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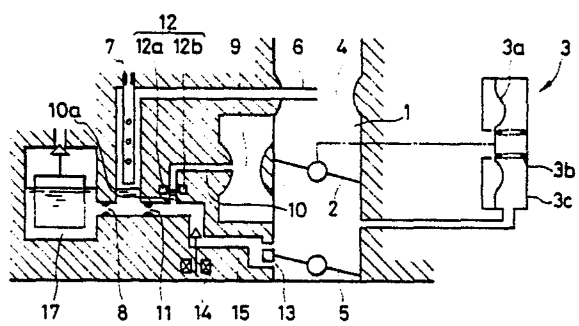
(54) **Low-speed fuel control system for carburetors.**

(57) A carburetor comprising a vacuum passageway connecting a low-speed system venturi with a slow jet; a level detecting means capable of detecting whether or not the level of a fuel column to be defined in the vacuum passageway is higher than a predetermined position; and a solenoid valve capable of switching over the opening degree of a low-speed fuel passageway in response to an output delivered from the level detecting means, in which a flow rate of fuel flowing through the low-speed fuel passageway is controlled so that the level of the fuel column is held at a predetermined position and thereby the fuel having the flow rate suitable for a flow rate of suction air passing through the low-speed system venturi is supplied to an intake bore, in order to be able to provide a low-speed fuel control system for carburetors in an internal combustion engine which facilitates the selection of the diameter and setting position of a slow port and is excellent in performance and durability.

FIG. 2



EP 0 255 952 A2

LOW-SPEED FUEL CONTROL SYSTEM FOR CARBURETORS

The present invention relates to a carburetor and more particularly to a low-speed fuel control system for carburetors which is provided with a low-speed system venturi to enable an air to fuel ratio of mixture in a low-speed region to be controlled into an optimum condition.

For the carburetor, as shown in Fig. 1, the lowspeed system comprising a slow port 33, a slow jet 31 and a slow air jet 36 is generally known. In such an instance, the amount of fuel coming out of the slow port 33 is controlled by varying the opening area of the slow port 33 opening at the downstream side of a throttle valve 35 in accordance with the opening degree of the throttle valve and thereby the measurement of a flow rate of fuel is performed. On the other hand, in order to determine the diameter and position of the slow port 33, many tentative steps are required. Also, in principle, the opening degree of the throttle valve 35 is not exactly proportional to a flow rate of air passing through a venturi 34 and it is therefore difficult to control the fuel flow rate through the throttle valve 35. In contrast to this, as described in U.S. Patent No. 4,201,166, a method is proposed that a pressure sensor is disposed between the main jet and the venturi portion, a difference between a proper fuel flow rate and an actual fuel flow rate is determined on the basis of the pressure difference detected by the pressure sensor, and the difference is fed back to thereby bring about a proper air-fuel mixture. This technique, however, makes it difficult to detect an extremely weak venturi vacuum in the low-speed region in particular and has a disadvantage that problems relative to the accuracy of the pressure sensor may be produced in itself. On the other hand, European Patent Publication No. 0207796 filed by the present applicant proposes a fuel control system capable of being most effectively applied to such a low-speed region. In this prior art, however, the low-speed system venturi is not used and the structure distinct from that of the present invention is adopted.

It is therefore, a primary object of the present invention to provide a low-speed fuel control system for carburetors in which the diameter and setting position of a slow port can simply be selected and durability of which is excellent.

This object can be attained, according to the present invention, in such a way that a low-speed system venturi capable of generating a vacuum corresponding to a flow rate of air is provided in an intake bore, a sensor for detecting the height of a fuel column existing in a passageway connecting the venturi portion to a slow jet is disposed, and a fuel flow rate control device provided between a slow jet and a slow port is actuated in accordance with an output signal delivered from the sensor. Since the fuel flow rate control device controls the fuel flow rate so that the height of the fuel column follows exactly the variation of the vacuum occurring in the low-speed venturi portion correctly representative of the air flow rate in the intake bore through the output signal generated by a level sensor which has detected whether or not the level of the fuel column is higher than a preset level, the mixture with a proper air-fuel ratio can always be supplied in the low-speed region even if the air flow rate is varied.

