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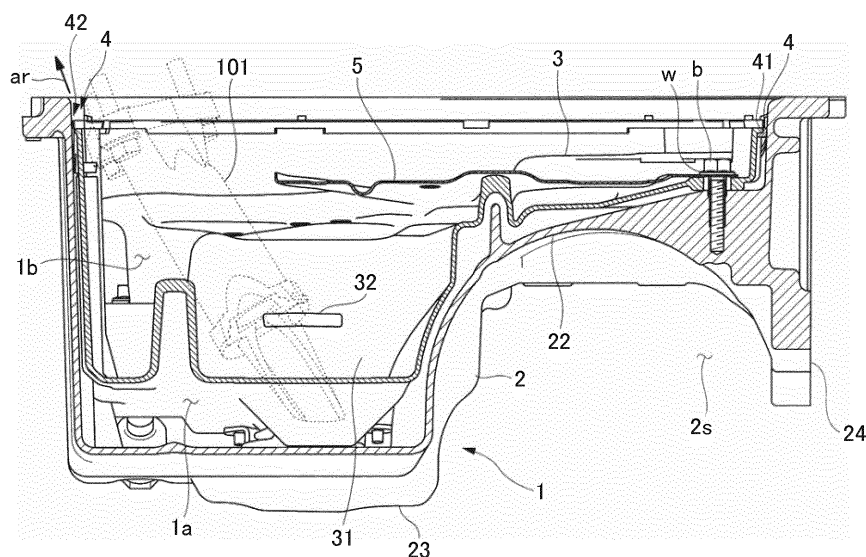
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(54) **Oil pan**

(57) An oil pan (1) includes an oil pan body (2), an oil separator (3) and a seal member (41). The oil separator (3) is configured to partition inside the oil pan body (2) into an inner tank (1b) and an outer tank (1a). The inner tank and the outer tank are configured to communicate with each other through an opening (32). The seal member (41) is provided in an area above the opening. The seal member (41) is configured to fill a gap between

the oil pan body and the oil separator. The seal member (41) has a communicating part configured to make inside and outside of the outer tank communicated with each other by cutting out a part of the seal member (41). An oil passage (102) that connects an oil strainer (101) with an oil pump (103) is arranged above the communicating part (42).

FIG. 3



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a double-tank type oil pan having an inner tank and an outer tank.

2. Description of Related Art

[0002] A double-tank type oil pan has been known, which is partitioned into an inner tank and an outer tank by assembling an oil separator inside an oil pan body that is assembled to a bottom part of an internal combustion engine (for example, see Japanese Patent Application Publication No. 2006-249951 (JP 2006-249951 A)). In such an oil pan, only oil, which serves as lubricant and is stored in the inner tank, is circulated after the engine is started to increase temperature of the oil in order to warm up an internal combustion engine in an early stage.

[0003] Incidentally, the oil that is used to lubricate the internal combustion engine is returned to the oil pan after going through an oil dropping passage provided in a cylinder block, and a crankshaft. The oil returned through the crankshaft to the oil pan is scattered with rotation of the crankshaft, and runs down along an inner wall of the cylinder block. A part of the oil returned through the dropping passage also runs down along the inner wall of the cylinder block. The oil that has run down along the inner wall of the cylinder block as stated above passes through a gap formed in an edge part of the oil pan body from the oil separator, and is flown into the outer tank. Then, when a maximum storage of the outer tank is exceeded, the oil starts flowing into the inner tank. In such a case, temperature of the oil stored in the inner tank is decreased, and it may not be possible to warm up the internal combustion engine in an early stage.

[0004] As measures to solve the above-mentioned problem, it is considered to seal the gap by using a seal member so that oil running down from above is prevented from flowing into the outer tank, thereby allowing the oil to flow into the inner tank.

[0005] However, when the gap is sealed, an upward flow of air from the outer tank is also blocked, which can hinder circulation of oil between the outer tank and the inner tank.

SUMMARY OF THE INVENTION

[0006] The invention provides an oil pan for an internal combustion engine, by which early warming performance is improved while keeping oil circulated between an outer tank and an inner tank.

[0007] An oil pan related to the present invention is for an internal combustion engine. The oil pan includes an oil pan body, an oil separator and a seal member. The oil pan body is configured to store lubricant. The oil sep-

arator is configured to partition inside the oil pan body into an inner tank and an outer tank. The inner tank and the outer tank are configured to communicate with each other through an opening. The seal member is provided in an area above the opening. The seal member is configured to fill a gap between the oil pan body and the oil separator. The seal member has a communicating part. The communicating part is configured to make inside and outside of the outer tank communicated with each other by cutting out a part of the seal member. An oil passage that connects an oil strainer with an oil pump is arranged above the communicating part.

[0008] With such a structure, it is possible to raise the oil in the inner tank in an early stage by allowing most of the oil that has fallen from above to flow into the inner tank. By maintaining a flow of air between the outer tank and an upper side by the communicating part, circulation of oil between the outer tank and the inner tank is also maintained. In addition, in the oil pan according to the invention, the oil passage is positioned above the communicating part. With this structure, a flow of oil from above the communicating part to the outer tank is effectively avoided without adding a new part. According to the invention, it is possible to provide an oil pan for an internal combustion engine, by which early warming performance is improved while maintaining circulation of oil between the outer tank and the inner tank.

[0009] Further, a timing chain cover may be positioned above the communicating part. Because of this, air is able to easily escape from the outer tank through the communicating part.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Features, advantages, and technical and industrial significance of exemplary embodiments of the invention will be described below with reference to the accompanying drawings, in which like numerals denote like elements, and wherein:

FIG. 1 is a schematic structural view of an internal combustion engine according to an embodiment of the invention;

FIG. 2 is a plan view of an oil pan according to the embodiment;

FIG. 3 is a sectional view taken along the line A - A in FIG. 2;

FIG. 4 is a plan view of an oil pan body according to the embodiment; and

FIG. 5 is a structural explanatory view based on a sectional view taken along the line B - B in FIG. 4.

DETAILED DESCRIPTION OF EMBODIMENTS

[0011] An embodiment of the invention is explained below with reference to the drawings.

[0012] In an internal combustion engine having an oil pan 1 according to the embodiment, the oil pan 1 that

also serves as a crankcase is assembled to a lower end of an internal combustion engine body 100 having three cylinders (not shown).

[0013] As schematically shown in FIG. 1, the internal combustion engine body 100 rotates crankshafts 106 by transmitting up and down movements of pistons 107 to the crankshafts 106 through connecting rods 108. The pistons 107 are arranged in the three cylinders formed between a cylinder block and a cylinder head. The crankshafts 106 are connected with a transmission side on the right side in the drawing where a transmission case TC is arranged, and also transmit rotary motion to an oil pump 103 and a timing chain 104 for allowing oil, which serves as lubricant, to lubricate inside the internal combustion engine body 100. A lower side of the oil pump 103 is connected with an oil strainer 101 arranged inside the oil pan 1 through an oil passage 102. The oil pump 103 sucks up oil in the oil pan 1 from the oil strainer 101 and circulates the oil upward. A timing chain cover 105 covers the timing chain 104 that is wound on a crank sprocket (not shown) fixed to the crankshaft 106, and a cam sprocket fixed to a cam shaft (not shown). In this embodiment, a structure is applied, in which the oil pump 103 is attached to the timing chain cover 105 as an example. In this specification, "upward, above or an upper side" and "downward, below or a lower side" mean "vertically upward or above" and "vertically downward or below".

[0014] As shown in FIG. 1 to FIG. 5, the oil pan 1 mainly includes an oil pan body 2 for storing lubricant, which is assembled to a bottom part of the internal combustion engine body 100, an oil separator 3 for partitioning inside the oil pan body 2 into an outer tank 1a and an inner tank 1b, and a baffle plate 5 that covers an upper part of the oil separator 3.

