

[54] EXHAUST GAS RECIRCULATION VALVE

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[58] Field of Search. 123/119 A; 137/510

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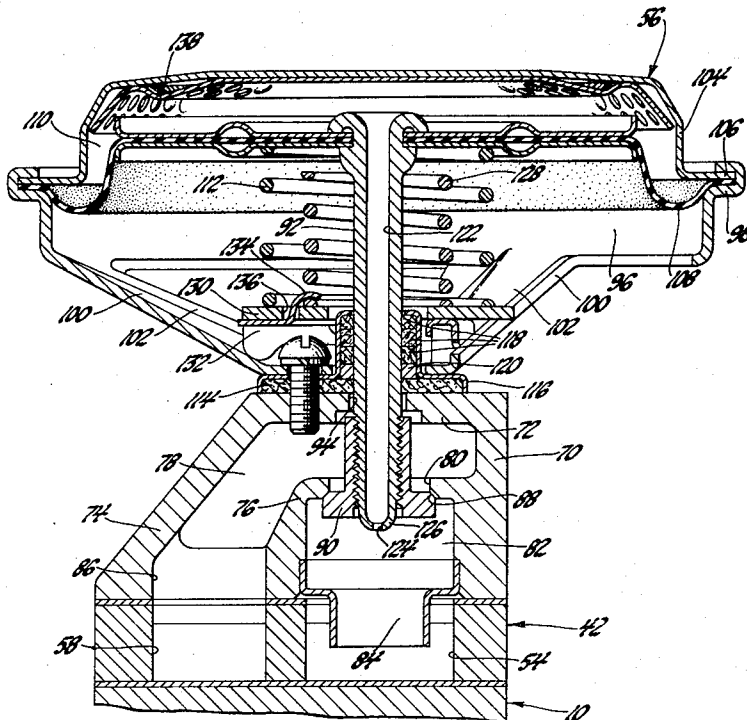
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[57]

ABSTRACT

A diaphragm operated control valve assembly, 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 back pressure signal is applied through a restrictive orifice in a passage formed in the valve stem. A screen disposed above the diaphragm prevents any ice formed on the diaphragm cover from dislodging to cause malfunction of the valve assembly.

