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(54) **CRANKCASE VENTILATION**

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Description

TECHNICAL FIELD

[0001] The present subject matter is related, in general to internal combustion (IC) engines, and in particular, but not exclusively to crankcase ventilation of IC engine.

BACKGROUND

[0002] Conventionally, internal combustion (IC) engines find use in industrial, transport, and marine applications. A typical IC engine includes a cylinder block having one or more cylinder bores and a piston reciprocating in each of the cylinder bore. Usually, in a multi-cylinder IC engine, the cylinder bores are provided in such a way that central longitudinal axes of the cylinder bores, also referred to as cylinder axes, are parallel to each other and lie in one plane. Such an IC engine is referred to as an in-line cylinder engine. In certain other type of multi-cylinder engines, the cylinder axes are inclined to each other. The reciprocating motion is imparted to the piston by expanding combustion products, produced as a result of ignition of charge in a combustion chamber of the IC engine. In such conventional IC engines, having parallel or inclined cylinder axes, the combustion chamber of the IC engine is formed between a cylinder head, a top surface of the piston, and walls of the cylinder bore. The reciprocating motion of the piston is converted into a rotary motion of a crankshaft through a connecting rod. Further, the motion from the crankshaft is transmitted to the wheels through a drive train.

[0003] During the operation of the IC engine, with the movement of the piston in the cylinder bore, a suction pressure is created inside a crankcase of the IC engine. In order to allow effective operation of the IC engine, the suction pressure has to be avoided. For preventing the formation of the suction pressure, the IC engine is usually provided with crankcase ventilation. In few conventional IC engines, an opening, open to the atmosphere, is formed in the crankcase for crankcase ventilation. From the opening, mixture of air and lubricant from inside the engine is released into the atmosphere. In few other conventional IC engines, instead of being released into the atmosphere, the mixture of air and lubricant is routed to an inlet manifold of the IC engine, from where the mixture is inducted into the combustion chamber and ignited along with the fresh charge.

SUMMARY

[0004] This summary is provided to introduce concepts related to internal combustion engines and crankcase ventilation therein, and the concepts are further described below in the detailed description. This summary is not intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

[0005] The invention relates to an internal combustion engine as defined in claim 1. Further optional features of the invention are described in the dependent claims.

[0006] In particular, an internal combustion engine having crankcase ventilation according to the invention is described herein. In particular, the internal combustion engine includes a crankcase housing a crankshaft of the internal combustion engine. The crankcase includes at least a first crankcase chamber forming a passage for exit of air-lubricant mixture from the crankcase. The internal combustion engine further includes a breather cover detachably attached to the crankcase. The breather cover has at least a first breather chamber in fluid connection with the crankcase chambers in the crankcase, thus forming a passage for an air-lubricant mixture to pass alternatively through the crankcase chambers and the breather chambers and to exit through the crankcase. Further, a size of the first crankcase chamber is substantially greater than a size of the first breather chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and components.

Fig. 1 illustrates an internal combustion engine having crankcase ventilation, in accordance with an implementation of the present subject matter.

Fig. 2 illustrates an exploded perspective view of the internal combustion engine, in accordance with an implementation of the present subject matter.

Fig. 3 (a) illustrates a front view of a crankcase and a breather cover of the internal combustion engine, in accordance with an embodiment of the present subject matter.

Fig. 3 (b) illustrates a schematic showing flow of air-lubricant mixture through different chambers in the crankcase and the breather cover of the internal combustion engine, in accordance with an implementation of the present subject matter.

DETAILED DESCRIPTION

[0008] The subject matter described herein relates to crankcase ventilation for an internal combustion (IC) engine, according to an embodiment of the present subject matter. In an embodiment, the IC engine can be a common combustion chamber inclined bore IC engine.

[0009] Conventionally, to achieve crankcase ventilation, an opening is provided in a crankcase, in certain IC engines. The opening is open to the atmosphere and

prevents building of a suction pressure inside a crankcase of the IC engine, which may otherwise be developed because of reciprocatory motion of one or more pistons in their respective cylinder bores. The development of the suction pressure inside the crankcase can cause a lubricant provided therein to leak through other convenient exits, such as oil seals and oil control rings on the piston. In the latter case, the lubricant can leak into a combustion chamber of the IC engine and interfere with the combustion process, and may adversely affect the operation of the IC engine. For example, the lubricant can mix with the products of combustion, form a sludge, and cause increased engine wear.

[0010] With the provision of crankcase ventilation, during operation of the IC engine, a mixture of air and lubricant vapours is released from inside the IC engine to the atmosphere, through the opening in the crankcase. In certain other conventional engines, the mixture of the air and the lubricant vapours is passed into the inlet manifold to allow the mixture to enter the combustion chamber during induction of charge into the combustion chamber. In such a case, the lubricant vapours undergo combustion and are subsequently expelled as the products of combustion. However, in such a case, the combustion of the lubricant can cause emission of pollutants in the exhaust from the IC engine.

[0011] Additionally, in the crankcase ventilation provisions as provided conventionally, the lubricant is lost from the IC engine. The loss of the lubricant can subsequently lead of increased wear of the parts of the IC engine during operation. As a result, the operation of the IC engine is adversely affected and may reduce the service life of the IC engine.

[0012] The subject matter described herein relates to an internal combustion (IC) engine and crankcase ventilation achieved therein. In an embodiment, the internal combustion engine can be a common combustion chamber inclined bore engine, and is hereinafter referred to as engine.

[0013] According to said embodiment, the engine can include a cylinder block having two cylinder bores - a first cylinder bore and a second cylinder bore. In an implementation, the first cylinder bore and the second cylinder bore, having a common combustion chamber, can be inclined with respect to each other, i.e., central longitudinal axes of the two cylinder bores are inclined to each other in a substantially horizontal plane. The first and the second cylinder bores are positioned such that extreme ends, hereinafter referred as combustion ends, of each of the cylinder bores face each other and the other extreme ends of the cylinder bores, herein after referred as crankshaft ends, lie away from each other.

[0014] In case of a vertically disposed cylinder bore, the combustion end of the cylinder bore can be understood as a top dead centre and the crankshaft end can be understood a bottom dead centre of the cylinder bore. In case of a horizontally disposed cylinder bore, the combustion end can be understood as an outer dead centre

and the crankshaft end can be understood as an inner dead centre. A piston is disposed in the each cylinder bore, which reciprocates in the respective cylinder bore. The pistons provided in the first cylinder bore and the second cylinder bore are referred to as the first piston and the second piston, respectively.

[0015] Further, at the crankshaft ends of the first cylinder bore and the second cylinder bore, a first crankshaft and a second crankshaft are disposed, respectively. Further, the first crankshaft is disposed in a first crankcase, and the second crankshaft is disposed in a second crankcase. The first piston in the first cylinder bore is connected to the first crankshaft through a first connecting rod and, similarly, the second piston is connected to the second crankshaft through a second connecting rod. During operation, the reciprocatory motion of the pistons is converted into a rotational motion of the respective crankshafts, through the respective connecting rods.

