Breather structure of motorcycle engine

[Object] To prevent an oil from flowing into a breather outlet (102) in a motorcycle engine (E) even when a vehicle body is considerably leaned with the engine in operation, the motorcycle engine (E) including: an engine body (20) supported by a vehicle-body frame (F) such that an axis (C) of a cylinder bore (26) is arranged in parallel to a vertical plane (VP) in a vehicle-longitudinal direction; a power-transmission-member chamber (61) for moving an endless power transmission member (60) of a timing transmission device (57) provided between a crankshaft (25) and a camshaft (52) constituting a part of a valve system (51), the power-transmission-member chamber (61) formed in the engine body (20) at one side in a lateral direction of a vertical plane (VP) including the axis (C) of the cylinder bore (26); and a breather outlet (102) provided in a cylinder head (23) or a head cover (24), the breather outlet (102) configured to exhaust a blow-by gas introduced into a valve chamber (50) from a crank chamber (27) to the outside of the engine body (20).

[Solving Means] The breather passage (85) connecting the valve chamber (50) and the crank chamber (27) is formed in the engine body in such a manner as to be arranged on an opposite side of the vertical plane VP including the axis (C) of the cylinder bore (26) to the power-transmission-member chamber (61).
Description

[Technical Field]

[0001] The present invention relates to a motorcycle engine including: an engine body including at least a crankcase rotatably supporting a crankshaft, a cylinder body coupled to the crankcase and having a cylinder bore in which a piston connected to the crankshaft is slidably fitted, and a cylinder head coupled to the cylinder body, the engine body supported by a vehicle-body frame such that an axis of the cylinder bore is arranged in parallel to a vertical plane in a vehicle-longitudinal direction; a valve system for opening and closing an intake valve and an exhaust valve, the valve system housed in a valve chamber formed in the cylinder head or between the cylinder head and a head cover coupled to the cylinder head; a power-transmission-member chamber formed in the engine body at one side in a lateral direction of a vertical plane including the axis of the cylinder bore; and a breather outlet provided in any one of the cylinder head and the head cover, the breather outlet configured to exhaust a blow-by gas to the outside of the engine body is provided in the cylinder head or a head cover, there is a passage for supplying an oil from a valve chamber formed in the engine body in such a manner as to be positioned at the left side of the cylinder bore; and an oil return passage for returning an oil from a valve chamber to a crankcase, the oil return passage provided below a middle portion, in a lateral direction, of the engine body. Particularly, the present invention relates to an improvement in a breather structure.

[Background Art]

[0002] From Patent Document 1 and the like, there has been already known a motorcycle engine including: an engine body supported by a vehicle-body frame in such a posture that an axis of a cylinder bore parallel to a vertical plane along a center line of a vehicle body in a vehicle-longitudinal direction inclines forward to be set almost horizontally; a cam chain chamber for moving a cam chain constituting a part of the valve system, the power-transmission-member chamber formed in the engine body at one side in a lateral direction of a vertical plane including the axis of the cylinder bore; and a breather outlet provided in any one of the cylinder head and the head cover, the breather outlet configured to exhaust a blow-by gas introduced into the valve chamber from a crank chamber in the crankcase to an outside of the engine body. In this event, if a breather outlet for exhausting a blow-by gas to the outside of the engine body is provided in the cylinder head or a head cover, there is a possibility that the oil flows into the breather outlet by an increase in internal pressure of the crank chamber.

[0003] Moreover, Fig. 5 of Patent Document 1 discloses a structure in which a passage for supplying an oil toward a camshaft from an oil pump is formed using one of through bolts for coupling a crankcase, a cylinder block, and a cylinder head together and an insertion hole provided in the cylinder block and the cylinder head so that the through bolt can be inserted through the insertion hole. In the structure, the passage is always filled with an oil during the operation of the engine. The communications of the other insertion holes with the inside of the crankcase are blocked by gaskets, and thus an oil inside the crankcase is prevented from oozing toward the cylinder head through the insertion holes.

[Prior Art Document]

[Patent Document]


[Summary of the Invention]

[Problems to be Solved by the Invention]

[0005] Meanwhile, the vehicle body of a motorcycle is considerably leaned rightward or leftward in some occasions. In a motorcycle engine in which a cam chain passage is arranged at the left side of the cylinder bore, the cam chain chamber may be filled with an oil when the vehicle body is leaned leftward. Even when the oil return passage is provided below the middle portion, in the lateral direction, of the engine body as disclosed in Patent Document 1, the oil return passage may also be filled with an oil. In this event, if a breather outlet for exhausting a blow-by gas to the outside of the engine body is provided in the cylinder head or a head cover, there is a possibility that the oil flows into the breather outlet by an increase in internal pressure of the crank chamber.

