

[54] **SURGING PREVENTION DEVICE FOR USE IN VEHICLE HAVING MULTICYLINDER SPARK-IGNITION INTERNAL COMBUSTION ENGINE**

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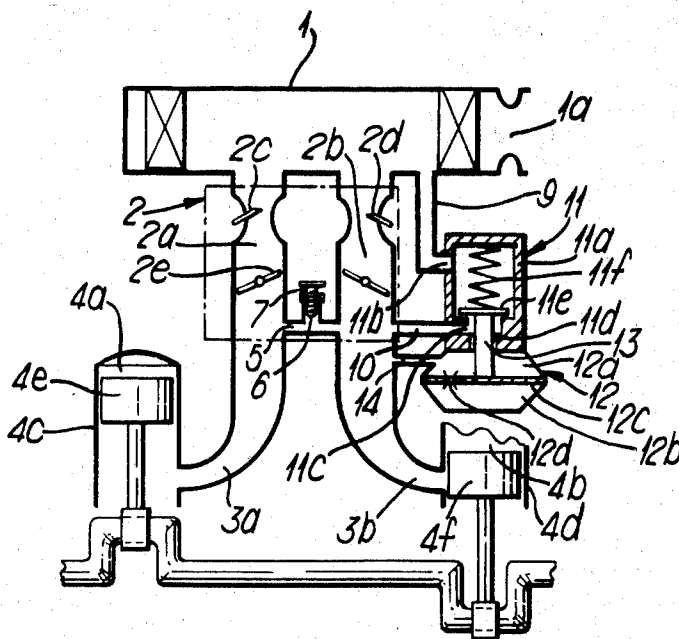
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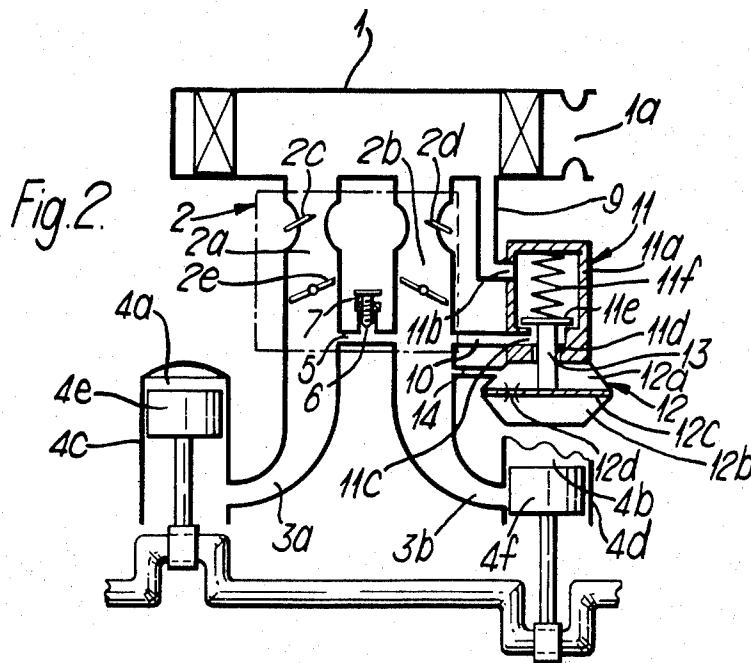
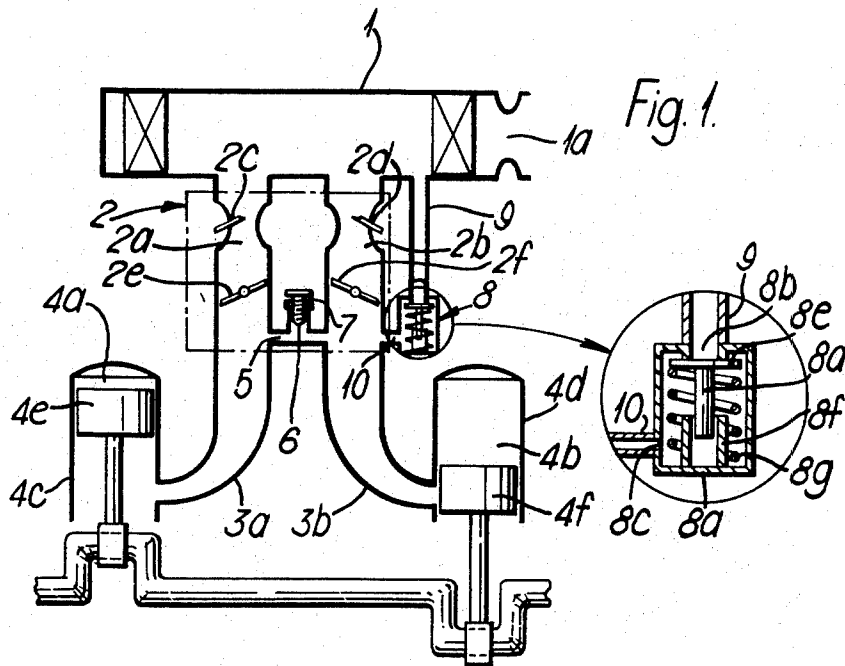
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ABSTRACT

A device for preventing fluctuations in the output torque of a spark-ignition internal combustion engine which result from irregular combustion of air-fuel mixture. According to the present invention, instead of the conventional idling device of which the idling jet is situated on the engine side of the edge of the throttle valve, a communication passage communicating at the downstream side of the throttle valves between a pair of intake passages each connecting the carburetor to the respective combustion chambers, an additionally fuel supplying means interposed in the communication passage and means for supplying a primary air from an air source to one of said pair of the intake passages are provided in the intake system of the internal combustion engine.

4 Claims, 2 Drawing Figures





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SURGING PREVENTION DEVICE FOR USE IN VEHICLE HAVING MULTICYLINDER SPARK-IGNITION INTERNAL COMBUSTION ENGINE

The present invention relates to a surging prevention device for use in vehicles having spark-ignition internal combustion engines and, more particularly, to a device for preventing irregular combustion of fuel in a plurality of combustion chambers of a spark-ignition internal combustion engine of an automotive vehicle which will result in the fluctuations in the engine output torque and bumpy running or surging of the vehicle.

It has been often experienced that, when the accelerator pedal is rapidly released while an automotive vehicle mounted with a multicylinder internal combustion engine is running at high speed or when the vehicle is descending hills while a throttle valve or throttle valves are substantially closed, the vehicle speed exceeds over the engine speed so that the engine is braked. While in this condition, since the throttle valve is substantially closed, the amount of air drawn in the intake system of the engine is considerably reduced and, on the other hand, a limited quantity of residual fuel that has been wetted on the inner peripheral surface of the intake manifold is supplied to the combustion chamber in a delayed timing. In this case, since the air-fuel mixture ratio is often enriched in view of the fact that a mixture of air with fuel supplied from the idling jet under the influence of the high negative pressure in the intake system is further mixed with the residual fuel that has been wetted on the inner peripheral surface of the intake manifold, a complete combustion will not take place in the cylinder even if the spark plug is fired.

However, when the vehicle speed is reduced until the engine speed arrives at the idling speed, a proper amount of fuel can be supplied from the idling jet through the idling adjustment screw so that a favorable combustion takes place.

In a certain case, an irregular combustion which is an unstable repetition of misfire and fire will occur in the process from the engine braking operation till the idling operation, resulting in that the output torque of the engine will vary to such an extent as to create a bumpy running or surging of the vehicle. This occurrence of the irregular combustion will also constitute a cause for after-burning in the exhaust system of the engine as well as discharge of a considerable amount of noxious unburned compounds present in an exhaust gas to the atmosphere.

The same may occur not only in a vehicle having the multicylinder internal combustion engine, but also in a vehicle having the rotary piston internal combustion engine which is generally referred to as "Wankel engine" to which current attention is centered. Especially in the rotary piston internal combustion engine, although it has been largely admitted that the amount of noxious unburned compounds present in an exhaust gas emerged from the exhaust system thereof is considerably smaller than that emerged from the exhaust system of a reciprocating internal combustion engine, it is desirable to further reduce the amount of noxious unburned compounds beyond the current or future air-pollution standards.

Accordingly, one object of the present invention is to provide an improved device capable of reducing variations in the output torque of the engine which often occur when the engine is decelerated.

Another object of the present invention is to provide an improved device including a communication passage communicating a pair of intake manifolds which are connected independently to combustion chambers, additionally fuel supplying means interposed in said communication passage and a primary air supplying means formed adjacent to either of said intake manifolds for supplying a primary air and operable in such a manner that, when the engine is decelerated, this air can be supplied to one of the pair of the intake manifolds which is provided with the primary air supplying means, a portion of said primary air thus supplied being in turn supplied to the other intake manifold together with fuel supplied from said additionally fuel supplying means through the communication passage, whereby variations in the output torque of the engine which often occur during the deceleration of the engine can be substantially eliminated.

