United States Patent

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[33] **Japan**
[31] **43/49419**

[54] **CARBURETOR WITH FLUID AMPLIFYING ELEMENTS**
4 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **261/36,** 261/41, 261/69, 137/81.5, 123/119
[51] **Int. Cl.** **F02m 7/04**
[50] **Field of Search** 261/36.1, 69, 69.1, 41; 137/81.5; 123/119

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ABSTRACT: A carburetor employing three pure fluid amplifiers. Fuel from a supply source is applied to the power inputs of a first and a second amplifier, with a power outlet of the second amplifier being connected to the power inlet of the third amplifier. One power outlet of each amplifier terminates at an opening in a cylinder wall upstream of a throttle valve for supplying fuel to the cylinder. One control input of each amplifier terminates at an opening in the cylinder wall for sensing the pressure therein and controlling the amplifiers to supply fuel at a rate dependent upon the pressure sensed. The arrangement is such that one, two or all three amplifiers may supply fuel to the cylinder.

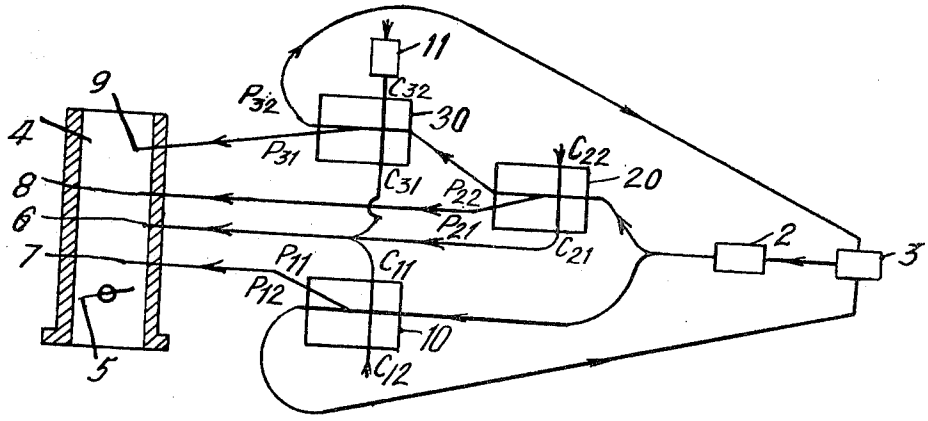


Fig. 1

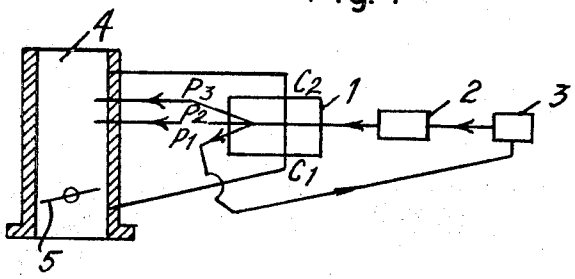


Fig. 2

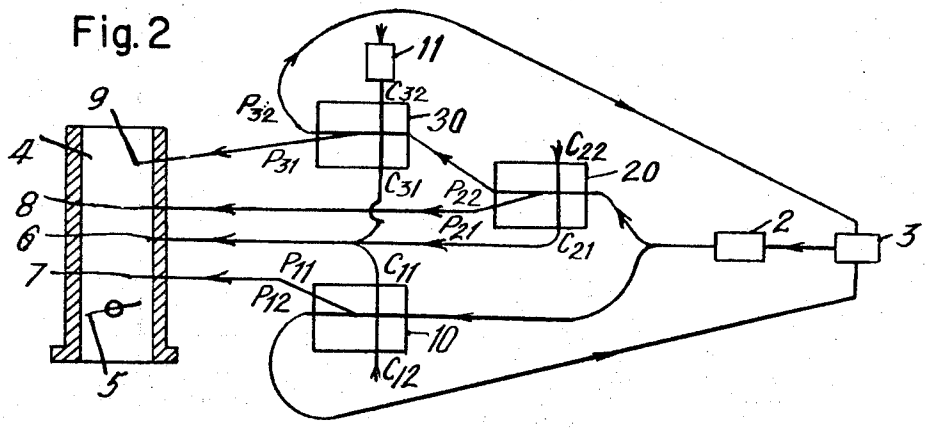


Fig. 3

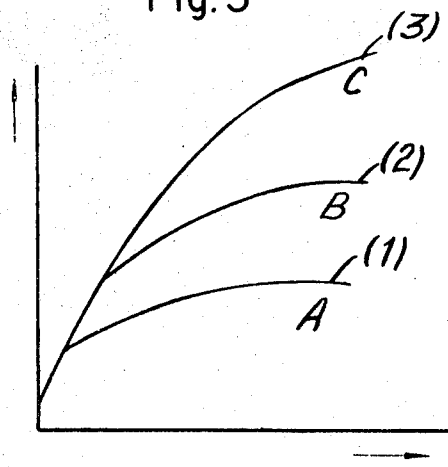
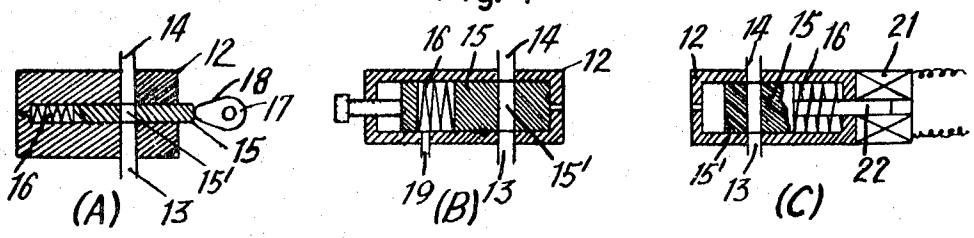


Fig. 4



CARBURETOR WITH FLUID AMPLIFYING ELEMENTS

PRIOR ART

FIG. 1 illustrates a typical prior art device employing a fluid amplifier. As shown in FIG. 1, the fuel in the fuel tank 3 is forced out by the fuel pump 2 and is supplied to the supply port of the fluid amplifier 1 having power output outlets P_1, P_2 and P_3. The controlling signal (fluid) circuit, which is connected to the control circuit terminals C_1 and C_2 of the fluid amplifier 1, is opened at the upstream and downstream of the throttle valve 5 of the cylinder 4, respectively, and a fluid amplifying element is used to control the quantity of fuel supplied to the cylinder 4 from the power output outlets P_1 and P_2 in accordance with engine operation conditions. The carburetor of this type is well known. Since only one fluid element with multiple power output outlets is used to control the fuel supply from the idling state to the state of full