

[54] **EXHAUST GAS RECIRCULATION CONTROL VALVE**

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

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[21] Appl. No.: **242,420**

[52] U.S. Cl. 123/119 A

[51] Int. Cl. F02m 25/06

[58] Field of Search. 123/119 A; 60/278

[56] **References Cited**

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Primary Examiner—Wendell E. Burns

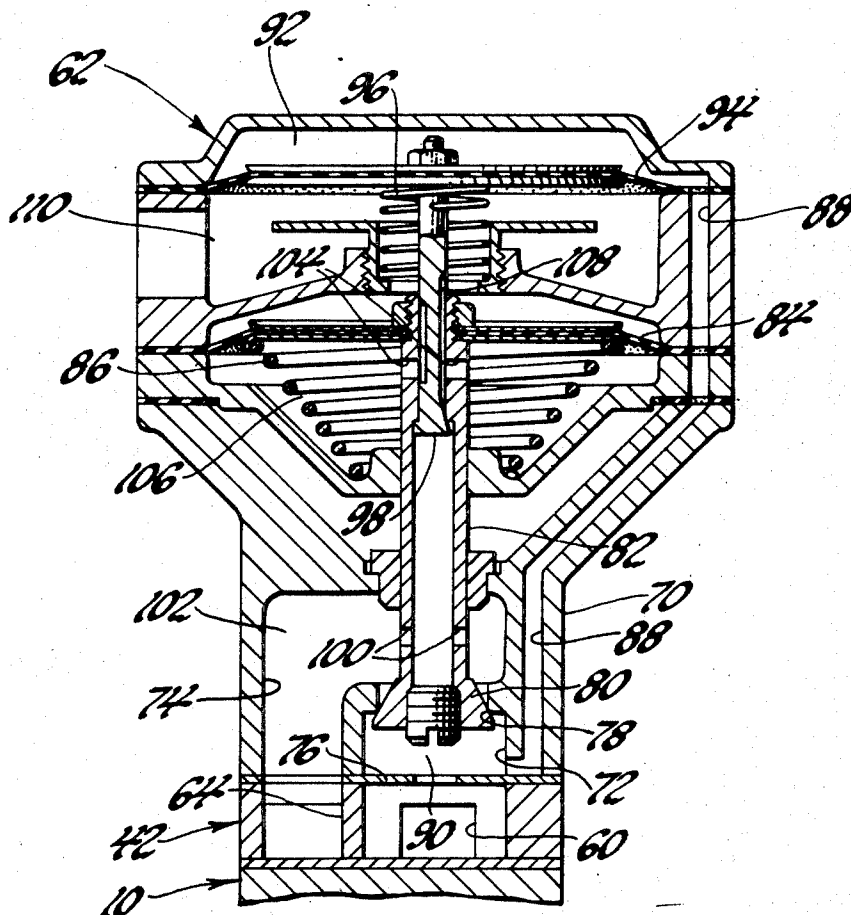
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[57]

ABSTRACT

An induction passage vacuum operated valve responsive to exhaust back pressure controls recirculation of exhaust gases from the intake manifold exhaust cross-over passage to the intake manifold induction passages. The valve assembly is designed whereby both the induction passage vacuum signal and the exhaust back pressure signal are routed internally of the structural members, thus obviating the need for external hose connections.