[0016] Further, during operation of reciprocatory movement of the pistons in the respective cylinder bore, a suction pressure is created in the crankcases. To avoid the formation of such suction pressure during operation, the engine is provided with crankcase ventilation. In an implementation, for achieving crankcase ventilation, at least one of the first crankcase and the second crankcase is provided with a breather cover. In an embodiment, the breather cover is disposed on a lateral surface of the crankcase, and can be provided with a ventilation opening for allowing passage of air-lubricant mixture out from the engine, and air into the engine. In an example, in which the breather cover is provided on one of the crankcases, the cylinder block is provided with one or more ventilation passages formed adjacent to and substantially parallel to the cylinder bores. As will be understood, the ventilation passages can be formed as through bores along a central longitudinal axis of the cylinder block.

[0017] According to an aspect, the crankcase, on which the breather cover is mounted, can have a plurality of crankcase chambers formed therein. The crankcase chambers can form the passage through which the air-lubricant mixture passes through and out of the engine. In an embodiment, the size of the crankcase chambers is provided such that the size of the crankcase chambers progressively and alternately increases and decreases. For example, in case the crankcase includes three crankcase chambers, namely, a first crankcase chamber, a second crankcase chamber, and a third crankcase chamber, the size of the second crankcase chamber is less than the size of the first crankcase chamber and the third crankcase chamber.

[0018] In addition, according to an aspect of the present subject matter, the breather cover can be provided with a plurality of breather chambers formed therein. In the same manner as described for crankcase chambers, the breather chambers can form the path for the passage of the air-lubricant mixture from the engine. In an implementation, the size of the breather chambers is provided such that the size of the breather chambers

progressively and alternately increases and decreases. For example, in case there are two breather chambers, namely, a first breather chamber and a second breather chamber, then the size of the first breather chamber is substantially greater than the size of the second breather chamber.

[0019] Further, according to an implementation, the crankcase chambers and the breather chambers are in fluid connection and the passage of the air-lubricant mixture is formed in combination by the crankcase chambers and the breather chambers. In an embodiment, the crankcase chambers and the breather chambers are so formed that the passage of the air-lubricant mixture is achieved alternately through the crankcase chambers and the breather chambers. Accordingly, in the above examples, the passage of the air-lubricant mixture occurs through the first crankcase chamber, the first breather chamber, the second crankcase chamber, the second breather chamber, and through the third crankcase chamber, before the mixture exits the engine.

[0020] In both the above embodiments, the sizes of the crankcase chambers and the breather chambers are provided in the same manner as provided above. For example, the sizes of the crankcase chambers and the breather chambers are provided based on sequence in which the air-lubricant mixture passes, and are provided such that the sizes progressively and alternately increase and decrease as the air-lubricant mixture passes from inside the engine to the atmosphere. In another case, the air-lubricant mixture may also go back into an air filter of the engine rather than going directly into the atmosphere.

[0021] As a result of the provision of the sizes of the crankcase chambers and/or the breather chambers in progressively and alternately increasing and decreasing sizes, the air-lubricant mixture while passing through the crankcase and/or the breather cover experiences a continuous cycle of contraction and expansion of volume. In an example, during the contraction of the air-lubricant mixture, the lubricant vapours in the air-lubricant mixture are condensed, and flow back into the engine. As a result, the loss of lubricant vapours from the engine is substantially prevented, which in turn enhances a service life of the engine and reduces the running cost of the engine.

[0022] The engine and aspects relating to crankcase ventilation thereof shall be explained in detail with respect to the figures. While aspects of the crankcase ventilation in the engine can be implemented in a variety of ways, the same are described with reference to the following implementations. It should be noted that the description and figures merely illustrate the principles of the present subject matter. It will thus be appreciated that those skilled in the art will be able to devise various arrangements without departing from the scope of the claims.

[0023] Fig. 1 illustrates an internal combustion engine 100 having crankcase ventilation, according to an embodiment of the present subject matter. Fig. 1 shows a longitudinal section of the inclined bore IC engine 100,

hereinafter referred to as engine 100.

[0024] According to an embodiment of the present subject matter, the engine 100 is a twin-cylinder internal combustion engine with common combustion chamber, hereinafter referred to as engine 100. In the said embodiment, the engine 100 includes a cylinder block 102 having a first cylinder bore 104 and a second cylinder bore 106. In said embodiment, the cylinder block further includes a centre-piece 108, which separates the first cylinder bore 104 and the second cylinder bore 106. In one embodiment, the cylinder block 102 is formed as a single component having the first cylinder bore 104, the second cylinder bore 106, and the centre-piece 108. In another embodiment, the cylinder block 102 is formed as a plurality of cylinder block portions, each cylinder block portion having the cylinder bore 104, 106 formed therein. In said embodiment, the centre-piece 108 is positioned between the cylinder block portions.

[0025] According to an aspect of the subject matter, the first cylinder bore 104 and the second cylinder bore 106 are inclined to each other. In one example, a first cylinder bore axis (not shown in figure) and a second cylinder bore axis (not shown in figure) are inclined to each other, such that an included angle between the two axes is less than 180°. The cylinder bore axis can be understood as a central longitudinal axis of the cylinder bore. In an embodiment, the included angle is about 160°. The included angle can be understood as an angle formed between the first cylinder bore axis and the second cylinder bore axis, measured from the first cylinder bore axis in a counter-clockwise direction. Further, in one embodiment, the centre-piece 108, provided between the first cylinder bore 104 and the second cylinder bore 106, is formed as a hollow cylinder.

[0026] Further, at a crankshaft end of the first cylinder bore 104, a first crankcase 110 is provided. The first crankcase 110 houses a first crankshaft 112, which is connected to a first piston 114, reciprocating in the first cylinder bore 104, through a first connecting rod 154. Similarly, a second crankcase 118 is provided at a crankshaft end of the second cylinder bore 106. A second crankshaft 120 is disposed in the second crankcase 118, and is connected to a second piston 119 through a second connecting rod 122. The second piston 119 reciprocates in the second cylinder bore 106. In one embodiment, in which the engine 100 is disposed in a vertical direction, the crankshaft end of the cylinder bore 104, 106 is a bottom dead centre of the cylinder bore 104, 106. In another embodiment, in which the engine 100 is disposed in a horizontal direction, the crankshaft end of the cylinder bore 104, 106 is an inner dead centre of the cylinder bore 104, 106.

[0027] During operation of the engine 100, the first piston 114 and the second piston 119 are at the combustion ends in the respective cylinder bores 104 and 106 at the end of a compression stroke of the engine 100. At the end of the compression stroke, i.e., when the compression of charge is almost complete, the top surface of the

first piston 114 and the top surface of the second piston 119 are adjacent to each other, as shown in fig. 1. In such a position of the pistons 114 and 120, also referred to as combustion ends of the respective cylinder bores 104 and 106, the top surfaces of the pistons 114 and 120 form a common combustion chamber 124 therebetween, along with inner lateral wall of the centre-piece 108. In an implementation, the common combustion chamber 124, when formed, includes compressed charge.