[0015] The oil pan 1 according to this embodiment is a double-tank type oil pan 1 in which the oil separator 3 has an opening 32 that communicates the inner tank 1b and the outer tank 1a. The oil pan 1 is characterized in that a seal member 41 is provided to fill a gap between the oil pan body 2 and the oil separator 3 in an area above the opening 32. The oil pan is also characterized in that a communicating part 42, which communicates inside and outside the outer tank 1a, is provided by cutting out a part of the seal member 41, and that the oil passage 102, which connects the oil strainer 101 with the oil pump 103, is positioned above the communicating part 42.

[0016] A specific structure of the oil pan 1 is explained below. The oil pan 1 includes not only the above-mentioned oil pan body 2, the oil separator 3, and the baffle plate 5, but also a sealing part 4, which fills a gap between the oil pan body 2 and the oil separator 3, in an upper end part of the oil pan body 2.

[0017] As shown in FIG. 2 and FIG. 4, the oil separator 3 is fixed to the oil pan body 2 at six locations in total by using bolts b and washers w, and the baffle plate 5 is also fixed to the oil pan body 2 by being fastened together with the oil separator 3 at four locations among the fore-

going six locations. On one end side of the oil pan body 2, a joining part 24 having a vertical wall is formed so as to be joined to the transmission case TC. The other end side of the oil pan body 2 is formed to be the deepest so that the deepest bottom part 23 for storing a sufficient amount of oil is positioned. The oil pan 1 is provided with a shallow bottom part 21, which is formed by protruding a bottom wall of the center of a location adjacent to the other end side of the joining part 24. Also, the oil pan 1 has deep bottom parts 22, which are deeper than the shallow bottom part 21, on both sides of the shallow bottom part 21. In this embodiment, the deep bottom parts 22 are set to be deeper than the shallow bottom part 21 and shallower than the deepest bottom part 23.

[0018] The joining part 24 has a tool insertion hole 26, which is an approximately rectangular opening, in the center and at a position on a slightly lower side of the shallow bottom part 21. Due to the tool insertion hole 26 and the shallow bottom part 21, a work space 2S is formed below the shallow bottom part 21. In the work space 2S, a tool and so on is able to pass through the tool insertion hole 26 further to the one end side from the joining part 24. The deepest bottom part 23 is formed across an approximately half dimension of the oil pan body 2 on the other end side, and almost all oil is stored in the outer tank 1a and the inner tank 1b that are formed in the deepest bottom part 23. The shallow bottom part 21 has a quadrangle loop-shaped rib 25 that is erected upwardly. The rib 25 improves rigidity of an area near the joining part 24. The rib 25 is formed so as to extend to both side end parts of the shallow bottom part 21, that is, to a boundary with the deep bottom part 22. In other words, the rib 25 is formed across the deep bottom part 22.

[0019] The oil separator 3 is fixed to an inner side of the oil pan body 2 at six locations in total. The oil separator 3 is arranged so as to cover the deepest bottom part 23 and the deep bottom parts 22 in a plan view, and also to cover the shallow bottom part 21 at a location other than a cut-out part 33 that is cut out into a hole shape in a plan view. The oil separator 3 has a storage part 31 formed along the shape of the deepest bottom part 23, the opening 32 that is provided at a given depth position of the storage part 31 and allows oil to be communicated to/from the outer tank 1a, and the cut-out part 33 stated above. The cut-out part 33 is formed into a rectangular shape in a plan view so as to correspond to the shape of the above-mentioned rib 25. In this embodiment, the oil strainer 101 is arranged in the storage part 31, and the oil passage 102 is set to extend from the oil strainer 101 towards the oil pump 103 to above the other end edge of the oil pan body 2.