3 Claims, 3 Drawing Figures



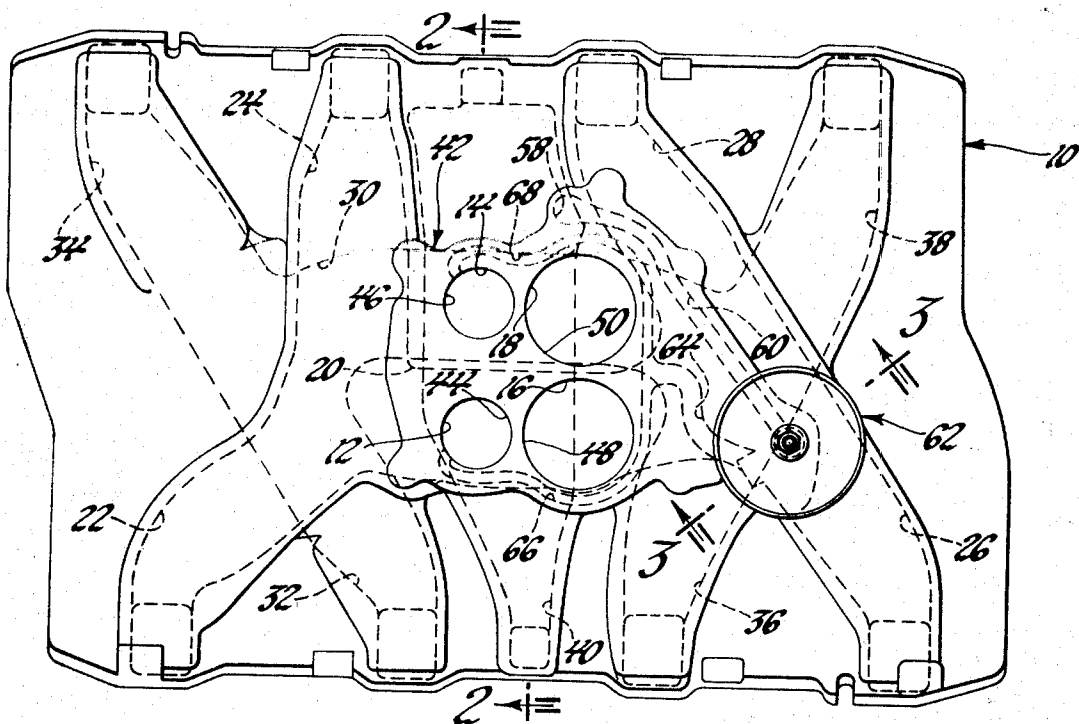


Fig. 1

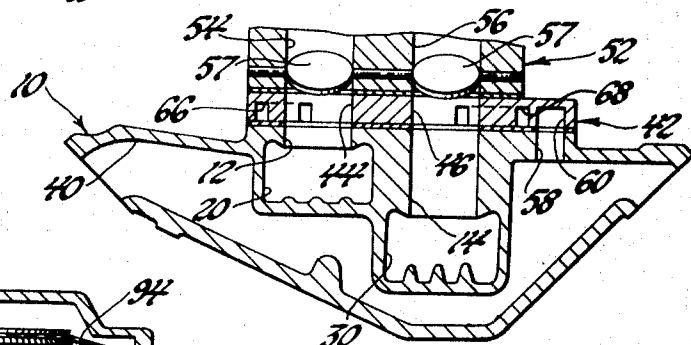


Fig. 2

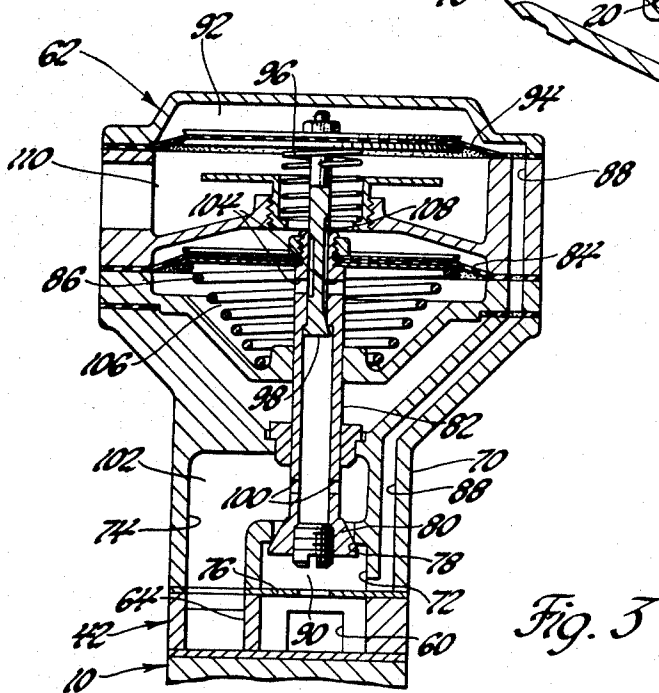


Fig. 3

EXHAUST GAS RECIRCULATION CONTROL VALVE

SUMMARY OF THE INVENTION

This invention relates to exhaust gas recirculation in an internal combustion engine and more particularly to a novel valve assembly for controlling exhaust gas recirculation.

