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Gumbleton et al.

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

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

[51] **Int. Cl.** **F02m 25/06**

[58] **Field of Search** ..... 123/119 A

[56] **References Cited**

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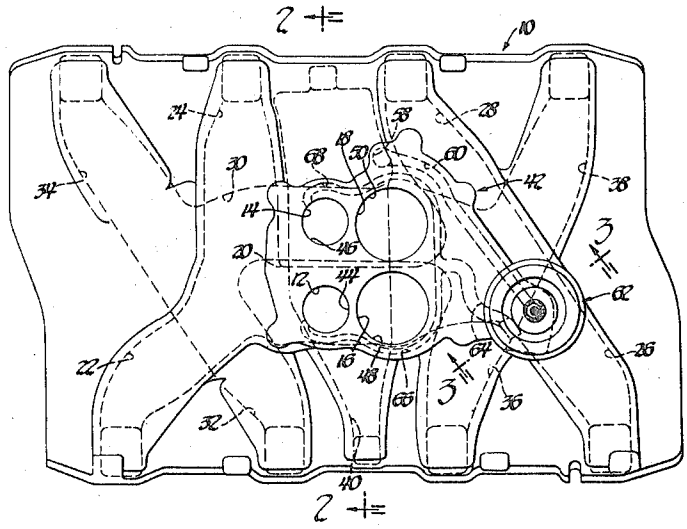
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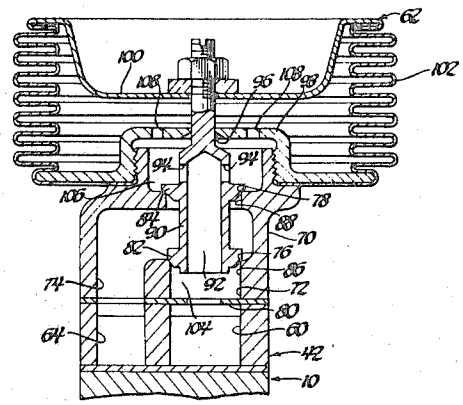
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[57] **ABSTRACT**

A metal bellows responsive to exhaust back pressure positions a valve to control recirculation of exhaust gases from the intake manifold exhaust crossover passage to the intake manifold induction passages.