A further object of the present invention is to provide an improved device adaptable in the rotary piston internal combustion engine by which the amount of noxious unburned compounds present in an exhaust gas emerging from the exhaust system of such rotary piston internal combustion engine can be additionally reduced.

A still further object of the present invention is to provide the improved device of the character above referred to which can be manufactured at low cost without necessitating any complicated manufacturing steps.

The present invention will be hereinafter fully described by way of example in conjunction with preferred embodiments shown in the accompanying drawings, in which:

FIG. 1 is a schematic sectional view of an intake system of an internal combustion engine embodying the present invention and

FIG. 2 is a schematic sectional view of a modified intake system of the internal combustion engine embodying the present invention.

Before the description proceeds, it is to be noted that, for the sake of brevity, the present invention will be described on the assumption that it is employed in an intake system of a two-cylinder two-stroke gasoline engine. However, the present invention is, of course, applicable in the intake system of any type of internal combustion engines including a two-rotor rotary piston internal combustion engine, i.e., two-rotor Wankel engine, now in the center of attention from the automobile industry.

Referring now to FIG. 1, the intake system shown includes a conventional air-cleaner 1 having an air intake opening 1a and a carburetor assembly as generally indicated by 2. This carburetor assembly 1 may be of conventional two-barrel carburetor as shown and is provided therein with a pair of first and second passages 2a and 2b and a pair of first and second main fuel nozzles 2c and 2d respectively extended through venturi portions of said first and second passages 2a and 2b for supplying fuel to be atomized into the corresponding passages 2a and 2b. Each of said first and second passages 2a and 2b of the carburetor assembly 2 has one end connected with the air cleaner 1 and the other end connected with a corresponding one of first and second intake manifolds 3a and 3b respectively connecting said first and second passages 2a and 2b to

combustion chambers 4a and 4b of an internal combustion engine having, in the instance as shown, a pair of cylinders 4c and 4d respectively provided therein with pistons 4e and 4f. The carburetor assembly 2 is provided in its first and second passages 2a and 2b with respective throttle valves 2e and 2f for regulating the flow of air-fuel mixture to be supplied to the combustion chambers 4a and 4b of the internal combustion engine.

The structure of each of the air cleaner 1 and carburetor assembly 2 so far described is well known to those skilled in the art and, therefore, the details thereof are herein omitted. In addition, the two-stroke internal combustion engine herein employed for the only purpose of illustration of the present invention is also well known to those skilled in the art and, therefore, no reference is made to the details thereof except for such components of said engine as are necessitated to proceed the description of the present invention which are recited as indicated by the reference numerals.

The surging prevention device constructed in accordance with the teachings of the present invention comprises a communication passage having one end, in the instance as shown, open to the interior of the first passage 2a of the carburetor assembly 2 at the downstream side with respect to the throttle valve 2e and the other end open to the interior of the second passage 2b of said assembly 2 at the same side with respect to the throttle valve 2f. This communication passage 5 may be disposed outside said carburetor assembly 2 so as to communicate the first and second intake manifolds 3a and 3b, provided that the length of said communication passage 5 be maintained at an optimum value.

This communication passage 5 is provided at its intermediate portion, preferably at the central point of the length of said communication passage 5, with an additionally fuel supplying means including a nozzle 6 open to the interior of said passage 5 and an adjustment screw 7 adapted to regulate the flow of fuel from a fuel source (not shown) to the interior of said passage 5 through said nozzle 6. The structure of this additionally fuel supplying means may be substantially the same as that of the conventional idling device of which the nozzle or idling jet is normally situated on the engine side of the edge of the throttle valve. This additionally fuel supplying means which is a substitute for the conventional idling device acts in a similar manner to the conventional idling device, in view of the fact that, when the opening of the both throttle valves is so small that the amount of air drawn in the respective intake manifolds 3a and 3b is considerably reduced, fuel can be supplied through the nozzle 6 to the combustion chamber 4a and 4b as will be mentioned later.

