fluid calculating means F and a conduit 7 directed to the rotating pulse generating means C. The liquid fuel for calculation control and injection that is regulated to a predetermined pressure is directly supplied to the means C and E, respectively. The rotating pulse generating means C develops pulsewise fluid pressure in the liquid fuel medium in conformity with the number of engine revolutions per unit time and is connected to the fluid calculating means F by means of a conduit 16 for set pulse, thereby performing setting operation for the calculating mechanism. In the fluid calculating means F, the pulse-width modulating means D multiplies the number of engine revolution by the internal pressure of the intake manifold 11 so that the width of the fluid pulses is changed in conformity with the air pressure in the intake manifold 11. The fuel injection duration conforming to the width of the fluid pulses is obtained by the injection means E. Furthermore, the fluid calculating means F is also connected to the rotating pulse generating means C by means of a conduit 17 for resetting, thus making sure that the calculation control is stopped when the supplying fuel is completed. With respect to the fluid calculating means F, the intake manifold assembly A comprises an air intake regulating valve 14 and a throttle valve 13 connected to the resetting conduit 17, (See FIG. 3) both valves being provided in parallel with the throttle valve 12 of the intake manifold 11. Also, both valves are responsive to the temperature of the cooling water. Valve 14 is designed to change the amount of intake air and valve 13 is used to change the pulse width thereby adjusting the sensitivity of the fluid calculating operation. Moreover, the excess fuel in the rotating pulse generating means C and the fluid calculating means F is returned to the fuel tank 1 through feed-back conduits 18 and 19.

Referring to FIGS. 2 and 3, the rotating pulse generating means C comprises a pulse generator 9 and a pure fluid element 45 for wave-form shaping. In the pulse generator 9, as shown in FIG. 2, two rotating discs 24 and 25 having notches 24' and 25', respectively, are secured to a shaft 27 rotating in synchronism with the revolutions of the engine. A nozzle 22 having a throttle 21 and connected to the conduit 7 on the fuel pump side is provided in a position facing the notch 24' of the rotating disc 24, thereby generating a fuel medium fluid pulse conforming to the position of the constant revolving angle of the engine at an output port 23 of the nozzle 22. A nozzle 26 connected to the resetting conduit extending from the fluid calculating means F is provided in a position facing the notch 25' of the rotating disc 25. Thus, the fuel fluid pressure required for operation of the fluid calculating means F is rapidly decreased in synchronism with the zero signal of the fluid pulse, thereby assuring calculation control. As shown in FIG. 3, the output port 23 of the pulse generator 9 is connected by way of a conduit 29 to a control port 30 of the wave-form shaping pure fluid element 45 to which the liquid fuel is supplied in advance through the conduit 7. An outlet 32' of the fluid element 45 is connected to the fuel tank 1 by the feed-back conduit 19, and another outlet 32 thereof is connected to the resetting conduit 16, thus shaping the waveform of the fluid pulse.

In FIG. 3, the fluid calculating means F is shown with only one channel illustrated. The fluid calculating means F comprises the pulse-width modulating means D having a variable liquid resistor 31 and a pulse-width control pure fluid element 46, and further comprises the fuel injection means E having a pure fluid element 47 for fuel injection. The variable liquid resistor 31 has an intake air pressure detecting bellows 28 which expands and contracts in accordance with the internal pressure in the intake manifold. The interior of the cylinder is divided into an inlet chamber 33 and an outlet chamber 35 by means of a driving shaft 54 connected directly to the bellows 28. The inlet chamber 33 is connected to the setting conduit 16 extending from the wave-form shaping pure fluid element 45 and includes a fuel shut-off valve 52 at the lateral wall of the cylinder together with a valve rod 55 provided on the driving shaft 54. A throttle portion 53 is provided between the inlet chamber 33 and the outlet chamber 35 so that the area of the fluid passage between both chambers is changed in conformity with the displacement of the driving shaft 54. The outlet chamber 35 is coupled to a fluid volume 34 having a bellows and a spring.

The liquid fuel is supplied to the pulse-width control pure fluid element 46 through the conduit 6 on the fuel pump side. An inlet port 39 thereof at the setting side is connected to the fuel shut-off valve 52 of the variable liquid resistor 31 by means of a conduit 51, and an input port 40 thereof at the resetting side is connected to the outlet chamber 35 of the variable liquid resistor 31 by means of a conduit 36, which is in turn connected to the throttle valve 13 through the conduit 37. The fuel is supplied to the fuel injection pure fluid element 47 through the conduit 6 in a manner similar to that described above. Control ports 43 and 44 thereof are connected to output ports 41 and 42 of the pulse-width control pure fluid element 46, respectively. One output port 48' of the fluid element 47 is connected to the fuel tank 1 through the feed-back conduit 18 and another output port 48 thereof is connected by means of a conduit 49 to an injection port 15 provided downstream of the throttle valve 12 of the intake manifold 11.