2 Claims, 3 Drawing Figures





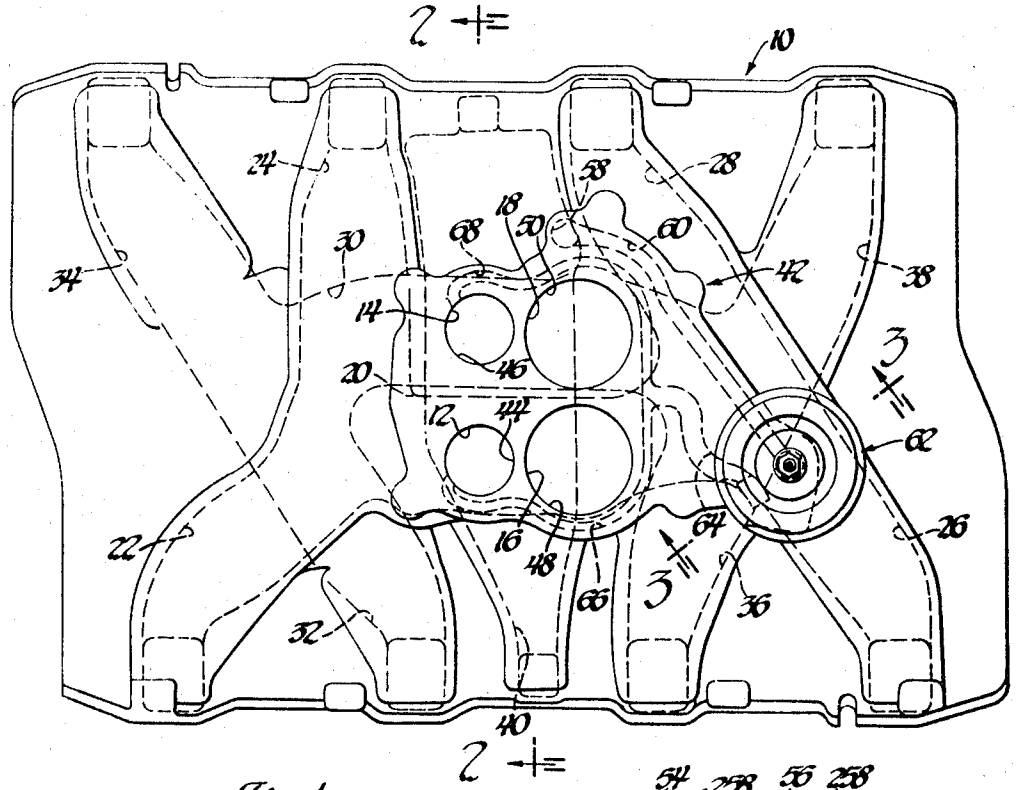


Fig.1

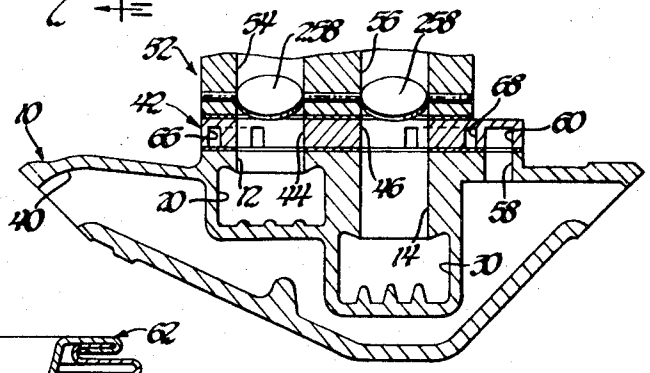


Fig.2

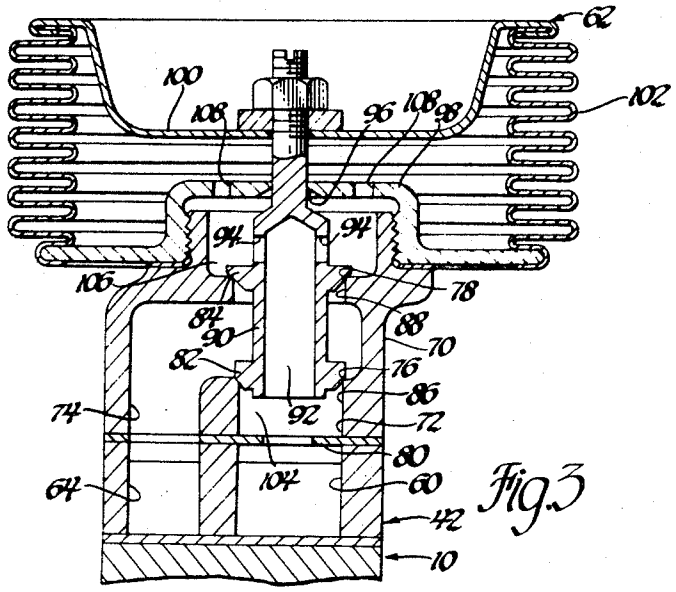


Fig.3

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 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 by a bellows 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 pressure in the zone may be maintained either above or below atmospheric pressure, and the rate of recirculation of exhasut gases through the zone will be proportional to the rate of induction air flow.

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 drawings.

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 on the insert plate;

FIG. 2 is a sectional view along line 2—2 of FIG. 1 showing the induction, exhaust gas crossover, and exhasut 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.

Control valve assembly 62 is shown in FIG. 3 and comprises a valve body 70 which has an inlet 72 receiving exhaust gases from the first portion 60 of the exhaust recirculation passage and an outlet 74 discharging exhaust gases to second portion 64 of the exhaust recirculation passage.

Coaxial upwardly facing valve seats 76 and 78 are formed in valve body 70 to control flow of exhaust gases from inlet 72 to outlet 74. An orifice member 80 is disposed across inlet 72.