The surging prevention device according to the present invention further comprises a control valve for supplying the primary air during the deceleration of the engine which is generally indicated by 8. This control valve is designed such as shown in an enlarged fragmental portion of FIG. 1 and includes a valve housing 8a formed with an inlet port 8b communicated with the air cleaner 1 by means of a conduit 9 and an outlet port 8c communicated with the interior of the second passage 2b by means of a piping 10. While the opening at one end of said piping 10 is open to the interior of

the valve housing 8a, the opening at the other end thereof is open to said second passage 2b at the downstream side of the throttle valve 2f, preferably, in register with the adjacent opening of the communication passage 5 positioned in the opposite side of said second passage 2b.

The control valve housing 8a is provided therein with a piston rod 8d having one end rigidly connected with a valve member 8e and the other end slidably supported in a bearing member 8f, and a resilient member 8g preferably in the form of a compression spring adapted to normally upwardly urge the piston rod 8d so as to cause the valve member 8e to close the inlet port 8b. However, the resiliency of said resilient member 8g is such that, the piston rod 8d can be downwardly moved against said resilient member 8g when the value of pressure within the valve housing 8a become smaller than that of pressure in the conduit 9 during the deceleration of the engine, said pressure in said conduit 9 being substantially equal to the atmospheric pressure.

In another preferred embodiment of the present invention shown in FIG. 2, the control valve 8 shown in FIG. 1 is replaced by a control valve assembly comprising a combination of first and second valve sections 11 and 12. The first valve section 11 includes a valve housing 11a formed at its upper portion with an inlet port 11b communicated with the air cleaner 1 by means of the conduit 9 and at its lower portion with an outlet port 11c communicated with the interior of the intake manifold 3b by means of the piping 10. This valve housing 11a is also formed at its lower wall portion with a bore 11d through which a piston rod 13 is slidably extended. Positioned below the valve housing 11a is a second valve section 12 having first and second diaphragm chambers 12a and 12b divided by a diaphragm member 12c formed with a small hole 12d communicating between said first and second diaphragm chambers 12a and 12b. However, the first diaphragm chamber 12a is also communicated with the interior of the intake manifold 3b by means of another piping 14 disposed below the first mentioned piping 10.

The piston rod 13 has one end rigidly connected with a valve member 11e of the size sufficient enough to close the outlet port 11c which is situated within the valve housing 11a, while the other end of said piston rod 13 is rigidly connected with an upper surface of said diaphragm member 12c, and is normally downwardly urged by a resilient member 11f which may be employed in the form of a compression spring.

While in this arrangement of the control valve assembly shown in FIG. 2, the values of pressure in the diaphragm chambers 12a and 12b are normally equalized to each other and the valve member 11e of the first valve section 11 is at this time in position to close the outlet port 11c. However, when the values of negative pressure in the intake manifolds 3a and 3b are suddenly increased during the deceleration of the engine, the value of pressure in the first diaphragm chamber 12a will become smaller than that in the second diaphragm chamber 12b so that the piston rod 13 can be upwardly moved against the resilient member 11f, which is situated in the first valve section 11, to permit the flow of air from the air cleaner 1 to the intake manifold 3b through said first valve section 11. However, this flow of air to the intake manifold 3b is permitted for a cer-

tain period of time until the value of pressure in the first diaphragm chamber 12a that has been reduced is equalized to that in the second diaphragm chamber 12b. This can be achieved by the provision of the hole 12d, formed in the diaphragm member 12c, through which the both chambers 12a and 12b are communicated to each other so that the diaphragm member 12c that has been deformed can be restored to its original posture. More particularly, the piston rod 13 that has been upwardly moved against the resilient member 11f can be returned to its original position when the difference between the values of pressure in the both chambers 12a and 12b becomes smaller than the resiliency of the resilient member 11f normally acting to urge the piston rod 13 in the downward direction.

While the arrangement of the surging prevention device of the present invention is such as hereinbefore fully described, the operation thereof will be hereinafter fully described.

It is to be noted that, so long as the engine is driven while the both throttle valves 2e and 2f are respectively in the open position, the surging prevention device constructed in accordance with the teachings of the present invention will not operate. In this case, means for regulating the flow of air to the intake manifold 3b which is employed in the form of the control valve 8 in FIG. 1 or the control valve assembly in FIG. 2 is in position to cut off the flow of air to the intake manifold 3b. Accordingly, combustion of fuel, supplied through the respective main nozzles 2c and 2d, which is properly mixed with a primary air drawn from the air cleaner 1 steadily takes place in the combustion chambers 4a and 4b in a manner well known to those skilled in the art.

