(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 105 790
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 83401867.3

(22) Date of filing: 23.09.83

(51) Int. Cl.³: F 01 N 3/22

(30) Priority: 30.09.82 US 430906

(43) Date of publication of application: 18.04.84 Bulletin 84/16

(84) Designated Contracting States: DE FR GB IT

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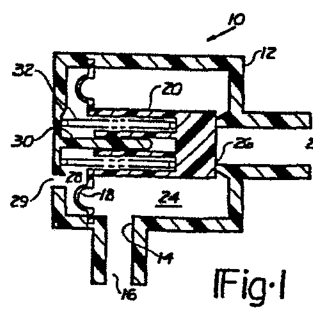
(54) **Constant pressure relief valve for an air control valve.**

(57) A constant pressure relief valve (10) for an air control valve maintains the pressure in a secondary air system below a predetermined value. A diaphragm (18) divides the valve housing (12) into two chambers (24 and 28) wherein the first chamber (24) contains the inlet orifice (22) controlled by a valve member (20) and an exhaust orifice (16). The second chamber (28) contains a reference pressure and a valve bias spring (32) cooperating together to provide the constant pressure. Due to back pressures at the exhaust orifice (16), the lift of valve member (20) is increased to increase flow through the relief valve (10) maintaining the constant relief pressure.



Fig·1

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CONSTANT PRESSURE RELIEF VALVE FOR AN AIR CONTROL VALVE

This invention relates to fluid actuated control valves in general and more particularly to a constant pressure relief valve for an air control valve.

In order to control emissions from internal combustion engines in motor vehicles, manufacturers have added secondary air control systems to improve the combustion and exhaust processes in the engine. These secondary air control systems generally include an air pump which is driven by the engine for supplying air under pressure and an air control valve responsive to various operating signals, either electrical, hydraulic or pneumatic to direct the output of the pump to various components in the engine exhaust system.

Due to various restrictions in the control system and more particularly in the air flow system, various back pressures are developed. Further, since the pump is driven by the vehicle engine, variations in speed of the pump contribute to pressure variations, which if not limited, can cause damage to the air pump.

Various air control valves such as that described in U.S. Patent 4,163,543 entitled "Air Control Valve" have provided relief valves which are spring biased. The disadvantage of such a relief valve is that as back pressures are developed, the curve of relief pressure plotted against the pump speed or air flow rate is not flat but increases as speed or air flow rates increase.

It is an advantage of the invention to provide a constant pressure relief valve in an air control valve wherein the pressure from the air pump does not exceed a predetermined value regardless of pump speed, air flow rate, or system back pressures.

These and other advantages of the invention will become apparent in the following detailed description and drawings wherein:

FIGURE 1 is a schematic drawing of the relief valve shown in longitudinal cross-section;

FIGURE 2 is a longitudinal cross-sectional view of an air control valve embodying the relief valve of the present invention; and

FIGURE 3 is a graph of the relief pressure plotted against air pump speed.

Referring to the FIGURES by the reference characters, the constant pressure relief valve 10 in FIGURE 1 comprises a housing 12, a flow restrictor 14 in the exhaust orifice or port 16, a diaphragm means 18 and valve means 20.

The housing 12, which is typically molded from a plastic-type material able to withstand the environmental conditions found in the engine compartment of a motor vehicle, has an inlet orifice or port 22 and an exhaust orifice or port 16. The inlet orifice 22 terminates within a first chamber 24 of the housing 12 at a valve seat 26.

Located within or connected to the exhaust orifice 16 of the housing 12 is a flow restrictor 14 which in the preferred embodiment comprises silencing material not shown. The purpose of the silencing material is to quiet the noise of the air exhausting from the housing 12 but in doing so functions as a restrictor whereby the pressure in the first chamber 24 of the housing 12 increases.

A diaphragm means 18 comprising a rubber bellows is connected to the interior walls of the housing 12 and operates to divide the housing into a first chamber 24 and a second chamber 28. Both the inlet orifice 22 and the exhaust orifice 16 are located in the first chamber 24. Air flow is prevented by the diaphragm 18 from flowing between the two chambers. A vent 29 is in the wall of the second chamber 28 to maintain the pressure therein at some pressure being supplied to the vent.