5 Claims, 3 Drawing Figures



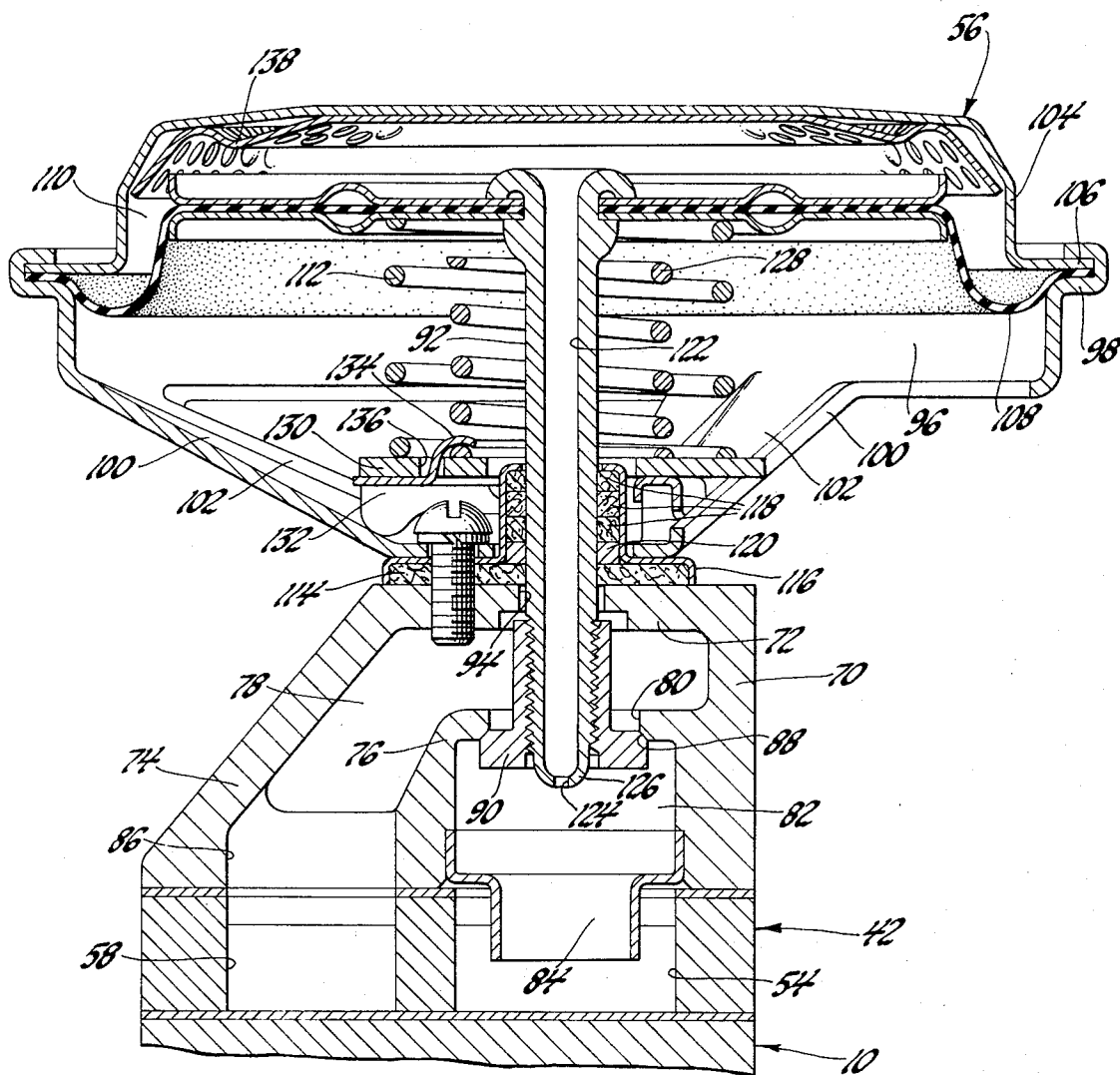


Fig. 3

EXHAUST GAS RECIRCULATION VALVE

Recirculation of engine exhaust gases to the engine induction system has been proposed to reduce formation of oxides of nitrogen in the engine combustion chamber. In general, it is desirable to control the rate of flow of exhaust gases into the induction system in proportion to the rate of induction air flow. Valve assemblies responsive to the back pressure of the exhaust gases have been proposed to provide such control.

This invention provides an exhaust gas recirculation control valve assembly which regulates exhaust gas recirculation in accordance with exhaust back pressure. Improvements over the prior valve assemblies of this nature include a restrictive orifice to dampen variations in exhaust back pressure and a screen to prevent any ice formed within the diaphragm cover from dislodging.

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 in which:

FIG. 1 is a top plan view of a V-8 engine intake manifold containing induction passages and an exhaust crossover passage, together with a carburetor spacer plate containing an exhaust gas recirculation passage and carrying an exhaust gas recirculation control valve assembly;

FIG. 2 is a transverse sectional view taken generally along line 2—2 of FIG. 1, showing the induction passage plenums and the exhaust crossover passage in the manifold and the inlet to the exhaust gas recirculation passage in the spacer plate; and

FIG. 3 is an enlarged sectional view, taken along line 3—3 of FIG. 1, showing the details of the exhaust gas recirculation control valve assembly.

Referring first to FIGS. 1 and 2, an intake manifold 10 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.

An exhaust crossover passage 40 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 bore 52 in manifold 10 leads upwardly from exhaust crossover passage 40 to the first portion 54 of an exhaust recirculation passage formed in insert plate 42. The first portion 54 of the exhaust recirculation passage leads through a control valve assembly 56 to a second portion 58 of the exhaust recirculation passage. This second portion 58 divides into a pair of branches 60 and 62 which lead to the primary riser bores 44 and 46 in insert plate 42.

It should be appreciated that both portions 54 and 58 of the exhaust recirculation passage may be integrated in manifold 10 rather than in separate insert plate 42.

Control valve assembly 56 is shown in detail in FIG. 3. It comprises a base member 70 having an upper wall 72, a peripheral wall 74, and a lower wall 76 which define a chamber 78. Chamber 78 has an inlet 80 opening from a zone 82 separated from the first portion 54 of the exhaust gas recirculation passage by an orifice member 84. Chamber 78 also has an outlet 86 opening to the second portion 56 of the exhaust gas recirculation passage. A valve seat 88 is formed in inlet 80.

