ABSTRACT: A crankcase ventilation system to be used on an automotive engine, adapted on the one hand to draw blowby gases from the crankcase interior not only to the air cleaner but to the intake manifold of the engine and on the other to supply the crankcase with fresh air for scavenging the interior thereof. The blowby gases are pulled out of the crankcase and fresh air introduced thereinto by special valve and orifice arrangements operating in close relation with the pulsation of the intake manifold vacuum.
Fig. 7-a

Fig. 7-b

Fig. 9-a

Fig. 9-b

Fig. 8
CRANKCASE VENTILATION SYSTEM

The invention relates to ventilation system of the crankcase used on a gasoline-powered automotive engine and has particular reference to the ventilation system which is adapted, on the one hand, to prevent an air pollution resulting from the release to the atmosphere of the so-called blowby gases from the engine combustion chamber and, on the other, to minimize the deterioration of the engine oil and the formation of sludge and rust within the crankcase.

The term "crankcase" as herein used is intended to refer to a structure defined by an oil pan, a chain case, a crankcase proper, a cylinder head and a rocker cover.

Typical of the crankcase ventilation systems that have been devised and placed on practical use for preventing the emission of the blowby gases to the outside of the automotive engine are what is known as the sealed system and what is known as the closed system. In the crankcase ventilation system of sealed type, as will be discussed with greater detail in connection with the drawing, the carburetor is subject to contamination and malfunction partly because the crankcase is not supplied with fresh air from outside and partly because the blowby gases are drawn to the upstream of the carburetor. In the ventilation system of closed type, on the other hand, problems are experienced from the fact that, during the full-throttle operation or in the event the flow of the blowby gases into the intake manifold of the engine is regulated, the blowby gases are forced back to the engine air cleaner with the consequent stoppage of the flow of ventilation air into the crankcase.

In order to overcome these and other drawbacks that are inherent in the conventional crankcase ventilation system of sealed or closed type and to offer increased reliability of the ventilating performance of the crankcase, the present invention contemplates to provide a novel and improved crankcase ventilation system of the type which is adapted to supply an appropriate amount of fresh air to the crankcase under every mode of the engine operation.

The features and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic view showing the general construction, in vertical section, of a conventional crankcase ventilation system of sealed type;

FIG. 2 is similar to FIG. 1, but shows a crankcase ventilation system of closed type;

FIG. 3 shows oscillographic representation exemplifying the fluctuation in the pressure in the crankcase interior having the ventilation system embodying the present invention, wherein FIG. 3-a pertains to the case where the blowby gases are drawn only to the engine air cleaner and FIG. 3-b to the case where a portion of the blowby gases is drawn not only to the engine air cleaner but to the engine intake manifold by way of an orifice;

FIG. 4 is a view schematically showing the general construction, in vertical section, of the crankcase ventilation system according to the invention, in which the structural details are omitted for the sake of clarity of illustration;

FIGS. 5 and 6 are vertical sectional views of practical examples of the crankcase ventilation systems realizing the design concept of the system shown in FIG. 4;

FIG. 7-a is a lengthwise section of a preferred example of the orifice used in the ventilation systems shown in FIGS. 5 and 6;

FIG. 7-b is the section taken on the line 1-1 of FIG. 7-a;

FIG. 8 is similar to FIG. 7-a but shows another preferred example;

FIG. 9-a is a cross section of a preferred example of the check valve used in the ventilation systems of FIGS. 5 and 6;

FIG. 9-b is the plan of the valve seat member constituting the check valve shown in FIG. 9-a;

FIG. 10-a is a vertical section of another preferred example of the orifice used in the systems according to the invention;

FIG. 10-b is the top plan view of the check valve shown in FIG. 10-a;

FIG. 11 is a vertical section of the crankcase ventilation system using the check valve of FIGS. 10-a and 10-b;

FIG. 12 is a graph showing the results of the experiments conducted on the characteristics of the flow of the blowby gas mixture through the orifice shown previously; and

FIG. 13 is a graph showing the results of the experiments conducted on the flow characteristics of ventilation air to be drawn to the crankcase of different types.

Referring now to FIG. 1 which shows a representative example of the crankcase ventilation system of sealed type as heretofore constructed, the crankcase chamber 11 is totally sealed off with a single exception of the opening 12 through which the blowby gases are drawn to the engine air cleaner 13 by way of the oil separator 14 and the conduit or passageway 15, or more specifically, either to the dust side 16 or to the clean side 17 thereof, viz., to the carburetor 18 upstream of the butterfly valve 19. The blowby gases thus introduced into the carburetor 18 are mixed with engine inlet air and are thereafter fed to the combustion chamber 20 of the engine where they are burnt for the second time.

Since the blowby gases are drawn to the upstream side of the carburetor and since the crankcase is not supplied with fresh ventilation air in the ventilation system of this type, the carburetor is more or less subject to contamination that will eventually lead to degraded metering performance of the carburetor.

In the other representative example of the conventional crankcase ventilation system, viz., in the ventilation system of closed type as shown in FIG. 2, the blowby gases which have developed in the crankcase 11 are pulled out of the opening 12 by way of the oil separator 14, similarly to the case of the ventilation system of FIG. 1. The blowby gases as pulled out of the opening 12 are, different from the system shown in FIG. 1, led by way of the conduit 15 to the flow control valve 21 and by which the flow of the blowby gases is regulated in accordance with the level of the vacuum at the intake manifold 22. The blowby gases thus regulated in flow rate at the flow control valve 21 is led to the intake manifold 22 downstream of the carburetor 18 and further to the combustion chamber 20 of the engine for recombustion therein.

While the blowby gases are being recycled from the crankcase 11 to the engine combustion chamber 20, fresh ventilation air is fed from the clean side 17 of the engine air cleaner 13 to the crankcase 11 by way of the conduit 23 and the oil separator 24 which serves to prevent the engine oil to be pulled over due to the reverse flow of the blowby gases toward the oil cleaner 19. Although the crankcase ventilation system of closed type is considered as more advantageous than the ventilation system of sealed type in that the crankcase is supplied with fresh air and that the blowby gases are drawn to the downstream side of the carburetor, the former still exhibits a drawback that is inherent in the particular construction arrangements thereof.

During the full-throttle operation or in the event the flow control valve fails to properly regulate the flow rate of the blowby gases to be introduced into the intake manifold, for example, the blowby gases tend to be forced back toward the air cleaner so that the crankcase is no longer supplied with fresh ventilation air. To protect the engine oil from being pulled over due to the reverse flow of the blowby gases toward the air cleaner, it is imperative to use an oil separator member to be mounted in the passage linking the air cleaner and the crankcase as designated at 24 in FIG. 2. Furthermore, the flow control valve used in the ventilation system of closed type must be so constructed as to provide for sufficiently stabilized performance quality plus increased durability. All these are eventually reflected by increased production cost of the ventilation system as a whole.

The problems thus encountered in the crankcase ventilation system of prior art, whether it is of sealed or closed type, are advantageously overcome in the ventilation system according to the invention.
As illustrated in the graphs of FIG. 3, the volume of the crankcase interior and accordingly the pressure in the crankcase periodically pulsates or fluctuates with the amount of piston displacement in a reciprocating engine of single cylinder, or with the different stroke on said engine. Thus, it will be appreciated in an engine of multiple-cylinder type. Such pulsation in the pressure in the crankcase interior is effectively utilized in the present invention for the purpose of supplying the crankcase with fresh ventilation air and recycling the blowby gases for recombustion in the engine with increased reliability and stability.

FIG. 4 shows a schematic view of the general construction of the crankcase ventilation system according to the invention, wherein structural details are removed for clarity of illustration.

Check valves 25 and 26 are provided at the outlet 12 (which is located downstream of the oil separator 14) and the inlet 27, respectively, of the crankcase 11 in such a manner that the valve 25 remains opened and the valve 26 closed while the pressure inside of the crankcase remains higher than the outside pressure and that the valve 25 remains closed and the valve 26 opened while the pressure within crankcase chamber remains lower than the outside pressure. With the valve 25 kept open and the valve 26 closed, the blowby gases emitted from the combustion chamber 20 of the engine are forced out of the outlet 12 of the crankcase 11 but prohibited to be released from the inlet 27 even though the pressure in the crankcase 11 exceeds the outside pressure. With the valve 25 kept closed and the valve 26 opened, to the contrary, fresh ventilation or scavenging air is introduced into the crankcase by way of the inlet 27 to scaveng the crankcase interior so that the blowby gases existing in the crankcase are mixed with the ventilation air.

The blowby gas mixture discharged out of the outlet 12 while the check valve 26 is kept open is drawn either to the dust side 16 or to the clean side 17 of the air cleaner 13, viz., to the carburetor 18 upstream of the butterfly valve 19 by way of the conduit 15. The blowby gas mixture is further mixed with engine inlet air and introduced into the combustion chamber 20 of the engine for recombustion therein.

In an engine emitting a considerably large amount of blowby gases, however, the check valve 25 (even though it is held in an open position) acts as an obstacle to the flow of blowby gas mixture through the outlet 12 so that the pressure in the crankcase interior fails to attain a level that is required to introduce an adequate amount of fresh ventilation air into the crankcase 11. This will mean that it is advantageous to have the size of the valve 25 increased at the sacrifice of the compactness of the crankcase ventilation system using such valve arrangement.

According to the present invention, however, a second outlet 12' is provided past the oil separator 14 in the crankcase 11 and communicates by way of a conduit 15' with the carburetor 18 downstream of the butterfly valve 19. An orifice 28 is provided at a suitable location of the conduit 15' so that the blowby gas mixture delivered from the crankcase 11 is metered and introduced into the carburetor 18 downstream of the butterfly or throttle valve 19 at a flow rate which is so predetermined as to provide for sustained, satisfactory driveability of the engine under the varying driving conditions thereof. As seen in FIG. 4, the orifice effectively meters the crankcase gases, etc., directly to the intake manifold in accordance with the pressure differentials existing across it, or in other words, in accordance with the difference in pressure between the intake manifold and the air cleaner, either side of which is opened. Thus, it will be appreciated that, due to the provision of a second outlet opening 12' in the crankcase 11, the pressure in the crankcase interior can be lowered to a such level as is appropriate for the introduction of ventilation air into the crankcase even through a check valve 25 having a relatively small size is used. This is clearly ascertained from the oscillographic representation of FIG. 3. Introduction of a portion of the blowby gas mixture into the carburetor 18 downstream of the butterfly valve 19 is, moreover, conducive to the protection of the carburetor in its entirety.

One practical example of the crankcase ventilation system implementing the design concept described in connection with FIG. 4 is shown in FIG. 5.

As shown, an inlet opening 27 is provided in the crankcase 11 through which ventilation air is admitted to the crankcase 11 while the pressure in the crankcase (which pressure is pulsating between the positive and negative) remains negative. A check valve 26 is provided at the inlet opening 27 (or at any location in the passage leading to the inlet opening, if desired) in such a manner that, while the pressure in the crankcase remains positive, the valve 26 is kept closed and the blowby gases are accordingly not allowed to the atmosphere. Upstream or outside of the inlet opening 27 and the check valve 26 is mounted a ventilation air cleaner 29 which serves to remove dusts from ventilation air to be introduced into the crankcase 11. The ventilation air cleaner element 30 of the cleaner 29 is shown to be integrally mounted on the check valve 26, but it may be mounted separately thereof. Or, otherwise, the cleaner element 30 may be located at a suitable position in the engine air cleaner 13, as illustrated in FIG. 6. In this instance, a portion of the air sucked in by the engine air cleaner 13 is introduced into the crankcase 11 by way of the check valve 26 and the ventilation air inlet 27.

The ventilation air introduced into the crankcase 11 serves to scavange the interior thereof and is simultaneously mixed with the blowby gases that have debouched into the crankcase 11. The resultant mixture of ventilation air and blowby gases is then fed to the oil separator 14 for removal of engine oil content and spouts out of the outlet opening 12 into the engine air cleaner 13 by way of the conduit 15. As the gas pressure present in the crankcase 11 exceeds the pressure in the air cleaner 13, the check valve 25 opens to permit the crankcase 11 to communicate with the air cleaner 13 so that the blowby gas mixture is admitted from the crankcase 11 into the air cleaner. According to the invention, a portion of the mixture is also fed to the intake manifold 22 of the engine by way of the conduit 15' which is branched from the conduit 15 upstream of the check valve 25. At a suitable location in the conduit 15' between the opening to the intake manifold and the junction with the conduit 15 is provided an orifice 28 which is adapted to regulate the flow rate of the blowby gas mixture to be drawn to the carburetor 18 downstream of the butterfly valve 19.

Thus, a portion of the blowby gas mixture existing in the crankcase 11 is introduced into the intake manifold 22 (namely, to the carburetor 18 downstream of the butterfly valve 19) by way of the orifice 28 provided at a suitable position in the conduit 15' branched from the conduit 15 upstream of the check valve 25. The blowby gas mixture fed into the intake manifold 22 is further mixed with the blowby gas mixture that has been drawn to the carburetor 18 upstream of the butterfly valve 19 from the engine air cleaner 13, the resultant mixture being pulled into the combustion chamber of the engine where it is burnt for the second time.

As seen from the graph of FIG. 12, the flow rate of the blowby gas mixture passing through the orifice 28 varies according to the inside diameter thereof and to the level of the negative pressure present in the carburetor 18 downstream of the butterfly valve 19, viz., to the level of the vacuum at the intake manifold of the engine. Judging from the illustration of FIG. 12 only, it is considered advantageous for increasing the flow rate of the blowby gas mixture to increase the inside diameter of the orifice increased to a largest possible extent. In so doing, however, a problem arises from the fact that such a high flow rate of the blowby gas mixture is offset by an excess air-fuel ratio of the engine fuel mixture that is detrimental to the driveability of the engine. In order to have an optimum flow rate of the blowby gas mixture, it is desirable to vary the driving conditions of the engine, therefore, it is important to determine the inside diameter of the orifice in such a manner that neither the flow rate of the blowby gas mixture...
The orifice 28 being liable to deposit of sludge resulting from the passage of a blowby gas mixture, it tends to become clogged after prolonged use of the engine. A simple yet effective expedient of avoiding such an inconvenience is to have the inner periphery of the orifice 28 sharpened in shape thereby to prevent the sludge to deposit around the peripheral circumference thereof, as shown in FIG. 8. As an alternative, it would also be advantageous to provide a ball member 31 and a tubular member 32 having internally raised portions 33 and 34, as shown in FIGS. 7-a and 7-b. In the shown example, the clearance formed between the outer contour of the ball member 31 and the inner wall surface of the tubular member 32 acts like an orifice to meter the flow rate of the blowby gas mixture passing therethrough, wherein the upward and downward movement of the ball member 31 serves to purge the sludge that will otherwise deposit within the tubular member 32. The raised portion 34 serves to prevent the ball member 31 to be released from the tubular member 32.

FIGS. 9-a and 9-b illustrate an example of the construction of the check valve 25 or 26 used in the crankcase ventilation system according to the invention. As shown, the check valve 25 or 26 consists of a valve seat 35 having ports 36, a valve plate 37 superposed on the valve seat 35 and closing said ports 36 in a normal state, a retainer 38 superposed on the valve plate 37. The valve plate 37 has centrally three members 35, 37 and 38 together. The valve seat 35 faces the upstream side of the conduit 15 or 15' while the retainer 38 faces downstream thereof. More specifically, the valve seat 35 faces the crankcase side for the check valve 25 and faces the air source side for the check valve 26, while the retainer 38 faces the engine air cleaner side for the check valve 25 and faces the crankcase side for the check valve 26. The valve plate 37 is made of a certain kind of pliable material so that it becomes warped toward the retainer 38 when a pressure is applied from outside of the valve seat 35, thus causing the ports 36 to open.

While the gas pressure upstream of the check valve remains lower than that existing downstream thereof, the valve plate 37 is kept closely contiguous with the valve seat 35 to prohibit the blowby gas mixture or ventilation air to pass from the retainer side to the valve seat side (viz., from the downstream side to the upstream side) through the ports 36. When, however, the gas pressure upstream of the check valve exceeds the pressure downstream thereof, the valve plate 37 is forced to warp away from the valve seat 35 so that the ports 36 become opened to permit the blowby gas mixture or ventilation air to flow through the valve from the upstream side to the downstream side. As soon as the pressures between the upstream and downstream sides of the check valve becomes balanced, the valve plate 37 resumes its original position to close the ports 36, thus shutting off the flow of the blowby gas mixture or ventilation air therethrough. Although the valve seat 35 is illustrated to have three ports, a more or less number of ports may be provided in the valve seat 35. The retainer 38 serves to prevent the valve plate 37 to be warped excessively away from the valve seat 35 and protect the same from probable damage resulting from mechanical fatigue thereof. If desired, it will be advantageous for better sealing and increased durability of the valve seat 35 and the valve plate 37 to mount a rubby or other elastic sheet material over the entire or partial area of the valve seat 35 or the valve plate 37.

FIGS. 10-a and 10-b illustrate another form of the check valve to be used in the ventilation system according to the invention. As shown, the check valve consists of a generally cylindrical casing 40, a valve seat 41, a ball member 42, a coil spring 43 and a retainer 44. The casing 40 is opened at one end, viz., at its upstream end and closed at the other, viz., at its downstream end. The wall closing the downstream end of the casing 40 is provided therein with openings 45. The valve seat 41 is located at the entire inner periphery of the open or upstream end of the casing 40. The ball member may preferably be made of a light material and normally rests on the valve seat 43 by the action of the coil spring 43 by way of the retainer 44 so that the check valve is held in a closed position.

When, now, a pressure resulting from the flow of the blowby gas mixture or ventilation air is applied to the ball member 42 from the upstream side, the ball member 42 is forced away from the valve seat 41 in the opposite direction of the action of the spring 43 so that the check valve is held in an open position to allow the flow of the blowby gas mixture or ventilation air to pass through the openings 45.

FIG. 11 shows a ventilation system incorporating the check valves 25 and 26 of FIGS. 10-a and 10-b at the blowby gas mixture outlet 12 and in the conduit 37 interconnecting the ventilation air cleaner element 30 and the crankcase 11, respectively. As shown, the check valve 26 may be positioned in the conduit 37, preferably in such a manner that the ball member 42 is positioned at the bottom of the check valve in a normal state thereby to facilitate the ball member to move upward when it is pushed upward with the pressure applied thereto.

Now, to make more clearly understood the advantages attainable from the crankcase ventilation system according to the invention, I conducted experiments on different types of crankcase ventilation system—the conventional system of closed type, the system according to the invention using the described check valve, and the system according to the invention not using the check valve, all under the full-throttle operation of the carburetor. As seen from the graph of FIG. 13, it has proved that a remarkably increased amount of ventilation air is supplied to the crankcase interior and the reverse flow of the blowby gas mixture to the crankcase is perfectly eliminated if the ventilation system having the described check valve is used, whilst the reverse flow of the blowby gas mixture still takes place unless the described check valve is used in the ventilation system according to the invention.

While a few embodiments of the present invention have been described with reference to the accompanying drawings, the present invention will be carried out in various other forms without departing the spirit and scope of the invention which is defined in the appended claims.

I claim:

1. A crankcase ventilation system for an automotive gasoline-powered engine having an intake manifold and an air cleaner for cleaning the air delivered to said intake manifold, which system comprises a crankcase, a ventilation air inlet provided in said crankcase and opened to the atmosphere, a ventilation air check valve mounted in said ventilation air inlet, a blowby gas mixture outlet provided in said crankcase, a blowby gas mixture conduit connecting said outlet with said air cleaner, a blowby gas mixture check valve mounted in said blowby gas mixture conduit, a branch conduit branched from said blowby gas mixture conduit before said blowby gas mixture check valve and communicating with said intake manifold of the engine, and means defining an orifice provided in said branch conduit, whereby as the pressure in the crankcase is increased due to the presence of blowby gases therein, said ventilation air check valve closes to stop delivery of atmospheric air into the crankcase and concurrently said blowby gas mixture check valve opens to release the mixture of the blowby gas and air into the engine air cleaner.

2. The system as set forth in claim 1, further comprising an air cleaner element located upstream of said ventilation air check valve.

3. The system as set forth in claim 1, wherein at least one of said check valves comprises, in combination, a valve seat having provided therein a plurality of openings, a valve plate made of a pliable material and superposed on said valve seat for normally closing said openings, a shallow cuplike retainer superposed on said valve plate and a rivet means fastening said.
valve seat, valve plate and retainer in place, said valve plate becoming warped, in situ, against said retainer with a force exercised thereto through said openings whereby said check valve is held in an open position.

4. The system as set forth in claim 1, wherein at least one of said check valves comprises, in combination, a generally cylindrical casing which is opened at one end and closed at the other with a wall having provided therein a plurality of openings, an annular valve seat mounted at the entire periphery of said open end of the casing, a ball member normally resting on said valve seat, a coil spring acting to normally hold said ball member against said valve seat, and a generally cuplike retainer mounted between said ball member and said coil spring, wherein said ball member is forced away from said valve seat against the action of said coil spring with a force exercised on said ball member through said open end of said casing.

5. The system as set forth in claim 1, wherein said orifice is constituted as a unitary tubular member having its downstream end sharpened and constricted internally and radially.

6. The system as set forth in claim 1, wherein said orifice comprises a tubular member and a ball member accommodated therein, said tubular member having portions internally and radially raised at its upstream and downstream ends.

7. A crankcase ventilation system for an automotive gasoline-powered engine, which system comprises a ventilation air inlet provided in the wall of the crankcase and opened to the atmosphere through a ventilation air conduit, a ventilation air check valve mounted in said ventilation air conduit, a blowby gas mixture outlet provided in the wall of the crankcase and the oil separator thereof, a blowby gas mixture conduit connecting said outlet with the engine air cleaner, a blowby gas mixture check valve mounted in said blowby mixture conduit, a branch conduit branched from said blowby gas mixture conduit before said blowby mixture gas check valve and communicating with the intake manifold of the engine, and an orifice provided in said branch conduit, wherein, as the pressure in the crankcase is increased due to the presence of blowby gases therein, said ventilation air check valve closes to stop delivery of atmospheric air into the crankcase and concurrently said blowby gas mixture check valve opens to release the mixture of the blowby gas and air into the engine air cleaner.

8. The system as set forth in claim 7, wherein said ventilation air conduit communicates with the engine air cleaner.

9. The system as set forth in claim 7, wherein at least one of said check valves comprises, in combination, a valve seat having provided therein a plurality of openings, a valve plate made of a pliable material and superposed on said valve seat for normally closing said openings, a shallow cuplike retainer superposed on said valve plate and a rivet means fastening said valve seat, valve plate and retainer in place, said valve plate becoming warped, in situ, against said retainer with a force exercised thereto through said openings whereby said check valve is held in an open position.

10. The system as set forth in claim 7, wherein at least one of said check valves comprises, in combination, a generally cylindrical casing which is opened at one end and closed at the other with a wall having provided therein a plurality of openings, an annular valve seat mounted at the entire periphery of said open end of the casing, a ball member normally resting on said valve seat, a coil spring acting to normally hold said ball member against said valve seat, and a generally cuplike retainer mounted between said ball member and said coil spring, wherein said ball member is forced away from said valve seat against the action of said coil spring with a force exercised on said ball member through said open end of said casing.

11. The system as set forth in claim 7, wherein said orifice is constituted as a unitary tubular member having its downstream end sharpened and constricted internally and radially.

12. The system as set forth in claim 7, wherein said orifice comprises a tubular member and a ball member accommodated therein, said tubular member having portions internally and radially raised at its upstream and downstream ends.

13. In combination with an internal combustion engine having an intake manifold and having a crankcase chamber receptive of engine blowby mixtures and being maintained under fluctuating positive and negative fluid pressure conditions during engine operation, a carburetor connected to said intake manifold having a throttle valve operable to regulate the supply of air-fuel mixtures delivered through said intake manifold to said engine, an improved crankcase ventilation system for scavenging the crankcase chamber and recycling the engine blowby mixtures comprising: first varying means for admitting atmospheric air into said crankcase chamber to effect scavenging same in response to negative fluid pressure conditions therein; means including second valve means for communicating said crankcase chamber and said carburetor of upstream of said throttle valve only when the fluid pressure within said crankcase chamber is greater than the fluid pressure upstream of said throttle valve to allow flow of crankcase chamber fluids including engine blowby mixtures to said carburetor; and flow control means for continuously controlling the flow of crankcase chamber fluids to said intake manifold downstream from said throttle valve.

14. A combination according to claim 13; wherein said flow control means comprises a conduit providing fluid communication between said crankcase chamber and said intake manifold, and means defining a metering orifice disposed within said conduit to meter the flow of crankcase chamber fluids in accordance with fluid pressure differentials thereacross.

15. A combination according to claim 14; including a knife edge peripherally surrounding said metering orifice to prevent formation thereupon of sludge deposits.

16. A combination according to claim 13; wherein said first valve means comprises means defining an opening communicating said crankcase chamber with the atmosphere, and a check valve operable to open and close said opening in direct response to fluid pressure differentials applied thereacross; and wherein said means including second valve means for communicating said crankcase chamber with said carburetor upstream of said throttle valve comprises means defining another opening in said crankcase chamber, means defining a passageway communicating said another opening with said carburetor upstream of said throttle valve, and another check valve operable in direct response to fluid pressure differentials applied thereacross to open and close said another opening.

17. A combination according to claim 16; wherein said flow control means comprises a conduit connected to said passageway and said intake manifold, and means defining a metering orifice disposed within said conduit effective to meter the flow of crankcase chamber fluids to said intake manifold in response to fluid pressure differentials thereacross.

18. A combination according to claim 13; including an air filter in communication with the atmosphere disposed upstream from said carburetor; and a conduit providing fluid communication between said first valve means and said air filter; whereby atmospheric air admitted into said crankcase chamber first passes through said air filter.