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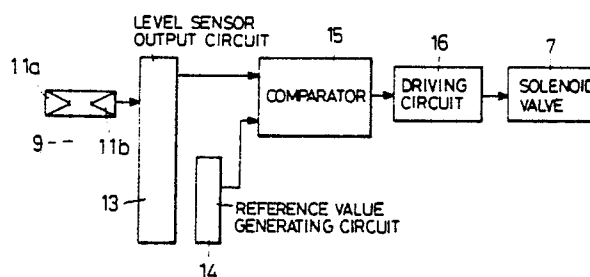
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Fuel supply device for carburetors.

A fuel supply device for carburetors of the type which provides a branch passageway communicating with a fuel passageway between a fuel metering jet and a connection of a fuel passageway with a negative pressure passageway and a float chamber, places a diaphragm type enriched valve, in the middle of the branch passageway, controlled in accordance with the variation of the negative pressure generated on the downstream side of a solenoid valve or a throttle valve controlled by signals issued from various sensors detecting an operating condition of an engine and controls a fuel flow rate so that the level of a fuel column to be formed in the negative pressure passageway for intake flow rate detection communicating with the fuel passageway is kept constant, in order to enable a fuel supply to be positively performed with respect to any transient state of engine operation.

FIG. 2



FUEL SUPPLY DEVICE FOR CARBURETORS

The present invention relates to a fuel supply device for supplying a mixture to an engine and, more particularly, to a fuel supply device for carburetors in which an air-fuel ratio of a mixture to be supplied to an engine is properly maintained by controlling a fuel flow rate so that a fuel liquid level in a vacuum passageway for a suction air flow rate detection communicating with a fuel passageway is constantly maintained.

An example of conventional carburetors of the type is described in European Patent Publication No. 0207796 filed previously by the same applicant as in this application. Such a carburetor, as shown in Fig.1, comprises a solenoid valve 7 arranged in the middle of a fuel passageway 6 having a main nozzle 3 opening into a fixed venturi 2 of a suction bore 1 at the one end and communicating with a float chamber 5 through a jet 4 at the other end; a fuel liquid level sensor 11 comprising, for example, a light emitting element 11a and a light receiving element 11b (Fig.2) which is arranged in the middle of a vacuum passageway 9 opening into a fixed venturi 8 generating a vacuum or negative pressure weaker than that of the fixed venturi 2 on the upstream side of the fixed venturi 2 at the one end and communicating with a portion between the jet 4 and the solenoid valve 7 in the fuel passageway 6 at the other end; and a control circuit (as shown in Fig.2) receiving a signal issued from the fuel liquid level sensor 11 and controlling the solenoid valve 7 to change the amount of fuel discharged into the suction bore 1 so that a fuel liquid level is kept constant at a predetermined level. In Fig.2, reference numeral 13 denotes a level sensor output circuit connected to a light receiving element 11b; 14 denotes a reference value generating circuit producing a reference value necessary for setting a reference level (that is, the predetermined level mentioned above) of the fuel liquid level in the float chamber 5; 15 denotes a comparator; and 16 denotes a driving circuit for the solenoid valve 7. That is to say, when an opening degree of a throttle valve 12 or an engine speed varies, pressure in the vacuum passageway 9 changes with the variation of the amount of air flowing through the suction bore 1, while on the other hand, the amount of fuel sucked out of the main nozzle 3 changes with the variation of the amount of air flowing through the venturi 2 and therefore the pressure in the fuel passageway 6 also varies. In such a case, if the amount of fuel flowing through the passageway 6 is in excess, a fuel liquid surface, which is in a position lower than the predetermined level, is detected by the level sensor 11 and an output issued from the level sensor output circuit 13 be-

comes smaller than that of the reference value from the reference value generating circuit 14, with the result that a signal is transmitted from the comparator 15 to the solenoid valve 7 through the driving circuit 16 to control the fuel discharge amount, whereas, in case the amount of fuel flowing through the passageway 6 is extremely small, the fuel discharge amount is increased by reversing the above behavior to maintain always constantly the air-fuel ratio.

The above fuel supply device, however, is designed in such a way that the solenoid valve 7 is actuated by only the signal delivered from the level sensor as mentioned above and therefore, if it is desired to change temporarily the air-fuel ratio of the mixture by a signal based on other factor, for example, a detecting signal for the starting or warming-up of the engine or a signal issued from an O₂ sensor, it is required to shift the position of the present level of the fuel liquid surface. Since such is impossible with the structure of the above device, the device has been unable to positively cope with a transient state of engine operation.

The object of the present invention, in view of the above problems, is to provide a fuel supply device for carburetors of the type capable of positively coping with the transient state of the engine operation.

According to the present invention, this object is accomplished by providing a branch passageway opening into a fuel passageway between a connection of a fuel passageway with a vacuum passageway and a fuel jet at the one end and communicating with a fuel supply source at the other end, placing a valve device, in the middle of the branch passageway, controlled by an electrical signal obtained by detecting an operating condition of the engine, and increasing the flow rate of fuel to be fed from the fuel supply source into the fuel passageway in accordance with the operating condition of the engine to thereby further increase the opening degree of the solenoid valve for fuel flow rate control.

According to a preferred formation of the present invention, the valve device is constructed as a solenoid valve whose opening degree is controlled by a signal indicative of the starting or warming-up operation of the engine or a signal from an O₂ sensor or as a diaphragm type enriched valve whose opening degree is controlled in accordance with the extent of a vacuum generated on the downstream side of a throttle valve. Thereby, the fuel supply device of the type can cope with a transient state of engine operation positively and accurately.

This and other objects as well as the features and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment when taken in conjunction with the accompanying drawings.

In the drawings:

Fig. 1 is a sectional view showing a conventional basic structure of a fuel supply device for carburetors using a level sensor;

Fig. 2 is a block diagram of a control circuit used along with the device shown in Fig. 1;

Fig. 3 is an explanatory view showing a carburetor provided with an embodiment of a fuel supply device according to the present invention and a principal part of an engine connected thereto;

Fig. 4 is a block diagram of a control circuit used along with the device shown in Fig. 3;

Figs. 5 and 6 are characteristic charts for explaining the functions of the circuit shown in Fig. 4; and

Fig. 7 is a sectional view of a principal part of a carburetor provided with another embodiment of the fuel supply device according to the present invention.

In accordance with the embodiments illustrated in which like reference numerals are used to designate like members employed in the above-mentioned conventional device, the present invention will be explained in detail in the following.

First of all, in Figs. 3 and 4, reference numeral 17 denotes a branch passageway communicating with a fuel passageway between a portion where the fuel passageway 6 is connected with the vacuum passageway 9 and the jet 4 at the one end and communicating with the float chamber 5 at the other end; 18 a solenoid valve used as an auxiliary fuel flow rate control device arranged in the middle of the branch passageway 17; 19 a throttle sensor for detecting the opening degree of the throttle valve 12; 20 an intake manifold connected to the suction bore 1 on the downstream side of the throttle valve 12; 21 an engine body; 22 a water temperature sensor for detecting the temperatures of cooling water for the engine; 23 a distributor; 24 an exhaust manifold; 25 an O₂ sensor attached to the exhaust manifold 24; 26 a revolution number detector; 27 a low-temperature increment calculator; 28 a calculator of amount to be enriched; 29 a PI-controller; 30 a driving range discriminator; and 31 an adder.

Next, the functions of the device mentioned above will be described.

When the engine is started, a signal indicative of the number of revolutions of the engine obtained from the distributor 23 and the revolution number detector 26, a signal indicative of the opening degree of the throttle valve 12 obtained from the