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

In the drawings;

Fig. 1 is a sectional view showing the basic structure of the low-speed fuel control system of conventional carburetors for internal combustion engines;

Fig. 2 is a sectional view showing the basic structure of a first embodiment of the low-speed fuel control system of the carburetor according to the present invention;

Fig. 3 is a view of a control circuit including a level sensor for sensing the height of a fuel column in the first embodiment;

Fig. 4 is a graph showing a relation between the output generated by the level sensor and the height of the fuel column;

Fig. 5 is a view showing a driving control circuit for a solenoid valve used in the first embodiment;

Figs. 6 and 8 are sectional views of the fuel column portion showing the arrangements of level sensors different from each other;

Figs. 7 and 9 are graphs showing the relation between the output delivered from the level sensors and the height of the fuel column shown in Figs. 6 and 8, respectively; and

Fig. 10 is a sectional view showing the basic structure of a second embodiment of the low-speed fuel control system of the carburetor according to the present invention.

Figs. 2 to 9 show a first embodiment of the low-speed fuel control system according to the present invention. In these figures, reference numeral 1 represents an intake passageway of the carburetor; 2 an air valve capable of opening and closing the intake passageway 1; 3 an operation controlling device of the air valve 2 provided with a diaphragm 3a connected to the air valve 2, a spring

3b and a vacuum chamber 3c communicating with the downstream side of the air valve 2; 4 a fixed venturi; 5 a throttle valve; 6 a main nozzle opening in to the fixed venturi 4; 7 a main air jet; 8 a main jet; 9 a low-speed system venturi formed in a bypass through which the upstream side of the air valve 2 is connected to the downstream side thereof on the downstream side of the fixed venturi 4; 10 a passageway connecting the low-speed system venturi 9 and the downstream side of the main jet 8 through a slow jet 11; 12 a level detector comprising a light-emitting device 12a and a light-receiving device 12b disposed to face each other across the passageway 10, for example, in a circuit configuration shown in Fig. 3; 13 a slow port opening into a vacuum generating section which is formed by the outer peripheral edge of the throttle valve 5 and the inner circumferential surface of the intake passageway 1; 14 a solenoid valve disposed in a fuel passageway 15 in position and capable of opening and closing the passageway 15 in accordance with the variation of an input voltage; 16 a control circuit for controlling the input voltage to the solenoid valve 14; and 17 a float chamber. In the above case, the arrangement is such that the operation controlling device 3 holds the air valve 2 at a closing position through the diaphragm 3a pressed by the spring 3b when an engine is stopped and, after the engine is started, it displaces the diaphragm 3b against the resilience of the spring 3a by virtue of a vacuum or negative pressure produced at the downstream side of the air valve 2 in at least its low speed region and enables the air valve 2 to open. Also, level detector 12 is adapted to detect whether or not the pressure head of the fuel column in the passageway 10 is higher than the preset head to be able to supply outputs O_h, O_ℓ (see Figs. 3 and 4) corresponding thereto. Further, as shown in, for example, Fig. 5, the control circuit 16 includes a comparator C which enables a reference voltage V_R to be imputted to a negative terminal and which enables the output from the level detector 12 to be inputted to a positive terminal, and a transistor T connected to the output side of the comparator C and is made up so that the opening degree of the solenoid valve 14 can be controlled into two steps (which will be hereinafter referred to as steps A and B) corresponding to the outputs O_h, O_ℓ supplied from the level detector 12.