[0006] The present invention has been made in view of such circumstances. An object of the present invention is to provide a breather structure of a motorcycle engine, which is capable of preventing an oil from flowing into a breather outlet even when a vehicle body is considerably leaned with the engine in operation.

[Means for Solving the Problems]

[0007] For the purpose of achieving the above-mentioned object, a first aspect of the present invention provides a breather structure of a motorcycle engine including:

an engine body including at least a crankcase rotatably supporting a crankshaft, a cylinder body coupled to the crankcase (21) and having a cylinder bore in which a piston connected to the crankshaft is slidably fitted, and a cylinder head coupled to the cylinder body, the engine body supported by a vehicle-body frame such that an axis of the cylinder bore is arranged in parallel to a vertical plane in a vehicle-longitudinal direction; a valve system for opening and closing an intake valve and an exhaust valve, the valve system housed in a valve chamber formed in the cylinder head or between the cylinder head and a head cover coupled to the cylinder head; a power-transmission-member chamber for moving
an endless power transmission member of a timing transmission device provided between the crankshaft and a camshaft constituting a part of the valve system, the power-transmission-member chamber formed in the engine body at one side in a lateral direction of a vertical plane including the axis of the cylinder bore; and a breather outlet provided in any one of the cylinder head and the head cover, the breather outlet configured to exhaust a blow-by gas introduced into the valve chamber from a crank chamber in the crankcase to an outside of the engine body,

wherein a breather passage connecting the valve chamber and the crank chamber is formed in the engine body in such a manner as to be arranged on an opposite side of the vertical plane including the axis of the cylinder bore to the power-transmission-member chamber.

A third aspect of the present invention is that, in addition to the configuration of the second aspect, in the cylinder body and the cylinder head, a plurality of bolt holes are provided coaxially with a plurality of bolts which are to be inserted therethrough to couple the cylinder body and the cylinder head to the crankcase, and the breather passage is formed between an inner periphery of one specific bolt hole among the bolt holes and an outer periphery of a bolt inserted through the specific bolt hole among the plurality of bolts.

A fourth aspect of the present invention is that, in addition to the configuration of any one of the second and third aspects, the engine body is supported by the vehicle-body frame such that the axis of the cylinder bore inclines forward to be set almost horizontally, the breather outlet is provided in any one of the cylinder head and the head cover of the engine body at a position higher than the axis of the cylinder bore, and the breather passage is arranged lower than the axis of the cylinder bore.

A fifth aspect of the present invention is that, in addition to the configuration of the fourth aspect, the bolt hole arranged lower than the cylinder bore is selected as the specific bolt hole among the plurality of bolt holes arranged to surround the cylinder bore.

A sixth aspect of the present invention is that, in addition to the configuration of the fifth aspect, the valve chamber has a quadrangular cross section with four corners apart from one another vertically and horizontally, and the breather passage formed in the specific bolt hole is communicatively connected to an inside of the valve chamber at a corner at a lower position on an opposite side to the power-transmission-member chamber among the corners.

A seventh aspect of the present invention is that, in addition to the configuration of any one of the second to sixth aspects, a groove connecting an opening end, on a crankcase side, of the specific bolt hole and a cylindrical piston guide wall integrally provided in the cylinder body in such a manner as to protrude into the crankcase is formed in a coupling surface of the cylinder body to the crankcase in such a manner that the breather passage is communicatively connected to the crank chamber.

Note that a cam chain 60 in an embodiment corresponds to the power transmission member of the present invention, a cam chain chamber 61 in the embodiment corresponds to the power-transmission-member chamber of the present invention, and a first bolt hole 81 in the embodiment corresponds to the specific bolt hole of the present invention.

[Effects of the Invention]

According to the first aspect of the present invention, the breather outlet for exhausting a blow-by gas to the outside of the engine body is provided in the cylinder head or the head cover. The power-transmission-member chamber for moving the endless power transmission member of the timing transmission device provided between the crankshaft and the camshaft constituting a part of the valve system housed in the valve chamber is formed in the engine body at one side in the lateral direction of the vertical plane including the axis of the cylinder bore; meanwhile, the breather passage connecting the valve chamber and the crank chamber is formed in the engine body in such a manner as to be arranged on the opposite side of the vertical plane including the axis of the cylinder bore to the power-transmission-member chamber. Accordingly, even when the vehicle body is considerably leaned either rightward or leftward with the engine in operation, any one of the power-transmission-member chamber and the breather passage is prevented from being immersed in an oil, allowing a blow-by gas to flow, and the internal pressure of the crank chamber does not increase. Hence, it is possible to prevent an oil from flowing into the breather outlet, and the usability of the motorcycle can be improved.