power output, a highly accurate element is needed. It is difficult for one fluid element to control the fuel supply in accordance with the need of the engine, i.e., a rich fuel mixture is needed during the idling, a (lean) economical fuel mixture during the state of partial power output, and a rich fuel mixture during the state of full power output. Various auxiliary equipment is needed, causing difficulty in mass production. Furthermore, this device requires a controlling vacuum outlet downstream of the throttle valve where it is affected by changes in manifold vacuum. This creates the possibility of a large quantity of fuel being injected during periods of acceleration.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a carburetor which has none of the disadvantages enumerated above.

An object of the present invention is to provide a carburetor having plural fluid amplifying elements for controlling fuel flow.

An object of the present invention is to provide plural fluid amplifiers for controlling fuel flow to a cylinder, said amplifiers being selectively and successively operated to supply said fuel in response to the pressure within said cylinder.

In a first embodiment of the invention, a combination of fluid elements is employed. The outputs of each element are additively supplied to the engine and thus the quantity of fuel can be controlled in a wide range. There is a time lag in the start of operation of each fluid-amplifying element, and the fuel flow from each fluid-amplifying element is supplied additively to the engine. The nozzle for supplying fuel as well as the vacuum outlet for controlling fuel are all located at the upstream of the throttle valve to decrease the effect caused by the manifold vacuum.

A second embodiment also employs multiple fluid-amplifying elements. Similarly, there is a time lag in the start of operation of each fluid-amplifying element, and the fuel flow from each fluid-amplifying element is also supplied additively to the engine. To one of the elements is installed a circuit switch operated by vacuum to control the starting time of operation of the element. This circuit switch is connected to the vacuum portion of the engine to supply an overly rich fuel mixture during the period of low boost.

BRIEF EXPLANATION OF THE FIGURES

FIG. 1 shows the pipe arrangement of a conventional carburetor with fluid-amplifying elements;

FIG. 2 shows the pipe arrangement of carburetors invented;

FIG. 3 shows the fuel characteristics of the carburetors shown in FIG. 2; and

FIG. 4(A), (B) and (C) are the longitudinal sections of various circuit switches used in the invented carburetors.

DETAILED EXPLANATION OF THE INVENTION

The carburetors invented are now explained by the use of FIGS. When the engine is started, the fuel pump 2 shown in FIG. 2 will start to operate; the fuel is drawn from the fuel tank 3 and forced into the supply ports of the fluid elements 10 and 20. The fluid element 10 always supplies a small quantity of idling fuel flow to the cylinder 4 from the power output outlet P_{11} through the nozzle 7. The excess fuel which was sent to the supply port of the fluid element from the fuel pump 2 is returned to the tank 3 from the power output outlet P_{12}. The fuel sent to the fluid element 20 is forced into the supply port of the fluid element 30 through the power output outlet P_{22} and is returned to the fuel tank 3 from the power output outlet P_{32}. The starting level of the operation of the fluid element 20 is so preset that it will not start operation even though the cylinder vacuum during the idling is present at the control circuit terminal C_{21} of the fluid element 20.

During the partial power output of the engine, the throttle valve will open and the quantity of air passing through the cylinder 4 is increased. Consequently, the cylinder vacuum will increase in accordance with the quantity of air sucked in. From the vacuum outlet 6 which opens at the cylinder sidewall, the cylinder vacuum will be transferred through the fluid circuit used for transferring the control signal, and will be impressed simultaneously upon one side of the control circuit terminals C_{11}, C_{21} and C_{31} of each fluid element. Since the other side of the control circuit terminals C_{12} and C_{22} of the fluid elements 10 and 20 are connected to atmospheric air, the aforementioned cylinder vacuum as a control signal will be impressed on the control circuit terminals C_{11} and C_{21} as mentioned above, and the cylinder vacuum is gradually increased. Subsequently, the quantity of fuel flowing out of the power output outlet P_{11} of the fluid element 10 is also increased in accordance with the degree of the cylinder vacuum. When the quantity of the fuel flow reaches a certain degree, the quantity of the fuel flowing out of P_{11} will no longer increase even though the cylinder vacuum is increased further, i.e., a saturated state is reached. In this way, when the cylinder vacuum becomes slightly smaller than the cylinder vacuum at which the fluid element 10 becomes saturated, the fluid element 20 will start to operate and the fuel from the power output outlet P_{21} begins to be fed into the cylinder 4 via the nozzle 8. When the cylinder vacuum is increased further, the negative pressure on the control circuit terminal C_{21} will also increase. Therefore, the output from the fluid element 20 will be shifted gradually from the power output outlet Pto P_{21}. In this state, the fuel supplied to the engine is equal to the sum of the fuel from the power output outlets P_{11} and P_{21}. During this state of partial power output of the engine, the circuit switch 11 connected to the control circuit terminal C_{32} of the fluid element 11 is closed, and thus the fluid element 30 will not perform its control activity. Consequently, all the fuel supplied to the fluid element 30 is returned to the fuel tank 3 from the power output outlet P_{32}.

As will be mentioned later, when the engine is in the state of full power output, the circuit switch 11 interlocked with the throttle valve 5 will be opened, and the control circuit terminal C_{32} of the fluid element 30 is connected to atmospheric air to start the operation of the fluid element 30. The fuel drawn from the output opening P_{31} will be added to the fuel from the aforementioned power output outlets P_{11} and P_{21} in accordance with the increase in the cylinder vacuum, and is supplied to the engine. 9 is the nozzle for supplying fuel to the cylinder from the power output outlet P_{31}.

FIG. 3 shows the relationship between the cylinder vacuum of the carburetor with fluid-amplifying elements, as shown in FIG. 2, and the quantity of fuel flow. In this FIG., the curve 1 represents the quantity of fuel supplied to the engine from the power output outlet P_{11} of the fluid element 10; the curve 2 represents the fuel shown in the curve 1 plus the additional fuel supplied from the power output outlet P_{21} of the fluid element 20. The curve 3, in addition to the fuel given by the curves 1 and 2, also includes the fuel from the power output outlet P_{31} of the fluid element 30. The area A enclosed by curve 1, the vertical axis and the horizontal axis indicates the amount of fuel to be supplied by the fluid element 10. The area B enclosed by the curves 1 and 2 represents the amount

of fuel to be supplied by the fluid element **20**, and the area C between the curves **2** and **3** represents the amount of fuel to be supplied by the fluid element **30**.

Various circuit switches **11** connected to the control circuit terminal **32** of the fluid element **30** shown in FIG. **2** are shown in FIG. **4**(A), (B) and (C). FIG. **4**(A) is a mechanically operated circuit switch. Its main body **12** contains the opening **13** connected to the control circuit terminal C32 of the fluid element **30** and the opening **14** connected to atmospheric air. The piston **15** which can connect or disconnect the two openings **13** and **14** is also present in the main body. The spring **16** is used to keep the piston to the right. The piston is interlocked with the throttle valve **5** and is pressed by the cam **18** which rotates around the axle **17**. During the full power output of the engine, the cam **18** will push the piston **15** to the left as shown in FIG. **4**(A), and the hole **15'** which passes through at about the center of the piston **15** will move to a proper position to connect the openings **13** and **14**. Consequently, the fluid element **30** will start to operate as mentioned earlier and supply the fuel for full power output.

The circuit switch shown in FIG. **4**(B) also contains within its main body **12** the piston **15** and the spring which keeps the piston to the right at all times. It also contains the vacuum connection opening **19** connected to the chamber enclosed by the piston **15** and the main body **12** and located at the left side of the piston. The vacuum connection opening **19** is connected to the engine manifold or the vacuum portion of the engine located at the downstream of the throttle valve. When the degree of vacuum is about that of the full power output of the engine (about 60 mmHg) the spring **16** can work against the vacuum to push the piston **15** toward the right, and the openings **13** and **14** are connected through the hole **15'**. The fluid element will then start to operate. During the partial power output of the engine, the negative pressure in the vacuum portion of the engine will increase, and the negative pressure created in the chamber on the left side of the piston will work against the spring **16** to suck the piston toward the left. The openings **13** and **14** are now closed.

The circuit switch shown in FIG. **4**(C) is operated electromagnetically. The piston **15** in the main body **12** consists of the plunger **22** and the coils **21** and is kept to the left side at all times by the action of the spring **16**. The coils **21** are connected in series to a switch and a battery. The switch will be closed when the accelerator pedal of an automobile is depressed deeply. Therefore, during the full power output of the engine, the aforementioned switch interlocked with the accelerator pedal is closed and the excitation current will flow through the coils. The plunger **22** will be sucked in and thus the piston **15** will work against the spring **16** to move toward the right. The openings **13** and **14** are now connected through the hole **15'** and the fluid element **30** will start to operate to supply additional fuel for the full operation of the engine. During the partial power output, the switch connected to the accelerator pedal will open and the excitation current of the coils **21** will be shut off. Therefore, the piston **15** will be pushed toward the left by the action of the spring **16** to shut off the connection between the openings **13** and **14**. Subsequently, the fluid element will stop performing its controlling action and the fuel for the full operation of the engine cannot be supplied, and only the fuel from the fluid elements **10** and **20** will be supplied to the engine.

In the carburetor shown in FIG. **2**, the controlling signals applied on the control circuit terminals C_{11}, C_{21} and C_{31} of each fluid element are obtained from the same vacuum outlet **6**. However, the signals can be obtained from their respective vacuum outlets which have their exits in the cylinder **4**. Since one side of the control circuit terminals of each fluid element is exposed to atmospheric air, the control signal obtained is the difference between the atmospheric pressure and the negative pressure in the cylinder. Therefore, the size of signal will change with varying atmospheric pressures. In order to avoid this variation, one can install in the cylinder **4** a stage having a different diameter from that of the cylinder, or multiple cylinders with different diameters, and the pressure differences between the two places having different pressures in the cylinder is used as a control signal for the fluid elements.

In order to carry out the microadjustment of the starting time of the operation (fuel supply) of each fluid element (namely, level of starting signal) and the quantity of fuel flow, an adjusting screw and jet which can act as an adjustable throttle are installed either on the control circuits of each fluid element or on the passage (the fluid circuit) connected to the power output outlets, or both.

For the determination of the starting time of the operation of the fluid elements **20** and **30**, the circuit switch can be installed at the fuel intake opening connected to the supply port of the fluid element, or on the control circuits, or on various passages of the power output outlet.

The fluid elements **10**, **20** and **30**, can be connected in series. This pipe arrangement will result in the fuel from the power output outlet P_{12} of the fluid element **10**, as shown in FIG. **2**, becoming the fuel to be fed into the supply port of the fluid element **20**. The characteristic capacity of this pipe arrangement is about the same as that of the arrangement shown in FIG. **2**.

According to this invention, the multiple fluid amplifying elements will start to operate gradually and successively as the power output of the engine increases in accordance with the performance of the engine. At the beginning, the engine is operated solely by the output fuel from one fluid element. During the full power output of the engine, total outputs from all fluid elements are supplied to the engine. Because of the characteristics mentioned above, it is not necessary to especially improve the processing accuracy of each fluid element in order for the entire system to be able to provide the fuel supply in accordance with fuel characteristics requested by the engine. Since no controlling vacuum outlet is present at the downstream of the throttle valve, the system will be affected very little by the manifold vacuum, and the possibility of a large quantity of fuel flow during the deceleration period is eliminated.

In the case in which the circuit switch operated by negative pressure is present, the system can automatically supply an over-rich gas mixture in accordance with the requirements of the engine during the low boost, full power output operation. At the start of the engine, the cranking negative pressure is low, but the system described above can still improve the starting property of the engine by opening the circuit switch for the addition of small quantities of fuel.

We claim:

1. A carburetor for controlling the flow of fuel to a cylinder bore, said carburetor comprising:

a throttle valve in said bore;

a plurality of fluid-amplifying means each having a power input, first and second control inputs, and first and second power outputs to which fuel supplied to said power input may be selectively directed in response to signals at said control inputs;

each of said fluid-amplifying means having an internal configuration such that a control signal of a different magnitude is required at said first control inputs in order to direct fuel from said first to said second power output;

means for conveying fuel from one of said power outputs of each amplifier to said cylinder bore;

means for conveying to said first control inputs the pressure in said bore;

switch means for selectively blocking said second control input of one of said fluid-amplifying means, or connecting it to the atmosphere;

means interlocking said switch with said throttle valve whereby said switch means connects said second control input to atmosphere when said throttle valve is opened; and

means connecting said second control input of each of the other fluid-amplifying means to the atmosphere.

2. A carburetor as claimed in claim 1 wherein said means for conveying fluid pressure comprises fluid passage means communicating with said bore upstream of said throttle valve.

3. A carburetor for controlling the flow of fuel to a cylinder bore, said carburetor comprising:

a throttle valve;

a plurality of fluid-amplifying means each having a power input, first and second control inputs, and first and second power outputs to which fuel supplied to said power input may be selectively directed in response to signals at said control inputs;

each of said fluid-amplifying means having an internal configuration such that a control signal of a different magnitude is required at said first control inputs in order to direct fuel from said first to said second power output;

means for conveying fuel from one of said power outputs of each amplifier to said cylinder bore;

means for conveying to said first control inputs the pressure in said bore;

pressure-responsive switch means for selectively blocking said second control input of one of said fluid-amplifying means, or connecting it to the atmosphere;

a fluid passage connected to said switch means and terminating at an opening in said bore downstream from said throttle valve for operating said switch in response to a negative pressure of predetermined value; and

means connecting said second control input of each of the other fluid-amplifying means to the atmosphere.

4. A carburetor as claimed in claim 3 wherein said means for conveying fluid pressure comprises fluid passage means communicating with said bore upstream of said throttle valve.