Operatively connected to the diaphragm 18 is a valve member 20 which extends from the diaphragm 18 and seats against the valve seat 26 on the inlet orifice 32. As shown in FIGURE 1, the valve member 26 moves in a direction normal to the valve seat 26 and is guided by means of a guide pin 30 extending from one wall of the housing 12. The guide pin 30 extends into a guide tube in the valve member and both cooperate to keep the valve member 20 normal to the valve seat 26. A spring means 32 biases the valve member 20 against the valve seat 26. In the preferred embodiment, there are one or more vents 29 in the wall of housing 12 for venting the second chamber 28 to atmospheric pressure which becomes the reference pressure. The pressure therefore required to lift the valve member 20 from the valve seat 26 is the summation of the reference pressure and the force applied by the spring bias means 32.

Referring to FIGURE 2 there is illustrated in longitudinal cross-section, an air control valve 34 including the constant pressure relief valve 10 of FIGURE 1. The air control valve 34 is similar to the air control valve of U.S. Patent 4,163,543 entitled "Air Control Valve" which issued on August 7, 1979. That patent is expressly incorporated herein as it defines and describes the operation of the air control valve 34 in greater detail.

The air control valve 34 is connected by means of conduit 36 to an air pump not shown, which provides pressurized air to the input port 22 of the valve 10. Typically the air pump is a vane pump driven by means of belts from the drive shaft of the engine of a motor vehicle. A vane pump provides a pulsating air flow and the faster the pump runs, the closer together the air pulses become hence the higher the pressure of the air. In addition, the flow rate of the pump increases with pump speed.

The air control valve 34 contains a main diverter valve 38 and its valve member 40 which valve member operates to cause the air flow from the pump to either be diverted to the exhaust system or to be discharged to the atmosphere when the operation of the motor vehicle does not require the use of auxiliary air to the exhaust system. Since air, when it is blown or pushed through an orifice creates a sound, there is provided in the air control valve 34 silencing material 42 between the pump input port 44 of the control valve 34 and the atmosphere.

When the engine control system, which is not shown, requires that the auxiliary air or secondary air be applied to the exhaust system, the diverter valve 38 closes the discharge port 46 and diverts the air to either one of the exhaust system ports 48, 49. One port 49 is typically connected to the exhaust manifold of the engine and the other port 48 is connected to the exhaust system near the catalytic converter which is not shown. In most systems, selection of which exhaust port is to be used is governed by a vacuum motor controlled by a temperature operated vacuum switch.

The constant pressure relief valve 10 of the present invention is illustrated as being in fluid communication with the pump input port 44 at all times. The input orifice 22 of the relief valve 10 receives the air flow directly from the air pump. The pressure at the face of the valve member 20 is the pressure which the relief valve 10 operates to avoid being exceeded beyond a predetermined value as determined by the relief valve 10.

When the relief valve 10 opens, the pressure and the flow from the air pump is communicated between the valve seat 76 and the valve member 20 to the first chamber 24 of the relief valve 10. The air flows through the first chamber 24 to the exhaust orifice 16 and therethrough to the silencing material 42 and to the atmosphere through a series of vents 50. If the pressure in the first chamber starts 24 to build up higher than the pressure which caused the valve member 20 to lift off the valve seat 26, this increased pressure operates against the diaphram 18 and the valve member 20 causing the valve member 20 to lift higher. This increased lift, increases the air flow and an equilibrium is reached which is the pressure which initially caused the valve member 20 to lift off the valve seat 26.

This increased pressure is a back pressure developed by the pressure drop through the restriction or silencing material 42. The combination of reference pressure in the second chamber 28, the force developed by the spring bias means 32 and the back pressure produces a constant pressure in the air being supplied to the exhaust system.

In one application of the preferred embodiment, the reference pressure in the second chamber 28 is atmospheric and the constant relief pressure is 20 inches of mercury. As illustrated in FIGURE 3, the curve of relief pressure plotted against pump speed or fluid flow for the relief valve 10 of the present invention is flat. In prior art devices where the relief valve 10 has only one chamber which is connected to the exhaust orifice, the plot of the relief pressure is illustrated by the dashed curve. The reason for the dashed curve is that the back pressure is added to the spring bias of the valve and since the back pressure increases, the relief pressure increases.

There has thus been shown and illustrated a constant pressure relief valve 10 as used in an air control valve 34 found in a secondary or auxiliary air system in a motor vehicle. A cooperation of the diaphragm 18 providing a reference pressure chamber 28 controlling the valve member 20 and the added lift of the valve member 20 by the system back pressure maintains a constant relief pressure.