The operation of the fluid calculating means F of the above-described construction will be described hereinbelow. In the variable liquid resistor 31, the driving shaft 54 is positioned in accordance with the internal pressure of the intake manifold. The pressure approaches atmospheric pressure at the time of acceleration when the engine load is large, and the shaft 54 is moved to the right to increase the throttling action of the throttle portion 53, thereby increasing the liquid resistance. The fluid pulse admitted into the inlet chamber 33 of the variable liquid resistor 31 is passed from the fuel shut-off valve 52 through the conduit 51 to the setting side inlet port 39 of the pulse-width control pure fluid element 46, thus deflecting the main jet of the fluid element 46 toward the output port 41. At the ame time, it is passed into the output port 35 through the throttle portion 53. Then, the fluid pulse is passed to the resetting side inlet port 40 of the fluid element 46 through the conduit 36, while being converted by the fluid volume 34 into a saw-tooth pressure wave determined by the time constant thereof. Thus, based on the relationship between the fluid pulse passed into the input port 39 at the setting side and the saw-tooth pressure wave admitted into the input port 40 at the resetting side, the pulse-width control pure fluid element 46 controls the flow of fuel to the injection port 15 through the fuel injection pure fluid element 47 into the intake manifold 11 until the pressure of the saw-tooth pressure wave reaches the level at which the main jet is changed over from the output port 41 to the output port 42.

The operation of the above-described pulse-width modulating means D will be described with reference to the wave-form diagram of FIG. 5. While the input pulse *f* to be applied to the setting side input port 39 of the pulse-width control pure fluid element 46 is of nearly rectangular shape, the saw-tooth pressure wave applied to the resetting side input port 40 is successively changed from the curve *b* to the curves c and d as the time constant determined by the liquid resistance of the variable liquid resistor 31 and the volume of the fluid volume 34 is increased, thus increasing the time duration required until the resetting pressure level *e* is reached. Consequently, the output pulse *g* determining the fuel injection duration takes the waveform in which the pulse duration is changed by multiplying the number of engine revolution by the internal pressure of the intake manifold.

As described above, the fuel supply device is controlled so that the liquid resistance of the variable liquid resistor **31** is increased to increase the fuel injection duration; that is, the amount of fuel supplied, when the engine load is large and the internal pressure of the intake manifold is high. In contrast, if the engine load is light, the fuel supply device is controlled so that the liquid resistance is decreased to increase the supply pressure to the resetting side input port **40** of the pulse-width control pure fluid element **46** rapidly, thus decreasing the fuel supply duration and consequently the amount of fuel injected. Furthermore, at the time the engine is started, the throttle valve **13** and the intake air regulating valve **14** are open in response to the temperature of the cooling water, and a part of the pressure supplied to the resetting side of the pulse-width control pure fluid element **46** escapes through the throttle valve **13.** Consequently, the time constant is further increased and the width of the output pulse is increased, thus permitting a large amount of fuel to be supplied. At the same time, the amount of intake air is increased independently of the throttle valve **12** due to the opening of the intake air regulating valve **14.** Thus, starting of the engine is smoothly controlled. When the engine is very lightly loaded, the fuel shut-off valve **52** is closed to shut off the flow of the fluid pulse to the setting side of the pulse-width control pure fluid element **46.** Thus, neither control over the fluid calculation nor fuel injection is accomplished.

The construction of the intake air pressure detecting bellows **28,** variable liquid resistor **31** and fluid volume **34** of the pulse-width modulating means D will be described in more detail with reference to FIGS. 4A and 4B.