A pair of valve members 82 and 84 are associated with valve seats 76 and 78 to control exhaust gas flow therethrough. It will be noted that the opening 86 (about which valve seat 76 is formed) is smaller than the opening 88 (about which valve seat 78 is formed) and that valve member 82 is smaller than valve member 84 and may pass through opening 88 for ease of assembly.

Valve members 82 are formed on or otherwise secured to a hollow stem 90 which is open at its lower end 92 and which has lateral openings 94 above valve member 84.

The upper end of stem 90 is guided in the central aperture 96 of a web 98 forming part of valve body 70 and is secured to the top plate 100 of a resilient stainless steel bellows 102.

In operation, the pressure in the zone 104 just downstream of orifice 80 is transmitted through hollow stem 90 to the chamber 106 above upper valve seat 78 and

thence through apertures **108** in web **98** to the interior of bellows **102.** As shown here, the exterior of bellows **102** is exposed to atmospheric pressure. Upon an increase in pressure in zone **104,** bellows **102** expands to lift valve stem **90** and displace valve members **82** and **84** away from valve seats **76** and **78.** Exhaust gases are then recirculated from first portion **60** of exhaust gas recirculation passage past orifice **80,** through valve seat **76** and through stem **90,** lateral openings **94,** chamber **106** and valve seat **78,** to second portion **64** of the exhaust gas recirculation passage. Upon a decrease in pressure in zone **104,** bellows **102** contracts to lower stem **90** and displace valve members **82** and **84** toward valve seats **76** and **78,** thus reducing recirculation of exhaust gases. Control valve assembly **62** is thus effective to maintain a substantially constant pressure in zone **104** just downstream of orifice **80.**

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 orifice **80** into a zone such as **104** 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 geneally proportional to the rate at which combustion air flows to the engine.

It will be noted that bellows **102** may be designed to maintained any desired pressure in zone **104.** If zone **104** is to be maintained at a pressure above atmospheric, bellows **102** is designed to bias valve members **82** and **84** toward valve seats **76** and **78;** if zone **104** is to be maintained at a pressure below atmospheric, bellows **102** is designed to bias valve members **82** and **84** away from valve seats **76** and **78.** If desired, spring means may be employed to assist the inherent elasticity of bellows **102.**

It also will be noted that valve seat **76** and valve member **82** are disposed on the outlet side of opening **86** while valve member **84** and valve seat **78** are disposed on the inlet side of opening **88.** Thus the upper surface of valve member **84** and the lower surface of valve member **82** are subjected to the pressue of zone **104** while the lower surface of valve member **84** and the upper surface of valve member **82** are subjected to the pressure in outlet **74.** The pressures acting on valve members **82** and **84** are thereby balanced, and thus control valve assembly **62** is substantially unaffected by pressures acting on valve members **82** and **84.**

We 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 said recirculation passage, an orifice formed in said inlet, and a pair of upwardly facing valve seats aligned coaxially above said inlet, a pair of valve members associated with said valve seats for controlling the flow of exhaust gases therethrough, a hollow stem interconnecting said valve members for concurrent movement, said hollow stem having an open lower end for receiving exhaust gases from the zone between said orifice and the lower of said valve seats and further having a lateral port for discharging exhaust gases above the upper of said valve seats, a pressure responsive bellows connected to the upper end of said stem and responsive to the pressure transmitted from said zone through said stem to lift said valve members from said valve seats upon an increase in pressure in said zone, thereby permitting increased flow of exhaust gases upwardly through said lower valve seat and downwardly through said upper valve seat, and to lower said valve members toward said valve seats upon a decrease in pressure in said zone, thereby reducing flow of exhaust gases through said valve seats, whereby the pressure in said zone is maintained at a substantially constant value and exhaust gases may be recirculated through an orifice into a zone of substantially constant pressure to thereby provide recirculation of exhaust gases at a rate which varies in accordance with exhaust gas pressure in said exhaust passage and is thereby proportional to the rate of air flow through said induction passage.

2. The control valve assembly of claim **1** wherein said valve body also has a web with a central aperture receiving and guiding said stem and with a plurality of other apertures for transmitting pressure from above said upper valve seat to said bellows.

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