Claims:

1. A constant pressure relief valve for an air control valve comprising:

a housing (12) having an inlet orifice (22) adapted to be connected to an air source having pulsating pressure and variable fluid flow rates from an air pump and an exhaust orifice (16);

flow restriction means (14) connected to said exhaust orifice to develop a pressure thereat as a function of the flow therethrough;

a diaphragm (18) dividing said housing into two chambers (24, 28) wherein said first chamber (24) contains said inlet and exhaust orifices (22, 16) and said second chamber (28) contains a reference pressure; and

a valve member (20) connected to said diaphragm and operable to close said inlet orifice (22) when the pressure thereat is below said reference pressure and to open said inlet orifice (22) when the pressure thereat is above said reference pressure and responsive to said pressure at said exhaust orifice (16) for varying the lift of said valve member (20) for maintaining the pressure at the inlet orifice (22).

2. In a secondary air control system for internal combustion engines having an air pump supplying air to an air control valve for selective distribution to various components in an exhaust system, a constant pressure relief valve operatively connected to the air control valve for limiting the maximum pressure in the system to a predetermined value independently of the speed of the air pump, the constant pressure relief valve comprising:

an inlet orifice (22) in fluid communication with the air pump inlet to the air control valve;

an exhaust orifice (16) for discharging air;

a housing (12);

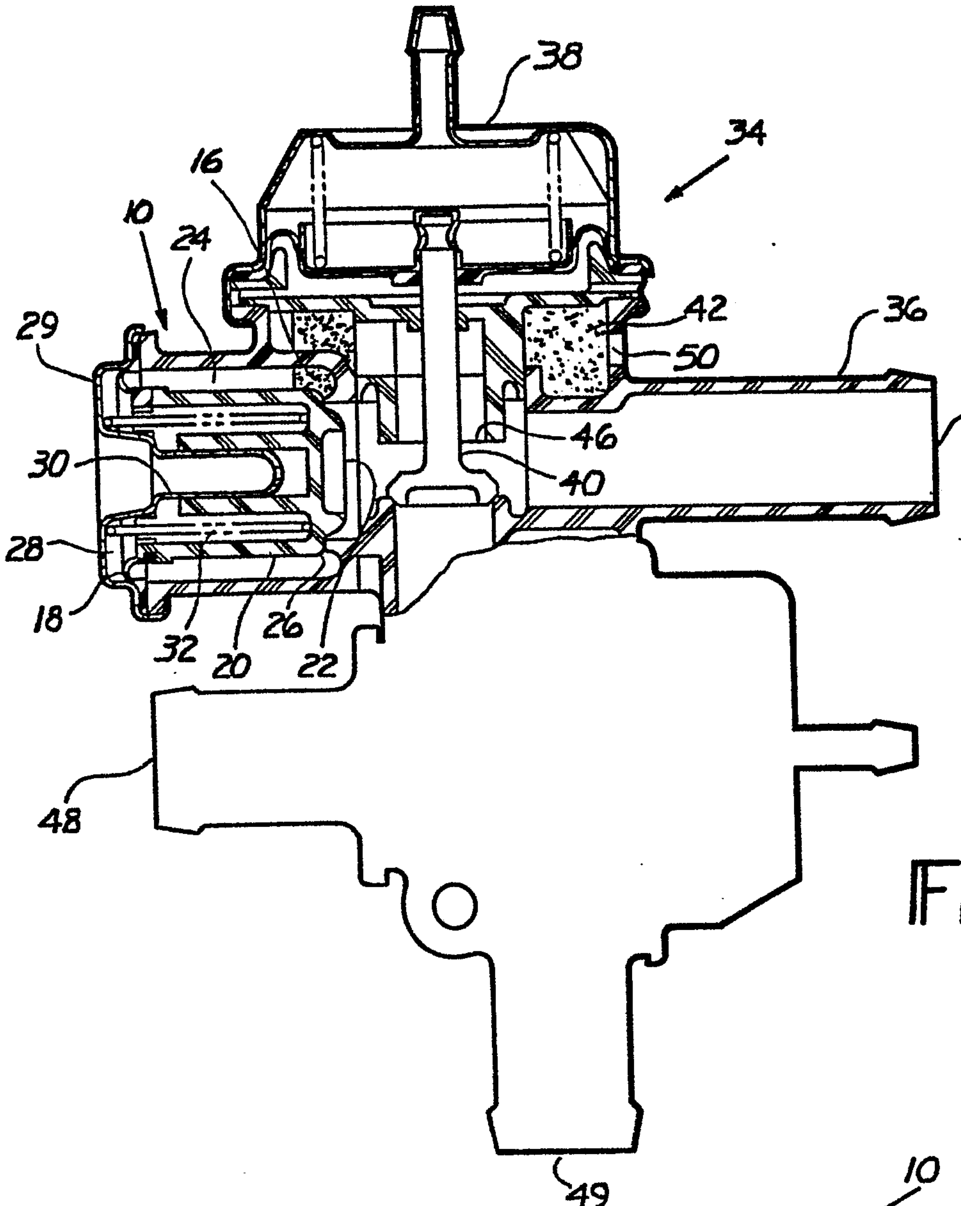
a diaphragm (18) located in said housing dividing said housing into two chambers wherein said first chamber (24) includes said inlet and exhaust orifices and said second chamber (28) containing a reference pressure; and

a valve member (20) connected to said diaphragm and operable to close said inlet orifice (22) when the pressure at said inlet orifice (22) is less than said reference pressure and operable to connect said inlet orifice (22) to said exhaust orifice (16) to limit the maximum pressure at said inlet orifice (22) to a predetermined value independently of the speed of the air pump and the amount of air flowing through the system.

3. The combination according to Claim 2 additionally including spring bias means (32) in said second chamber (28) for biasing said valve member (20) to close said inlet orifice (22).

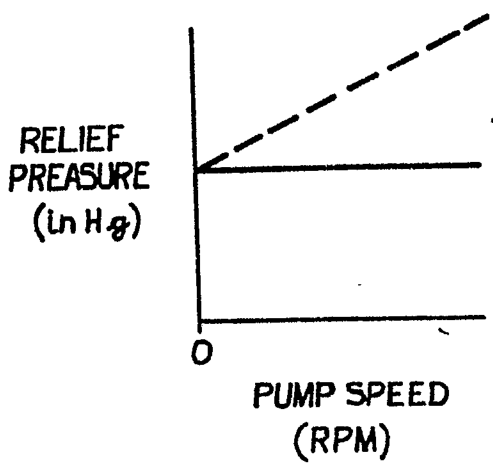
4. The combination according to Claim 3 wherein said reference pressure is atmospheric and the maximum pressure is equivalent to atmospheric pressure plus the pressure exerted by said spring bias means (32) whereby said valve opening is proportional to both pump speed and fluid flow rates in the system.

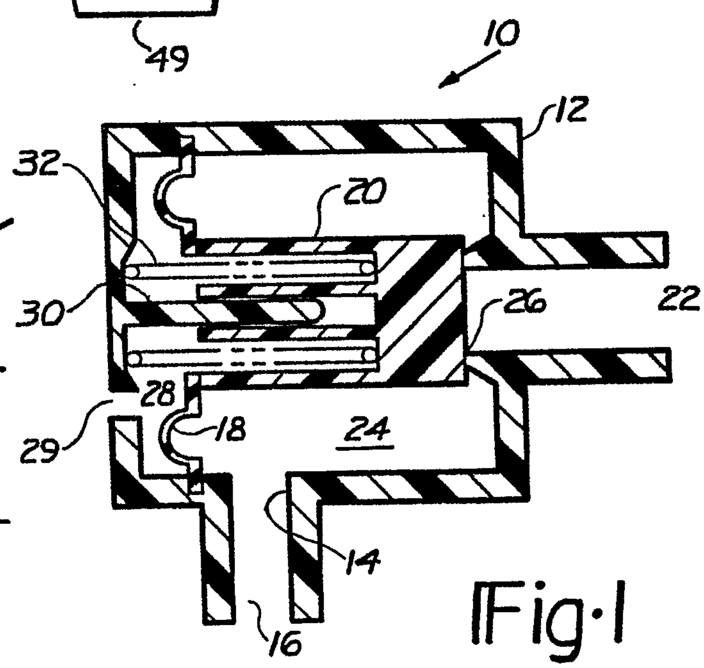
5. The combination according to Claim 2 wherein said exhaust orifice (16) is connected to a restriction means developing a back pressure causing said inlet orifice (22) to open wider thereby increasing the flow rate of the fluid through said first chamber (24).



Fig·2

Fig·3





Fig·1