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ANTI-FLUTTER METERING VALVE

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FIG. 1.

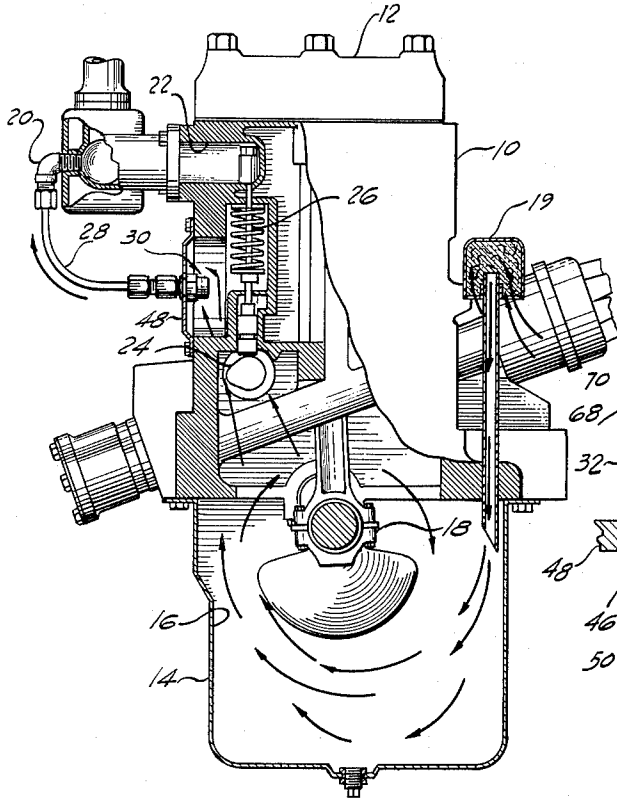


FIG. 2.

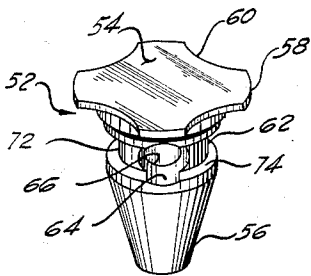
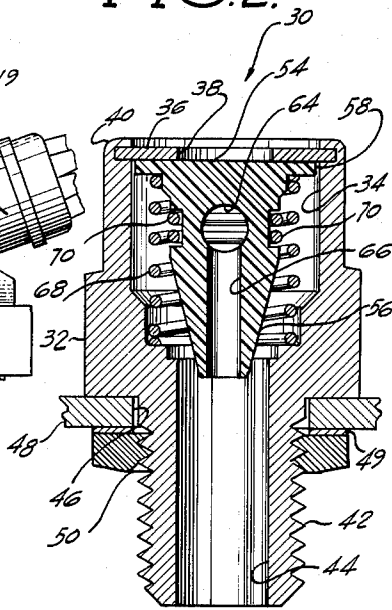


FIG. 3.

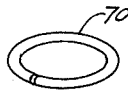


FIG. 4.

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This invention relates to positive venting of an internal combustion engine crankcase enclosure, and more particularly to a metering valve disposed in a venting line between the crankcase enclosure and the engine fuel induction means to meter the gas flow from the crankcase enclosure to the induction means.

Gases from the combustion chamber of an internal combustion engine blow by the mating piston-cylinder to the crankcase enclosure. The blow-by gases contain moisture, unburned hydrocarbons and other foreign material that would contaminate the engine lubricating oil if not withdrawn from the crankcase enclosure. Positive crankcase venting utilizes the partial vacuum in the engine intake manifold or fuel induction system to withdraw the blow-by gases from the crankcase enclosure. The vented gases then are recycled through the engine with the regular combustible intake mixture.

The quantity of fuel supplied to the engine is generally inversely proportional to the differential between the intake manifold pressure and the atmospheric or crankcase enclosure pressure. Thus to avoid undue dilution of the combustible intake mixture, a metering valve is required in the venting line to meter the vented blow-by gases to the engine throughout the various engine operating conditions.

A typical metering valve existing prior to this invention generally has a valve member movable in a hollow casing, the valve member being operable at different positions in the casing to cover aligned openings at opposite ends of the casing. A light spring biases the valve member to close one of the openings and hence the valve. As the pressure differential increases, the valve member is moved within the casing against the force of the spring to uncover the one opening. Blow-by gases from the crankcase enclosure thus can be drawn through the valve to the intake manifold.

In operation, however, the pressure differential is not smooth and constant, but is generally subject to rapid and large fluctuations. Since the movable valve member generally forms an undamped spring-mass system, the fluctuating pressure differential is sufficient to induce harmonic vibrations in the member. The vibrations or flutter of the valve member destroys valve calibration to permit excessive or insufficient blow-by gas venting to the intake manifold.

Another serious drawback accompanies these vibrations or flutter of the movable valve member. The valve member frequently impacts against the valve casing to mar or wear the matched seats over the valve openings. This rapid wear further destroys the calibration of the valve and prevents accurate metering throughout the operating conditions of the engine.

Accordingly, an object of this invention is to provide a metering valve capable of accurate calibration throughout the entire range of pressure differential between the engine induction means and crankcase enclosure.

Another object of the invention is to provide a metering valve having damping means to prevent inaccuracy of the valve caused by valve flutter.

Another object is to provide an anti-flutter metering valve that is economical to fabricate and dependable in operation without rapid wear or loss of calibration.

In order that the principle of operation will be fully

understood, a preferred embodiment of the invention is shown in the accompanying drawing wherein:

FIG. 1 is a broken away end view of an internal combustion engine showing the metering valve of this invention;

FIG. 2 is a longitudinal section view of the metering valve forming a part of this invention;

FIG. 3 is a perspective view of a valve member used in this invention; and

FIG. 4 is a perspective view of a split ring used in this invention.

Referring to FIG. 1, a conventional internal combustion engine is shown having a frame 10, a removable head 12, and an oil pan 14 defining in part a crankcase enclosure 16. A crankshaft and piston rod assembly 18 mounted within the crankcase enclosure 16 rotates in a clockwise direction as seen in FIG. 1. Oil breather or pour spout 19 mounted on the engine communicates with the crankcase enclosure 16. Fuel and air intake manifold 20 is shown with an intake passage 22 leading toward the engine. Cam shaft 24 actuates the spring biased engine valves 26 (only one of which is shown) in the well known manner to control the intake and exhaust of the engine.

A venting line 28 intercommunicates the crankcase enclosure 16 and the intake manifold 20 to withdraw the blow-by gases within the crankcase enclosure 16. A metering valve 30 is disposed in the venting line 28 to regulate the blow-by gas flow to the intake manifold as a function of pressure differential as noted above.

Referring to FIG. 2, the metering valve 30 has a hollow casing 32 having an enlarged generally cylindrical chamber 34 at one end. A cap or washer 36 having an opening 38 therein is secured against the casing 32 by crimping the edges 40 thereof onto the washer 36. Plug 42 at the other end of the casing 32 has a bore 44 generally aligned with opening 38 of the washer. The plug 42 is insertable through an opening 46 in a valve covering plate 48 and held by sealing lock washer 49 and nut 50. The metering valve thus is in direct communication with crankcase enclosure 16 through the venting holes not shown) in the frame 10.

A valve member 52 (FIG. 3) having a generally flat top portion 54 at one end and a generally conical portion 56 at the opposite end is disposed within the chamber 34 of casing 32. The top portion 54 of the valve member is generally X-shaped with four equally spaced radial tabs 58. Circular fillets 60 interconnect the tabs 58 so that the minimum diametric distance across the upper surface of the top portion is slightly greater than the diameter of opening 38. The valve member 52 is further provided with a recess 62 extending circumferentially around the member intermediate its ends. A transverse opening 64 extends completely through member 52 generally in line with recess 62. An axial bore 66 communicates the end of member 52 having the conical portion 56 with the transverse opening 64.

A compression spring 68 extends between casing 32 and the underside of tabs 58 to bias member 52 axially within casing 32 toward opening 38. In one extreme axial position of the member 52 within casing 32, the conical portion 56 seats over the periphery of bore 44 whereas the top portion 54 is spaced from opening 38 in washer 36. In the other extreme axial position of member 52 in casing 32, top portion 54 seats over opening 38 while conical portion 56 is spaced from bore 44. At all intermediate positions of the member 52 in casing 32, both opening 38 and bore 44 are uncovered to define a communicating passageway extending entirely through metering valve 30.

When the pressure differential between the intake mani-

3

fold 20 and the crankcase enclosure 16 is small, spring 68 maintains the member 52 seated over opening 38. However, as the pressure differential increases, the member 52 is moved away from opening 38 against the compression of spring 68. A direct communication is established between the crankcase enclosure 16 and intake manifold 20 to withdraw the blow-by gases then in the crankcase enclosure. The blow-by gas flow through the metering valve 30 is determined by the axial position of valve member 52 in the casing 32, which position governs the cross-sectional area of the flow path past opening 38 and bore 44.

Compression spring 68 is calibrated so that when the pressure differential is large or at the idle condition of the engine, the conical portion 56 seats over the periphery of bore 44. The flow path through metering valve 30 then is limited to the flow through transverse opening 64 and axial bore 66. The size of the bore 66 can be accurately calibrated to admit only the maximum amount of tolerable diluting blow-by gases to the intake manifold 20.

It will be noted that the axial position of the valve member is determined by the pressure differential across the valve balanced by the force of spring 68. Thus all intermediate positions of the valve member 52 in the casing 32 result in an unstable spring-mass system. Since the pressure differential generally fluctuates rapidly over a wide range, the member 52 is readily subject to induced vibrations within valve casing 32. Friction damping of the valve member 52 is not readily possible since the valve member must be freely movable to meter the blow-by flow accurately.

The metering valve of this invention substantially eliminates all the above-mentioned problems while yet being of dependable, simple and economical construction. Split rings 70 (FIG. 4) are pressed over conical portion 56 and received in recess 64. Each split ring can be of conventional wire stock shaped slightly larger than land 72 of recess 64 but smaller than the inside dimension of spring 68. Consequently, the ring 72 can frictionally slide on valve member 52 without engaging spring 68.

The split ring 70 is thus freely and independently movable relative to the valve member 52 a limited distance as determined by the relative size of the ring and the distance between the abutment surfaces 74. Preferably the distance between the abutment surfaces 74 and the thickness of the ring 72 are such that the ring is movable independently of the valve member 52 a distance substantially less than the distance the valve member 52 moves within the casing.

Flutter or vibration of member 52 is resisted by the independent mass of the split rings 70 thereon. Minor vibration is substantially eliminated by the friction between the split rings 70 and the member 52. However, if severe vibrations happen to take place they are quickly damped by impact of the split rings 70 against each other and the edges 74 of recess 64.

While two split rings 70 are shown, it is sometimes advantageous to use only one split ring or to use more than two split rings. Generally the greater number of independent split rings used, the less total mass of split rings is needed to control vibration. However, it will be apparent that in no case should any one of the split rings bind with any other split ring, the valve member 52 or compression spring 68. Similarly the valve member 52 should not bind with the valve casing 32 or the compression spring 68.

The split ring 70 generally dampens vibration more effectively when the path of movement of the valve member 52 is not vertical. Thus gravity always causes some friction between the ring and valve member which is independent of any motion of the valve member.

The cyclic or natural frequency of valve member 52 is determined by its mass, and the spring constant and mass of spring 68. Thus the valve member 52 preferably is made of a hard molded plastic to reduce its weight and increase its natural frequency. The tendency of the valve

4

member 52 to vibrate at a high rate readily causes the split rings to dampen the vibration, thus ensures a continuously damped system. The reduced weight of the member 52 further decreases the kinetic energy of member 52 to reduce damage thereto caused by impact against the washer 36 or the casing 32. By making the valve member 52 of plastic, it is further noted that the periphery of bore 44 need not be accurately machined or heat treated. Consequently, the production cost of the metering valve is materially less than the cost of metering valves existing prior to this invention.

By these rather simple economical means, induced vibration or flutter of valve member 52 is substantially eliminated. It has been found that a valve member 52 having a mass of approximately one gram is adequately damped by a pair of substantially identical split rings 70 having a combined mass of approximately $\frac{1}{10}$ gram.

While a single embodiment has been shown, it will be obvious to those skilled in the art that other embodiments are possible. It is desired, therefore, that the invention not be limited by the embodiment shown but by the true spirit of the invention as recited in the appended claims.

What is claimed is:

1. An anti-flutter metering valve, comprising a casing having a through passageway including spaced openings, a valve member movable axially in the casing a given distance between two axially spaced limits, said valve member having a tapered end seatable in one of the limits with one casing opening and having a generally flat end seatable in the other of the limits with the other casing opening, a spring between the casing and valve member to bias the flat end of the member against the casing over the other casing opening to close the metering valve, said valve member having a flow calibrated through opening extending from intermediate its ends to the tapered end, the differential pressure across the metering valve being operable to move the valve member against the bias of the spring axially within the casing for metering the flow through the valve, spaced annular abutment surfaces on the intermediate portion of the valve member extending transversely thereof, and a split ring dampening member supported solely by the valve member loosely between the spaced surfaces, the distance between the abutments and the thickness of said ring being such that said ring is freely movable independently of the valve member between the spaced surfaces a distance substantially less than the distance of valve member movement and is operable upon impact against the abutment surfaces to dampen flutter of the valve member when the latter is unseated from both casing openings.

2. An anti-flutter metering valve according to claim 1, wherein said valve member and said spring form a spring mass vibration system when the valve member is unseated from both casing openings, and said valve member is fabricated of a plastic material of less density than conventional metallic materials common in the valve art, operable to cause a higher natural frequency of vibration of the spring mass system than with the conventional materials, thereby ensuring more effective continuous damping between the valve member and dampening member.

3. An anti-flutter metering valve according to claim 1 wherein said casing is disposed with its through passageway inclined at an angle relative to the vertical, and the valve member is movable within the casing in a direction other than the vertical.

4. An anti-flutter metering valve, comprising a casing having a through passageway including spaced openings defining valve seats, a valve member movable axially in the casing, said valve member having one end seatable on one of said seats and having a generally flat other end seatable on the other of said seats, a spring between the casing and valve member to bias the flat end of the valve member against the casing over the other casing opening to close the metering valve, said valve member having flow calibrated passage means extending from an exterior

5

6

surface thereof intermediate its ends to said one end, the differential pressure across the metering valve being operable to move the valve member against the bias of the spring axially within the casing for metering the flow through the valve, spaced annular abutment surfaces on the valve member extending transversely thereof, and a ring shaped dampening member supported solely by the valve member loosely coupled between the spaced annular abutment surfaces, the distance between the spaced annular abutment surfaces and the thickness of said ring shaped member being such that said ring shaped member is freely movable independently of the valve member between the spaced annular abutment surfaces a distance substantially less than the distance of valve member movement and is operable upon impact against the abutment surfaces to

dampen flutter of the valve member when the latter is unseated from both casing openings.

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