When the both throttle valves 2e and 2f are subsequently closed and, at the same time, the engine speed is reduced to a value equal to or less than the vehicle speed, a relatively high value of negative pressure can be suddenly created in each of the intake passages 2a and 2b. Then, in the case of the embodiment shown in FIG. 1, the valve member 8e can be downwardly moved against the spring 8g by the action of the negative pressure thus created so as to permit the flow of the primary air from the air cleaner 1 into the second intake passage 2b through the piping 10. At this time, a portion of the primary air thus supplied into the second intake passage 2b also flows into the first intake passage 2a through the communication passage 5. As this portion of the primary air flows through the communication passage 5, fuel supplied from the nozzle 5 can be atomized and in turn supplied into the intake manifold 3a and then the combustion chamber 4. Such flow of the primary air through the communication passage 5 is substantially maintained during the deceleration of the engine from the second intake passage 3b, wherein the negative pressure is first lowered, to the first lowered, to the first intake passage 2a, wherein the negative pressure is not yet lowered. Consequently, as well as air is supplied into the combustion chamber 4a of the cylinder 4c so that combustion takes place therein. On the other hand, the combustion chamber 4b only receives the air and, therefore, no combustion takes place in the combustion chamber 4b of the cylinder 4d. Thus, it can be clearly understood that the variations in the engine out-

put torque or the surging of the vehicle which are often times caused by the irregular combustion in the both cylinders can be advantageously prevented by effecting combustion in either of the pair of the cylinders while the other is misfired.

Even in the case of the arrangement shown in FIG. 2, the same operation proceeds without affecting the advantage obtainable therefrom, although the manner in which the control valve assembly operates is slightly different from that of the control valve shown in FIG. 1.

Accordingly, it will be clearly understood that not only the vehicle can be prevented from surging but also, in view of the fact that either of the two cylinders of an internal combustion engine is forcibly directed to undergo the combustion with the small amount of fuel supplied through the additionally fuel supplying means while the other cylinder is merely directed to receive the air, the amount of unburned compounds present in an exhaust gas can be considerably reduced to an extent that the after-burning in the exhaust system can be advantageously prevented.

Although the present invention has been fully described by way of example wherein the two-cylinder two-stroke gasoline engine is employed, it should be noted that the present invention is not to be limited thereby and various modification and change are apparent to those skilled in the art. Therefore, such modification and change are to be construed as included within the scope of the present invention.

What is claimed is:

1. A surging prevention device for use in a vehicle having multicylinder spark-ignition internal combustion engine which comprises a plurality of main inlet passages each having therein a main fuel nozzle and a throttle valve and each independently connecting between an air source to a corresponding individual combustion chamber; a communication passage connecting between each pair of said main inlet passages at the downstream side with respect to a corresponding pair of the throttle valve; additionally, fuel supplying means formed at an intermediate portion of said communication passage; and a primary air supplying means disposed adjacent to either of the pair of said main inlet passages at the downstream side with respect to said pair of said throttle valve and operable in such a manner that, when the engine is decelerated, said air supplying means permits air from the air source to flow into the inlet passage, wherein, when the engine is decelerated, only air is supplied to one of the pair of said inlet passages so that no combustion arises in combustion chamber connected to said one of the pair of said main inlet passage and mixture of air and fuel from said additionally fuel supplying means is supplied to the other of the pair of said inlet passages so that combustion arises in combustion chamber connected to said the other of pair of said main inlet passage.

2. A surging prevention device according to claim 1, wherein said additionally fuel supplying means is positioned in said communication passage at a position substantially equally spaced from the both ends of said communication passage.

3. A surging prevention device according to claim 1, wherein said air supplying means comprises a control valve having an inlet port communicated with the air source and an outlet port communicated with the ad-

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adjacent inlet passage at the downstream side with respect to the throttle valve positioned within said inlet passage and operable so as to permit the flow of air from the air source to said outlet port through said inlet port when the engine is decelerated and to cut off said flow of air when said engine is accelerated.

4. A surging prevention device according to claim 1, wherein said air supplying means comprises a control

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valve assembly including a control valve section and a diaphragm valve section operably associated with said control valve section so as to permit the flow of air from the air source to the adjacent inlet passage therethrough when the engine is decelerated and to cut off said flow of air when said engine is accelerated.

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