throttle sensor 19, and a signal indicative of the cooling water temperature of the engine obtained from the water temperature sensor 22 are inputted to the driving range discriminator 30 to discriminate that the operation of the engine is in a starting and warming-up condition and then a driving pulse duty-controlling the solenoid valve 18 is outputted from the driving range discriminator 30 so that a standard amount of auxiliary fuel suitable for the operating condition described above flows into the fuel passageway 6 through the branch passageway 17. In such a case, if the relationship between the number of revolution of the engine and the opening degree of the throttle valve exists in the region indicated in (I) in Fig. 5 and the cooling water temperature of the engine is below the temperature of the change-over point shown in Fig. 6, an output signal issued from the increment calculator 27 determined by the characteristic curve shown in Fig. 6 in accordance with the above temperature and an output signal from the enriched calculator 28 are summed up by the adder 31 to be added to the above driving pulse through a terminal (b) and a switch S and thereby the duty ratio of the solenoid valve 18 is increased. As a result, a larger amount of auxiliary fuel is fed to the fuel passageway 6. Also, if the relationship between the number of revolutions of the engine and the opening degree of the throttle valve exists in the region shown in (II) in Fig. 5 and the cooling water temperature of the engine is below the temperature of the change-over point shown in Fig. 6, an output signal of the duty ratio calculated on the basis of the characteristic curve shown in Fig. 6, from the increment calculator 27 in accordance with the above temperature condition, is added to the above driving pulse through a terminal (a) and the switch S and thereby the duty ratio of the solenoid valve 18 is increased. Further, if the relationship between the number of revolutions of the engine and the opening degree of the throttle valve 12 exists in the region shown in (II) in Fig. 5 and the cooling water temperature of the engine is above the temperature of the change-over point shown in Fig. 6, that is, when the warming-up operation is completed, an output signal of the PI-controller 29 produced by the signal issued from the O₂ sensor 25 is added to the above driving pulse through a terminal (c) and the switch S and as a result, the duty ratio of the solenoid valve 18 is properly adjusted. The above change-over temperature (the change-over point shown in Fig. 6) and the standard value are determined on the basis of experimental data and the above change-over operation of the switch S to the terminals (a), (b) and (c) can be performed automatically or manually. Since the level of a fuel column in the vacuum passageway 9 is raised when a flow rate of fuel passing through the fuel

passageway 6 is properly increased in accordance with the operating condition of the engine in this manner, the opening degree of the solenoid valve 7 is further increased to return the level of the fuel column to a predetermined level, based on the same operating principle as in the above-mentioned conventional device, and consequently the amount of fuel discharged from the main nozzle 3 becomes large. Therefore, the air-fuel ratio of the mixture becomes smaller than a preset value (for example, a value suitable for normal operation), that is, a rich mixture is brought about, which is a condition appropriate to the starting and warming-up operation of the engine. Also, when the warming-up operation is completed, the duty ratio of the driving pulse of the solenoid valve 18 becomes small, as will be evident from the above description, and the fuel flow rate in the fuel passageway 6 decreases, so that the level of the fuel column is positioned below the predetermined level, the opening degree of the solenoid valve 7 is decreased, and the air-fuel ratio of the mixture is returned to the preset value, that is, the above standard value. After this, with the result that the air-fuel ratio of the mixture is changed in accordance with the variation of the concentration of oxygen contained in an exhaust gas detected by the O₂ sensor 25, the oxygen concentration in the exhaust gas is controlled so as to be constant.

Thus, the fuel supply device according to the present invention can positively cope with the transient state of the engine operation.

Fig. 7 shows a principal part of another embodiment, which is provided with a diaphragm type enriched valve 32 in the middle of the branch passageway 17. That is to say, the valve 32 comprises a fuel chamber 32a provided in the middle of the branch passageway 17 and a vacuum chamber 32b communicating with, for example, the downstream side of the throttle valve 12, through a vacuum passageway 33 so that the valve 32 opens to bring about the rich mixture when the negative pressure of the manifold is low.

Also, it is needless to say that the fuel supply device according to the present invention is applicable to a low-speed fuel system in addition to a main fuel system.

Claims

1. A fuel supply device for carburetors, comprising:
an intake mixture passageway having a first negative pressure generating section and a second negative pressure generating section disposed upstream of said first negative pressure generating section for generating a negative pressure weaker