Since the low-speed fuel control system in the first embodiment is constructed as mentioned above, the air valve 2 closes the intake bore 1 at the start of the engine or in the low-speed region of the engine and suction air is introduced from the downstream side of the fixed venturi 4 through the low-speed system venturi 9 to the manifold. In this low-speed region, the negative pressure in the fixed venturi 4 is not increased enough to cause the fuel to be jetted from the main nozzle 6 and, on the other hand, the negative pressure in the low-speed system venturi 9 is raised in proportion to the square of the flow rate of air passing through the venturi 9. Also, since the negative pressure generated on the downstream of the slow jet 11 is proportional to the square of the flow rate of the fuel flowing through the passageway 15, it follows that if the magnitude of this negative pressure is made to coincide with that in the low-speed system venturi 9, a proper amount of fuel according to the flow rate of the air flowing through the venturi 9 can be supplied into the intake bore 1. Now, in case the throttle valve 5 is positioned in a low opening degree so that the opening area of the slow port 13 at the downstream side of the throttle valve 5 is small and the solenoid valve 14 opens the passageway 15, at the step A of a larger opening degree, through which the fuel flows, if the pressure head of the fuel column 10a in the passageway 10 is lower than the level of the preset value, this means that the fuel flow rate is excessively large relative to the air flow rate corresponding to the vacuum produced in the low-speed system venturi 9, with the result that a rich mixture will inevitably be supplied to the engine. In such a state, light emitted from the light-emitting device 12a travels across the passageway 10 to reach the light receiving device 12b, so that the light-receiving device 12b generates superpower and therefore the output delivered from the level detector 12 will become a low level O_ℓ(see Fig. 4). Since the output O_ℓ is set lower than the reference voltage V_R, the transmission of a driving signal from the control circuit 16 to the solenoid valve 14 is stopped and thereby the solenoid valve 14 opens the passageway 15 at the step B of a smaller opening degree to increase the pressure of the fuel in the downstream side of the slow jet 11. Thus, the pressure head of the fuel column 10a is raised in accordance with the difference between the fuel pressure and the negative pressure of the low-speed system venturi 9. Also, if the height of the fuel column 10a exceeds the preset value, the light travelling from the light-emitting device 12a to the light-receiving device 12b traverses the fuel column and as a result, due to the presence of the fuel or a float in the fuel column 10a, the amount of the light reaching the light-receiving device 12b from the light-emitting device 12a will be decreased. Accordingly, the output delivered from the level detector 12 will become a high level O_h(see Fig. 4). The output O_h is transmitted through the control circuit 16 to the solenoid valve 14 as a driving signal and thereby the opening degree of the valve 14 is switched over to the step A of a larger opening degree. As a result, the fuel flow rate is increased and the fuel pressure on the downstream side of the slow jet 11 is reduced to lower the level of the fuel column 10a. Such raising and lowering of the fuel column 10 are repeated alternately and thereby the level of the fuel column 10a is substantially always held at the preset level to thus maintain the balance between the vacuum generated in the low-speed system venturi 9 and the fuel pressure in the downstream side of the slow jet 11. In other words, the amount of the fuel coming out of the slow port 13 follows exactly with respect to the vacuum produced in the low-speed system venturi 9 fully representative of the flow rate of intake air, so that the mixture with the air to fuel ratio which is always proper over the entire low-speed region is supplied to the engine.

As mentioned above, the relationship between the flow rate of the air flowing through the suction bore 1 and the flow rate of the fuel fed into the suction bore 1 is directly controlled, thereby determining the air to fuel ratio of the mixture supplied to the engine. This fact, therefore, eliminates delicate settings necessary for the determination of, for example, the diameter and position of the slow port 13 and makes it possible to control automatically the air flow rate and the fuel flow rate. Hence the steps of such settings can materially be reduced.

Also, the light-emitting device 12a and the light-receiving device 12b of the level detector 12 in the above embodiment may be disposed in such a manner as to project into the passageway 10 at the predetermined height thereof as shown in Fig. 6 and may be arranged, as indicated in Fig. 8, in such a manner as to be incorporated in the passageway 10 at the predetermined height thereof to detect then the fuel level by providing a float 10b formed of an opaque material in the fuel column 10a. In these examples shown in Figs. 6 and 8, the outputs generated from the level detector 12 deliver the signals to the control circuit 16 in accordance with the fuel level as indicated in Figs. 7 and 9, respectively, and consequently the same function as in the above embodiment can be brought about.

Fig. 10 shows a second embodiment of the present invention, which is an example that the low-speed fuel control system of the present invention is applied to a primary bore side P of a compound type carburetor. In this figure, reference numeral 21 denotes a venturi, 22 a throttle valve, 23 a passageway for connecting a slow jet 24 with a venturi 21, 25 a level detector disposed in the passageway 23 and having the same structure as in the first embodiment, 26 a slow port communicating with the slow jet 24 through a passageway 27 and opening into the intake bore of the primary side P, and 28 a solenoid valve disposed in position along the passageway 27 and having the same structure as in the first embodiment. Further, a secondary bore side S comprises a venturi 29, a throttle valve 30, a main nozzle 31, a main air jet 32, a main jet 33, a slow jet 34, and a slow air jet 35, and the throttle valve 30 is set so that the intake bore of the secondary side S is closed, in the low-speed region, through a control device 36 actuated by the vacuums in the venturi 21 and the venturi 29.

In the case of this embodiment, the suction air is supplied from the primary side P in the low-speed region of the engine, while the level detector 25, the solenoid valve 28 and the like are operated as is the case with the first embodiment. That is, the flow rate of the fuel discharged from the slow port 26 is controlled so that the ratio of the fuel pressure in the downstream side of the slow jet 24 to the negative pressure generated in the venturi 21 properly representative of the flowrate of the air passing through the venturi 21 is consistently maintained to be a constant value, and therefore the mixture with the air to fuel ratio which is always constant is supplied to the manifold over varying air flow rates. Also in this case, such an effect that the reduction of the setting steps of the slow port 26 can be made is brought about as in the case with the first embodiment and the mixture with the most proper air-fuel ratio is available in the low-speed region of the primary side P. Further, it is basically the same as in ordinary compound type carburetors that the supply of the mixture is gradually shifted to the secondary side S as the engine speed exceeds the low-speed region.

Also, the solenoid valves 14, 28 in respective embodiments mentioned above may be duty-controlled by an input pulse or may be adapted to open and close the fuel passageways 15, 27, respectively, by the variation of an input voltage. Further, the level detectors 12, 25 can be replaced by known level indicators for which a float provided with an electric contacts or optical fibers and supersonic are utilized and in any of these cases, the same effect as in the above embodiments is achieved.

Claims

1. A carburetor provided with a low-speed fuel control system, comprising:

a low-speed system venturi capable of generating a vacuum in accordance with a flow rate of air to be fed to an intake bore;

a vacuum passageway connecting said low-speed system venturi with a slow jet;

a level detecting means detecting whether or not the level of a fuel column to be formed in said vacuum passageway is higher than a predetermined position;

a low-speed fuel passageway connecting said slow jet with a slow port opening on an internal wall of said intake bore; and

a fuel flow rate controlling means provided in said low-speed fuel passageway and capable of controlling a flow rate of fuel to flow through said low-speed fuel passageway in accordance with an output signal delivered from said level detecting means,

said flow rate of fuel flowing through said low-speed fuel passageway being controlled in proportion to said air flow rate by said fuel flow rate controlling means so that the level of said fuel column is held at said predetermined position.

2. A carburetor according to Claim 1 further comprising:

an air valve provided in said intake bore and capable of closing said intake bore; and

a throttle valve provided at the downstream side of said air valve in said intake bore,

said low-speed system venturi being provided in a bypass by which the upstream side of said air valve communicates with the downstream side thereof,

said slow port being adapted to cooperate with said throttle valve.

3. A carburetor of a compound type according to Claim 1, wherein:

said intake bore is a primary bore; and

said slow port is adapted to cooperate with a throttle valve provided in said primary bore.

4. A carburetor according to one of Claims 1 to 3, wherein:

said level detecting means comprises a light-emitting device and a light-receiving device arranged on opposite sides of said vacuum passageway at said predetermined position and an output issued from said light-receiving device when the level of said fuel column is higher than said predetermined position is different in level from an output issued when lower.

5. A carburetor according to Claim 4, wherein:

said light-emitting device and said light-receiving device are arranged so that tops thereof project into said vacuum passageway.

6. A carburetor according to Claim 4, wherein:

said light-emitting device and said light-receiving device are incorporated in a pair of concaves defined on opposite sides of said vacuum passageway and an opaque float is provided on the top of said fuel column.

7. A carburetor according to one of Claims 1 to 3, wherein:

said level detecting means includes a fixed contact and a movable contact associated with a float provided on the top of said fuel column and, when the level of said fuel column is higher or lower than said predetermined position, said fixed contact comes in contact with or is out of contact with said movable contact, respectively.

8. A carburetor according to one of Claims 1 to 3, wherein:

said fuel flow rate controlling means includes a solenoid valve capable of switching over the opening degree of said low-speed fuel passageway into plural steps in accordance with the output signal delivered from said level detecting means or capable of opening and closing said low-speed fuel passageway with different periods.

FIG. 1

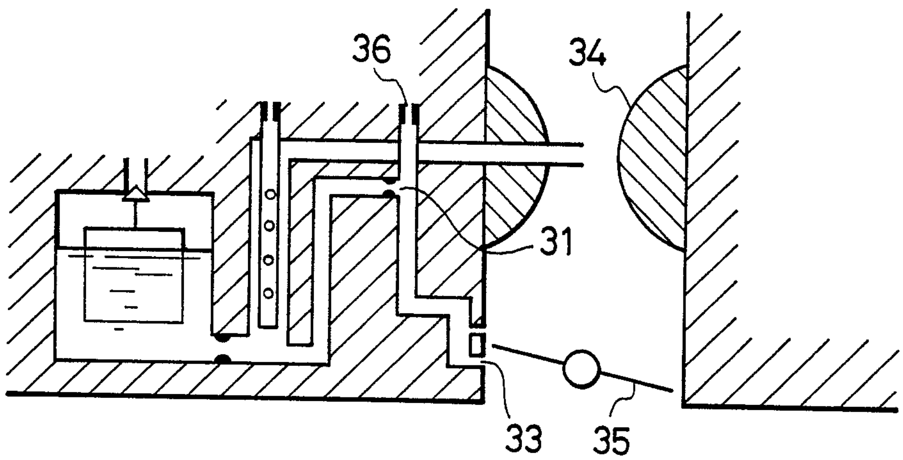


FIG. 2

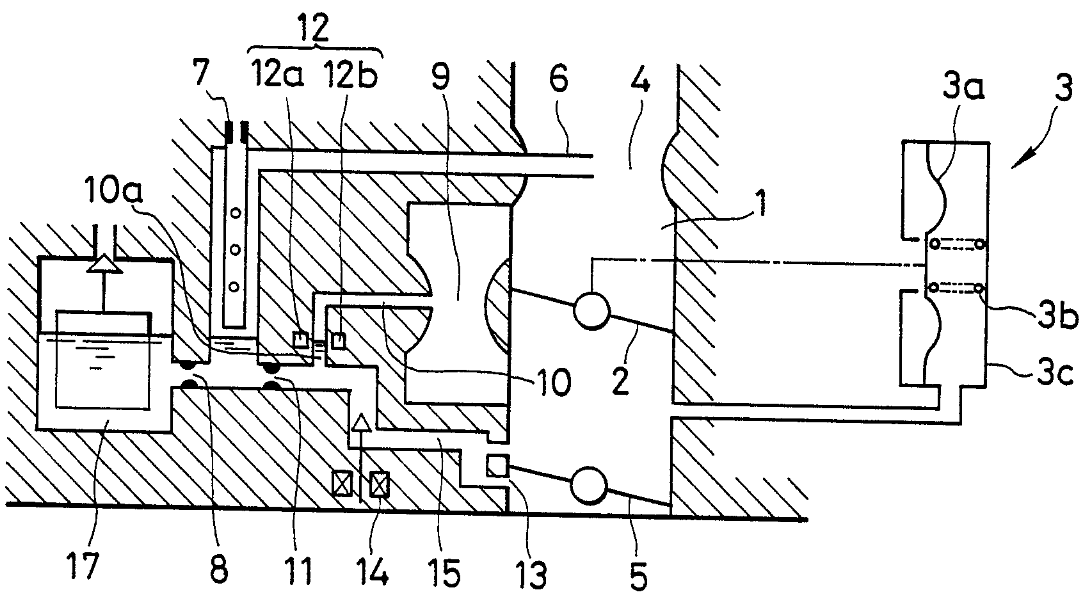


FIG. 3

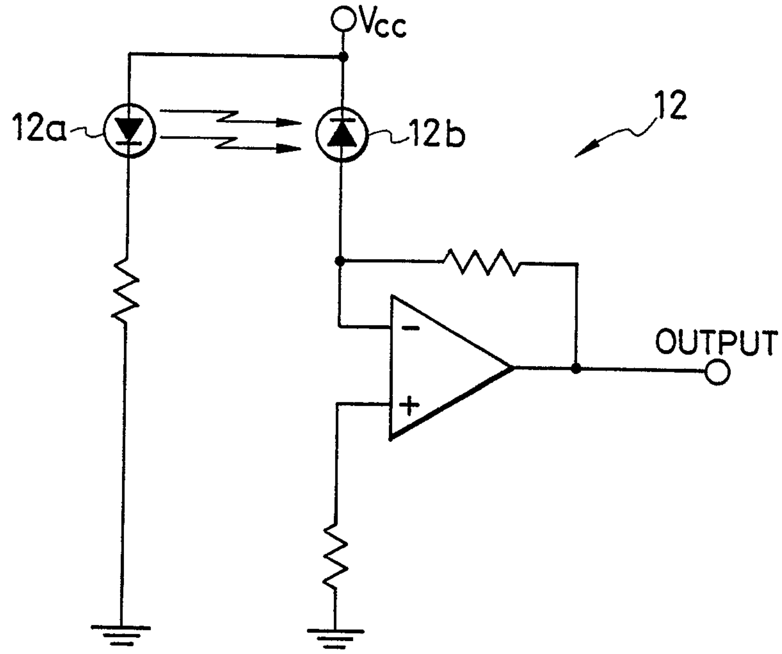


FIG. 4

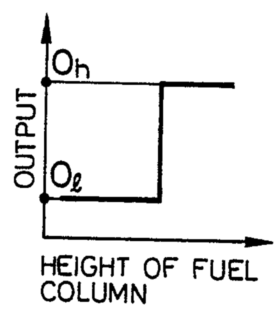


FIG. 5

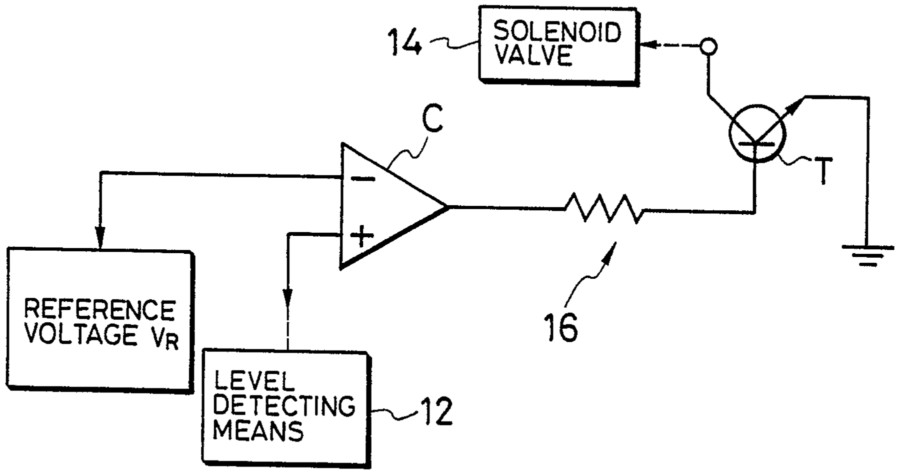


FIG. 6

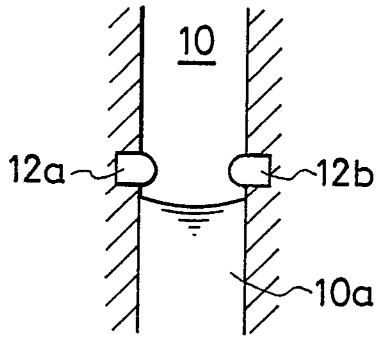


FIG. 8

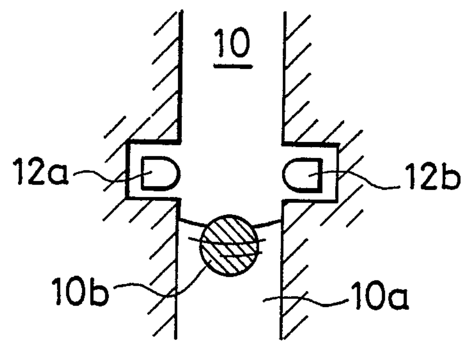


FIG. 7

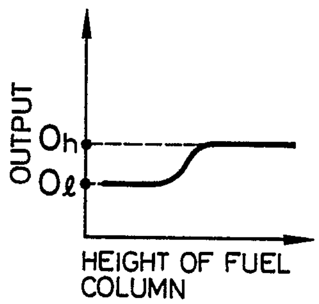


FIG. 9

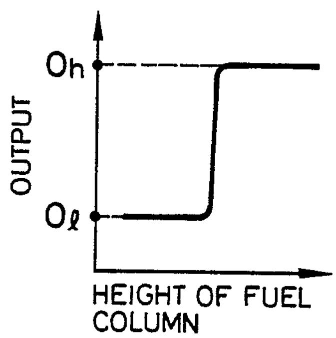


FIG. 10