First, the intake air pressure detecting bellows **28** and the variable liquid resistor **31** will be described with reference to FIG. 4A. By means of the bellows **28** the interior of a cylinder **65** is divided into a pressure chamber **58** to be connected to the interior of the intake manifold **11** and a chamber **66** which is held at a constant pressure to compensate the characteristic changes caused by the variation in atmospheric pressure. The bellows **28** is provided with a return spring **60** so as to maintain the displacement of the bellows due to its expansion and contraction at a certain ratio. A piston **64** is fitted into a cylinder **59** of the pressure chamber **58.** The piston **64** is integrally connected with the driving shaft **54** through a connecting rod **57,** and a pawl **56** thereof is slidably contacted to a resistance plate **62** provided removably at one lateral side of the cylinder, thus defining the throttle portion **53.** The interior of the cylinder **59** is divided by the driving shaft **54** into the input chamber **33** and the output chamber **35.** The input chamber **33** is connected to the setting conduit **16** through a hole **61** and is further connected to the conduit **51** through the fuel shut-off valve **52** defined by said chamber and the valve rod **55** provided at the driving shaft **54.** The output chamber **34** is connected to the conduit **36** of the fluid volume **34** by means of a passage **50.** Referring to FIG. 4B, the resistance plate **62** has a fluid passing groove **63** at a place where the pawl **56** of the driving shaft **54** slides. Thus, throttling action is performed with the vertical movement of the pawl **56** to change the liquid resistance. In order to obtain the liquid resistance conforming to the engine performance, the fluid passing groove **63** is configured into a desired shape by means of chemical treatment such as etching. In the illustrated case, the groove width at the lower part *a* is specifically increased so that the liquid resistance is decreased and the fuel is decreased or shut off when the engine load is light. The configuration of the fluid passing groove **63** may be varied so that the amount of fuel injected is not influenced by the pressure at the injection port **15.** Thus, in a manner similar to that described above, the variable liquid resistor **31** increases the liquid resistance with increase in the engine load and in the internal pressure of the intake manifold **11,** as a result of which the quantity of fuel supplied is increased. As the cross-sectional area of the piston **64** is larger than that of the driving shaft **54,** the volume of the outlet chamber **35** is increased during acceleration when the internal pressure of the intake manifold **11** is increasing. Consequently, the width of the output pulse as well as the fuel supply amount are increased, and accelerated injection is accomplished. On the other hand, at the time of deceleration when the internal pressure is decreasing, the fuel supply amount is reduced by decreasing the width of the output pulse.

A variable container **67** comprising a bellows or the like is sealingly installed with respect to a hold **69.** A spring **68** is provided between the variable container **67** and a case **70.** The fluid pressure pulse to be passed from the variable liquid resistor **31** through the conduit **36** into the fluid volume **34** is balanced with the reaction force of the spring **68,** thus inflating the variable container **67.** The fluid pressure pulse is transformed into a saw-tooth pressure wave in accordance with the time constant in the manner described hereinbefore. The liquid fuel accumulated in the variable container **67** is rapidly discharged through the resetting nozzle **26** shown in FIG. 3 each time the calculation is completed, thus returning the pressure at the resetting side input port **40** of the pulse-width control pure fluid element **46** to atmospheric.

Referring now to FIG. **6,** the fuel supply device applied to a six cylinder engine will be described. The intake manifold assembly A is constructed in a manner similar to that described hereinbefore. However, in order to improve the distribution accuracy of the fuel to be supplied to respective cylinders of the engine, injection ports **71** through **76** are provided for the respective cylinders. The liquid fuel supply means B is of the same construction as the one described before and is designed to supply fuel to respective units by means of a pump **3.** The rotating pulse generating means C produces fluid pulse each time the engine makes two revolutions. The pulse-width modulating means D of the fluid calculating means comprises the variable liquid resistor **31** which also serves as a valve mechanism for distributing fuel to respective cylinders, and further comprises two pulse-width control pure fluid elements **46** and **46'**. The fuel distribution and injection means E employs six bistable pure fluid elements **47'** corresponding to the fuel injection pure fluid element **47** in order to distribute the modulated fluid pulses to respective cylinders with a high degree of accuracy. These fluid elements **47'** are divided into two groups. Thus, the fuel is successively injected into respective cylinders in the amount determined and controlled by multiplying the number of engine revolution by the internal pressure of the intake manifold in the manner described hereinbefore.

As described above, the fuel supply device according to this invention utilizes liquid fuel to perform a calculation and control function by multiplying the number of engine revolution by the internal pressure of the intake mainfold (density of intake air). Consequently, the optimum and highly accurate fuel supply control conforming to the engine performance and exhaust characteristic is insured. As the liquid fuel is used as a calculating medium, the construction of the control system is simplified, and such factors as reliability and others are fully satisfied. Structurally speaking, the determination of the amount of fuel required in accordance with the operating condition of the engine is accomplished by using a variable liquid resistor, fluid volume, fluid elements and other fluid components. As a result comprehensive control and fine adjustments can be attained thereby contributing to improved accuracy. A fluid passing groove of a resistance plate defining a throttle portion of a variable liquid resistor may be appropriately configured in conformity with the engine performance, exhaust characteristic, injection port pressure and other parameters. Furthermore, the device according to this invention is advantageous in that the control characteristic of the air fuel ratio can be freely adjusted to an optimum value in conformity with the operating condition of the engine.

The volume of the output chamber of the variable liquid resistor is increased or decreased with the increase or decrease in the manifold pressure, and therefore the volume of the output chamber is increased at the time of acceleration when the manifold pressure is increased, thus increasing the time duration required until the output of a pulse-width control pure fluid element is reset. In other words, at the time of acceleration the amount of fuel to be injected may be increased in accordance with the degree of acceleration. Accelerated injection, as is done in conventional carburetors, can also be accomplished. On the other hand, the volume of the output chamber is decreased at the time of deceleration, and therefore the time required until resetting (that is, the fuel injection duration) is further decreased. Furthermore, the above-mentioned operations can be accomplished almost simultaneously with the operation of throttle valves, and therefore the response characteristic is quite high, compared with mechanical accelerator pumps of conventional type.

What is claimed is:

1. In an internal combustion engine of the type wherein the amount of fuel injected into the intake air is determined by the number of engine revolutions per unit time and by the engine load, a fuel supply system comprising;

pulse generating means displaceable at a rate corresponding to the number of revolutions per unit time of said engine and adapted to receive liquid fuel, said pulse generating means generating a fluid pulse signal in synchronism with said engine revolutions;

a variable liquid resistor having a resistance corresponding to the pressure within the intake manifold of said engine, said resistor producing a set pulse signal when it receives said fluid pulse signal from said pulse generating means and a reset pulse signal a predetermined interval after said set pulse signal is produced, said interval corresponding to the resistance of said liquid resistor; and

fluid element means coupled to said liquid resistor and adapted to receive liquid fuel, said fluid element injecting said fuel into the intake air during said predetermined interval.

2. A fuel supply system as defined by claim **1** wherein said variable liquid resistor comprises a throttle portion including a liquid fuel passing groove connecting inlet and outlet thirty five chambers and means for changing the area of said fluid passing groove in response to the pressure within the intake manifold of said engine, the inlet chamber of said variable liquid resistor being coupled to the output of said pulse generating means; and fluid volume means coupled to said outlet chamber for generating a saw-tooth pressure wave having a time constant corresponding to the area of said fluid passing groove.

3. A fuel supply system as defined by claim **1** wherein said fluid element means comprises a pulse-width control fluid element adapted to receive said liquid fuel and having first and second inlet port means connected to the inlet and outlet chambers of said liquid resistor respectively, said pulse-width control element further having outlet port means; and a fuel-injection fluid element adapted to receive said liquid fuel and having control port means connected to the outlet port means of said pulse-width control element, the output of said fuel-injection fluid element injecting fuel into said intake manifold in response to the signals at the output port means of said pulse-width control element.

4. A fuel supply system as defined by claim **1** wherein

said pulse generating means comprises a pulse generator rotatable at a rate corresponding to the number of engine revolutions per unit time; and a wave-form shaping fluid element receiving said liquid fuel and having an input coupled to the output of said pulse generator, the output of said wave-form shaping fluid element comprising said fluid pulse signals;

said variable liquid resistor comprises a throttle portion including a liquid fuel passing groove connecting inlet and outlet chambers and means for changing the area of said fluid passing groove in response to the pressure with the intake manifold of said engine, the inlet chambers of said variable liquid resistor being coupled to the output of said pulse generating means; and fluid volume means coupled to said outlet chamber for generating a saw-tooth pressure wave having a time constant corresponding to the area of said fluid passing groove; and

said fluid element means comprises a pulse-width control fluid element adapted to receive said liquid fuel and having set and reset inlet ports connected respectively to the inlet chamber of said liquid resistor and to said fluid volume means, said pulse-width control element further having first and second output ports; and a fuel-injection fluid element adapted to receive said liquid fuel and having first and second input ports connected to the output ports of said pulse-width control element the output of said fuel injection fluid element injecting fuel into said intake manifold in response to the output signal from said pulse-width control element.

5. A fuel supply system as defined by claim 4 which further comprises a throttle valve coupled to the intake manifold of said engine, said throttle valve being further coupled to said fluid volume means.

6. A fuel supply system as defined by claim 4 wherein said variable liquid resistor is further provided with means for preventing fluid from reaching the set inlet port of said pulse-width control fluid element when said engine is operating under a light load.

7. A fuel supply system as defined in claim 1 wherein said pulse generating means comprises,

a pulse generator rotatable at a rate corresponding to the number of engine revolutions per unit time and

a wave-form shaping fluid element receiving said liquid fuel and having an input coupled to the output of said pulse generator, the output of said wave-form shaping fluid element comprising said fluid pulse signals.

* * * * *