[0028] Further, an ignition element 126 is provided in the common combustion chamber 124 to achieve combustion of the compressed charge in the common combustion chamber 124. In one example, in case of a spark ignition engine, the ignition element 126 can be a spark plug, whereas in case of a compression ignition engine, the ignition element 126 can be a glow plug. In an embodiment, the ignition element 126 is disposed in a through-opening in a lateral wall of the centre-piece 108. In said embodiment, the ignition element 126 is disposed in the common combustion chamber 124 in such a way that substantially complete combustion of the charge can be achieved in the common combustion chamber 102. In another embodiment, the engine 100 can include more than one ignition elements 126 disposed in the common combustion chamber 124. It will be understood that, in other embodiments, a number of ignition elements 126 can be provided in the common combustion chamber 124, so as to achieve a substantially complete combustion of the charge in the common combustion chamber 124.

[0029] In addition, according to an embodiment, the cylinder block 102 includes one or more inlet ports 128 that are connected to a fuelling system (not shown in figure) of the engine 100, for inducting charge into the common combustion chamber 124 for combustion. For example, the fuelling system may include a carburetor or a fuel injection system. Additionally, the cylinder block 102 includes one or more exhaust ports 130 in the cylinder block 102 to allow combustion products to escape from the common combustion chamber 124, subsequent to the combustion of charge. In an implementation, to control the induction of charge into the common combustion chamber 124 and expulsion of combustion products from the common combustion chamber 124, the engine 100 includes a first sleeve 132 and a second sleeve 134 disposed in the first cylinder bore 104 and in the second cylinder bore 106, respectively. The sleeves 132, 134 may serve as a liner for the first cylinder bore 104 and the second cylinder bore 106, respectively. In an embodiment, the first sleeve 132 and the second sleeve 134 are disposed in the respective cylinder bore 104, 106 such that the sleeve 132, 134 is capable of sliding in the respective cylinder bore 104, 106 along a direction of the cylinder bore axis.

[0030] In an embodiment, the first sleeve 132 is provided with one or more inlet apertures (not shown in figure) for allowing charge to be inducted into the first cylinder bore 104. The actuation of the first sleeve 132 reg-

ulates an opening and closing of the inlet ports 128. In an implementation, the engine 100 can include a first actuation assembly (not shown in figure) to achieve actuation of the first sleeve. In said embodiment, the first actuation assembly actuates the first sleeve 132 to align the inlet apertures in the first sleeve 132 with the inlet ports 128 to open the inlet ports 128 and allow entry of charge into the first cylinder bore 104. In one embodiment, the first sleeve 132 is spring loaded on one end to keep the inlet ports 128 closed, until the first sleeve 132 is actuated to open the inlet ports 140.

[0031] In a similar manner as described above, the actuation of the second sleeve 134 can be achieved to control the expulsion of the combustion products from the engine 100. In one embodiment, the second sleeve 134 includes one or more exhaust apertures (not shown in figure), that align with the exhaust ports 130. The alignment of the exhaust apertures in the second sleeve 134 and the exhaust ports 130 is achieved by a second actuation assembly (not shown in figure). It will be understood that instead of having separate first and second actuation assemblies for the actuation of the first sleeve 132 and the second sleeve 134, in another embodiment, the engine 100 can include a single actuation assembly for the actuation of both the sleeves 132 and 134.

[0032] Further, in one embodiment, the first crankshaft 112 meshes with the second crankshaft 120. In said embodiment, the first crankshaft 112 and the second crankshaft 120 are coupled to each other through a gear train so that one of the crankshafts 112, 120 serves as a power-take-off shaft, i.e., the shaft from which the drive is finally obtained. In an embodiment, the second crankshaft 120 can be the power-take-off shaft, and in said embodiment, the second crankshaft 120 can be further connected to a transmission assembly, such as a continuously variable transmission (CVT) assembly, for further providing a drive, for example, to a vehicle on which the engine 100 is mounted and implemented.

[0033] Further, during operation of the engine 100, the reciprocatory movement of the first piston 114 and the second piston 119 in the respective cylinder bore 104, 106, a suction pressure is created in the crankcases 110 and 118. To avoid the formation of such suction pressure during operation, the engine 100 is provided with crankcase ventilation. In an embodiment, the engine 100 can include a plurality of crankcase chambers formed in one of the crankcases 110, 118 for forming a passage for exit of air-lubricant mixture from the crankcase 110, 118. In an example, the crankcase chambers can be formed in a wall of the crankcase 110, 118. The air-lubricant mixture, as will be understood, can be formed during operation of the engine 100, when the high temperatures reached during combustion of charge in the common combustion chamber 124 cause vapourization of the lubricant inside the engine 100. The vapours of the lubricant can mix with the air inside the crankcases 110, 118 and form the air-lubricant mixture.

[0034] Further, according to said embodiment, the cyl-

inder block 102 can be provided with one or more ventilation passages (not shown in the figure) for the passage of the air-lubricant mixture from one crankcase, say the first crankcase 110, to the other crankcase, say the second crankcase 118, to allow the exit of the air-lubricant mixture. As a result, the crankcase ventilation of the both the crankcases 110, 118 can be achieved through one of the crankcases 110, 118 in which the crankcase chambers are formed.

[0035] According to an aspect of the present subject matter, the sizes of the crankcase chambers formed in the crankcase 110, 118 progressively decrease as the distance of the passage formed by the crankcase chamber decreases from an exit opening in the crankcase for the exit of the air-lubricant mixture. For example, if the crankcase 110, 118 includes three crankcase chambers, the air-lubricant mixture flowing sequentially from the first crankcase chamber to the third crankcase chamber and finally exits the crankcase 110, 118, then the size of the crankcase chambers progressively decreases from the first crankcase chamber to the third crankcase chamber.

[0036] In addition, according to an embodiment, the crankcase 110, 118 in which the chambers are formed can further have a breather cover (not shown in figure) fixed thereon. In an aspect of the present subject matter, the breather cover can be fixed to the crankcase 110, 118 and can be in direct fluid connection with an exit opening for the air-lubricant mixture from the crankcase 110, 118. Further, according to an embodiment of the present subject matter, the breather cover can also include one or more breather chambers, which, along with the crankcase chambers, serve as passage for the exit of the air-lubricant mixture from the crankcase 110, 118 and into the atmosphere. In another case, the air-lubricant mixture may also go back into an air filter rather than going directly into the atmosphere.

[0037] According to an embodiment, the flow of the air-lubricant mixture through the crankcase chambers and the breather chambers is such that the air-lubricant mixture flows alternately through the crankcase chambers and breather chambers while exiting the engine 100. For example, while exiting the crankcase 110, 118, the air-lubricant mixture first passes through one crankcase chamber, and then into one breather chamber. Subsequently, from the breather chamber, the air-lubricant mixture flows back into another crankcase chamber, and so on. Accordingly, in said embodiment, the size of each of the breather chambers is less than the size of the preceding crankcase chamber, in sequence of the passage of the air-lubricant mixture. With such a construction of the crankcase chambers and the breather chambers, according to an aspect, the size of one chamber is substantially less than the size of the immediately preceding and the immediately succeeding chamber.

[0038] As a result, the air-lubricant mixture undergoes a constant contraction and expansion of volume. During each of the contraction processes, the temperature of the air-lubricant mixture drops, due to which substantial

amount of the lubricant vapours in the air-lubricant mixture condense. Further, the condensate, i.e., the lubricant, flows back into the crankcase 110, 118, and assists in the lubrication of the engine 100 and other components. Hence, according to the present subject matter, the lubricant in the air-lubricant mixture is preserved and the loss of the lubricant is prevented. Therefore, the service life of the engine 100 is enhanced and also the cost of the running of the engine 100 is reduced.

[0039] In another embodiment, which is not part of the invention, the flow of the air-lubricant mixture occurs sequentially from the crankcase 110, 118 and then to the breather cover. In said embodiment, the size of each alternate chamber, starting from a first chamber in the crankcase, is greater than the size of the successive chamber, in order to allow the air-lubricant mixture to undergo the sequential contraction and expansion processes, for achieving the condensation of substantially all the lubricant vapours in the air-lubricant mixture. As will be understood, the flow of the air-lubricant mixture through the crankcase chambers and the breather chambers in any sequence in which the size of one chamber is substantially less than the size of the immediately preceding and the immediately succeeding chamber.

[0040] Fig. 2 illustrates an exploded perspective view of the engine 100, according to an embodiment of the present subject matter. In said embodiment, fig. 2 illustrates certain components of the engine 100. In said embodiment, the fig. 2 illustrates the cylinder block 102, the first crankcase 110, and a breather cover 202 of the engine 100. According to said embodiment, the crankcase chambers (not shown) are formed in the first crankcase 110.

[0041] In an embodiment, the cylinder block 102 can be formed as a single, integrated component having cavities for housing various components of the engine 100. For example, the cylinder block 102 can include the first cylinder bore 104 and the second cylinder bore 106 (not shown in the figure) for housing the first sleeve 132 and the second sleeve 134, respectively. In another embodiment, the cylinder block 102 can be formed of a plurality of blocks connected together to form the cylinder block 102.

[0042] According to an aspect, as mentioned earlier, in order to allow crankcase ventilation, the cylinder block 102 is provided with one or more ventilation passages (not shown in the figure). In an implementation, a ventilation passage is formed vertically below each of a first actuation assembly servicing window 204 and a second actuation assembly servicing window 206 formed in the cylinder block 102, for servicing the first actuation assembly and the second actuation assembly (both not shown), respectively. As explained previously, the first actuation assembly and the second actuation assembly are responsible for the actuation of the first sleeve 132 and the second sleeve 134, respectively, during operation of the engine 100. In said embodiment, the two ventilation passages, formed vertically below the actuation

assembly servicing windows 204 and 206, are formed on lateral sides of the engine 100, i.e., on either side of a vertical plane passing through a central longitudinal axis (not shown) of the engine 100. In addition, in said embodiment, the ventilation passages can be formed as a through-passage from one end of the cylinder block 102 to the other end, in the direction of the central longitudinal axis of the engine 100. The central longitudinal axis can be understood as an axis extending in a direction substantially parallel to the cylinder bores 104, 106, along a length of the cylinder block 102.

[0043] Further, on a distal end 208, the cylinder block 102 has the first crankcase 110 attached thereto, the first crankcase 110 can be adapted to house the first crankshaft 112 (not shown in the figure). The first crankshaft 112 can have the gear train mounted thereon for meshing with the second crankshaft 120 (not shown in the figure), in order to transmit the final drive to the second crankshaft 120. As mentioned previously, the second crankshaft 120 can be housed inside the second crankcase 118 (not shown in the figure) mounted on a distal end 208 of the cylinder block 102.

[0044] Further, according to an embodiment of the present subject matter, the breather cover 202 is mounted on the first crankcase 110. According to an aspect, the breather cover 202 can have one or more breather chambers (not shown) in fluid connection with the crankcase chambers in the first crankcase 110. As explained earlier, the air-lubricant mixture from the crankcases 110, 118 are expelled through the crankcase chambers and the breather chambers, where the condensation of the lubricant vapours is achieved. In addition, in said embodiment, the breather cover 202 can be mounted on the first crankcase 110 along with a breather gasket 210. The breather gasket 210 can serve as a sealing component which provides a leakage proof mounting of the breather cover 202 on the first crankcase 110. In addition, the breather gasket 210 can also be provided with a plurality of holes to serve as passage for the air-lubricant mixture, during the movement of the air-lubricant mixture between the first crankcase 110 and the breather cover 210. The construction and functionalities associated with the first crankcase 110, the breather gasket 210, and the breather cover 202, with reference to crankcase ventilation, are described in detail with reference to fig. 3 (a) and fig. 3(b)

[0045] Further, in other embodiments of the present subject matter, as explained earlier, the breather cover 202 can be mounted on the second crankcase 118. In said embodiment, the first crankshaft 112 housed in the first crankcase 110 can be a power take-off shaft. In such a case, one end of the first crankshaft 112 can be connected to the transmission assembly, such as the CVT assembly, and the other end can have a dynamo or a starter-generator assembly mounted thereon.

[0046] Fig. 3 (a) illustrates a front view of the first crankcase 110, the breather cover 202, and the breather gasket 210 of the engine 100, in accordance with an embod-

iment of the present subject matter. Fig. 3 (b) illustrates a schematic diagram showing the flow of the air-lubricant mixture through the various chambers of the first crankcase 110 and the breather cover 202, according to an implementation of the present subject matter. For the purpose of brevity, fig. 3 (a) and fig. 3 (b) will be described in conjunction herein.

[0047] According to the embodiment shown in fig. 3 (a), the first crankcase 110 can include a first crankcase chamber 302, a second crankcase chamber 304, and a third crankcase chamber 306. In said embodiment, the first crankcase chamber 302 is not in fluid connection with the second crankcase chamber 304 and the third crankcase chamber 306. Further, in said embodiment, the second crankcase chamber 304 and the third crankcase chamber 306 can be in direct fluid communication. In another embodiment, the three crankcase chambers 302, 304, and 306 can be in direct fluid connection with each other. In yet another embodiment, the three crankcase chambers 302, 304, and 306 can be formed to be fluidically isolated, i.e., the three crankcase chambers 302, 304, and 306 are not in direct fluidic communication with each other. In said embodiment, as will be understood along with the description provided later, the crankcase chambers 302, 304, and 306 may be fluidically isolated from each other but in the assembled state of the first crankcase 110 and the breather cover 202, they are in indirect fluidic communication with each other.

[0048] Further, in the embodiment shown in fig. 3 (a), the breather cover 202 can include a first breather chamber 308 and a second breather chamber 310. In said embodiment, the first breather chamber 308 can be fluidically isolated from the second the second breather chamber 310, i.e., the first breather chamber 308 is not in direct fluid communication with the second breather chamber 310. In other embodiments, however, the first breather chamber 308 and the second breather chamber 310 can be in direct fluid communication with each other.

[0049] According to an aspect of the present subject matter, when the breather cover 202 is mounted on the first crankcase 110, the crankcase chambers 302, 304, and 306 come in direct or indirect fluid communication with the breather chambers 308 and 310. Further as mentioned earlier, the breather gasket 210 can include a plurality of holes 314-1, 314-2, and 314-3, collectively referred to as holes 314. The holes 314 can serve as a connecting passage between the crankcase chambers 302, 304, and 306 and the breather chambers 308 and 310, based on the sequence in which they are fluidically connected for flow of air-lubricant mixture out of the engine 100.

[0050] According to an aspect of the present subject matter, the size of the crankcase chambers 302, 304, and 306 decreases progressively, i.e., the size of the first crankcase chamber 302 is greater than the size of the second crankcase chamber 204, and the size of the second crankcase chamber 304 is greater than the size of the third crankcase chamber 308. Further, the size of the

breather chambers 308 and 310 also decreases progressively, which means that the size of the first breather chamber 308 is more than the size of the second breather chamber 310.

[0051] According to an aspect, the sizes of the crankcase chambers 302, 304, and 306, and correspondingly, the sizes of the breather chambers 308 and 310 can be provided based on the sequence in which the air-lubricant mixture passes through the chambers 302, 304, 306, 308, and 310. For example, the sizes of the chambers 302, 304, 306, 308, and 310 can be provided in such a way that the air-lubricant mixture undergoes a continual expansion and contraction of volume, while passing through each of the chambers 302, 304, 306, 308, and 310. Accordingly, in an implementation, the size of one chamber 302, 304, 306, 308, 310 is substantially less than the size of the immediately preceding and the immediately succeeding chamber 302, 304, 306, 308, 310. Such an implementation is depicted in fig. 3 (b).

[0052] The schematic shown in fig. 3 (b) illustrates the implementation in which the air-lubricant mixture alternatively passes through the first crankcase 110 and the breather cover 202. As described above, in said implementation, the size of the first breather chamber 308 can be less than the size of the first crankcase chamber 302 as well as the size of the second crankcase chamber 304. Further, the size of the second breather chamber 310 can be less than the size of the third crankcase chamber 306. As will be understood, the sequence in which the air-lubricant mixture passes through the first crankcase 110 and the breather cover 202 is not limited to said implementation, and other implementations are also possible.

[0053] In an example, in the above implementation, the volume of the first crankcase chamber 302 can be about 19.6 cubic centimeter (cc), the volume of the second crankcase chamber 304 can be about 15.4 cc, and the volume of the third crankcase chamber 306 can be about 9.59 cc. Further, in said example, the volume of the first breather chamber 308 can be about 11.3 cc and the volume of the second breather chamber 310 can be about 9.59 cc. The volumes of the chambers 302, 304, 306, 308, and 310 can be, in one example, provided for the engine 100 with a capacity of about 100cc to about 150 cc. As will be understood, the volume of the chambers 302, 304, 306, 308, and 310 may vary based on the capacity of the engine 100.

[0054] As a result of such construction of the chambers 302, 304, 306, 308, and 310, when the air-lubricant mixture passes alternatively through the crankcase chambers 302, 304, and 306 and the breather chambers 308 and 310, a continual contraction and expansion of the air-lubricant mixture is achieved. As explained earlier, the contraction and expansion process causes a reduction in the temperature of the air-lubricant mixture, as a result of which, a substantial amount of lubricant vapours from the air-lubricant mixture undergo condensation. The condensed lubricant flows back into the first crankcase

110, and mixes with the already present lubricant in the engine 100. As a result, according to aspects of the present subject matter, the loss of lubricant in the form of vapours is substantially prevented, which in turn increases the periods between consecutive services of the engine 100. Further, the cost of running the engine 100 is also substantially reduced.

[0055] Further, in said implementation, the first crankcase 110 can include a connecting passage 312 between the second crankcase passage 304 and the third crankcase chamber 306 for providing a fluidic connection between the two, to allow flow of the air-lubricant mixture.

[0056] Further, according to an implementation, each of the first crankcase chamber 302, the second crankcase chamber 304, the third crankcase chamber 306, the first breather chamber 308, and the second breather chamber 310 can include a plurality of baffle plates (not shown). The baffle plates provided in each chamber 302, 304, 306, 308, 310 can obstruct the flow of the air-lubricant mixture. Such obstruction can cause the lubricant vapours, which are heavier and denser than air, to be left behind in the first crankcase 110 and/or the breather cover 202, where the lubricant vapours can condense and flow back to the engine 100. As a result, the provision of the baffle plates further prevents the loss of lubricant from the engine 100, and complements the operation of crankcase ventilation in the engine 100.

[0057] As will be understood that although it has been mentioned that the mixture of air and lubricant flows out of the engine 100, as a result of the aspects of the present subject matter the air-lubricant mixture flowing out of the engine 100 is substantially devoid of lubricant vapours.

Claims

1. An internal combustion engine (100) having crankcase ventilation, the internal combustion engine (100) comprising:

a crankcase (110, 118) housing a crankshaft (112, 120) of the internal combustion engine (100), the crankcase (110, 118) comprising plurality of crankcase chambers (302, 304, 306); and
a breather cover (202) detachably attached to the crankcase (110, 118), the breather cover (202) comprising plurality of breather chambers (308, 310);

characterized in that

said plurality of crankcase chambers (302, 304, 306) and said plurality of breather chambers (308, 310) are in fluidic connection forming a passage for an air-lubricant mixture to pass alternatively through the plurality of crankcase chambers (302, 304, 306) and the plurality of breather chambers (308, 310) and to exit through the crankcase (110, 118); and

at least a first crankcase chamber (302) of said plurality of crankcase chambers (302, 304, 306) has a size substantially greater than that of at least a first breather chamber (308) of said plurality of breather chambers (308, 310).

2. The internal combustion engine (100) as claimed in claim 1, wherein the first crankcase chamber (302) is in fluid connection with the first breather chamber (308) through a breather gasket (210), the breather gasket (210) comprising an opening for providing the fluid connection between the crankcase (110, 118) and the breather cover (202).
3. The internal combustion engine (100) as claimed in claim 1, wherein the crankcase (110, 118) further comprises a second crankcase chamber (304) and a third crankcase chamber (306), the third crankcase chamber (306) receiving the air-lubricant mixture from the first breather chamber (308) through the second crankcase chamber (304), wherein a size of the second crankcase chamber (304) is substantially greater than a size of the third crankcase chamber (306).
4. The internal combustion engine (100) as claimed in claim 3, wherein the breather cover (202) further comprises a second breather chamber (310) in direct fluid connection with the third crankcase chamber (306) to receive the air-lubricant mixture from the third crankcase chamber (306), the size of the third crankcase chamber (306) being substantially greater than the size of the second breather chamber (310).
5. The internal combustion engine (100) as claimed in any one of the preceding claims, wherein at least one of the first crankcase chamber (302), the second crankcase chamber (304), the third crankcase chamber (306), the first breather chamber (308), and the second breather chamber (310) comprises a plurality of baffles plates obstructing a flow of the air-lubricant mixture in the crankcase (110, 118) and in the breather cover (202).
6. The internal combustion engine (100) as claimed in any one of the preceding claims, wherein the internal combustion engine (100) is a common combustion chamber inclined bore engine (100).
7. The internal combustion engine (100) as claimed in any one of the preceding claims, wherein the breather cover (202) further comprises a second breather chamber (310) in fluid connection with the first breather chamber (308) to receive the air-lubricant mixture from the first breather chamber (308), the size of the first breather chamber (308) being substantially greater than the size of the second breather

chamber (310).

Patentansprüche

1. Verbrennungsmotor (100) mit Kurbelraumventilation, wobei der Verbrennungsmotor (100) umfasst:

ein Kurbelgehäuse (110, 118), in dem eine Kurbelwelle (112, 120) des Verbrennungsmotors (100) untergebracht ist, wobei das Kurbelgehäuse (110, 118) eine Vielzahl von Kurbelraumkammern (302, 304, 306) aufweist, und eine an dem Kurbelgehäuse (110, 118) lösbar angebrachte Lüftungsabdeckung (202), welche eine Vielzahl von Lüftungskammern (308, 310) aufweist;

dadurch gekennzeichnet, dass

die Vielzahl von Kurbelraumkammern (302, 304, 306) und die Vielzahl von Lüftungskammern (308, 310) in Fluid-Verbindung stehen und einen Durchgang für ein Luft-Schmiermittel-Gemisch zum abwechselnden Durchlaufen der Vielzahl von Kurbelraumkammern (302, 304, 306) und Vielzahl von Lüftungskammern (308, 310) und zum Austreten durch das Kurbelgehäuse (110, 118) bilden, und zumindest eine erste Kurbelraumkammer (302) aus der Vielzahl von Kurbelraumkammern (302, 304, 306) eine Größe hat, die wesentlich größer als jene einer ersten Lüftungskammer (308) aus der Vielzahl von Lüftungskammern (308, 310) ist.

2. Verbrennungsmotor (100) nach Anspruch 1, wobei die erste Kurbelraumkammer (302) in Fluid-Verbindung mit der ersten Lüftungskammer (308) durch eine Lüftungsichtung (210) steht, wobei die Lüftungsichtung (210) eine Öffnung zum Herstellen der Fluid-Verbindung zwischen dem Kurbelgehäuse (110, 118) und der Lüftungsabdeckung (202) aufweist.
3. Verbrennungsmotor (100) nach Anspruch 1, wobei das Kurbelgehäuse (110, 118) zudem eine zweite Kurbelraumkammer (304) und eine dritte Kurbelraumkammer (306) aufweist, wobei die dritte Kurbelraumkammer (306) das Luft-Schmiermittel-Gemisch aus der ersten Lüftungskammer (308) durch die zweite Kurbelraumkammer (304) empfängt, wobei eine Größe der zweiten Kurbelraumkammer (304) wesentlich größer ist als eine Größe der dritten Kurbelraumkammer (306).
4. Verbrennungsmotor (100) nach Anspruch 3, wobei die Lüftungsabdeckung (202) zudem eine zweite Lüftungskammer (310) in direkter Fluid-Verbindung mit der dritten Kurbelraumkammer (306) aufweist, um das Luft-Schmiermittel-Gemisch aus der dritten

Kurbelraumkammer (306) zu empfangen, wobei die Größe der dritten Kurbelraumkammer (306) wesentlich größer ist als die Größe der zweiten Lüftungskammer (310).

5. Verbrennungsmotor (100) nach einem der vorhergehenden Ansprüche, wobei zumindest eine aus der ersten Kurbelraumkammer (302), zweiten Kurbelraumkammer (304), dritten Kurbelraumkammer (306), ersten Lüftungskammer (308) und zweiten Lüftungskammer (310) eine Vielzahl von Baffleplatten aufweist, die eine Strömung des Luft-Schmiermittel-Gemischs in dem Kurbelgehäuse (110, 118) und in der Lüftungsabdeckung (202) aufhält.
6. Verbrennungsmotor (100) nach einem der vorhergehenden Ansprüche, wobei der Verbrennungsmotor (100) ein Motor (100) mit gemeinsamer Verbrennungskammer und geneigten Zylinderbohrungen ist.
7. Verbrennungsmotor (100) nach einem der vorhergehenden Ansprüche, wobei die Lüftungsabdeckung (202) zudem eine zweite Lüftungskammer (310) in Fluid-Verbindung mit der ersten Lüftungskammer (308) aufweist, um das Luft-Schmiermittel-Gemisch von der ersten Lüftungskammer (308) zu empfangen, wobei die Größe der ersten Lüftungskammer (308) wesentlich größer ist als die Größe der zweiten Lüftungskammer (310).

Revendications

1. Moteur à combustion interne (100) ayant une ventilation de carter de moteur, le moteur à combustion interne (100) comprenant :

un carter de moteur (110, 118) recevant un vilebrequin (112, 120) du moteur à combustion interne (100), le carter de moteur (110, 118) comprenant une pluralité de chambres de carter de moteur (302, 304, 306) ; et

un couvercle de reniflard (202) fixé de manière détachable au carter de moteur (110, 118), le couvercle de reniflard (202) comprenant une pluralité de chambres de reniflard (308, 310) ;

caractérisé par le fait que

ladite pluralité de chambres de carter de moteur (302, 304, 306) et ladite pluralité de chambres de reniflard (308, 310) sont en liaison fluide formant un passage pour permettre à un mélange air/lubrifiant de passer de manière alternée à travers la pluralité de chambres de carter de moteur (302, 304, 306) et la pluralité de chambres de reniflard (308, 310) et de sortir à travers le carter de moteur (110, 118) ; et
au moins une première chambre de carter de

moteur (302) parmi ladite pluralité de chambres de carter de moteur (302, 304, 306) a une taille sensiblement plus grande que celle d'au moins une première chambre de reniflard (308) parmi ladite pluralité de chambres de reniflard (308, 310).

2. Moteur à combustion interne (100) selon la revendication 1, dans lequel la première chambre de carter de moteur (302) est en liaison fluide avec la première chambre de reniflard (308) par l'intermédiaire d'un joint de reniflard (210), le joint de reniflard (210) comprenant une ouverture pour établir la liaison fluide entre le carter de moteur (110, 118) et le couvercle de reniflard (202) .

3. Moteur à combustion interne (100) selon la revendication 1, dans lequel le carter de moteur (110, 118) comprend en outre une deuxième chambre de carter de moteur (304) et une troisième chambre de carter de moteur (306), la troisième chambre de carter de moteur (306) recevant le mélange air/lubrifiant provenant de la première chambre de reniflard (308) par l'intermédiaire de la deuxième chambre de carter de moteur (304), une taille de la deuxième chambre de carter de moteur (304) étant sensiblement plus grande qu'une taille de la troisième chambre de carter de moteur (306).

4. Moteur à combustion interne (100) selon la revendication 3, dans lequel le couvercle de reniflard (202) comprend en outre une seconde chambre de reniflard (310) en liaison fluide directe avec la troisième chambre de carter de moteur (306) pour recevoir le mélange air/lubrifiant provenant de la troisième chambre de carter de moteur (306), la taille de la troisième chambre de carter de moteur (306) étant sensiblement plus grande que la taille de la seconde chambre de reniflard (310).

5. Moteur à combustion interne (100) selon l'une quelconque des revendications précédentes, dans lequel au moins une parmi la première chambre de carter de moteur (302), la deuxième chambre de carter de moteur (304), la troisième chambre de carter de moteur (306), la première chambre de reniflard (308) et la seconde chambre de reniflard (310) comprend une pluralité de déflecteurs bloquant un écoulement du mélange air/lubrifiant dans le carter de moteur (110, 118) et dans le couvercle de reniflard (202).

6. Moteur à combustion interne (100) selon l'une quelconque des revendications précédentes, dans lequel le moteur à combustion interne (100) est un moteur à alésage incliné à chambre de combustion classique (100).

7. Moteur à combustion interne (100) selon l'une quelconque des revendications précédentes, dans lequel le couvercle de reniflard (202) comprend en outre une seconde chambre de reniflard (310) en liaison fluïdique avec la première chambre de reniflard (308) pour recevoir le mélange air/lubrifiant provenant de la première chambre de reniflard (308), la taille de la première chambre de reniflard (308) étant sensiblement plus grande que la taille de la seconde chambre de reniflard (310).

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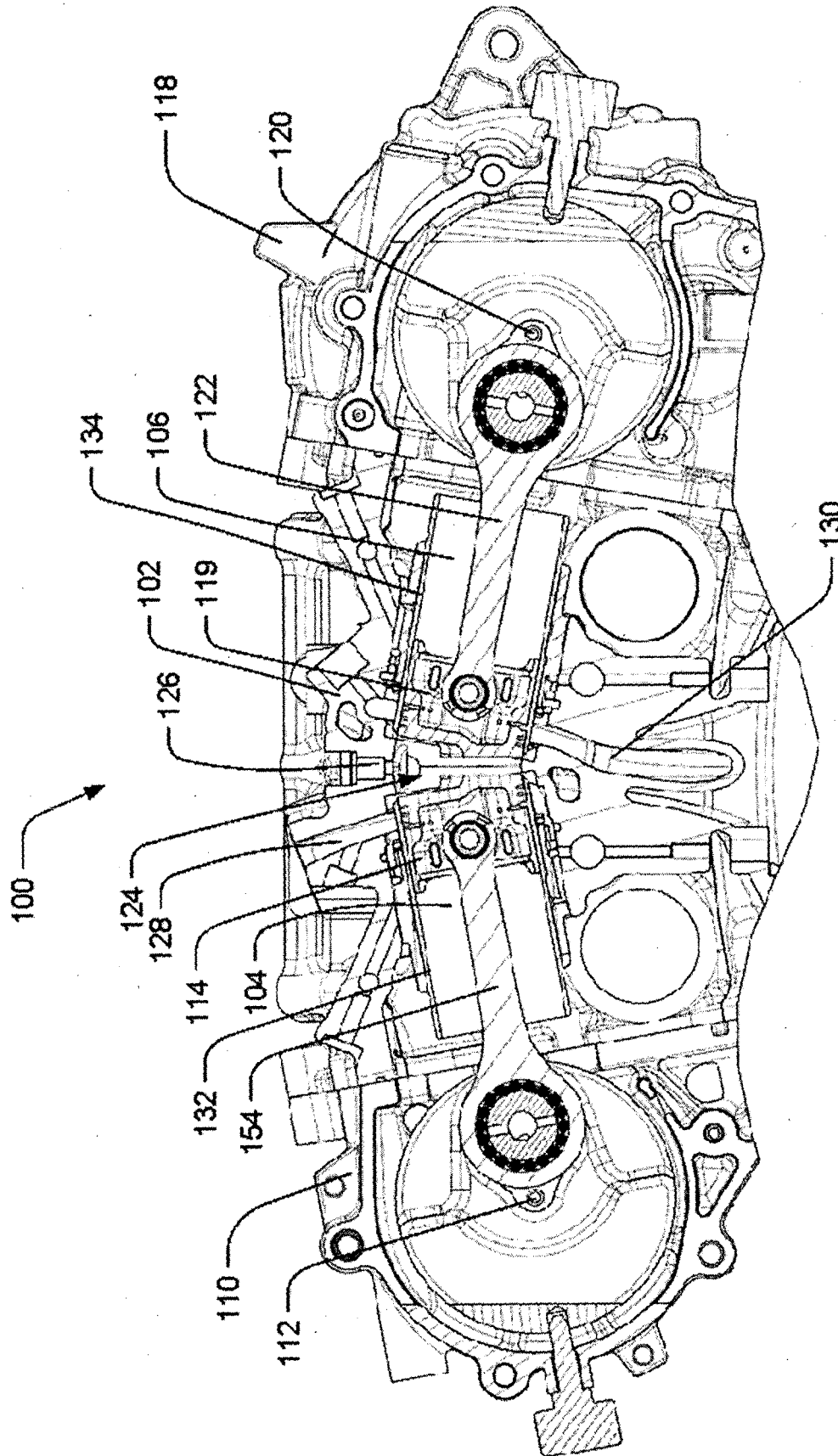


Fig. 1

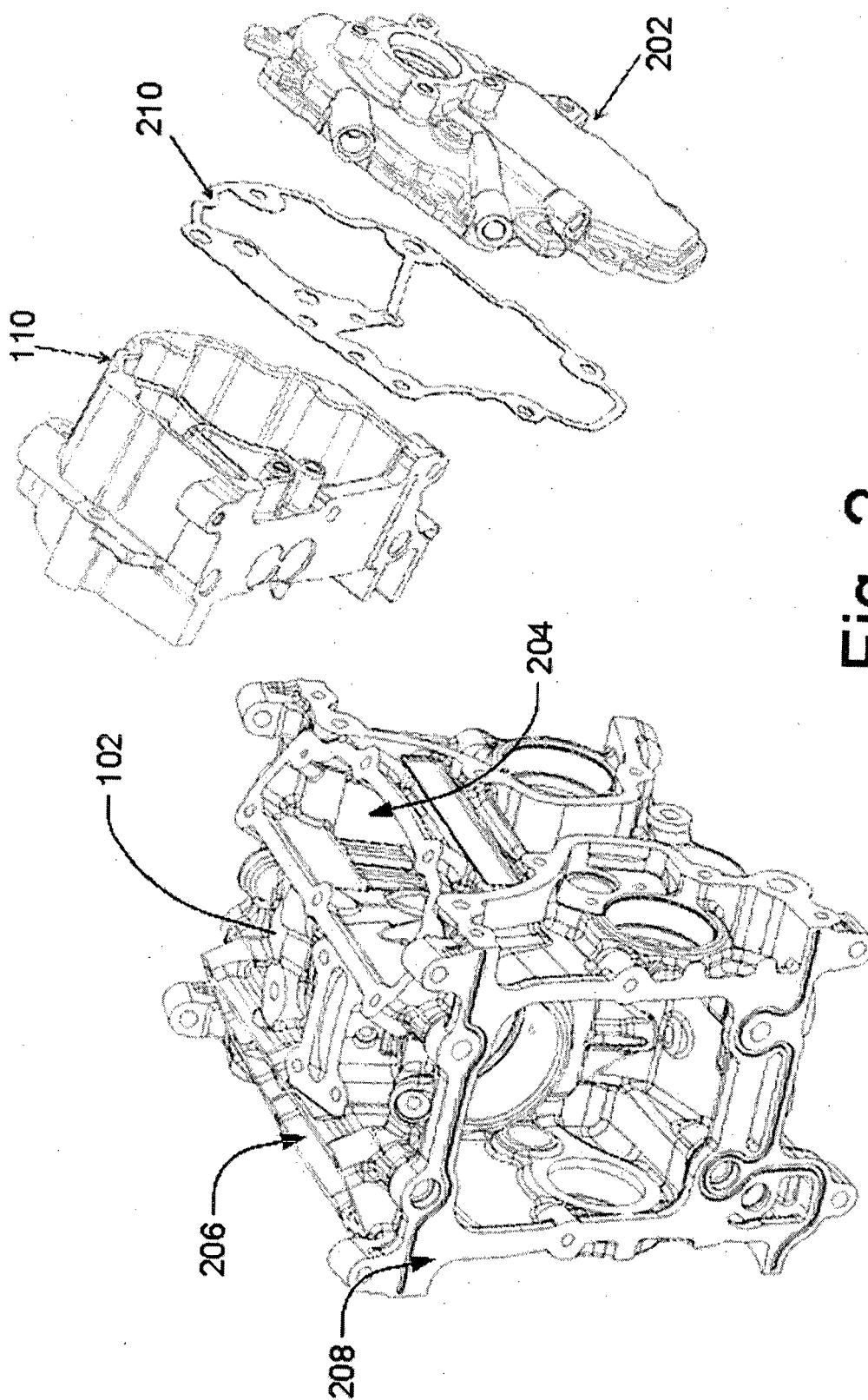


Fig. 2

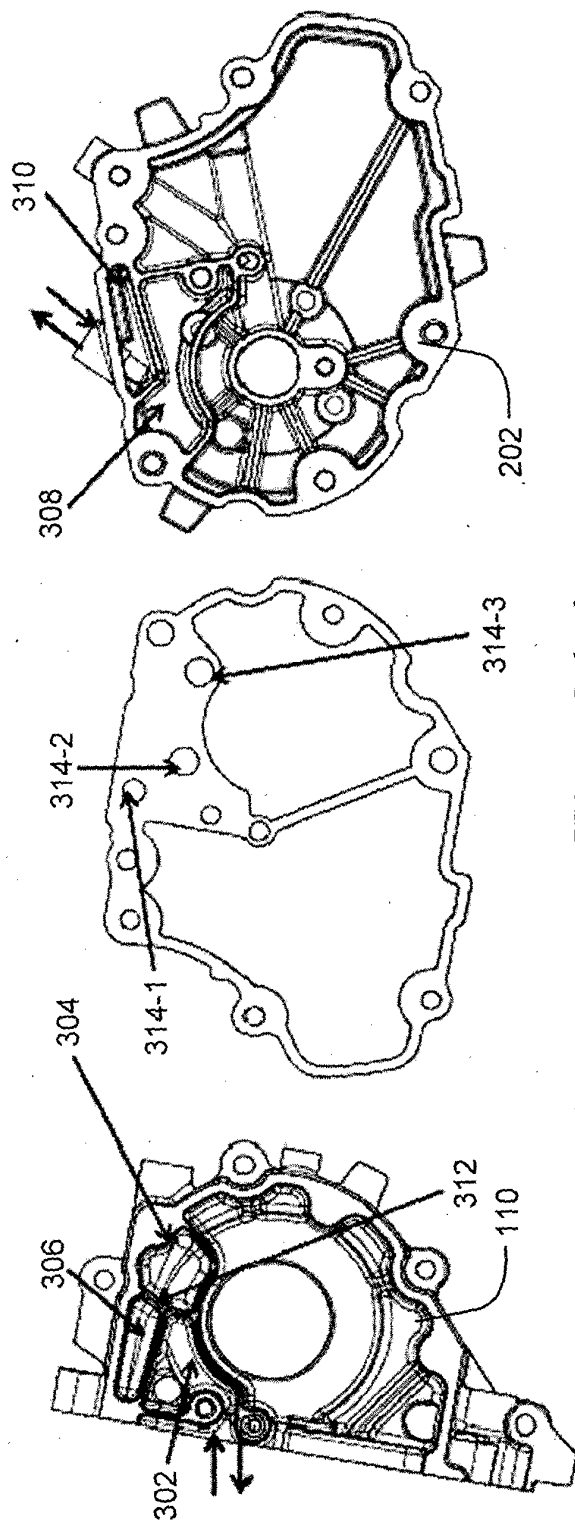


Fig. 3(a)

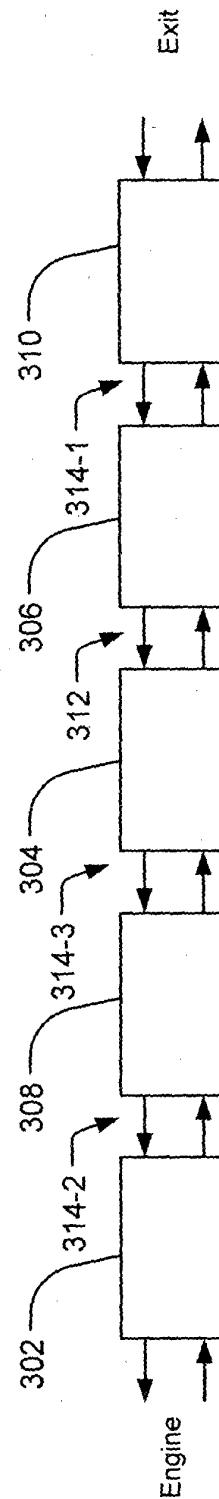


Fig. 3(b)