Moreover, according to the second aspect of the present invention, in the cylinder body and the cylinder head, the multiple bolt holes are provided coaxially with the multiple bolts which are to be inserted therethrough. The breather passage is formed between the inner periphery of one among the bolt holes and the outer periphery of the bolt inserted through the bolt hole. Ac-
cordingly, the breather passage can be formed in the engine body without an increase in the number of parts and complex structure.

[0017] According to the third aspect of the present invention, the generator chamber fluid-tightly partitioned from the power-transmission-member chamber is formed in the engine body in such a manner as to be arranged on the same side of the vertical plane including the axis of the cylinder bore as the power-transmission-member chamber. Accordingly, even in a state where the power-transmission-member chamber is filled with an oil when the vehicle body is leaned, the oil never flows into the generator chamber. This can prevent an increase in friction due to the oil which is otherwise stirred by the rotor of the generator.

[0018] According to the fourth aspect of the present invention, the engine body is supported by the vehicle-body frame such that the axis of the cylinder bore inclines forward to be set almost horizontally. The breather outlet is provided in the cylinder head or the head cover of the engine body at a position higher than the axis of the cylinder bore. The breather passage is arranged lower than the axis of the cylinder bore. Accordingly, it is possible to avoid filling of the breather passage with an oil when the vehicle body is considerably leaned rightward or leftward at greater than 90 degrees and to suppress an increase in pressure of the valve chamber.

[0019] According to the fifth aspect of the present invention, among the multiple bolt holes surrounding the cylinder bore, the bolt hole arranged lower than the axis of the cylinder bore is used to form the breather passage. Accordingly, when the vehicle body is considerably leaned at a level lower than the horizontal level, the height of the oil surface in the valve chamber can be retained. It is possible to create extra time for raising the vehicle body.

[0020] According to the sixth aspect of the present invention, the valve chamber has the quadrangular cross section with four corners apart from one another vertically and horizontally. The breather passage is communicatively connected to the inside of the valve chamber at the corner at the lower position on the opposite side to the power-transmission-member chamber among the four corners. Accordingly, the breather passage is communicatively connected to the valve chamber at a position where an oil is splashed less in the valve chamber. In addition, the breather passage is communicatively connected to an upper portion of the valve chamber when the vehicle body is leaned toward the power-transmission-member chamber. Thereby, the breather passage is prevented from being clogged by an oil, and the breather performance can be improved.

[0021] Furthermore, according to the seventh aspect of the present invention, the groove connecting the opening end, on the crankcase side, of the specific bolt hole and the cylindrical piston guide wall integrally provided in the cylinder body is formed in the coupling surface of the cylinder body to the crankcase. The breather passage is communicatively connected to the crank chamber through the groove. Accordingly, the breather performance can be further improved by communicatively connecting the breather passage to the crank chamber at a position where there is less influence from an oil splashed from the crankshaft in the crank chamber.

[Brief Description of the Drawings]

[0022] Fig. 1 is a right-side view of a motorcycle. Fig. 2 is a longitudinal cross-sectional view of a main part of an engine body seen in the same direction in Fig. 1.

[0023] An embodiment of the present invention will be described with reference to Figs. 1 to 7. Note that, in the following description, directions of front/rear, up/down, and left/right are directions seen from a driver who sits on a motorcycle.

[0024] First, in Fig. 1, a vehicle-body frame F of a scooter-type vehicle that is a motorcycle includes: a head pipe 12 steerable supporting a front fork 11 pivotally supporting a front wheel WF; a front frame 13 declining frontward from the head pipe 12 and extending to support a step floor 15; and a rear frame 14 extending upward to support the rear from a rear part of the front frame 13 to support a rider seat 16. From the vehicle-body frame F, a power unit P pivotally supporting a rear wheel WR and driving the rear wheel WR is suspended via a suspension link 17 so that the power unit P can vibrate up and down. Between the rear frame 14 and the power unit P, a rear cushion 18 is provided to buffer the up and down vibration of the power unit P.

[0025] The power unit P includes an engine E and a continuously variable transmission M housed in a transmission case 19 which is installed next to an engine body 20 of the engine E, and which extends to a right side of the rear wheel WR. The rear wheel WR is pivotally supported by a rear portion of the transmission case 19.
In Figs. 2 and 3, the engine body 20 includes at least a crankcase 21 rotatably supporting a crankshaft 25 having an axis along a vehicle-width direction, a cylinder body 22 having a cylinder bore 26 and coupled to the crankcase 21, and a cylinder head 23 coupled to the cylinder body 22. In this embodiment, the engine body 20 further includes a head cover 24 coupled to the cylinder head 23.

In the engine body 20, an axis C of the cylinder bore 26 is arranged in parallel to a vertical plane along a center line of a vehicle body in a vehicle-longitudinal direction. The engine body 20 is supported by the vehicle-body frame F via the suspension link 17 in such a posture that the axis C inclines forward to be set almost horizontally.

The crankcase 21 includes a left half case 21a and a right half case 21b which are coupled to each other and positioned respectively at a left side and a right side in a state where the engine body 20 is supported by the vehicle-body frame F. A crank chamber 27 communicatively connected to the cylinder bore 26 is formed in the crankcase 21. A ball bearing 28 and an annular seal member 29 are interposed between the left half case 21a and the crankshaft 25. A ball bearing 30 is interposed between the right half case 21b and the crankshaft 25 rotatably penetrating the right half case 21b.

A drive pulley 31 is provided at a left end portion of the crankshaft 25 protruding from the left half case 21a into the transmission case 19. The drive pulley 31 constitutes a part of the continuously variable transmission M. Moreover, a cylindrical case body 32 protruding outward is integrally provided on the crankshaft 25. A right end portion of the crankshaft 25 protrudes from the right half case 21b into the case body 32. A radiator 33 is attached to an outer end of the case body 32 as shown in Fig. 1.

A piston 36 is connected to the crankshaft 25 and is slidably fitted into the cylinder bore 26 of the cylinder body 22. A combustion chamber 37 is formed between the cylinder body 22 and the cylinder head 23 and opened to a top portion of the piston 36. Moreover, an intake port 38 that can be communicatively connected to the combustion chamber 37 is provided in an upper side surface of the cylinder head 23. An exhaust port 39 that can be communicatively connected to the combustion chamber 37 is provided in a lower side surface of the cylinder head 23.

An air cleaner 40 (see Fig. 1) is disposed above the power unit P. The air cleaner 40 is connected to the intake port 38 through a throttle body 41 and an intake pipe 42. A fuel injection valve 43 is attached to the intake pipe 42. Moreover, as shown in Fig. 1, an exhaust pipe 44 whose upstream end is connected to the exhaust port 39 extends downward from the cylinder head 23 and extends rearward below a front portion of the power unit P. A downstream end of the exhaust pipe 44 is connected to an exhaust muffler 45 disposed at a right side of the rear wheel WR.

Further, to the cylinder head 23, an intake valve 46 and an exhaust valve 47 are openably and closably disposed. The intake valve 46 controls an intake amount of gas flowing from the intake port 38 into the combustion chamber 37. The exhaust valve 47 controls an exhaust amount of gas flowing out from the combustion chamber 37 into the exhaust port 39. A spark plug 48 is also connected to the combustion chamber 37.

A valve system 51 is formed between the cylinder head 23 and the head cover 24. A valve system 51 includes a camshaft 52 having an axis parallel to the crankshaft 25 and rotatably supported by the cylinder head 23; an intake rocker arm 53 provided between the camshaft 52 and the intake valve 46; and an exhaust rocker arm 54 provided between the camshaft 52 and the exhaust valve 47. The intake rocker arm 53 and the exhaust rocker arm 54 are swingably supported respectively by an intake rocker shaft 55 and an exhaust rocker shaft 56, which have axes parallel to the camshaft 52, and which are supported by the cylinder head 23.

Referring to Fig. 4 together, a timing transmission device 57 transmits a rotational power from the crankshaft 25 to the camshaft 52 constituting a part of the valve system 51 at a gear reduction ratio of 1/2.

The timing transmission device 57 is formed by winding a cam chain 60 that is an endless power transmission member around a driving sprocket 58 fixed to the crankshaft 25 and a driven sprocket 59 fixed to the camshaft 52. A cam chain chamber 61 is formed in the right half case 21b of the crankcase 21, the cylinder body 22, and the cylinder head 23 in the engine body 20. So, the cam chain chamber 61 is arranged at one side in a lateral direction (right side in this embodiment) of a vertical plane VP including the axis C of the cylinder bore 26.

Additionally, the ball bearing 30 interposed between the right half case 21b and the crankshaft 25 allows a gas to flow. The cam chain chamber 61 is communicatively connected to the crank chamber 27.

A tensioner arm 63 is slidably in contact with a portion of the cam chain 60 which may be loosened as moving from the driving sprocket 58 toward the driven sprocket 59. The tensioner arm 63 has one end rotatably supported on the right half case 21b with a spindle 62. A tensioner 64 exerting a biasing force to push the tensioner arm 63 toward the cam chain 60 is attached to the cylinder body 22. Additionally, a chain guide 65 is slidably in contact with a portion of the cam chain 60 which moves from the driven sprocket 59 toward the driving sprocket 58. The chain guide 65 has one end rotatably supported on the right half case 21b and a middle portion supported by the cylinder body 22.

Referring to Fig. 3, a water pump 66 is attached to a right side wall of the cylinder head 23 in such a man-
ner as to face the camshaft 52. A pump shaft 67 of the water pump 66 is coaxially connected to the camshaft 52 but is unrotatable relatively thereto.

[0039] Meanwhile, a generator 70 is housed in the case body 32 integrally provided on the right half case 21b. The right end portion of the crankshaft 25 is connected to a rotor 71 of the generator 70 but is unrotatable relatively thereto.

[0040] The right half case 21b is integrally provided with a supporting flange 73 extending inwardly in a radial direction from a base portion of the case body 32. To form a generator chamber 74 for housing the generator 70 in the case body 32, an outer peripheral portion of a partition member 75 is fastened to the supporting flange 73. A stator 72 of the generator 70 is fixed to the partition member 75. Further, an annular seal member 76 is interposed between the outer peripheral portion of the partition member 75 and the supporting flange 73. An annular seal member 77 is interposed between the partition member 75 and the crankshaft 25, which rotatably penetrates a central portion of the partition member 75, and which protrudes into the generator chamber 74. More specifically, the generator chamber 74 fluid-tightly partitioned from the cam chain chamber 61 communicatively connected to the crank chamber 27 is formed in the engine body 20 in such a manner as to be arranged at one side in the lateral direction of the vertical plane VP including the axis C of the cylinder bore 26, that is, the same side as the cam chain chamber 61. The generator 70 connected to the crankshaft 25 is housed in the generator chamber 74.

[0041] Moreover, a cooling fan 78 positioned inward of the radiator 33 is coaxially attached to the rotor 71 of the generator 70. The cooling fan 78 rotates together with the rotor 71, and thereby cooling air is caused to flow through the radiator 33, promoting cooling of cooling water in the radiator 33.

[0042] Meanwhile, as shown in Fig. 4, the cylinder body 22 and the cylinder head 23 are coupled to the crankcase 21 using multiple, for example, four stud bolts 79, 79, ... and nuts 80, 80, ... The stud bolts 79, 79, ... are provided in the crankcase 21, and the nuts 80, 80, ... are screwed onto the stud bolts 79, 79, ... and brought into contact and engaged with the cylinder head 23.

[0043] In Figs. 5 and 6, four bolt holes, first to fourth bolt holes 81, 82, 83, 84 for inserting the stud bolts 79, 79, ... therethrough are arranged around the cylinder bore 26 provided in the cylinder body 22 and the cylinder head 23 in such a manner as to be coaxially connected to the stud bolts 79, 79, ... Further, the valve chamber 50 between the cylinder head 23 and the head cover 24 is formed to have a quadrangular cross section with four corners apart from one another vertically and horizontally. Meanwhile, the first to fourth bolt holes 81 to 84 are arranged respectively in corners of an imaginary right-angled quadrangle IS having four corners corresponding to the four corners of the valve chamber 50.

[0044] As shown in Fig. 7, an annular breather passage 85 is formed between an inner periphery of the first bolt hole 81 that is one specific bolt hole among the first to fourth bolt holes 81 to 84 and an outer periphery of the bolt 79 inserted through the first bolt hole 81. The breather passage 85 is arranged on an opposite side of the vertical plane VP including the axis C of the cylinder bore 26 to the cam chain chamber 61.

[0045] Moreover, the first bolt hole 81 is arranged at the corner lower than the axis of the cylinder bore 26 and on the opposite side to the cam chain chamber 61 among the four corners of the valve chamber 50 having the quadrangular cross section. In this embodiment, the first bolt hole 81 is arranged at the corner located lower than the cylinder bore 26.

[0046] Referring to Fig. 7, the crankcase 21 through which the stud bolt 79 inserted through the first bolt hole 81 is inserted is provided with a bolt hole 86. A cylindrical collar 67 is provided between ends of the first bolt hole 81 and the bolt hole 86 facing each other. In order to communicatively connect the breather passage 85 to the crank chamber 27 in the crankcase 21, a groove 88 is formed in a coupling surface 89 of the cylinder body 22 to the crankcase 21, the groove 88 connecting an opening end, on the crankcase 21 side, of the first bolt hole 81 and a cylindrical piston guide wall 22a integrally provided in the cylinder body 22 in such a manner as to protrude into the crankcase 21.

[0047] Referring to Fig. 8, a bearing surface 90 is formed on the cylinder head 23. The nut 80 screwed onto the stud bolt 79 inserted through the first bolt hole 81 is brought into contact and engaged with the bearing surface 90. A groove 91 communicatively connected to an end portion, on the valve chamber 50 side, of the first bolt hole 81 is provided in the bearing surface 90 and extends leftward from the first bolt hole 81. The breather passage 85 is communicatively connected to the valve chamber 50 at the corner at the lower position on the opposite side to the cam chain chamber 61 among the four corners of the valve chamber 50 having the quadrangular cross section.

[0048] Referring to Fig. 9 together, a plate-shaped separator 93 is fastened to an inner surface of the head cover 24 with, for example, four screw members 94, 94, ... The separator 93 and the head cover 24 form a breather chamber 92 therebetween.

[0049] A side wall rib 95 defining an outer periphery of the breather chamber 92 is integrally provided and protrudes from the inner surface of the head cover 24. The side wall rib 95 has such a shape that a lower portion of the breather chamber 92 is communicatively connected to the valve chamber 50. The separator 93 is formed to have an outer peripheral portion in contact with the side wall rib 95.

[0050] In addition, guide ribs 96, 97, 98, 99, 100 are integrally provided and protrude from the inner surface of the head cover 94 so that a blow-by gas introduced into the breather chamber 92 from a lower portion thereof can flow upward in a zigzag pattern.
A pipe member 101 is fixed to the head cover end of the timing transmission device. The cam chain chamber 61 for moving the vehicle body to the right and left sides.

Next, the operation of this embodiment will be described. The cam chain chamber 61 forms a breather outlet 102 where a blow-by gas introduced from the crank chamber 27 into the valve chamber 50 is exhausted to the outside of the engine body 20. An outer-side end of the pipe member 101, that is, the breather outlet 102 is provided in the head cover 24 at a position higher than the axis C of the cylinder bore 26. The blow-by gas is exhausted to the air cleaner 40 in the intake system of the engine E through a pipe member such as a hose connected to the outer-side end portion of the pipe member 101.

Moreover, recessed portions 97a, 100a are respectively provided around central portions, in a longitudinal direction, of the guide ribs 97, 100 extending to a large extent in the lateral direction among the guide ribs 96 to 100. Thereby, a passage is formed to allow a gas to flow between the recessed portions 97a, 100a and the separator 93. These recessed portions 97a, 100a are arranged at such positions as to be: not immersed in an oil when the vehicle body is considerably leaned rightward or leftward, causing the oil to flow from the cam chain chamber 61 into the valve chamber 50 in an area indicated by a shaded portion with lines drawn downward to the left in Fig. 9; and not to be immersed in an oil when the vehicle body is considerably leaned leftward at greater than 90 degrees, causing the oil to flow from the breather passage 85 into the valve chamber 50 in an area indicated by a shaded portion with lines drawn downward to the right in Fig. 9. Thus, even when the vehicle body is considerably leaned rightward or leftward at greater than 90 degrees, the recessed portions 97a, 100a play a role in avoiding an increase in pressure inside the breather chamber 92.

Further, the uppermost guide rib 96 among the guide ribs 96 to 100 is formed to protrude at a position higher than (in Fig. 9, at the left side of) an oil surface LR in a case where an oil flows into the valve chamber 50 in the area indicated by the shaded portion with the lines drawn downward to the left in Fig. 9 when the vehicle body is considerably leaned rightward at greater than 90 degrees. The second uppermost guide rib 97 among the guide ribs 96 to 100 is formed to protrude at a position higher than (in Fig. 9, at the right of) an oil surface LL in a case where an oil flows into the valve chamber 50 in the area indicated by the shaded portion with the lines drawn downward to the right in Fig. 9 when the vehicle body is leaned to the left as much as possible.

Positioning the recessed portions 97a, 100a and shaping the guide ribs 96, 97 in the above-described manner can prevent oil from flowing out due to the leaning of the vehicle body to the right and left sides.

Next, the operation of this embodiment will be described. The cam chain chamber 61 for moving the endless cam chain 60 of the timing transmission device is formed in the engine body 20 at one side in the lateral direction (right side in this embodiment) of the vertical plane VP including the axis C of the cylinder bore 26. The breather outlet 102 for exhausting a blow-by gas introduced to the valve chamber 50 from the crank chamber 27 in the crankcase 21 to the outside of the engine body 20 is provided in the head cover 24. The breather passage 85 connecting the valve chamber 50 and the crank chamber 27 is formed in the engine body 20 in such a manner as to be arranged on the opposite side (left side in this embodiment) of the vertical plane VP including the axis C of the cylinder bore 26 to the cam chain chamber 61. Accordingly, even when the vehicle body is considerably leaned either rightward or leftward, any one of the cam chain chamber 61 and the breather passage 85 is prevented from being immersed in an oil, allowing a blow-by gas to flow, and the internal pressure of the crank chamber 27 does not increase. Hence, it is possible to prevent an oil from flowing into the breather outlet 102, while cost reduction is achieved by eliminating the need for an inclination sensor for ceasing the operation of the engine by detecting whether the vehicle body is considerably leaned. Even when the vehicle body is considerably leaned, the engine E is continuously in operation, and the usability of the motorcycle can be improved.

Moreover, in the cylinder body 22 and the cylinder head 23, multiple (four in this embodiment) of the first to fourth bolt holes 81, 82, 83, 84 are provided coaxially with the multiple (four in this embodiment) bolts 79 ... which are to be inserted therethrough to couple the cylinder body 22 and the cylinder head 23 to the crankcase 21. The breather passage 85 is formed between the inner periphery of the first bolt hole 81 that is one specific bolt hole among these bolt holes and the outer periphery of the bolt 79 inserted through the first bolt hole 81. Accordingly, the breather passage 85 can be formed in the engine body 20 without an increase in the number of parts and complex structure.

Moreover, the generator chamber 74 fluid-tight partitioned from the cam chain chamber 61 communicatively connected to the crank chamber 27 is formed in the engine body 20 in such a manner as to be arranged on the same side of the vertical plane VP including the axis C of the cylinder bore 26 as the cam chain chamber 61. The generator 70 connected to the crankshaft 25 is housed in the generator chamber 74. Accordingly, even in a state where the cam chain chamber 61 is filled with an oil when the vehicle body is leaned, the oil never flows into the generator chamber 74. This can prevent an increase in friction due to the oil which is otherwise stirred by the rotor 71 of the generator 70.

Moreover, the engine body 20 is supported by the vehicle-body frame F such that the axis C of the cylinder bore 26 inclines forward to be set almost horizontally. The breather outlet 102 is provided in the head cover 24 of the engine body 20 at a position higher than the axis C of the cylinder bore 26. The breather passage 85...
is arranged lower than the axis C of the cylinder bore 26. Accordingly, it is possible to avoid filling of the breather passage 85 with an oil when the vehicle body is considerably leaned rightward or leftward at greater than 90 degrees and to suppress an increase in pressure of the valve chamber 50.

Moreover, among the first to fourth bolt holes 81 to 84 arranged to surround the cylinder bore 26, the first bolt hole 81 arranged lower than the cylinder bore 26 and the bolt 79 inserted through the first bolt hole 81 form the breather passage 85. Accordingly, when the vehicle body is considerably leaned at a level lower than the horizontal level, the height of the oil surface in the valve chamber 50 can be retained. Even in a case where it cannot be expected that an oil is returned from the valve chamber 50 to the crank chamber 27 with movement of the cam chain 60, the elevated oil surface in the valve chamber 50 has an advantage in returning the oil, making it possible to create time for raising the vehicle body.

Moreover, the valve chamber 50 has the quadrangular cross section with four corners apart from one another vertically and horizontally. The breather passage 85 is communicatively connected to the inside of the valve chamber 50 at the corner at the lower position on the opposite side to the cam chain chamber 61 among the corners. Accordingly, the breather passage 85 is communicatively connected to the valve chamber 50 at a position where an oil is splashed less in the valve chamber 50. In addition, the breather passage 85 is communicatively connected to an upper portion of the valve chamber 50 when the vehicle body is leaned toward the cam chain chamber 61. Thereby, the breather passage 85 is prevented from being clogged by an oil, and the breather performance can be improved.

Furthermore, the groove 88 connecting the opening end, on the crankcase 21 side, of the first bolt hole 81 and the cylindrical piston guide wall 22a integrally provided in the cylinder body 22 in such a manner as to protrude into the crankcase 21 is formed in a cylinder head. Accordingly, the breather performance can be further improved by communicatively connecting the breather passage 85 to the crank chamber 27 at a position where there is less influence from an oil splashed from the crankshaft 25 in the crank chamber 27.

Although the embodiment of the present invention has been described hereinabove, the present invention is not limited to this embodiment. Various design modifications can be made without departing from the present invention described in claims.

For example, in the above embodiment, the description has been given of the engine body 20 in which the valve chamber 50 is formed between the cylinder head 23 and the head cover 24. Nevertheless, the present invention is also applicable to a motorcycle engine having an engine body in which a valve chamber is formed in a cylinder head.
A breather structure of a motorcycle engine comprising:

an engine body (20) including at least a crankcase (21) rotatably supporting a crankshaft (25),
a cylinder body (22) coupled to the crankcase (21) and having a cylinder bore (26) in which a piston (36) connected to the crankshaft (25) is slidable fitted, and
da cylinder head (23) coupled to the cylinder body (22), the engine body (20) supported by a vehicle-body frame (F) such that an axis (C) of the cylinder bore (26) is arranged in parallel to a vertical plane in a vehicle-longitudinal direction;
a valve system (51) for opening and closing an intake valve (46) and an exhaust valve (47), the valve system (51) housed in a valve chamber (50) formed in the cylinder head (23) or between the cylinder head (23) and a head cover (24) coupled to the cylinder head (23);
a power-transmission-member chamber (61) for moving an endless power transmission member (60) of a timing transmission device (57) provided between the crankshaft (25) and a camshaft (52) constituting a part of the valve system (51), the power-transmission-member chamber (61) formed in the engine body (20) at one side in a lateral direction of a vertical plane (VP) including the axis (C) of the cylinder bore (26); and
the breather outlet (102) provided in any one of the cylinder head (23) and the head cover (24), the breather outlet (102) configured to exhaust a blow-by gas introduced into the valve chamber (50) from a crank chamber (27) in the crankcase (21) to an outside of the engine body (20), wherein a breather passage (85) connecting the valve chamber (50) and the crank chamber (27) is formed in the engine body (20) in such a manner as to be arranged on an opposite side of the vertical plane (VP) including the axis (C) of the cylinder bore (26) to the power-transmission-member chamber (61).

2. The breather structure of the motorcycle engine according to claim 1, wherein in the cylinder body (22) and the cylinder head (23), a plurality of bolt holes (81, 82, 83, 84) are provided coaxially with a plurality of bolts (79) which are to be inserted therethrough to couple the cylinder body (22) and the cylinder head (23) to the crankcase (21), and the breather passage (85) is formed between an inner periphery of one specific bolt hole (81) among the bolt holes (81, 82, 83, 84) and an outer periphery of a bolt (79) inserted through the specific bolt hole (81) among the plurality of bolts (79).

3. The breather structure of the motorcycle engine according to claim 1, wherein a generator chamber (74) fluid-tightly partitioned from the power-transmission-member chamber (61) communicatively connected to the crank chamber (27) is formed in the engine body (20) in such a manner as to be arranged on the same side of the vertical plane (VP) including the axis (C) of the cylinder bore (26) as the power-transmission-member chamber (61), and a generator (70) connected to the crankshaft (25) is housed in the generator chamber (74).

4. The breather structure of the motorcycle engine according to any one of claims 2 and 3, wherein the engine body (20) is supported by the vehicle-body frame (F) such that the axis (C) of the cylinder bore (26) inclines forward to be set almost horizontally,
the breather outlet (102) is provided in any one of the cylinder head (23) and the head cover (24) of the engine body (20) at a position higher than the axis (C) of the cylinder bore (26), and
the breather passage (85) is arranged lower than the axis (C) of the cylinder bore (26).

5. The breather structure of the motorcycle engine according to claim 4, wherein the bolt hole (81) arranged lower than the cylinder bore (26) is selected as the specific bolt hole among the plurality of bolt holes (81 to 84) arranged to surround the cylinder bore (26).

6. The breather structure of the motorcycle engine according to claim 5, wherein the valve chamber (50) has a quadrangular cross section with four corners apart from one another vertically and horizontally, and the breather passage (85) formed in the specific bolt hole (81) is communicatively connected to an inside
of the valve chamber (50) at a corner at a lower position on an opposite side to the power-transmission-member chamber (61) among the corners.

7. The breather structure of the motorcycle engine according to any one of claims 2 to 6, wherein a groove (88) connecting an opening end, on a crankcase (21) side, of the specific bolt hole (81) and a cylindrical piston guide wall (22a) integrally provided in the cylinder body (22) in such a manner as to protrude into the crankcase (21) is formed in a coupling surface (89) of the cylinder body (22) to the crankcase (21) in such a manner that the breather passage (85) is communicatively connected to the crank chamber (27).
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The Hague 16 August 2012
Aubry, Yann
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