than that generated in said first negative pressure generating section; a fuel passageway having its one end opening into said first negative pressure generating section of said intake mixture passageway and having its other end connected, via a fuel metering jet, to a fuel supply source; an electric fuel flow rate controlling means controlling the flow rate of the fuel which should flow through said fuel passageway; a negative pressure passageway having its one end opening into said second negative pressure generating section of said intake mixture passageway and having its other end connected to said fuel passageway at a site located between said fuel metering jet and said electric fuel flow rate controlling means; and a level detecting means disposed at a site close to said negative pressure passageway and capable of generating an electric signal indicative of whether or not the level of the fuel column ascending through the negative pressure passageway is higher than a preset level by virtue of a difference between the fuel pressure in the region where said negative pressure passageway is connected to said fuel passageway and a negative pressure produced in said second negative pressure generating section, said fuel flow rate controlling means being operated by a signal generated by said level detecting means, in order to control the flow rate of the fuel which is to be supplied into said intake mixture passageway from said fuel passageway, characterized in that said device further comprises a branch passageway having its one end connected to a portion of said fuel passageway between a connection of said negative pressure passageway with said fuel passageway and said fuel metering jet and having its other end connected to said fuel supply source and an auxiliary fuel flow rate controlling means controlled by a means or signal detecting an operating condition of an engine is provided in the middle of said branch passageway.

2. A fuel supply device for carburetors according to Claim 1, wherein said auxiliary fuel flow rate controlling means is a solenoid valve whose opening degree is controlled by the signal representative of the operating condition of the engine.

3. A fuel supply device for carburetors according to Claim 1, wherein said auxiliary fuel flow rate controlling means is a diaphragm type enriched valve whose opening degree is controlled in accordance with the extent of a negative pressure generated on the downstream side of a throttle valve in said intake mixture passageway.