A valve pintle 90 cooperates with valve seat 88 and may be contoured to provide a variable area for flow of recirculated exhaust gases. Valve pintle 90 is adjustably threaded on a valve stem 92. Stem 92 extends upwardly through an opening 94 in the upper wall 72 of base member 70.

A housing member 96 has an outer rim 98 supported by three outwardly and upwardly extending spokes 100 (only two of which appear in the FIG.). Each spoke 100 has a slightly raised rib 102 for reinforcement. Spokes 100 provide a minimized path for heat conduction to rim 98.

A cover member 104 has a rim 106 secured within rim 98 of housing member 96. A diaphragm 108 is clamped between rims 106 and 98 to define an enclosure 110 between diaphragm 108 and cover 104. Diaphragm 108 carries valve stem 92. A spring 112 exerts an upward bias on diaphragm 108, valve stem 92, and valve pintle 90 to engage valve pintle 90 with a valve seat 88.

Intermediate base member 70 and housing member 96 is an asbestos insulating disc 114 retained in place by an intermediate member 116. Insulating disc 114, together with spokes 100, minimizes conduction of heat to diaphragm 108.

The central portion of intermediate member 116 houses a plurality of graphited asbestos sealing discs 118 stacked above a steel washer 120. Discs 118 engage valve stem 92 to guide stem 92 and to reduce air flow into chamber 78 through opening 24.

The pressure in zone 82 is applied to enclosure 110 through a passage 122 in valve stem 92. Passage 122 has a restricted opening 124 at the tip 126 thereof. Upon an increase in pressure in zone 82, diaphragm 108 is depressed and valve pintle 90 is displaced from valve seat 88 to permit recirculation of exhaust gases from exhaust crossover passage 40 through bore 52, passage 54, inlet 80, chamber 78, outlet 86, passage 58 and branches 60 and 62 to riser bores 44 and 46. Upon a decrease in pressure in zone 82, spring 112 raises diaphragm 108 and valve pintle 90 is displaced toward valve seat 88 to reduce recirculation.

Control valve assembly 56 thus is effective to maintain the pressure in zone 82 within a narrow range despite wide variations in exhaust back pressure in passage 54 and induction passage vacuum in passage 58: valve pintle 90 is moved toward valve seat 88 to counteract a decrease in pressure occasioned by application of manifold vacuum through valve seat 88, and pintle 90 is moved away from valve seat 88 to counteract an increase in pressure occasioned by application of exhaust back pressure through orifice member 84. Hence exhaust gas is metered through orifice member 84 from passage 54 at full exhaust back pressure to a substantially constant pressure zone 82.

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 an exhaust passage such as 40 through an orifice such as 84 to a zone such as 82 at 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 of combustion air flow.

It will be appreciated that the exhaust back pressure in passage 54 may exhibit substantial pulsations above and below a mean value. Restrictive orifice 124 in tip 126 of valve stem 92 dampens such pulsations to prevent undue vibration of diaphragm 108 and valve pintle 90. In addition, orifice 124 provides an appropriate delay in response of control valve assembly 56 to a sudden increase in exhaust back pressure, thereby preventing a sudden increase in the rate of recirculation of exhaust gases.

In some applications, it may be desirable to employ a very weak spring 112 which will permit unseating of valve pintle 90 when the back pressure is very low — 10 inches of water, for example. However, such a construction would permit valve pintle 90 to prematurely engage orifice member 84 which shuts off recirculation of exhaust gases. In such an application, therefore, it may be desirable to employ a second spring 128, spaced slightly from diaphragm 108, which is engaged by diaphragm 108 after pintle 90 reaches a fully open position — at a back pressure of about 30 inches of water, for example. Spring 128 decreases the response of diaphragm 108 to further increases in back pressure so that pintle 90 does not engage orifice member 84 and shut off recirculation of exhaust gases until the back pressure reaches a value in the range of 80 to 90 inches of water, for example.

Spring 112 is seated on a plate 130 which is supported from housing 96 on a member 132. A tang 134 of member 132 extends through a slot 136 in plate 130 and is bent over and retains the lower end of spring 128.

In utilizing a diaphragm operated valve assembly responsive to the pressure of engine exhaust gases, circumstances may be encountered in which water condenses in the diaphragm chamber. During cold weather, the condensate could freeze to form a sheet of ice on the inside of cover member 104. If the ice were dislodged during subsequent operation, it could interfere with valve closing movement of diaphragm 108 — holding valve pintle 90 away from seat 88 and allowing an undesirable rate of exhaust gas recirculation.

While the amount of condensation may be controlled by a drain from enclosure 110, as by a drain line extending from enclosure 110 to chamber 78, we have found that operation of valve assembly 56 may be improved by addition of a perforated member or screen 138 to retain any ice away from diaphragm 108. In the preferred embodiment, screen 138 has a multiplicity of holes — for example, holes of about 0.090 inch diameter spaced on about 0.16 inch centers to provide about 47 holes per square inch — which apparently receive and retain portions of any ice sheet until such time as the ice melts. Of course, it may be expected that the ice will melt quickly during engine operation by exposure to the engine exhaust gases in enclosure 110.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

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, a valve seat formed between said inlet and said outlet, a valve pintle associated with said valve seat for controlling flow of exhaust gases therethrough, a valve stem extending from said pintle, a pressure responsive diaphragm connected to said valve stem, a cover associated with said diaphragm to form an enclosed chamber, and a passage extending from said chamber through said stem to an opening adjacent said pintle to thereby subject said diaphragm to exhaust gas pressure whereby said diaphragm positions said pintle to control the flow of exhaust gases through said valve seat in accordance with exhaust gas pressure, said opening having the smallest flow area of any location in said passage to thereby dampen exhaust gas pressure pulsations and prevent undue vibration of said diaphragm and valve pintle.

2. 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, a valve seat formed between said inlet and said outlet, a valve pintle associated with said valve seat for controlling flow of exhaust gases therethrough, a valve stem extending from said pintle, a pressure responsive diaphragm connected to said valve stem, a cover associated with said diaphragm to form an enclosed chamber, means exposing said chamber to exhaust gas pressure whereby said diaphragm positions said pintle to control the flow of exhaust gases through said valve seat in accordance with exhaust gas pressure, and a perforate member disposed intermediate said cover and said diaphragm to prevent any ice formed adjacent said cover from dislodging against said diaphragm.

3. The valve assembly of claim 2 wherein said perforate member comprises a sheet metal member secured to said cover and having a multiplicity of holes formed therein.

4. 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

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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, a valve seat formed between said inlet and said outlet, a valve pintle associated with said valve seat for controlling flow of exhaust dampen therethrough, a valve stem extending from said pintle, a pressure responsive diaphragm connected to said valve stem, a pressure responsive diaphragm connected to said valve stem, a cover associated with said diaphragm to form an enclosed chamber, a passage extending from said chamber through said stem to an opening adjacent said pintle to thereby subject said diaphragm to exhaust gas pressure whereby said diaphragm positions said pintle to control the flow of exhaust gases through said valve seat in accordance with exhaust gas pressure, said opening having the smallest flow area of any location in said passage to thereby dampen exhaust gas pressure pulsations and prevent undue vibration of said diaphragm and valve pintle, and a sheet metal member secured to said cover and having a multiplicity of holes formed therein, said member preventing any ice formed on said cover from dislodging against said diaphragm.

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5. 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, a valve seat formed between said inlet and said outlet, a valve pintle associated with said valve seat for controlling flow of exhaust gases therethrough, a valve stem extending from said pintle, a pressure responsive operating member connected to said valve stem, means associated with said operating member to form an enclosed chamber, and a passage extending from said chamber through said stem to an opening adjacent said pintle to thereby subject said chamber to exhaust gas pressure whereby said operating member positions said pintle to control the flow of exhaust gases through said valve seat in accordance with exhaust gas pressure, said opening having the smallest flow area of any location in said passage to thereby dampen exhaust gas pressure pulsations and prevent undue vibration in said valve assembly.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,783,848 Dated January 8, 1974

Inventor(s) Ernst L. Ranft et al

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 39, "24" should be -- 94 --. Column 3, line 11, "valve" should be -- value --; line 36, "ø" should be -- 100 --. Column 5, line 12, "dampen" should be -- gases -- lines 15-16, delete "a pressure responsive diaphragm connected to said valve stem,"; line 25, "dampe" should be -- dampen --.

Signed and sealed this 18th day of June 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents