ENGINE CRANKCASE BREATHING PASSAGE WITH FLOW DIODE

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ABSTRACT

An internal combustion engine is disclosed which includes an improved crankcase drain back system. A set of drain flow diodes are disposed in each of the drain lines to direct fluid flow in a direction from the head portion to the crankcase. Likewise, a set of breather flow diodes are disposed in the breather lines to direct fluid flow in a second direction from the cylinder portion to the head portion. The flow diodes include a series of stacked flow diode elements which allow flow in one direction, while resisting flow in the opposite direction.
Example Flow Diode Characteristics

Delta Pressure

- Mass Flow

- Forward Direction
- Reverse Direction

FIG 6

DRAINS ONLY SHOWN

Average mass flow. Positive values = towards oil pan

Mass Flow Rate [g/s]

Plain Tubes (constant 20mm)
Flow Diodes (24mm/16mm), Q=1.7

FIG 7
Max, Mean, Min Velocities - Breather (at inlet face)

Positive values represent flow going towards head

Plain Tube (constant 20mm)
Flow Diodes (24mm/16mm), Q=1.7
Flow Diodes (24mm/16mm), Q=2.3

Max, Mean, & Min Velocities - Oil Drain Back

Plain Tube (constant 20mm)
Flow Diodes (24mm/16mm), Q=1.7
Flow Diodes (24mm/16mm), Q=2.3

FIG 8

FIG 9
FIG 10A

FIG 10B
ENGINE CRANKCASE BREATHING PASSAGE WITH FLOW DIODE

FIELD

[0001] The present disclosure relates to flow control for crankcase draining and breathing of an internal combustion engine, and more specifically to the use of flow diodes in the crankcase drain and breather passageways for generating flow in the direction of intended oil drain back and/or direction of intended breather flow.

BACKGROUND

[0002] This section provides background information related to the present disclosure which is not necessarily prior art.

[0003] Under certain operating conditions gases from the cylinders of an internal combustion engine get past the piston rings and leak into the engine crankcase. These blow-by gases typical include intake air, unburned fuel, exhaust gas, oil mist and/or water vapor. It is desirable to ventilate the crankcase and re-circulate the blow-by gases to the intake side of the engine for combustion to enhance performance and improve emissions.

[0004] To this end, conventional engine blocks have a series of breathers that allow the blow-by gases to circulate from the crankcase to the inlet side of the engine and a series of drains that allow oil to drain from the top of the cylinder head to the crankcase. These passages are typically plain tubes or passages which flow equally in both directions. However, reciprocating engines often create a pulsating pressure differential in the crankcase which overrides the desired flow direction in the crankcase making drain back and breathing difficult to control. Generally, the average flow is against the oil flow direction due to the presence of blow-by gases. In addition, a pulsating flow due to piston movement generates significantly higher velocities than blow-by gases alone could achieve with flow velocities both with and against the oil drain direction, all within one engine revolution. Excessive oil may be retained in the valve covers and there is a highly likelihood that fine oil mist/droplets are created.

[0005] In addition to affecting drain back and breathing, conventional systems may create pressure waves in the crankcase which excite natural resonant frequencies of the engine, in the crankcase cavity or PCV system. The interaction between the pressure waves and the engine components when driven at these resonant frequencies can reduce power output and generate unwanted noise and vibration from the engine. These interactions will also hinder oil drain back and cause higher oil pullover into the intake region.

[0006] Accordingly, there is a need to develop a means for promoting directional flow of crankcase gases for improved drain back and breathing and generating directional flow while simultaneously reducing the pulsating (i.e., oscillating or unsteady) flow, as well as the crankcase pressure resonance.

SUMMARY

[0007] This section provides a general summary of the disclosure, and is not a comprehensive disclosure of all of its features.

[0008] An internal combustion engine having a crankcase drain back system is disclosed. The system includes a set of drain lines defined by passageways providing fluid communication between the cylinder head and the crankcase of an engine block, and a set of breather lines defined by passageways extending between an upper region of a cylinder block and the cylinder head. A flow diode is disposed in the drain lines and oriented to provide a preferential flow in one direction from the cylinder head to the crankcase. Another flow diode is disposed in the breather lines and oriented to direct fluid flow in a direction from the cylinder block to the cylinder portion. These flow diodes use fluid flow created by the unsteady pressure pulsations in the crankcase bays to pump flow in a preferential direction. In other words, directional flow of crankcase gases and oil in the oil drain passageway is generated in a direction from the top of the engine block back down to the crankcase.

[0009] As a result, the crankcase drain back system improves oil drain back and overall lubrication and ventilation of the engine. In addition, the crankcase drain back system reduces pressure pulsations within the interior volumes defined by the crank bays and cylinder heads, thereby reducing the excitation of resonant modes of the engine. Added benefits further include better draining of lubricant to the oil pan, reduced oil aeration, reduced oil-to-air mass fraction (oil mist), reduced oil pullover through the positive crankcase ventilation (PCV) valve, reduced oil migration up oil-drain passageways under high g-force handling maneuvers, and increased power output from the engine. The crankcase drain back system may be formed within existing structure and passageways of an engine block and without the use of any moving parts. Alternately, the crankcase drain back system may be formed as a separate, formed component which is inserted within an existing passageway or adapted as an external passageway or piping.

[0010] Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this section are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

[0011] The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

[0012] FIG. 1 is a schematic illustration of an engine block assembly with flow diodes disposed in the drain and breather passageways;

[0013] FIG. 2 is a cross-section showing a portion of a passageway having a series of stacked diode elements according to a first embodiment;

[0014] FIG. 3 is a cross-section showing a portion of a passageway having a series of stacked diode elements according to a second embodiment;

[0015] FIG. 4 is a cross-section showing a portion of a passageway having a series of stacked diode elements according to a third embodiment;

[0016] FIG. 5 is a cross-section showing a portion of a passageway having a series of stacked diode elements according to a fourth embodiment;

[0017] FIG. 6 is a plot showing the mass flow as a function of pressure drop across an exemplar flow diode;

[0018] FIG. 7 is a plot showing the average mass flow through the drain passageways as a function of engine speed;
Fig. 8 is a plot showing the maximum, mean and minimum velocity through the breather passageways as a function of engine speed;

Fig. 9 is a plot showing the maximum, mean and minimum velocity through the drain passageways as a function of engine speed; and

Fig. 10A-10D are plots showing the pressure amplitude as a function of engine speed with and without flow diodes at Boys 1-4 respectively.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Example embodiments will now be described more fully with reference to the accompanying drawings.

Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope of this disclosure to those who are skilled in the art. Specific details may be set forth to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known structures, and well-known technologies are not described in detail.

The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms “a,” “an,” and “the” may include the plural forms as well, unless the context clearly indicates otherwise. The terms “comprises,” “comprising,” “including,” and “having,” are inclusive and therefore specify the presence of recited structure(s) or step(s); for example, the stated features, integers, steps, operations, groups elements, and/or components, but do not preclude the presence or addition of additional structure(s) or step(s) thereof. The methods, steps, processes, and operations described herein are not to be construed as necessarily requiring performance in the stated or any particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional, alternative or equivalent steps may be employed.

When structure is referred to as being “on,” “engaged to,” “connected to,” or “coupled to” other structure, it may be directly or indirectly (i.e., via intervening structure) on, engaged, connected or coupled to the other structure. In contrast, when structure is referred to as being “directly on,” “directly engaged to,” “directly connected to,” or “directly coupled to” the other structure, there may be no intervening structure present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., “between” versus “directly between,” “adjacent” versus “directly adjacent”). As used herein, the term “and/or” includes any and all combinations of one or more of the associated referenced items.

Terms of degree (e.g., first, second, third) which are used herein to describe various structure or steps are not intended to be limiting. These terms are used to distinguish one structure or step from other structure or steps, and do not imply a sequence or order unless clearly indicated by the context of their usage. Thus, a first structure or step similarly may be termed a second structure or step without departing from the teachings of the example embodiments. Likewise, spatially relative terms (e.g., “inner, “outer,” “beneath,” “below,” “lower,” “above,” “upper”) which are used herein to describe the relative special relationship of one structure or step to other structure or step(s) may encompass orientations of the device or its operation that are different than depicted in the figures. For example, if a figure is turned over, structure described as “below” or “beneath” other structure would then be oriented “above” the other structure without materially affecting its special relationship or operation. The structure may be otherwise oriented (e.g. rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

Referring now to Fig. 1 an engine block assembly 10 is schematically illustrated and includes cylinder block 12, an oil pan 14 secured on the bottom of the cylinder block 12 and a set of cylinder heads 16 secured on the top of the cylinder block 12 over a set of cylinder bores 18 formed therein which collectively are referred to as an engine block. A cover 20 is secured over each cylinder head 16 and forms an enclosed volume 22 hereinafter referred to as the valve case that houses a portion of the valve train including the rockers (not shown). The cylinder block 12 and oil pan 14 form an enclosed volume 24 hereinafter referred to as the crankcase that houses the crankshaft (not shown). A set of breather lines 26 formed in the cylinder head 16 and the cylinder block 12 fluidly couple the valve case 22 with an upper portion of the crankcase 24 for ventilation thereof. Similarly, a set of drain lines 28 formed in the cylinder head 16 and the cylinder block 12 fluidly couple the top of the cylinder head 16 and the crankcase 24 for draining oil from the valve case 22 to the crankcase 24. The breather lines 26 and drain lines 28 illustrated in Fig. 1 are schematically represented as internal passageways formed within the structure of the engine block. However, one skilled in the art should appreciate that breather lines and drain lines may also be external passageways arranged on the exterior of the engine block which fluidly couple the enclosed volumes 22, 24 defined thereby.

Flow diodes 30 disposed in the breather lines 26 are oriented to promote flow in a direction from the crankcase 24 to the valve case 22. Flow diodes 32 disposed in the drain lines 28 are oriented to promote flow in a direction from the valve case 22 to the crankcase 24. As used herein, the term “flow diode” refers to an element formed or disposed within a passageway that has a highly directional flow characteristic resulting in a pressure loss across the element in one direction which is much greater than the pressure loss across the element in the opposite direction as represented in the plot 600 shown in Fig. 6. The characteristics of a given flow diode may be defined by a Q value. The Q value of a flow diode is defined as the ratio of fluid flow rate in one direction to the fluid flow rate in the opposite direction for a given pressure drop across the flow diode and a given fluid density. For purposes of the numeric ranges recited herein, the Q values are for a given pressure drop of 10 kPa and air at ambient conditions.

Each flow diode 30, 32 has a Q value greater than 1.1 and preferably in the range of 1.5 to 5.0, as dictated by the overall pressure drop which maximizes the flow rate effect and minimizes the pressure drop in the forward or preferred direction, particularly in the high pressure range. As presently preferred, flow diode 28 is a series of flow diode elements 30.1-30.6 and flow diode 32 is a series of flow diode elements 32.1-32.5. These flow diode elements are disposed in a stacked relationship within the respective passageways to achieve the preferred Q value. These flow diode elements may
be inserted into an engine block assembly having conventional breather and drain lines or may be integrally formed in the passageways. FIGS. 2-5 schematically illustrate various flow diode configurations suitable for use in the engine block assembly 10.

[0031] Referring now to FIG. 2, a flow diode 100 is illustrated as having a plurality of frusto-conical elements 102 to define tapered wall segments in the passageway 104. Arrow A2 illustrates the direction of preferred flow. Each frusto-conical element 102 has an inlet 106 and an outlet 108 and a length 110. The ratio of the cross-sectional area of inlet 106 to the cross-sectional area of outlet 108, is greater than 1:1 and as presently preferred is greater than or equal to 1:5.1. As presently preferred, the length 110 of the flow diode element is greater than the effective diameter of the inlet 106, wherein the effective diameter is the calculated as follows:

\[
d_{\text{eff}} = \frac{4A}{p}
\]

where

- \( d_{\text{eff}} \) = the effective diameter;
- \( A \) = cross-sectional area at the inlet; and
- \( p \) = perimeter at the inlet.

[0036] An exemplary flow diode satisfying these criteria would include 7 flow diode elements, each having an inlet diameter of 24 mm, an outlet diameter of 16 mm and a length of 27.5 mm. Another exemplary flow diode satisfying these criteria would include 7 flow diode elements, each having an inlet diameter of 20 mm, and outlet diameter of 13 mm and a length of at least 20 mm. While the inlet and outlet may be readily determined for simple flow diode geometries such as that illustrated in FIG. 2, this may be more difficult for more complex geometries. Therefore, the term “inlet” is used to refer to the region of the flow diode having a maximum cross sectional area, and the term “outlet” is generally used to refer to a region of the flow diode having a minimum cross sectional area. The term “cross sectional area” refers to an area of the passageway which is perpendicular to the longitudinal axis of the passageway or in other words, the direction flow direction.

[0037] Referring now to FIG. 3, a flow diode 200 is illustrated as having a plurality of cantilevered elements or fins 202 to define tapered wall segments extending into the passageway 204. Arrow A3 illustrates the direction of preferred flow. An inlet 206 is defined at the root 208 of the cantilevered element 202, an outlet 210 is define at the tip 212 of the cantilevered element 202 and a length 214 is defined by the distance from the root 208 to the tip 212. The ratio of the cross-sectional area of inlet 206 to the cross-sectional area of outlet 210, is greater than 1:1 and as presently preferred is greater than or equal to 1:5.1. As presently preferred, the length 214 of the cantilevered element 102 is greater than the effective diameter of the inlet 106.

[0038] Referring now to FIG. 4, a flow diode 300 is illustrated as having a plurality of heart-shaped elements 302 to define tapered wall segments in the passageway 304. Arrow A4 illustrates the direction of preferred flow. Each heart-shaped element 302 includes a central channel 306 designated with dotted lines and a pair of eddy channels 308 laterally disposed of the central channel 306. Each eddy channel 308 has an annular region 310 at the inlet 312 and a funnel region 314 extending from the annular region 310 to the outlet 316. Each heart-shaped element 302 functions to create eddies and back flow in the passageway 304 when flow is opposite the direction of preferred flow.

[0039] Referring now to FIG. 5, a flow diode 400 (also known as a Tesla valvular conduit, see U.S. Pat. No. 1,329,559 the disclosure of which is expressly incorporated by reference herein) is illustrated as having a plurality of diode segments 402 arranged on alternate sides of the passageway 404. Arrow A5 illustrates the direction of preferred flow. Each diode segment 402 includes a channel 406 with a partition 408 formed in the channel 406 and inwardly angled in the direction of preferred flow. The each diode segment 402 functions to disturbed flow through the passageway 404 when it is opposite the direction of preferred flow.

[0040] FIGS. 7-10D illustrate various engine parameters as a function of engine speed for comparing the performance of the improved drain back system with a conventional system using a computer-based simulation of a V8 engine. FIG. 7 shows a plot 700 of the average mass flow rate (g/s) as a function of engine speed (rpm) with a positive mass flow rate indicating the direction of preferred flow toward the crankcase. The solid lines 702.1-702.4 represent the mass flow rate through the drain lines 28 in crank bays #1-#4 for a conventional system (breather lines and drain lines with a Q value of 1.0). The dashed lines 704.1-704.4 represent the mass flow rate through the drain lines 28 in crank bays #1-#4 for a first embodiment of the improved system (breather lines and drain lines including flow diodes with element having an inlet diameter of 24 mm, an outlet diameter of 16 mm and a Q value of 1.7).

[0041] It will be noted that the average mass flow rate through most of the operating range (<8000 rpm) of the conventional system (curves 702.1-702.4) is negative, or in other words against the oil draining direction. In contrast, the average mass flow rate through the same operating range for the embodiment of the improved system (curves 704.1-704.4) are positive or in the oil draining direction.

[0042] FIG. 8 shows a plot 800 of the flow velocity (m/s) through the breather line 26 as a function of engine speed with a positive velocity indicating the direction of preferred flow from the crankcase to the valve case. Curves 802.\text{p}, 802.\text{s} and 802.\text{f} (solid) represent the maximum, minimum and mean flow velocity through a conventional breather line. Curves 804.\text{p}, 804.\text{s}, 804.\text{f} (long dashed) represents the maximum, minimum and mean flow velocity through a breather line 26 including flow diodes with a Q value of 1.7. Curves 806.\text{p}, 806.\text{s}, 806.\text{f} (short dashed) represents the maximum, minimum and mean flow velocity through a breather line 26 including flow diodes with a Q value of 2.3.

[0043] FIG. 9 shows a plot 900 of the flow velocity (m/s) through the drain line 28 as a function of engine speed (rpm) with a positive velocity indicating the direction of preferred flow from the valve case to the crankcase. Curves 902.\text{p}, 902.\text{s} and 902.\text{f} (solid) represent the maximum, minimum and mean flow velocity through a conventional drain line. Curves 904.\text{p}, 904.\text{s}, 904.\text{f} (long dashed) represents the maximum, minimum and mean flow velocity through a drain line 28 including flow diodes with a Q value of 1.7. Curves 906.\text{p}, 906.\text{s}, 906.\text{f} (short dashed) represents the maximum, minimum and mean flow velocity through a drain line 28 including flow diodes with a Q value of 2.3.

[0044] It should be noted that the mean velocity curve 802.\text{f}, 902.\text{f} for the conventional system is less than or equal to zero indicating an average flow in opposition to the oil
draining direction. Furthermore, the maximum and minimum velocity curves $802_x$, $802_y$, $902_x$, $902_y$ in the drain and breather lines of the conventional system show velocities of up to ±55 m/s around 6000 rpm indicating a back-and-forth flow pattern which hampers proper oil draining and crankcase ventilation. By comparison, the mean velocity curves $804_x$, $806_x$, $904_x$, $906_x$ for the system with flow diodes is positive indicating an average flow in the oil draining direction. In addition, the maximum and minimum velocity curves $804_x$, $806_x$, $904_x$, $906_x$, in the drain and breather lines of the system with flow diodes show up to about 66% reduction in the velocities indicating a more stable flow pattern.

[0045] Fig. 10A-10D show plots 1000, 1010, 1020, 1030 of the pressure amplitude (kPa) in the crankcase as a function of engine speed (rpm). The solid lines 1002, 1012, 1022, 1032 represent the pressure amplitude in crankcase bays #1-#4 respectively in a conventional system. The short dashed lines 1004, 1014, 1024, 1034 represent the pressure amplitude in crank bays #1-#4 respectively in a drain back system having flow diodes 30, 32 including flow diodes with a Q value of 2.3 in the breather and drain lines 26, 28. From these plots, it should be noted that the pressure resonance amplitudes observed in the peak power range (between 5000-7000 rpm) in the conventional system are drastically reduced by creating a direction of preferred flow with flow diodes 30, 32. Attenuating the crankcase resonances reduces power loss resonance in the peak power range. Additional power loss reduction is expected with a decrease in oil-to-air mass fraction associated with a drop in oil misting. Increasing the Q value of the flow diodes results in a larger decrease in the pressure amplitude at resonance. It is also important to note that the presence of the flow diodes has a minimal effect on the pressure amplitudes in the fuel economy (less than 3000 rpm) and mid-power (3000-5000 rpm) ranges.

[0046] While specific flow diodes are illustrated and described herein, one skilled in the art should appreciate that other flow diodes may be used in a crankcase drain back system without departing from the spirit and scope of the disclosure and claims set forth herein. To wit, the crankcase drain back system may be tuned by modifying the Q values for flow diodes in the breather and drain lines associated with different crank bays depending on the mass flow and velocity profiles associated with the location of the drain and breather lines. Alternately, flow diodes could be used in less than all of the breather and drain lines. Likewise, the flow diodes illustrated and described herein are a plurality of identical flow diode elements within a passageway. The present disclosure should be understood to encompass other flow diode configuration in which the flow diode elements arranged in a passageway are not identical in their geometry and/or Q values. In summary, the improved system uses flow diode to direct air flow in a preferred direction using the pressure pulsations in the crankcase to create pumping action with no moving parts. The improved system has the additional benefit of reducing pressure amplitude resonances in the crankcase resulting in some gain at peak power.

[0047] The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

What is claimed is:

1. An oil drain back system for an internal combustion engine comprising:
a drain line extending between an upper region and a lower region of an engine, the drain line having a preferred direction of drain flow from the upper region to the lower region;
a breather line extending between the lower region and the upper region, the breather line having a preferred direction of breather flow from the lower region to the upper region; and
a preferential flow passageway associated with at least one of the drain line and the breather line, the preferential flow passageway having a flow diode disposed therein and oriented to direct fluid flow in the preferred direction of the at least one of the drain line and the breather line; wherein a pressure differential across the flow diode for flow in preferred direction is less than the pressure differential across the flow diode for flow in a direction opposite the preferred direction.

2. The crankcase drain back system of claim 1 wherein the flow diode comprises a plurality of diode elements stacked in the preferential flow passageway such that a Q value for the flow diode is greater than the Q value for any of the plurality of diode elements.

3. The crankcase drain back system of claim 1 wherein the flow diode has a Q value greater than or equal to 1.1.

4. The crankcase ventilation system of claim 1 wherein the flow diode comprises an inlet having an inlet cross-sectional area and an outlet having an outlet cross-sectional area which is less than the inlet cross-sectional area.

5. The crankcase drain back system of claim 4 wherein the flow diode comprises a tapered wall extending from the inlet to the outlet.

6. The crankcase drain back system of claim 4 wherein the tapered wall comprises a fin extending from a sidewall of the preferential flow passageway toward a centerline thereof.

7. The crankcase drain back system of claim 4 wherein the tapered wall comprises a frusto-conical surface formed in a sidewall of the preferential flow passageway.

8. The crankcase ventilation system of claim 1 further comprising:
a first preferential flow passageway associated with the drain line and having a first flow diode disposed therein and oriented to direct fluid flow in the preferred direction of drain flow; and
a second preferential flow passageway associated with the breather line and having a second flow diode disposed therein and oriented to direct fluid flow in the preferred direction of breather flow.

9. The crankcase drain back system of claim 8 wherein each of the first flow diode and the second flow diode have a Q value greater than or equal to 1.1.

10. The crankcase drain back system of claim 8 further comprising:
a first plurality of diode elements stacked in the first preferential flow passageway such that a Q value for the first flow diode is greater than the Q value for any of the first plurality of diode elements; and
a second plurality of diode elements stacked in the second preferential flow passageway such that a Q value for the second flow diode is greater than the Q value for any of the second plurality of diode elements.

11. An internal combustion engine in combination with a crankcase drain back system comprising:

an engine block including a crankcase, a cylinder portion, and a head portion, the engine block having a drain line extending between the head portion and the crankcase and a breather line extending between an upper region of the cylinder portion and the head portion;

first flow directing means for directing fluid flow in a first preferred direction from the head portion to the crankcase, the first flow directing means being formed in a first preferential flow passageway associated with the drain line; and

second flow directing means for directing fluid flow in a second preferred direction from the cylinder portion to the head portion, the second flow directing means being formed in a second preferential flow passageway associated with the breather line.

12. The combination of claim 11 further comprising:

a plurality of first diode elements stacked in the first preferential flow passageway in the first preferred direction to define the first flow directing means; and

a plurality of second diode elements stacked in the second preferential flow passageway in the second preferred direction to define the second flow directing means.

13. An internal combustion engine having a crankcase drain back system comprising:

an engine block including a crankcase, a cylinder portion, and a head portion;

a plurality of drain lines, each drain line extending between the head portion and the crankcase and having a preferred direction of drain flow from the head portion to the crankcase;

a plurality of breather lines, each breather line extending between an upper region of the cylinder portion and the head portion and having a preferred direction of breather flow from the head portion to the crankcase; and

a preferential flow passageway associated with at least one drain line and/or breather line, the preferential flow passageway having a flow diode disposed therein and oriented to direct fluid flow in the preferred direction thereof;

wherein a pressure differential across the flow diode for flow in preferred direction is less than the pressure differential across the flow diode for flow in a direction opposite the preferred direction.

14. The internal combustion engine of claim 13 wherein the flow diode comprises a plurality of diode elements stacked in the drain line in the preferred direction of drain flow and forming a drain flow diode.

15. The internal combustion engine of claim 13 wherein the flow diodes comprises a plurality of diode elements stacked in the breather line in the preferred direction of breather flow and forming a breather flow diode.

16. The internal combustion engine of claim 13 wherein the preferential flow passageway comprises:

a first preferential flow passageway associated with the drain line and having a drain flow diode disposed therein and oriented to direct fluid flow in the preferred direction of drain flow; and

a second preferential flow passageway associated with the breather line and having a breather flow diode disposed therein and oriented to direct fluid flow in the preferred direction of breather flow.

17. The internal combustion engine of claim 16 wherein the drain flow diode has a Q value greater than or equal to 1.1.

18. The internal combustion engine of claim 17 wherein the breather flow diode has a Q value greater than or equal to 1.1.

19. The internal combustion engine of claim 16 wherein the breather flow diode has a Q value greater than or equal to 1.1.

20. The internal combustion engine of claim 17 further comprising:

a plurality of diode elements stacked in the drain line in the preferred direction of drain flow and forming the first flow diode; and

a plurality of diode elements stacked in the breather line in the preferred direction of breather flow and forming the second flow diode.