FIG. 1

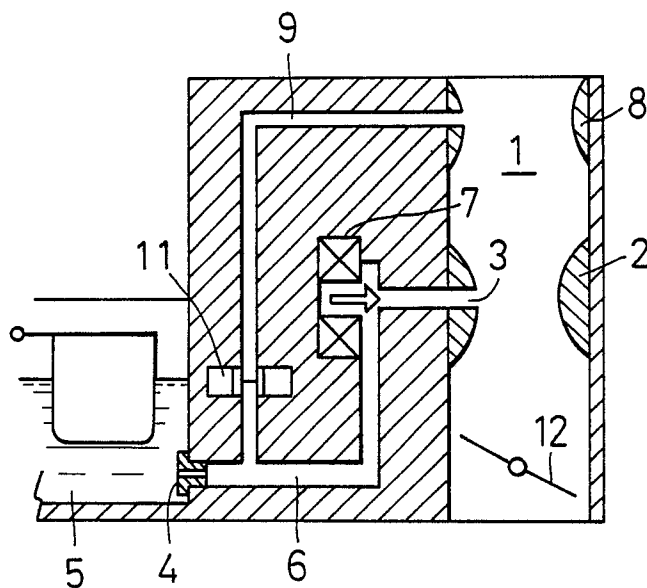


FIG. 2

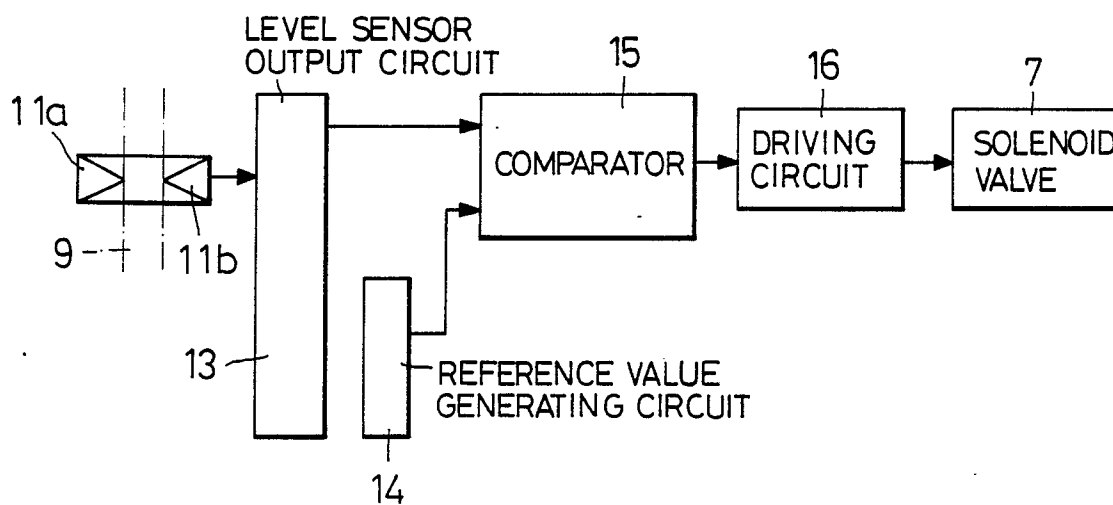


FIG. 3

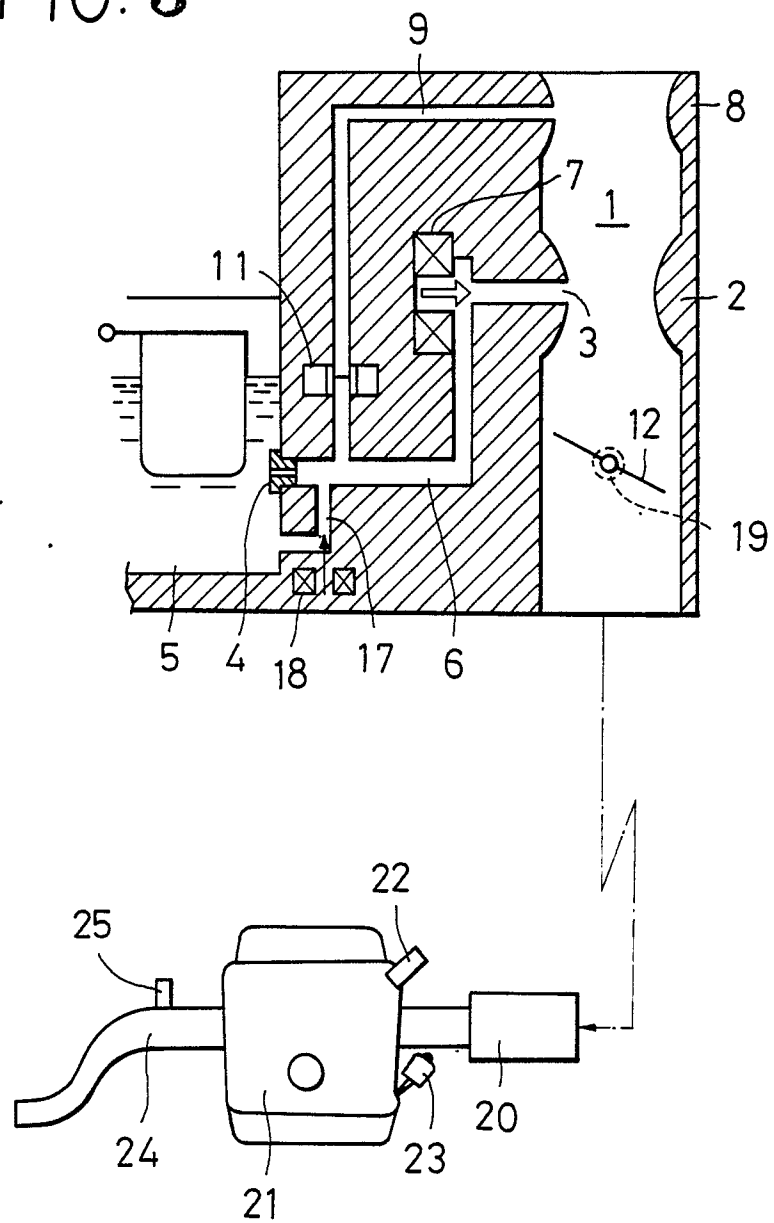


FIG. 4

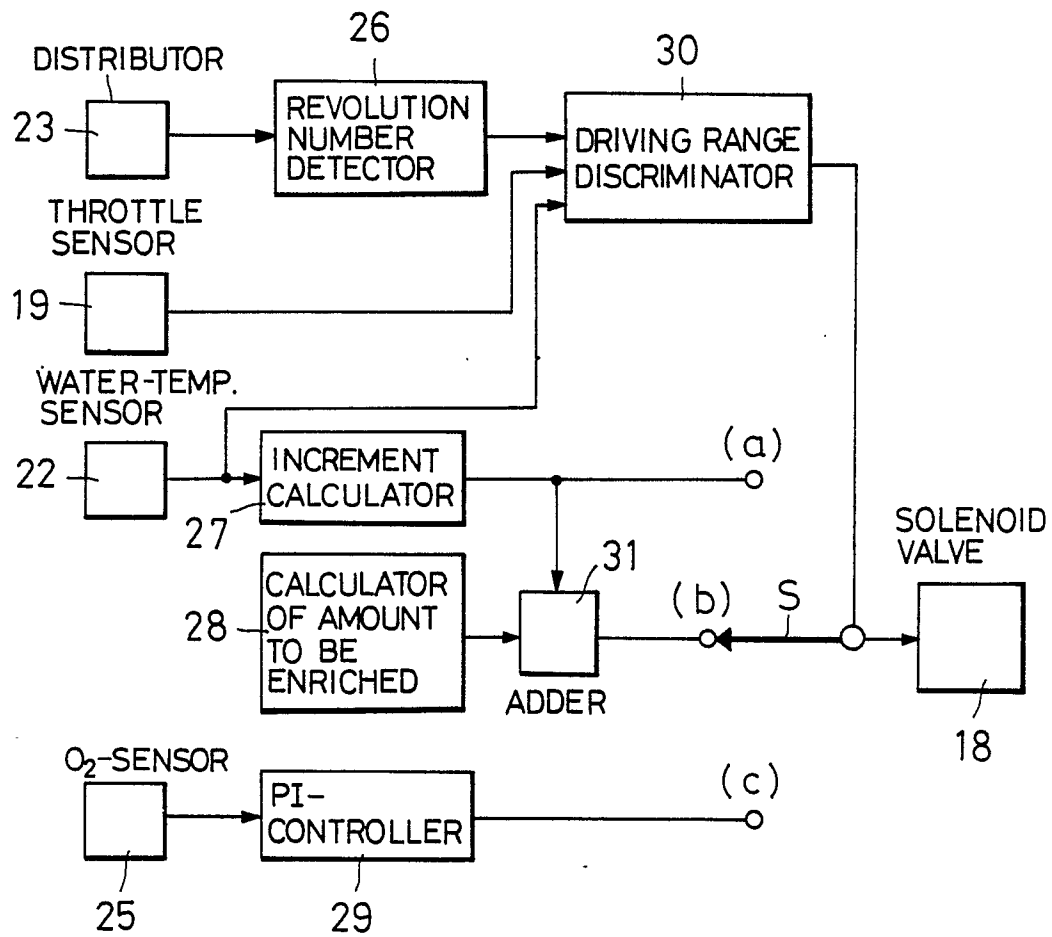


FIG. 5

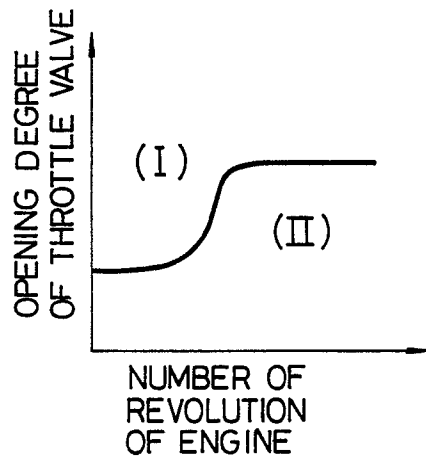


FIG. 6

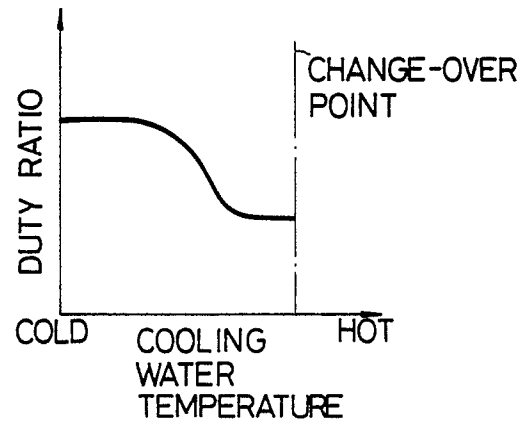


FIG. 7