Recirculation of exhaust gases has been developed as a method for reducing formation of oxides of nitrogen during the combustion process in an internal combustion engine. In general, it is desired to recirculate the exhaust gases at a rate proportional to the rate at which combustion air flows into the engine, and valves responsive to induction passage vacuum or throttle position have been utilized for this purpose.

It also has been recognized that if exhaust gases were recirculated through an orifice into a region of substantially atmospheric pressure in the engine air induction system, variations in exhaust back pressure would cause the exhaust gas recirculation rate to be proportional to the combustion air flow rate. However, such a system would require that the exhaust gases pass through at least a portion of the carburetor.

This invention provides a novel valve assembly utilizing the exhaust back pressure to recirculate exhaust gases at a rate proportional to air flow and in a manner which avoids recirculation of exhaust gases through the carburetor. In employing this invention, an exhaust gas recirculation passage is provided which extends from the engine exhaust passage to the engine air induction passage at a point downstream of the engine throttle. An orifice is provided in the recirculation passage, and a valve disposed downstream of the orifice is operated to create a zone of substantially constant pressure in the passage irrespective of the wide variations in exhaust back pressure and induction passage vacuum. The rate of recirculation of exhaust gases through the zone thus is proportional to the rate of induction air flow.

In other valve assemblies recently proposed for controlling exhaust gas recirculation in accordance with exhaust back pressure, the diaphragm or other member responsive to back pressure has directly operated the valve member which controls the flow of exhaust gases. In the design of such a valve assembly, certain limitations are encountered because the back pressure generally is very low. In the valve assembly of this invention, on the other hand, the exhaust gas flow controlling valve member is not directly operated by the member responsive to exhaust back pressure; instead, the valve member is positioned by a member operated by an induction passage vacuum signal, and the member responsive to exhaust back pressure controls that signal. And as a particular advantage of this valve assembly, both the induction passage vacuum signal and the exhaust back pressure signal are routed entirely internally of the structural members, thus obviating the need for external hose connections.

The details as well as other objects and advantages of this invention are set forth in the remainder of the specification and are shown in the drawing.

SUMMARY OF THE DRAWING

FIG. 1 is a top plan view of an internal combustion engine inlet manifold having induction and exhaust gas crossover passages, an insert plate having an exhaust

gas recirculation passage mounted on the manifold, and the exhaust gas recirculation control valve assembly mounted thereon;

FIG. 2 is a sectional view along line 2—2 of FIG. 1 showing the induction, exhaust gas crossover, and exhaust gas recirculation passages and also showing the throttle body portion of a carburetor mounted on the insert plate; and

FIG. 3 is an enlarged sectional view, in elevation, of the control valve assembly, taken generally along line 3—3 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. 1 and 2, the combustion air induction passages for the engine are formed in part by an intake manifold 10 which has a pair of vertical primary riser bores 12 and 14 and a pair of vertical secondary riser bores 16 and 18. Riser bores 12 and 16 open to an upper horizontal plenum 20 connected forwardly (leftwardly as viewed in FIG. 1) to a pair of transverse runners 22 and 24 and connected rearwardly (rightwardly as viewed in FIG. 1) to another pair of transverse runners 26 and 28. Similarly, riser bores 14 and 18 open to a lower horizontal plenum 30 connected forwardly to a pair of transverse runners 32 and 34 and rearwardly to another pair of transverse runners 36 and 38.

Intake manifold 10 also has an exhaust crossover passage 40 which extends transversely from the left-hand side of manifold 10 beneath plenums 20 and 30 and receives a portion of the exhaust gases discharged from the engine combustion chambers.

An insert plate 42 is secured on manifold 10 and has primary riser bores 44 and 46 and secondary riser bores 48 and 50 which meet, respectively, riser bores 12, 14, 16, 18 of manifold 10.

A carburetor 52 is secured on insert plate 42 and has primary throttle bores 54 and 56 which meet, respectively, primary riser bores 44 and 46 of insert plate 42. Carburetor 52 also has secondary throttle bores (not shown) which meet secondary riser bores 48 and 50 of insert plate 42. Throttles 57 are disposed in the carburetor bores to control induction air flow therethrough.

A bore 58 in manifold 10 leads upwardly from exhaust crossover passage 40 to the first portion 60 of an exhaust recirculation passage formed in insert plate 42. The first portion 60 of the exhaust recirculation passage leads through a control valve assembly 62 to a second portion 64 of the exhaust recirculation passage. This second portion 64 divides into a pair of branches 66 and 68 which lead to the primary riser bores 44 and 46 in insert plate 42.

It should be appreciated that both portions 60 and 64 of the exhaust recirculation passage may be integrated in manifold 10 rather than in separate insert plate 42.

As shown in FIG. 3, control valve assembly 62 comprises a valve body 70 having an inlet 72 for receiving exhaust gases from first portion 60 of the exhaust recirculation passage and an outlet 74 for discharging exhaust gases to second portion 64 of the exhaust recirculation passage. An orifice member 76 is disposed across inlet 72, and a downwardly facing valve seat 78 is disposed between inlet 72 and outlet 74. A valve member 80, associated with valve seat 78, is formed on a hollow stem 82 carried by a pressure responsive diaphragm 84 and upwardly biased by a spring 86.

A passage 88 senses the pressure in the zone 90 between orifice member 76 and valve seat 78 and transmits the zone pressure to the chamber 92 above a diaphragm 94. Diaphragm 94 operates against the bias of a spring 96 in response to variations in pressure in zone 90 to position a pilot valve 98 disposed in hollow stem 82.

Hollow stem 82 has lateral openings 100 disposed in the chamber 102 between valve seat 78 and outlet 74 and transmits the induction passage vacuum present therein past a valve seat shoulder 101 and valve 98 through upper lateral openings 104 to the chamber 106 below diaphragm 84. In operation, as the pressure in zone 90 increases, diaphragm 94 is depressed to move valve 98 away from shoulder 101 and admit manifold vacuum through openings 104 to chamber 106, thereby decreasing the pressure signal in chamber 106. Diaphragm 84 is then pulled downwardly against the bias of spring 86 to displace valve member 80 from valve seat 78. This operation permits increased recirculation of exhaust gases. Upon a reduction in pressure in zone 90, spring 96 raises diaphragm 94 thus closing valve 98 against shoulder 101 and permitting the pressure signal in chamber 106 to increase as air is bled through a slot 108 in valve member 98 from the chamber 110 between diaphragms 94 and 84. Diaphragm 84 is then pushed upwardly by spring 86 to displace valve member 80 toward valve seat 78, thereby reducing recirculation of exhaust gases. In practice, diaphragms 94 and 84 will move in unison and a substantially constant pressure will be maintained in zone 90.

The back pressure created in the exhaust passages such as 40 of an internal combustion engine is generally proportional to the square of the rate of combustion air flow through the engine induction passages. The rate of flow of exhaust gases from first portion 60 of the exhaust recirculation passage through an orifice such as 76 into a zone such as 90 of substantially constant pressure is generally proportional to the square root of the exhaust back pressure. Thus the rate at which exhaust gases are recirculated is generally proportional to the rate at which combustion air flows to the engine.

I Claim:

1. An exhaust gas recirculation control valve assembly for use on an internal combustion engine having an induction passage for air flow to the engine, a throttle disposed in said induction passage for controlling air flow therethrough, an exhaust passage for exhaust gas flow from the engine, and an exhaust gas recirculation passage having a first portion extending from said exhaust passage and a second portion extending to said induction passage downstream of said throttle, said control valve assembly comprising a valve body having

an inlet for receiving exhaust gases from said first portion of said recirculation passage, an outlet for discharging exhaust gases to said second portion of recirculation passage, valve seat means formed between said inlet and said outlet, and an orifice formed in said inlet, valve means associated with said valve seat means for controlling flow of exhaust gases therethrough, and control means for positioning said valve means to maintain a substantially constant pressure in the zone between said orifice and said valve seat means, said control means including spring means biasing said valve means toward engagement with said valve seat means, a pressure responsive member connected to said valve means, passage means subjecting said member to a control pressure created by induction passage vacuum received through a vacuum orifice connecting said passage means to said induction passage downstream of said throttle and increased by atmospheric air received through an air bleed orifice opening into said passage means, a bleed valve associated with said vacuum orifice for controlling admission of vacuum to said passage means, pressure responsive means connected to said bleed valve and subjected to the pressure in said zone whereby upon an increase in pressure in said zone said pressure responsive means displaces said bleed valve to increase admission of vacuum to said passage means through said vacuum orifice and thereby decreases said control pressure to thereby cause said pressure responsive member to overcome the bias of said spring means and displace said valve means from said valve seat means and increase recirculation of exhaust gases, and second spring means biasing said bleed valve to reduce admission of vacuum to said passage means through said vacuum orifice whereby upon a decrease in pressure in said zone said second spring means displaces said bleed valve member to decrease admission of vacuum to said passage means through said vacuum orifice and thereby increase said control pressure to thereby permit said first spring means to displace said valve member toward said valve seat means and decrease recirculation of exhaust gases.

2. The control valve assembly of claim 1 wherein said pressure responsive member is connected to said valve means by a hollow stem which provides said vacuum orifice.

3. The control valve assembly of claim 2 wherein said valve seat means is disposed coaxially with said inlet and said valve stem has a lateral opening between said pressure responsive member and said valve means which defines an opening from a region of induction passage vacuum.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,756,210 Dated September 4, 1973

Inventor(s) Paul B. Kuehl

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 55, "recirculation" should be -- recirculation --.

Cancel claims 1-3 and insert the following:

1. An exhaust gas recirculation control valve assembly for use on an internal combustion engine having an induction passage for air flow to the engine, a throttle disposed in said induction passage for controlling air flow therethrough, an exhaust passage for exhaust gas flow from the engine, and an exhaust gas recirculation passage having a first portion extending from said exhaust passage and a second portion extending to said induction passage downstream of said throttle, said control valve assembly comprising a valve body having an inlet region for receiving exhaust gases from said first portion of said recirculation passage, an outlet region for discharging exhaust gases to said second portion of said recirculation passage, valve seat means formed between and separating said inlet region and said outlet region, and an orifice formed in said inlet region, valve means associated with said valve seat means for controlling flow of exhaust gases therethrough, and control means for positioning said valve means to maintain a substantially constant pressure in the zone between said orifice and said valve seat means, said control means including spring means biasing said valve means toward engagement with said valve seat means, a pressure responsive member, a hollow valve stem connected to said valve means and said pressure responsive member, said valve stem providing passage means for subjecting said member to a control pressure created by induction passage vacuum and atmospheric air, said valve stem having a vacuum orifice connecting said passage means to said induction passage downstream of said throttle and an atmospheric air bleed orifice opening into said passage means, a bleed valve disposed in said passage means and associated

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

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Patent No. 3,756,210

Dated September 4, 1973

Inventor(s) Paul B. Kuehl

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

with said vacuum orifice for controlling admission of vacuum therethrough to vary said control pressure created by induction passage vacuum received through said vacuum orifice and by atmospheric air received through said air bleed orifice, pressure responsive means connected to said bleed valve and subjected to the pressure in said zone whereby upon an increase in pressure in said zone said pressure responsive means displaces said bleed valve to increase admission of vacuum through said vacuum orifice and thereby decreases said control pressure to thereby cause said pressure responsive member to overcome the bias of said spring means and displace said valve means from said valve seat means and increase recirculation of exhaust gases, and second spring means biasing said bleed valve to reduce admission of vacuum through said vacuum orifice whereby upon a decrease in pressure in said zone said second spring means displaces said bleed valve member to decrease admission of vacuum to said passage means through said vacuum orifice and thereby increase said control pressure to thereby permit said first spring means to displace said valve member toward said valve seat means and decrease recirculation of exhaust gases.

On the cover sheet, after the abstract, "3 Claims" should read -- 1 Claim --.

Signed and sealed this 26th day of February 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents