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## (54) Breather device for an engine

(57) In an example, an engine 1 comprises: a cylinder head 7; a cylinder head cover 9 attached to an upper side of the cylinder head 7 to form a cam chamber 8 in conjunction with the cylinder head 7; a camshaft 14 disposed in the cam chamber 8 and supported on an upper side of the cylinder head 7 for rotation R about an axis 11 extending generally horizontally; a partition plate 40 attached to a lower side of the cylinder head cover 9 to form a breather chamber 39 in conjunction with the cylinder head cover 9; a communication passage 41 formed through the partition plate 40 for communicating the side of the cylinder head 7 and the breather chamber 39 to each other; and a gas passage 42 for communicating an intake passage 30 communicated to a cylinder 6 and the breather chamber 39 to each other. The communication passage 41 has a lower opening 49 on the side of the cylinder head 7 which opens in a direction along the axis of the camshaft 14.

Such an arrangement can allow blow-by gas existing between a cylinder head and a cylinder head cover to be sucked into an intake passage communicated to a cylinder and burned in the cylinder without mixing oil mist with the blow-by gas so that oil will not be uselessly consumed.

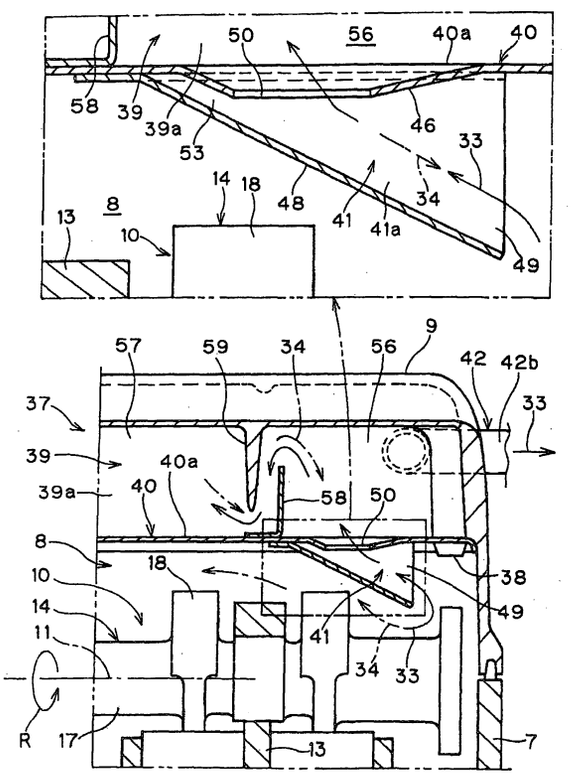


FIG. 1

EP 1 482 136 A1

## Description

**[0001]** The present invention relates to a breather device in an engine. In preferred examples, the device is for preventing oil mist being mixed with blow-by gas in a cam chamber between a cylinder head and a cylinder head cover when the blow-by gas having reached the cam chamber is sucked into an intake pipe communicating with a cylinder.

**[0002]** A breather device in an engine is disclosed in JP-A-2002-129929. According to the official gazette, the engine comprises a cylinder head, a cylinder head cover attached to an upper side of the cylinder head to form a cam chamber in conjunction with the cylinder head, a camshaft disposed in the cam chamber and supported on an upper side of the cylinder head for rotation about an axis extending generally horizontally, a partition plate attached to a lower side of the cylinder head cover to form a breather chamber in conjunction with the cylinder head cover, a communication passage formed through the partition plate for communication of the side of the cylinder head and the breather chamber to each other, and a gas passage for communication of an intake passage communicated to a cylinder and the breather chamber to each other. Lubricating oil is stored in the cam chamber.

**[0003]** While the engine is being driven, blow-by gas having reached from the cylinder side to the cylinder head side in the cam chamber is sucked through the communication passage, the breather chamber and the gas passage in sequence into the intake passage, and then sucked into the cylinder and burned therein.

**[0004]** In the above case, part of oil mist splashed up by the camshaft rotated by the operation of the engine tends to flow into the breather chamber. However, the oil mist collides with the lower side of the partition plate and is thereby prevented from flowing into the breather chamber. Thus, oil mist is prevented from being sucked into the cylinder together with blow-by gas and burned therein. Thereby, useless consumption of oil can be prevented.

**[0005]** In the above prior art, the cylinder head side opening of the communication passage opens in a tangential direction of the camshaft. Thus, part of oil mist splashed up by the rotating camshaft in its tangential direction may enter the communication passage through the opening and reach the breather chamber. Thus, the prior art is not necessarily sufficient to prevent oil mist from being mixed with blow-by gas.

**[0006]** It is thought to provide a baffle plate in the vicinity of the lower section of the opening of the communication passage to prevent oil mist from directly entering the opening. To do this, however, a space to additionally provide a baffle plate is needed in the cam chamber. This is not preferable because the engine may be increased in size for the baffle plate.

**[0007]** The present invention has been made in view of the above circumstances and it is, therefore, an object of examples of the present invention to allow blow-by gas existing between a cylinder head and a cylinder head cover to be sucked into an intake passage communicated to a cylinder and burned in the cylinder without mixing oil mist with the blow-by gas so that oil will not be uselessly consumed.

**[0008]** Another object of examples of the present invention is to accomplish the above abject without increasing the size of the engine.

**[0009]** The breather device in an engine of an aspect of the present invention, which has been made to seek accomplish the above objects, is constituted as follows. The reference numerals attached to the terms in this section should not be taken as limiting the technical scope of the present invention within the content of the described embodiments of the invention, or limiting in any other way.

**[0010]** According to an aspect of the invention there is provided a breather device in an engine, comprising: a cylinder head 7; a cylinder head cover 9 attached to an upper side of the cylinder head 7 to form a cam chamber 8 in conjunction with the cylinder head 7; camshafts 14 and 15 disposed in the cam chamber 8 and supported on an upper side of the cylinder head 7 for rotation R about axes 11 and 12, respectively, extending generally horizontally; a partition plate 40 attached to a lower side of the cylinder head cover 9 to form a breather chamber 39 in conjunction with the cylinder head cover 9; a communication passage 41 formed through the partition plate 40 for communicating the side of the cylinder head 7 and the breather chamber 39 to each other; and a gas passage 42 for communicating an intake passage 30 communicated to a cylinder 6 and the breather chamber 39 to each other,

wherein the communication passage 41 has a lower opening 49 on the side of the cylinder head 7 which opens in a direction along the axes of the camshafts 14 and 15.

**[0011]** Preferably the communication passage 41 has a bottom surface extending obliquely downward from the side of the breather chamber 39 to a lower edge of the lower opening 49.

**[0012]** Preferably the lower opening 49 is overlapped with the rotation locus 52 of cam noses 18 of the camshafts 14 and 15 as viewed in a direction along the axes 11 and 12 of the camshafts 14 and 15 (see Fig. 6).

**[0013]** Preferably the partition plate 40 has a main partition plate 46 attached to a lower side of the cylinder head cover 9, and a baffle plate 48 attached to the main partition plate 46 in an overlapping manner and that the communication passage 41 is formed between the main partition plate 46 and the baffle plate 48 and has an upper opening 50 on the side of the breather chamber 39 which is formed through the part of the main partition plate 46 above the baffle plate 48.

**[0014]** Preferably the lower sides of opening edges of the upper opening 50 and the upper side of the baffle plate 48 are separated from each other to form a space

53 therebetween.

**[0015]** Preferably the upper sides of opening edges of the upper opening 50 are gradually tilted downward from the region horizontally surrounding the upper opening 50 to the upper opening 50.

**[0016]** Preferably the device further comprise a pair of first and second vertical plates 58 and 59 extending vertically and located at positions separated from each other for partitioning the breather chamber 39 into a space 56 on the side of the communication passage 41 and a space 57 on the side of the gas passage 42, the first vertical plate 58 protruded upward from the partition plate 40 and the second vertical plate 59 protruded downward from a ceiling surface of the cylinder head cover 9.

**[0017]** Preferably the device further comprises a drain hole 60 formed through the part of the partition plate 40 under a space between the first and second vertical plates 58 and 59 and extending to the side of the cylinder head 7.

**[0018]** Preferably the first vertical plate 58 protruded upward from the partition plate 40 has a notch 61 formed at a lower end of a side thereof.

**[0019]** A broad aspect of the invention provides apparatus for returning blow-by gas from a cam chamber to a cylinder in an engine, the apparatus being adapted to reduce the amount of lubricant returned to the cylinder with the blow-by gas.

**[0020]** Preferably the apparatus comprises a communication passage, the arrangement being such that the lubricant is substantially prevented from entering the communication passage.

**[0021]** Preferably the apparatus includes a communication passage having a lower surface which is configured such that lubricant deposited on the lower surface is returned to the cylinder head side in the cam chamber.

**[0022]** A further broad aspect of the invention provides a breather device for an engine, the device comprising a breather chamber and a communication passage for connecting a cylinder head of the engine and the breather chamber, wherein the communication passage has a lower opening on the side of the cylinder head, the arrangement being such that the lower opening opens in a direction along the axis of a camshaft of the engine.

**[0023]** The invention extends to methods and/or apparatus substantially as herein described with reference to the accompanying drawings.

**[0024]** Any feature in one aspect of the invention may be applied to other aspects of the invention, in any appropriate combination. In particular, method aspects may be applied to apparatus aspects, and vice versa.

**[0025]** Preferred features of the present invention will now be described, purely by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a cross-sectional view taken along the line 1-1 in Fig. 4, looking in the direction of the appended arrows.

Fig. 2 is a front view of an engine.

Fig. 3 is a side view of the engine.

Fig. 4 is a plan view of the engine.

Fig. 5 is a plan view of what is shown in Fig. 1.

Fig. 6 is a cross-sectional view taken along the line 6-6 in Fig. 4, looking in the direction of the appended arrows.

Fig. 7 is a cross-sectional view taken along the line 7-7 in Fig. 4, looking in the direction of the appended arrows.

Fig. 8 is a plan view of what is shown in Fig. 7.

**[0026]** In Fig. 2 to Fig. 4, designated by reference numeral 1 is a multi-cylinder (four-cylinder), four-cycle engine (internal combustion engine) mounted on a vehicle such as a car. The engine 1 has an engine body 2 supported by a vehicle body.

**[0027]** The engine body 2 has a crankcase 5 for supporting a crankshaft 4 for rotation about an axis 3 extending generally horizontally, cylinders 6 extending upward from the crankcase 5, a cylinder head 7 attached to an upper side of the cylinders 6, a cylinder head cover 9 attached to an upper side of the cylinder head 7 to form a cam chamber 8 in conjunction with the cylinder head 7, and a valve mechanism 10 housed in the cam chamber 8. The valve mechanism 10 is lubricated by oil stored in the cam chamber 8 and oil supplied by a separately provided oil pump.

**[0028]** The valve mechanism 10 has intake and exhaust camshafts 14 and 15 disposed in the cam chamber 8 and supported on an upper side of the cylinder head 7 by bearings 13 for rotation indicated by R about axes 11 and 12, respectively, extending parallel to the axis 3 of the crankshaft 4, and chain entraining means 16 for operatively connecting the camshafts 14 and 15 with the crankshaft 4. Each of the camshafts 14 and 15 has a shaft member 17 supported by the bearing 13 and cam noses 18 formed integrally with the shaft member 17. Designated by reference numeral 19 is a spark plug.

**[0029]** The engine 1 has an intake system member 23 disposed on one side of the engine body 2 and connected to one side of the cylinder head 7 and an exhaust system member 24 disposed on the other side of the engine body 2 and connected to the other side of the cylinder head 7. The intake system member 23 has an intake manifold 26 extending from the cylinder head 7, a surge tank 27 connected to the extending end of the intake manifold 26, an intake pipe 28 extending from the surge tank 27, and a throttle valve 29 interposed in the intake pipe 28 at a position intermediate the length thereof. The inside of the intake system member 23 constitutes an intake passage 30 for communicating the atmosphere side to the cylinders 6 via an air cleaner (not shown).

**[0030]** When the engine 1 is driven, atmospheric air 34 in an amount depending upon the opening of the throttle valve 29 and fuel are supplied as air-fuel mixture

35 through the intake system member 23 into the cylinders 6 for combustion by operation of the valve mechanism 10 operatively connected to the crankshaft 4. Exhaust gas generated by the combustion is discharged as exhaust gas 36 through the exhaust system member 24 to the atmosphere side.

**[0031]** As shown in all the drawings, the engine 1 is provided with a breather device 37. The breather device 37 returns blow-by gas 33 having reached the cam chamber 8 from the crankcase 5 and the cylinders 6 as a result of operation of the engine 1 into the cylinders 6 for combustion.

**[0032]** The breather device 37 has a metal partition plate 40 attached to a lower side of the cylinder head 7 by fixing members 38 to form a breather chamber 39 in conjunction with the cylinder head 7, a communication passage 41 formed through the partition plate 40 for communicating the cylinder head 7 side and the breather chamber 39 in the cam chamber 8 to each other, and a gas passage 42 for communicating the intake passage 30 of the intake system member 23 communicated to the cylinders 6 and the breather chamber 39 to each other.

**[0033]** The axial direction of the camshafts 14 and 15 is herein defined as longitudinal direction and the left-hand side of Fig. 3 and Fig. 4 (indicated by the arrow Fr) is herein defined as front side. The breather chambers 39, the partition plates 40, the communication passages 41, and the gas passages 42 comprise a pair of first and second breather chambers 39a and 39b, a pair of first and second partition plates 40a and 40b, a pair of first and second communication passages 41a and 41b, and a pair of first and second gas passages 42a and 42b, respectively, on the left and right. The first breather chamber 39a, the first partition plate 40a, the first communication passage 41a and the first gas passage 42a are located above the intake camshaft 14, and the second breather chamber 39b, the second partition plate 40b, the second communication passage 41b and the second gas passage 42b are located above the exhaust camshaft 15.

**[0034]** In this case, as viewed in the axial direction of the camshafts 14 and 15, the first communication passage 41a is formed through one side end portion (which will be hereinafter referred to as "rear end portion") of the first partition plate 40a and the second communication passage 41b is formed through the other side end portion (which will be hereinafter referred to as "front end portion") of the second partition plate 40b The first gas passage 42a communicates the other side end of the first breather chamber 39a and the intake passage 30 in the intake pipe 28 upstream of the throttle valve 29 to each other. The second gas passage 42b communicates the one side end of the second breather chamber 39b and the intake passage 30 in the surge tank 27 downstream of the throttle valve 29 to each other. A one-way valve 43 which allows gas flow from the second breather chamber 39b to the intake passage 30 only is interposed in the second gas passage 42b at a position intermediate the length thereof.

**[0035]** The partition plate 40 has a main partition plate 46 extending generally horizontally and attached to a lower side of the cylinder head 7 by fixing members 38 and a baffle plate 48 attached to a lower side of the main partition plate 46 by securing means 47 in an overlapping manner and protruded downward from the main partition plate 46. The baffle plate 48 is of U-shaped cross-section as viewed in a direction along the axes of the camshafts 14 and 15 (see, in particular, Fig. 6). An upper end portion of the peripheral edges of the baffle plate 48 is joined to the lower side of the main partition plate 46 and secured thereto. The securing means 47, which is by means of spot welding in the example shown in the drawing, may be a fastening member or a rivet. The main partition plate 46 and the baffle plate 48 may be integrally formed by pressing a metal plate material.

**[0036]** Between the lower sides of the main partition plate 46 and the baffle plate 48, the communication passage 41 is formed. The communication passage 41 has a lower opening 49 as the cylinder head 7 side end formed among the lower side of the main partition plate 46 and the peripheral edges of the baffle plate 48, and an upper opening 50 as the breather chamber 39 side end, which is located entirely at the part of the main partition plate 46 above the baffle plate 48. The lower opening 49 and the upper opening 50, which have rectangular shapes, may have circular shapes.

**[0037]** The lower opening 49 opens in a direction along the axes of the camshafts 14 and 15. The communication passage 41 has a bottom surface which linearly extends obliquely downward from the breather chamber 39 side to the lower edge of the lower opening 49 at a descending angle of about 15 to 30°. The baffle plate 48 of the partition plate 40 is located above the cam noses 18. The minimum gap between the rotation locus 52 of the cam noses 18 and the lower side of the baffle plate 48 in the vertical direction is about 5 mm. As viewed in a direction along the axes 11 and 12 of the camshafts 14 and 15 (see, in particular, Fig. 6), the lower opening 49 is overlapped with the locus 52 of the cam noses 18. The downward protruded end of the baffle plate 48 is located in the vicinity of the shaft member 17.

**[0038]** As shown in Fig. 1, the lower sides of the edges of the upper opening 50 and the upper side of the baffle plate 48 are vertically separated to form a space 53 with a thickness of at least a few mm therebetween. The upper sides of the edges of the upper opening 50 are gradually tilted downward from the region horizontally surrounding the upper opening 50 to the upper opening 50 at an angle of about 5 to 20°.

**[0039]** As shown in Fig. 1 and Fig. 5 to Fig. 8, in each of the first and second breather chambers 39a and 39b, a pair of first and second vertical plates 58 and 59 extend generally vertically and are opposed to each other at longitudinally spaced positions to form a space 56 on the side of the communication passage 41 and a space

57 on the side of the gas passage 42.

**[0040]** The first vertical plate 58 is made of a metal plate and protruded upward from the partition plate 40 with its lower end secured to the main partition plate 46 of the partition plate 40 by spot welding. A gas passage is formed between the ceiling surface of the cylinder head cover 9 and the protruded end of the first vertical plate 58. The second vertical plate 59 is protruded downward integrally from the ceiling surface of the cylinder head cover 9. A gas passage is formed between the upper surface of the main partition plate 46 of the partition plate 40 and the protruded end of the second vertical plate 59. The second vertical plate 59 may be separate from the cylinder head cover 9.

**[0041]** More specifically, in the first breather chamber 39a, the first vertical plate 58 is located on the side of the first communication passage 41a and the second vertical plate 59 is located on the side of the first gas passage 42a. In the second breather chamber 39b, the first vertical plate 58 is located on the side of the second gas passage 42b and the vertical plate 59 is located on the side of the second communication passage 41b.

**[0042]** In the first breather chamber 39a, at least part of a drain hole 60 extending vertically to the side of the cylinder head 7 is formed through the part of the main partition plate 46 of the partition plate 40 under the space between the first and second vertical plates 58 and 59. The first vertical plate 58 has notches 61 on both sides of the lower end thereof. When the drain hole 60 is not provided, the descending angle of the bottom surface of the communication passage 41 is preferably about 20°.

**[0043]** As shown in all the drawings, when the opening of the throttle valve 29 is increased to supply a large amount of air-fuel mixture 35 into the cylinders 6 while the engine 1 is being driven, the engine 1 is rotated at a high speed and the negative pressure is increased in the intake passage 30 upstream and downstream of the throttle valve 29 in the intake system member 23. Then, by the negative pressure, the blow-by gas 33 on the side of the cylinder head 7 in the cam chamber 8 is sucked through the communication passage 41, the breather chamber 39 and the gas passage 42 in sequence into the intake passage 30 as indicated by solid line arrows. The blow-by gas 33 is then sucked into the cylinders 6 together with the air-fuel mixture 35 and burned therein.

**[0044]** When the opening of the throttle valve 29 is decreased to reduce the amount of the air-fuel mixture 35 to be supplied into the cylinders 6, the engine 1 is rotated at a low speed and the negative pressure is decreased in the intake passage 30 upstream of the throttle valve 29 in the intake system member 23. The negative pressure in the intake passage 30 in the surge tank 27 downstream of the throttle valve 29 is maintained at a high level since the opening of the throttle valve 29 is decreased.

**[0045]** Thus, by the negative pressure in the intake passage 30 in the surge tank 27, fresh atmospheric air 34 is sucked through the first gas passage 42a of the gas passage 42, the first breather chamber 39a of the breather chamber 39, and the first communication passage 41a of the communication passage 41 in sequence to the side of the cylinder head 7 in the cam chamber 8 as indicated by dot-dash line arrows and mixed therein with the blow-by gas 33. Then, the blow-by gas 33 is sucked through the second communication passage 41b of the communication passage 41, the second breather chambers 39b of the breather chamber 39, the one-way valve 43 and the second gas passage 42b of the gas passage 42 in sequence into the intake passage 30 in the surge tank 27 as indicated by double-dot-dash line arrows. The blow-by gas 33 is then sucked into the cylinders 6 together with the air-fuel mixture 35 and burned therein.

**[0046]** According to the above constitution, the lower opening 49 of the communication passage 41 on the side of the cylinder head 7 opens in a direction along the axes of the camshafts 14 and 15 as shown, in particular, in Fig. 1 and Fig. 7.

**[0047]** As described before, when the engine 1 is being driven, the blow-by gas 33 existing on the side of the cylinder head 7 in the cam chamber 8 is sucked through the communication passage 41 into the breather chamber 39 by the negative pressure in the intake passage 30. Then, the blow-by gas 33 is sucked through the gas passage 42 and the intake passage 30 into the cylinders 6 and burned therein.

**[0048]** When the engine 1 is driven and the camshafts 14 and 15 are rotated as indicated by R, oil mist is splashed up by the camshafts 14 and 15 in their tangential directions. Here, the lower opening 49 of the communication passage 41 opens in a direction along the axes of the camshafts 14 and 15.

**[0049]** Thus, oil mist splashed up by the camshafts 14 and 15 is prevented from entering the lower opening 49 of the communication passage 41. Namely, the oil mist is prevented from being mixed with the blow-by gas 33 directed to the breather chamber 39 through the communication passage 41, so that the oil mist is prevented from being sucked together with the blow-by gas 33 into the cylinders 6 and burned therein. As a result, useless consumption of oil can be prevented.

**[0050]** As described before, the bottom surface of the communication passage 41 extends obliquely downward from the side of the breather chamber 39 to the lower edges of the lower opening 49.

**[0051]** Thus, even when oil mist splashed up by the camshafts 14 and 15 in their tangential directions enters the lower opening 49 of the communication passages 41, the oil mist tends to adhere to the inner surfaces of the communication passage 41. Then, the oil slides down smoothly on the bottom surface of the communication passage 41 obliquely downward and is returned through the lower opening 49 to the cylinder head 7 side in the cam chamber 8.

**[0052]** Thus, even when oil mist enters the lower

opening 49, the oil mist is prevented from reaching the breather chamber 39. Namely, the oil mist is prevented from being sucked into the cylinders 6 through the breather chamber 39 together with the blow-by gas 33, and useless consumption of oil can be prevented.

**[0053]** As described before, the lower opening 49 is overlapped with the rotation locus 52 of the cam noses 18 of the camshafts 14 and 15 as viewed in a direction along the axes 11 and 12 of the camshafts 14 and 15.

**[0054]** Thus, since the camshafts 14 and 15 and the partition plate 40 through which the communication passage 41 is formed are arranged in a compact manner, useless consumption of oil can be prevented without increasing the size of the engine 1.

**[0055]** As described before, the partition plate 40 has the main partition plate 46 attached to the lower side of the cylinder head cover 9 and the baffle plate 48 attached to the main partition plate 46 in an overlapping manner, and the communication passage 41 is formed between the main partition plate 46 and the baffle plate 48 and has the lower opening 49 formed among the lower side of the main partition plate 46 and the peripheral edges of the baffle plate 48 and the upper opening 50 at the breather chamber 39 side end of the communication passage 41 formed through the part of the main partition plate 46 above the baffle plate 48.

**[0056]** Thus, since the upper opening 50 is entirely covered with the baffle plate 48 from below, the baffle plate 48 prevents oil mist splashed up by the camshafts 14 and 15 in their tangential directions from directly reaching the breather chamber 39 through the upper opening 50.

**[0057]** Thus, oil mist is prevented from being sucked into the cylinders 6 through the breather chamber 39 together with the blow-by gas 33, and useless consumption of oil can be prevented.

**[0058]** The baffle plate 48 is located above the cam noses 18 of the camshafts 14 and 15.

**[0059]** Thus, although a considerably large amount of oil mist is splashed up by the cam noses 18 of the camshafts 14 and 15, the oil mist immediately collides with the lower side of the baffle plate 48. Thus, the oil mist is prevented from entering the lower opening 49 of the communication passage 41 more reliably.

**[0060]** As described before, the lower sides of the edges of the upper opening 50 and the upper side of the baffle plate 48 are separated to form the space 53 therebetween.

**[0061]** Thus, even when oil mist splashed up by the camshafts 14 and 15 enters the lower opening 49 of the communication passage 41 and adheres to the inner surfaces of the communication passage 41, and even when the oil having adhered to the inner surfaces of the communication passage 41 is urged to flow toward the breather chamber 39 by the energy of the blow-by gas 33 flowing through the communication passage 41 to the breather chamber 39, the flow of the oil is prevented by the lower sides of the edges of the lower opening 49.

**[0062]** Then, even when oil mist enters the lower opening 49, the oil mist is prevented from reaching the breather chamber 39. Namely, oil mist is prevented from being sucked into the cylinders 6 through the breather chamber 39 together with the blow-by gas 33, and useless consumption of oil is prevented.

**[0063]** As described before, the upper sides of the edges of the upper opening 50 are gradually tilted downward from the region horizontally surrounding the upper opening 50 to the upper opening 50.

**[0064]** Thus, even if oil mist passes through the communication passage 41 and reaches the upper sides of the edges of the upper opening 50, the oil mist having adhered to the upper sides flows to the upper opening 50 because of the tilt of the upper sides and is returned to the cylinder head 7 side in the cam chamber 8 through the communication passage 41.

**[0065]** As described before with reference to, in particular, Fig. 1 and Fig. 7, in the breather chamber 39, the paired first and second vertical plates 58 and 59 extend vertically to form the space 56 on the side of the communication passage 41 and the space 57 on the side of the gas passage 42 and are located at positions separated from each other. The first vertical plate 58 is protruded upward from the partition plate 40, and the second vertical plate 59 is protruded downward from the ceiling surface of the cylinder head cover 9.

**[0066]** Here, suppose that oil mist passes through the communication passage 41 and reaches the space 56 on the side of the communication passage 41 in the breather chamber 39 together with the blow-by gas 33, and then flows into the space 57 on the side of the gas passage 42. In this case, the oil mist is guided by the first vertical plate 58 and the second vertical plate 59 together with the blow-by gas 33 and its flowing direction is changed from upward to downward. Thus, the oil mist adheres to the inner surfaces of the breather chamber 39 or the surfaces of the first and second vertical plates 58 and 59 by inertial force and is prevented from traveling to the intake passage 30 together with the blow-by gas 33.

**[0067]** As described before, the drain hole 60 extending to the cylinder head 7 side is formed through the part of the partition plate 40 under the space between the first and second vertical plates 58 and 59.

**[0068]** Most of the oil mist flowing from the space 56 to the space 57 in the breather chamber 39 is captured by the first and second vertical plates 58 and 59 and flows downward. Thus, the oil is smoothly returned to the cylinder head 7 side in the cam chamber 8 through the drain hole 60.

**[0069]** As described before, the notches 61 are formed in both sides of the lower end of the first vertical plate 58 protruded upward from the partition plate 40.

**[0070]** Thus, when oil accumulates on the upper surface of the partition plate 40 or when the vehicle runs and oil flows on the upper surface of the partition plate 40, the oil can flow into the drain hole 60 smoothly

through the notch 61 without being blocked by the first vertical plate 58 and is returned to the cylinder head 7 side in the cam chamber 8 through the drain hole 60.

**[0071]** Description has been made of the example shown in the drawings. However, the one-way valve 43 and the second gas passage 42b can be omitted. In this case, the breather chamber 39 may be communicated to the intake passage 30 downstream of the throttle valve 29 such as the intake passage in the surge tank 27 by the first gas passage 42a.

**[0072]** The effects of preferred features of the present invention are as follows.

**[0073]** An aspect of the present invention provides a breather device in an engine comprising: a cylinder head; a cylinder head cover attached to an upper side of the cylinder head to form a cam chamber in conjunction with the cylinder head; camshafts disposed in the cam chamber and supported on an upper side of the cylinder head for rotation about axes, respectively, extending generally horizontally; a partition plate attached to a lower side of the cylinder head cover to form a breather chamber in conjunction with the cylinder head cover; a communication passage formed through the partition plate for communicating the side of the cylinder head and the breather chamber to each other; and a gas passage for communicating an intake passage communicated to a cylinder and the breather chamber to each other,

wherein the communication passage has a lower opening on the side of the cylinder head which opens in a direction along the axes of the camshafts.

**[0074]** As described before, when the engine is being driven, the blow-by gas existing on the side of the cylinder head in the cam chamber is sucked through the communication passage into the breather chamber by the negative pressure in the intake passage. Then, the blow-by gas is sucked through the gas passage and the intake passage into the cylinders and burned therein.

**[0075]** When the engine is driven and the camshafts are rotated, oil mist is splashed up by the camshafts in their tangential directions. Here, the lower opening of the communication passage opens in a direction along the axes of the camshafts.

**[0076]** Thus, oil mist splashed up by the camshafts is prevented from entering the lower opening of the communication passage. Namely, the oil mist is prevented from being mixed with the blow-by gas directed to the breather chamber through the communication passage, so that the oil mist is prevented from being sucked together with the blow-by gas into the cylinders and burned therein. As a result, useless consumption of oil can be prevented.

**[0077]** Preferably the communication passage has a bottom surface extending obliquely downward from the side of the breather chamber to a lower edge of the lower opening.

**[0078]** Thus, even when oil mist splashed up by the camshafts in their tangential directions enters the lower opening of the communication passage, the oil mist tends to adhere to the inner surfaces of the communication passage. Then, the oil slides down smoothly on the bottom surface of the communication passage obliquely downward and is returned through the lower opening to the cylinder head side in the cam chamber.

**[0079]** Thus, even when oil mist enters the lower opening, the oil mist is prevented from reaching the breather chamber. Namely, the oil mist is prevented from being sucked into the cylinders through the breather chamber together with the blow-by gas, and useless consumption of oil can be prevented.

**[0080]** Preferably the lower opening is overlapped with the rotation locus of cam noses of the camshafts as viewed in a direction along the axes of the camshafts.

**[0081]** Thus, since the camshafts and the partition plate through which the communication passage is formed are arranged in a compact manner, useless consumption of oil can be prevented without increasing the size of the engine.

**[0082]** Preferably the partition plate has a main partition plate attached to a lower side of the cylinder head cover, and a baffle plate attached to the main partition plate in an overlapping manner, and the communication passage is formed between the main partition plate and the baffle plate and has an upper opening on the side of the breather chamber which is formed through the part of the main partition plate above the baffle plate.

**[0083]** Thus, since the upper opening is entirely covered with the baffle plate from below, the baffle plate prevents oil mist splashed up by the camshafts in their tangential directions from directly reaching the breather chamber through the upper opening.

**[0084]** Thus, oil mist is prevented from being sucked into the cylinders through the breather chamber together with the blow-by gas, and useless consumption of oil can be prevented.

**[0085]** Preferably the lower sides of opening edges of the upper opening and the upper side of the baffle plate are separated from each other to form a space therebetween.

**[0086]** Thus, even when oil mist splashed up by the camshafts enters the lower opening of the communication passage and adheres to the inner surfaces of the communication passage, and even when the oil having adhered to the inner surfaces of the communication passage is urged to flow toward the breather chamber by the energy of the blow-by gas flowing through the communication passage to the breather chamber, the flow of the oil is prevented by the lower sides of the edges of the lower opening.

**[0087]** Then, even if oil mist enters the lower opening, the oil mist is prevented from reaching the breather chamber. Namely, oil mist is prevented from being sucked into the cylinders through the breather chamber together with the blow-by gas, and useless consumption of oil is prevented.

**[0088]** Preferably the upper sides of opening edges

of the upper opening are gradually tilted downward from the region horizontally surrounding the upper opening to the upper opening.

**[0089]** Thus, even when oil mist passes through the communication passage and reaches the upper sides of the edges of the upper opening, the oil mist having adhered to the upper sides flows to the upper opening because of the tilt of the upper sides and is returned to the cylinder head side in the cam chamber through the communication passage.

**[0090]** Preferably the device further comprises a pair of first and second vertical plates extending vertically and located at positions separated from each other for partitioning the breather chamber into a space on the side of the communication passage and a space on the side of the gas passage, the first vertical plate protruded upward from the partition plate and the second vertical plate protruded downward from a ceiling surface of the cylinder head cover.

**[0091]** Here, suppose that oil mist passes through the communication passage and reaches the space on the side of the communication passage in the breather chamber together with the blow -by gas, and then flows into the space on the side of the gas passage. In this case, the oil mist is guided by the first vertical plate and the second vertical plate together with the blow-by gas and its flowing direction is changed from upward to downward. Thus, the oil mist adheres to the inner surfaces of the breather chamber or the surfaces of the first and second vertical plates by inertial force and is prevented from traveling to the intake passage together with the blow-by gas.

**[0092]** Preferably the device further comprises a drain hole formed through the part of the partition plate under a space between the first and second vertical plates and extending to the side of the cylinder head.

**[0093]** Most of the oil mist flowing from the space to the space in the breather chamber is captured by the first and second vertical plates and flows downward. Thus, the oil is smoothly returned to the cylinder head side in the cam chamber through the drain hole.

**[0094]** Preferably the first vertical plate protruded upward from the partition plate has a notch formed at a lower end of a side thereof.

**[0095]** Thus, when oil accumulates on the upper surface of the partition plate or when the vehicle runs and oil flows on the upper surface of the partition plate, the oil can flow into the drain hole smoothly through the notch without being blocked by the first vertical plate and is returned to the cylinder head side in the cam chamber through the drain hole.

**[0096]** In a preferred example, an engine 1 comprises: a cylinder head 7; a cylinder head cover 9 attached to an upper side of the cylinder head 7 to form a cam chamber 8 in conjunction with the cylinder head 7; a camshaft 14 disposed in the cam chamber 8 and supported on an upper side of the cylinder head 7 for rotation R about an axis 11 extending generally horizontally; a partition plate 40 attached to a lower side of the cylinder head cover 9 to form a breather chamber 39 in conjunction with the cylinder head cover 9; a communication passage 41 formed through the partition plate 40 for communicating the side of the cylinder head 7 and the breather chamber 39 to each other; and a gas passage 42 for communicating an intake passage 30 communicated to a cylinder 6 and the breather chamber 39 to each other. The communication passage 41 has a lower opening 49 on the side of the cylinder head 7 which opens in a direction along the axis of the camshaft 14.

**[0097]** Such an arrangement can allow blow-by gas existing between a cylinder head and a cylinder head cover to be sucked into an intake passage communicated to a cylinder and burned in the cylinder without mixing oil mist with the blow-by gas so that oil will not be uselessly consumed.

**[0098]** It will be understood that the present invention has been described above purely by way of example, and modification of detail can be made within the scope of the invention.

**[0099]** Each feature disclosed in the description, and (where appropriate) the claims and drawings may be provided independently or in any appropriate combination.

Description of Reference Numerals and Symbols

**[0100]**

1: engine
6: cylinder
7: cylinder head
8: cam chamber
9: cylinder head cover
10: valve mechanism
11: axis
12: axis
14: camshaft
15: camshaft
18: cam nose
23: intake system member
29: throttle valve
30: intake passage
33: blow-by gas
34: air
37: breather device
39: breather chamber
40: partition plate
41: communication passage
42: gas passage
46: main partition plate
48: baffle plate
49: lower opening
50: upper opening
52: rotation locus
53: space

56: space
57: space
58: first vertical plate
59: second vertical plate
60: drain hole
61: notch
R: rotation

## Claims

**1.** A breather device for an engine comprising:

a cylinder head;
a cylinder head cover attached to an upper side of said cylinder head to form a cam chamber in conjunction with said cylinder head;
a camshaft disposed in said cam chamber and supported on an upper side of said cylinder head for rotation about an axis extending generally horizontally;
a partition plate attached to a lower side of said cylinder head cover to form a breather chamber in conjunction with said cylinder head cover;
a communication passage formed through said partition plate for communicating the side of said cylinder head and said breather chamber to each other; and
a gas passage for communicating an intake passage communicated to a cylinder and said breather chamber to each other,

wherein said communication passage has a lower opening on the side of said cylinder head which opens in a direction along the axis of said camshaft.

**2.** The breather device in an engine of Claim 1 wherein said communication passage has a bottom surface extending obliquely downward from the side of said breather chamber to a lower edge of said lower opening.

**3.** The breather device in an engine of Claim 1 or 2 wherein said lower opening is overlapped with the rotation locus of a cam nose of said camshaft as viewed in a direction along said axis of said camshaft.

**4.** The breather device in an engine of any one of Claims 1 to 3 wherein said partition plate has a main partition plate attached to a lower side of said cylinder head cover, and a baffle plate attached to said main partition plate in an overlapping manner, and wherein said communication passage is formed between said main partition plate and said baffle plate and has an upper opening on the side of said breather chamber which is formed through the part of said main partition plate above said baffle plate.

**5.** The breather device in an engine of Claim 4 wherein the lower sides of opening edges of said upper opening and the upper side of said baffle plate are separated from each other to form a space therebetween.

**6.** The breather device in an engine of Claim 5 wherein said upper sides of opening edges of said upper opening are gradually tilted downward from the region horizontally surrounding said upper opening to said upper opening.

**7.** The breather device in an engine of any one of Claims 1 to 6, further comprising a pair of first and second vertical plates extending substantially vertically and located at positions separated from each other for partitioning said breather chamber into a space on the side of said communication passage and a space on the side of said gas passage,

said first vertical plate protruding upward from said partition plate and said second vertical plate protruding downward from a ceiling surface of said cylinder head cover.

**8.** The breather device in an engine of Claim 7, further comprising a drain hole formed through the part of said partition plate under a space between said first and second vertical plates and extending to the side of said cylinder head.

**9.** The breather device in an engine of Claim 8 wherein said first vertical plate protruding upward from said partition plate has a notch formed at a lower end of a side thereof.

**10.** Apparatus for returning blow-by gas from a cam chamber to a cylinder in an engine, the apparatus being adapted to reduce the amount of lubricant returned to the cylinder with the blow-by gas.

**11.** Apparatus according to claim 10 comprising a communication passage, the arrangement being such that the lubricant is substantially prevented from entering the communication passage.

**12.** An engine according to claim 10 or claim 11 including a communication passage having a lower surface which is configured such that lubricant deposited on the lower surface is returned to the cylinder head side in the cam chamber.

**13.** A breather device for an engine, the device comprising a breather chamber and a communication passage for connecting a cylinder head of the engine and the breather chamber, wherein the communication passage has a lower opening on the

side of the cylinder head, the arrangement being such that the lower opening opens in a direction along the axis of a camshaft of the engine.

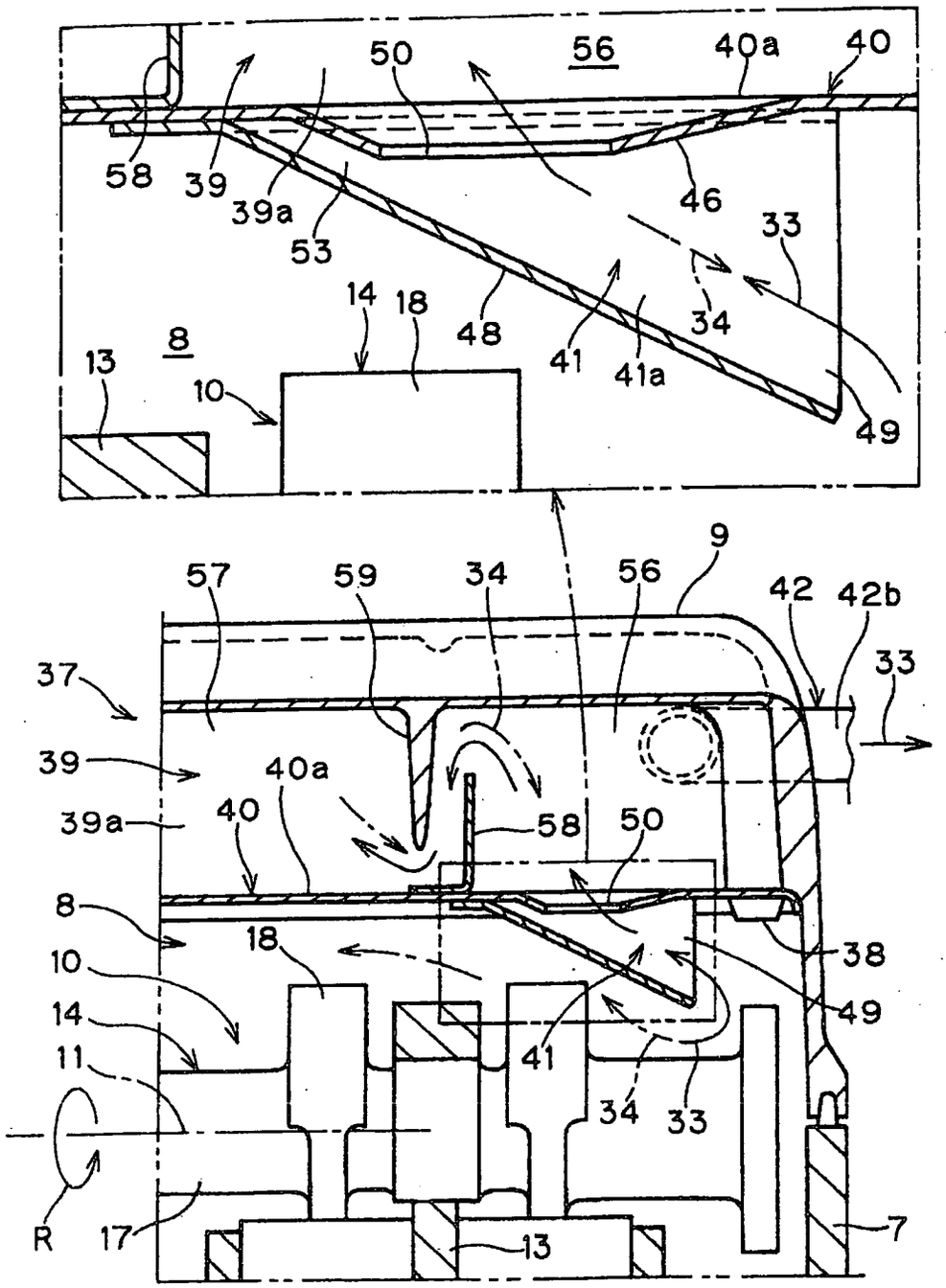
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FIG. 1

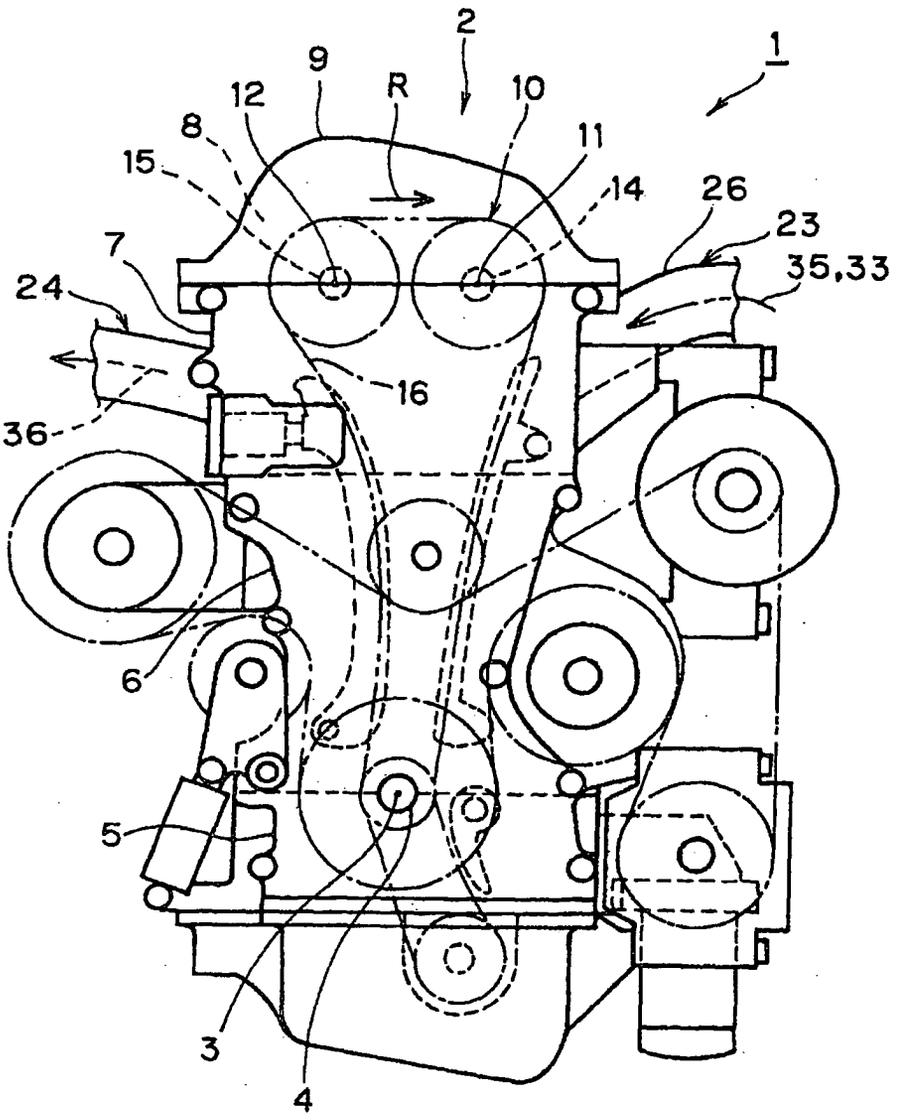


FIG. 2

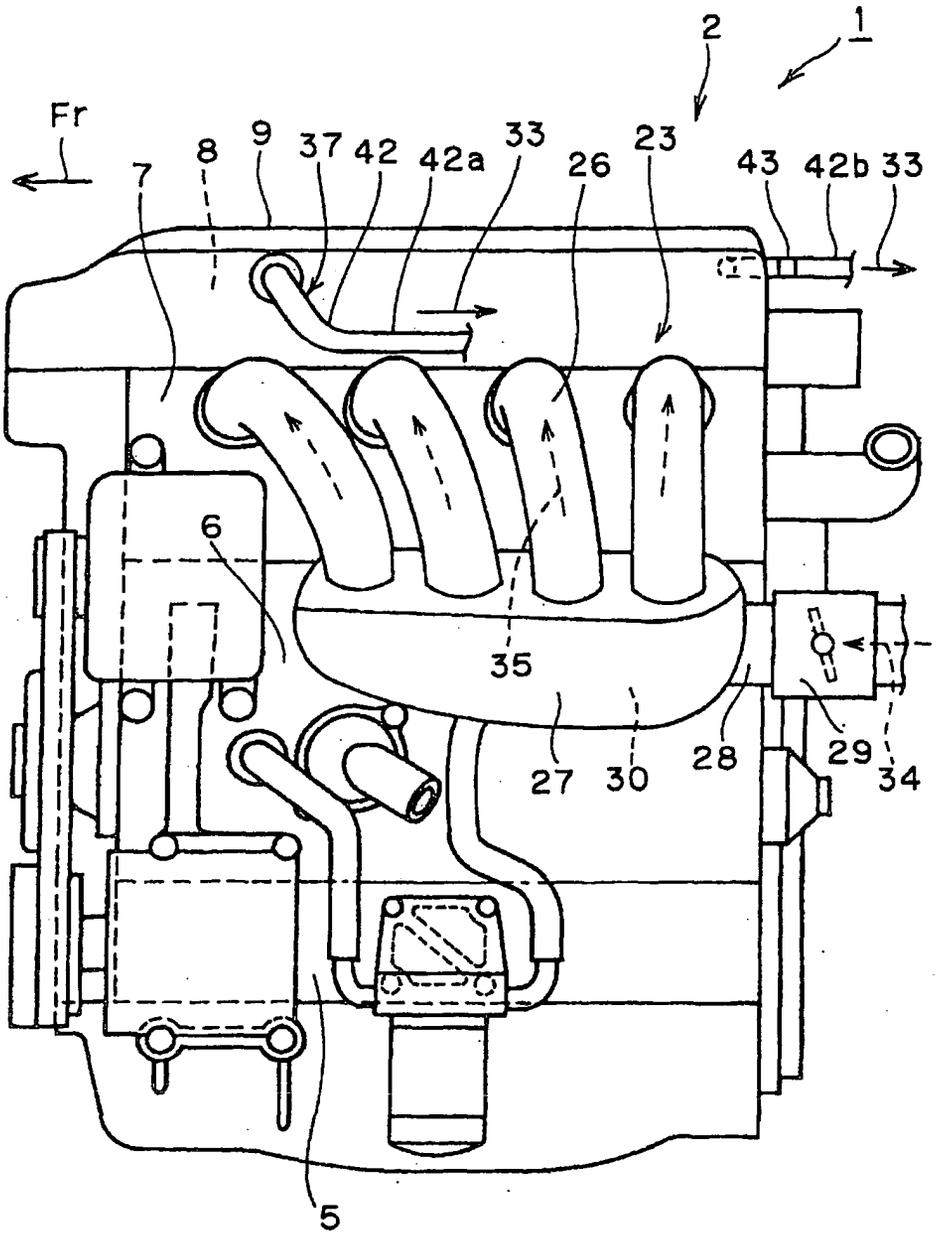


FIG. 3

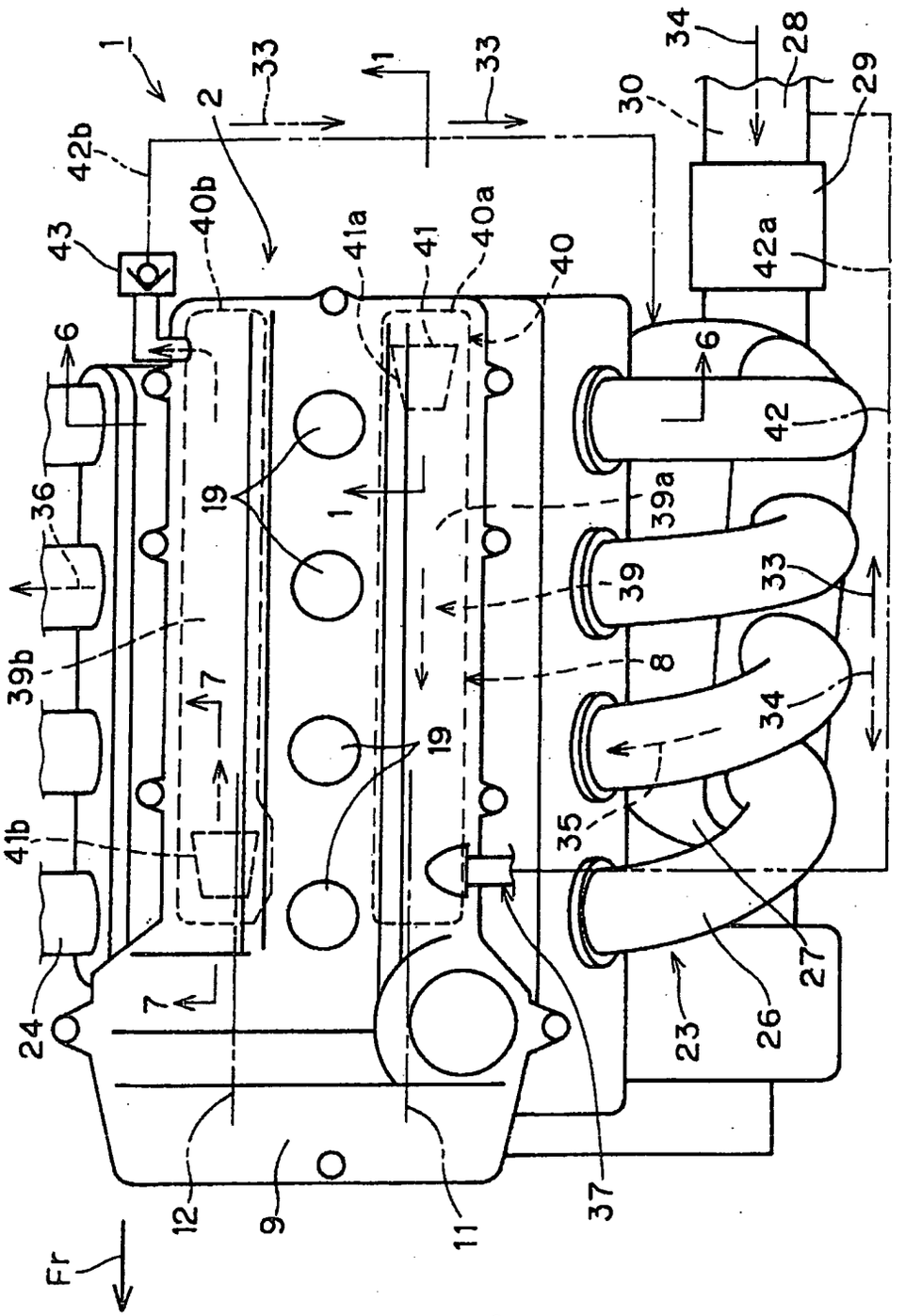
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Fig. 4

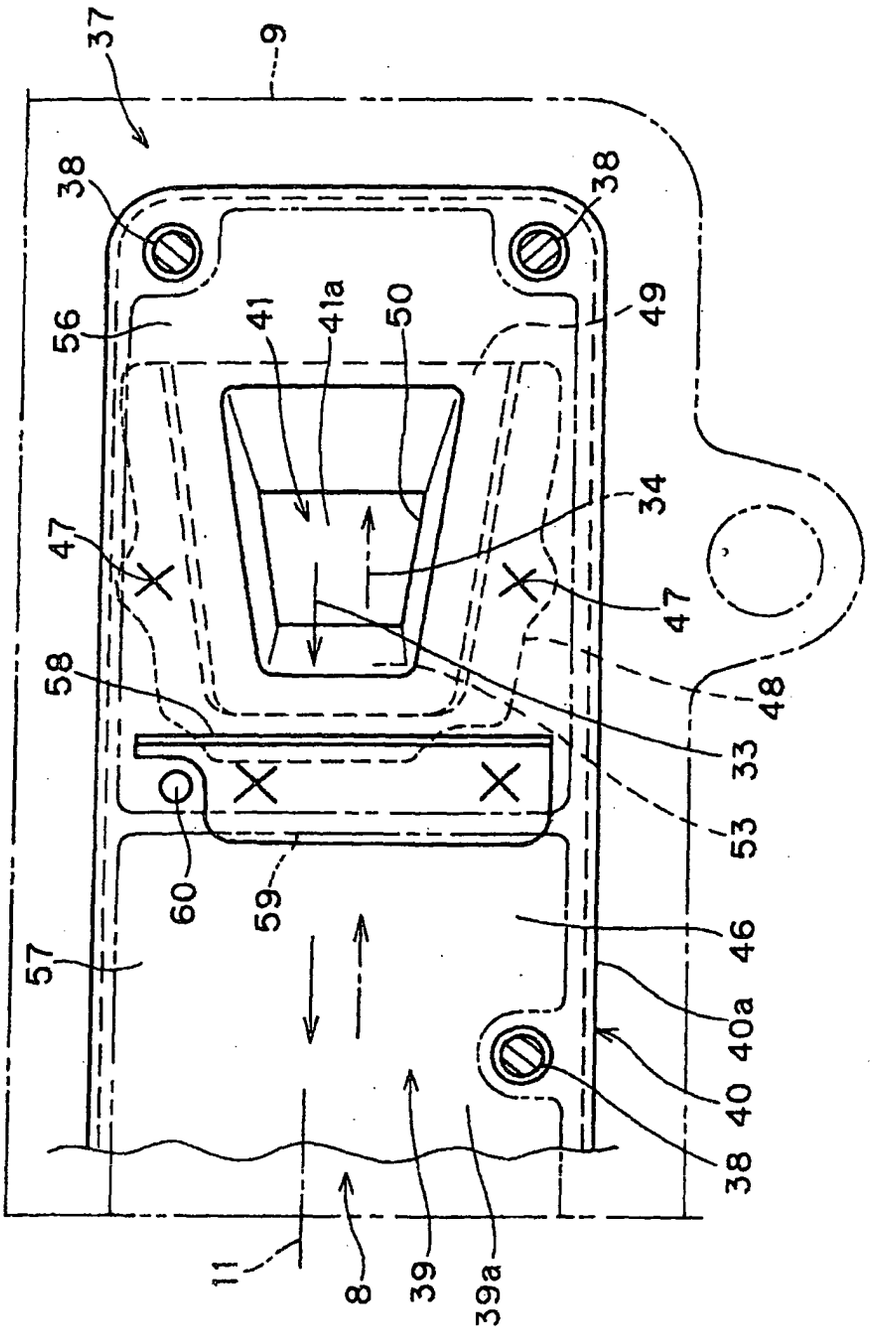
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Fig. 5

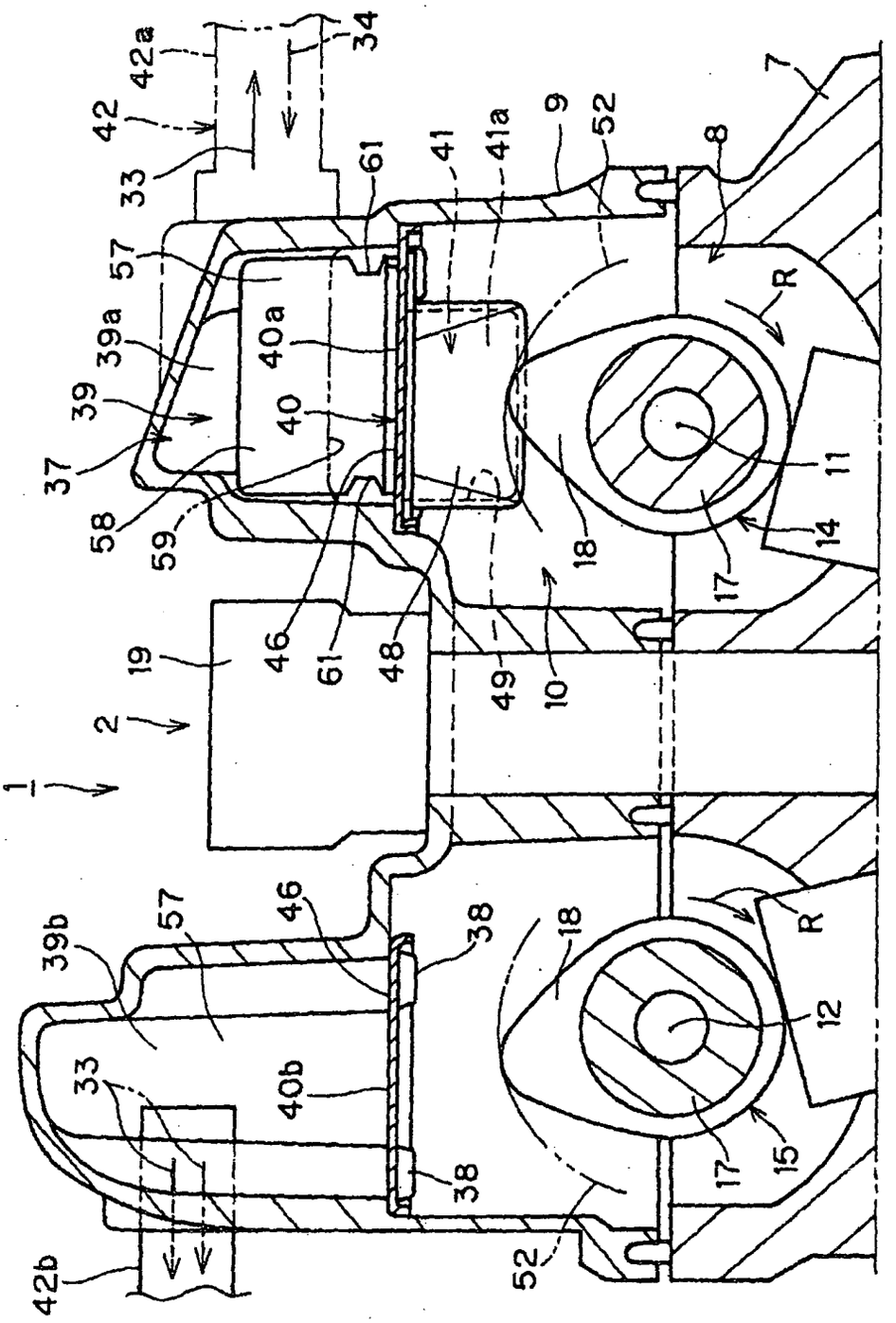
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Fig. 6

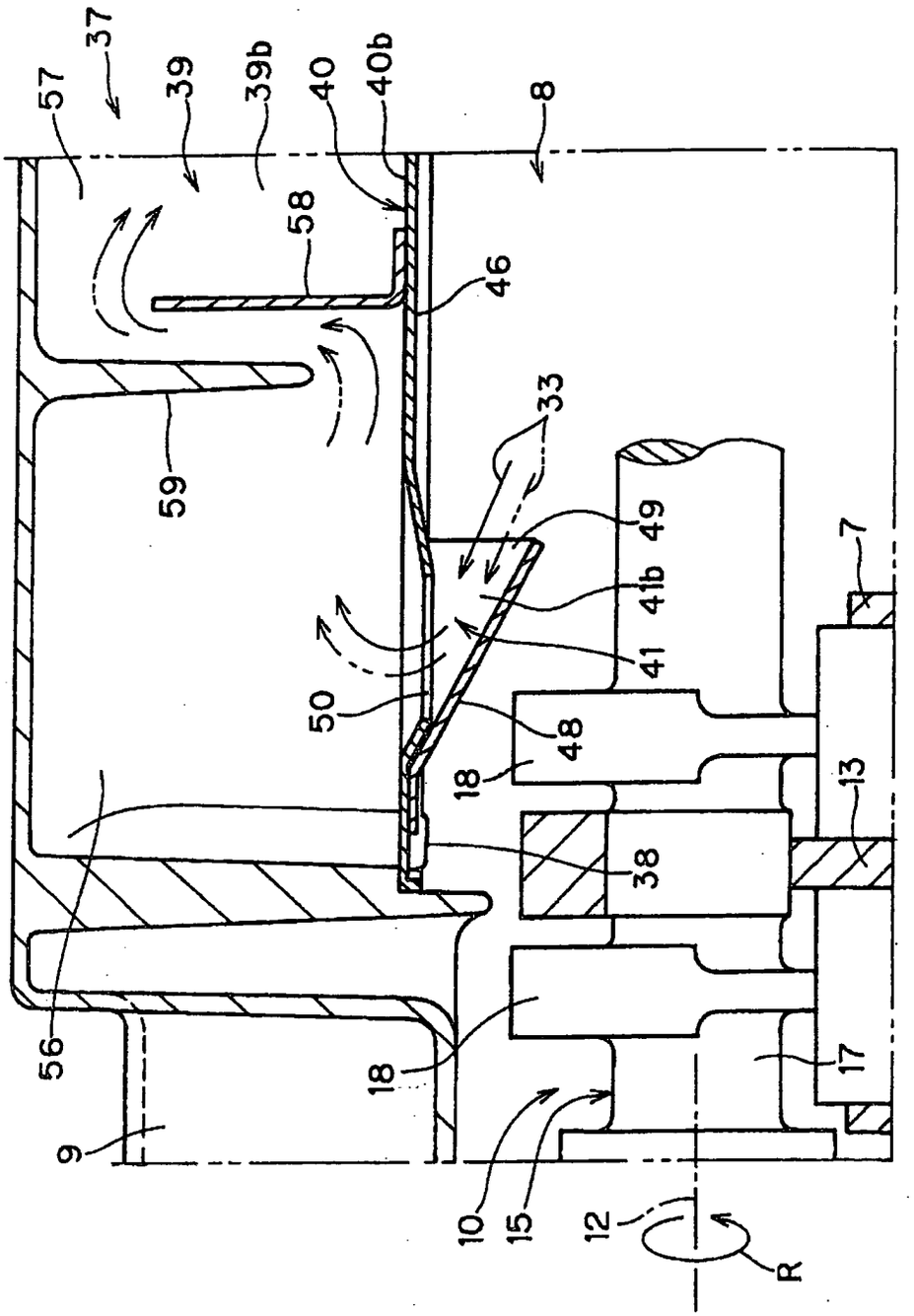
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Fig. 7

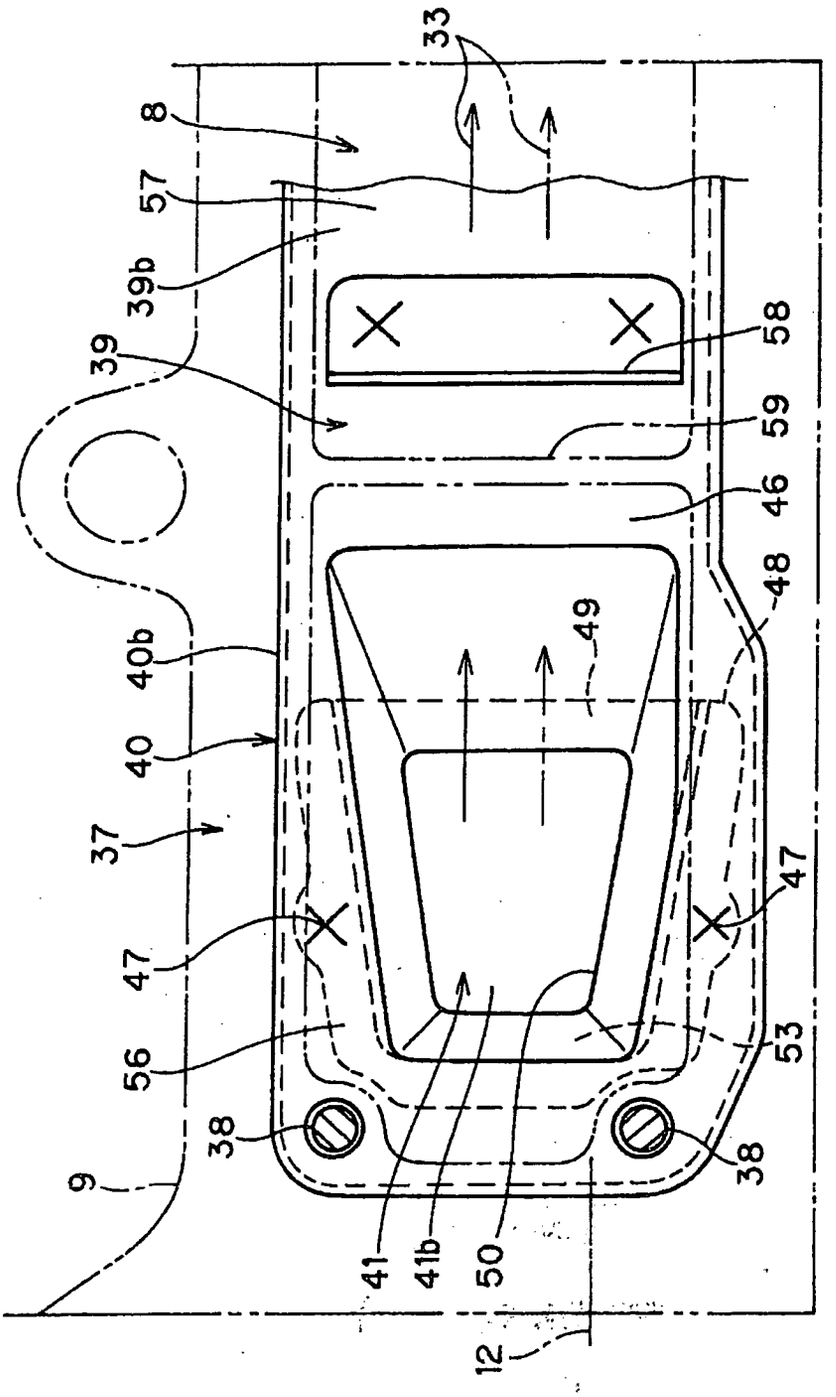


Fig. 8

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 04 25 3174

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F01M

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 7 September 2004 | Mouton, J |

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X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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