[0020] In this embodiment, a later-described partition wall part X is formed so that oil passing through the cut-out part 33 does not flow into the outer tank 1a side. In short, in this embodiment, because of the oil separator 3 and the partition wall part X, an upper-side region of the oil pan body 2 expressed by the oil separator 3 and

the cut-out part 33 becomes the inner tank 1b, and a lower-side region of the oil separator 3 at a location other than the cut-out part 33 becomes the outer tank 1a.

[0021] The baffle plate 5 is fixed to the upper side of the oil separator 3, and covers mainly an upper-side location of the deepest bottom part 23 in the inner tank 1b so as to avoid a location where the oil separator 3 is arranged. Having a shape that is depressed and projected as necessary, the baffle plate 5 maintains flexural rigidity even though a thickness of the baffle plate 5 is small.

[0022] The sealing part has the seal member 41 that fills a generally whole circumference of the oil pan body 2 at a position above the opening 32, and the communicating part 42 that communicates inside and outside the outer tank 1a by cutting out a part of the seal member 41.

[0023] The seal member 41 adheres the oil pan body 2 and the oil separator 3 while filling the gap in the vicinity of an upper end of the oil separator 3. The seal member 41 is structured by, for example, applying liquid gasket. In short, the liquid gasket in a liquid form is applied to the generally whole circumference of the upper end of the outer periphery of the oil separator 3. Then, the oil separator 3 is pressure-bonded before the liquid gasket in the liquid form is cured. In short, the oil pan body 2 and the oil separator 3 are fixed to each other by also using adhesion force of the liquid gasket.

[0024] In this embodiment, as shown in FIG. 2 and FIG. 3, the communicating part 42 is structured by cutting out the seal member 41 in the vicinity of the location where the oil strainer 101 is arranged. The oil passage 102, which is connected with the oil strainer 101, and the timing chain cover 105 are arranged above the communicating part 42.

[0025] Further, as shown in FIG. 5, in the oil pan 1 according to this embodiment, the oil separator 3 has the cut-out part 33 at a location above the shallow bottom part 21 in order to avoid interference with a crank arm 106a or a counter weight 106b of the crankshaft 106. Furthermore, the oil pan 1 is provided with the partition wall part X, which isolates the cut-out part 33 from the outer tank 1a, between the shallow bottom part 21 and the oil separator 3.

[0026] The partition wall part X has the above-mentioned rib 25, and an isolation seal SS, which is the seal member 41 for sealing a gap between the rib 25 and an edge part of the cut-out part 33. By providing the partition wall part X, inside of the oil pan body 2 is isolated so that an inner side of the partition wall part X becomes the inner tank 1b and an outer side becomes the outer tank 1a. Thus, oil falling towards the cut-out part 33 falls into the inner tank 1b without flowing into the outer tank 1a. In this embodiment, a motion locus Y is positioned inside and below the cut-out part 33. The motion locus Y is a locus where the crank arm 106a or the counter weight 106b of the crankshaft 106 corresponding to any one of the cylinders, or a lower end part of the connecting rod 108 passes. Thus, the shallow bottom part 21 is formed high while avoiding a size increase of the oil pan 1, there-

by sufficiently ensuring the work space 2S.

[0027] With the structure explained so far, the oil pan 1 according to this embodiment is able to raise oil in the inner tank 1b in an early stage by allowing most of the oil that has fallen from the internal combustion engine body 100 to flow into the inner tank 1b. At the same time, by maintaining a flow of air ar between the outer tank 1a and an upper side by the communicating part 42, circulation of oil between the outer tank 1a and the inner tank 1b is maintained. In addition, since the oil passage 102 is positioned above the communicating part 42, flow of oil from above the communicating part 42 to the outer tank 1a is effectively avoided without adding a new part.

[0028] Also, in this embodiment, the structure is applied, in which the timing chain cover 105 is positioned above the communicating part 42 in order to promote escape of air ar from the outer tank 1a through the communicating part 42. Because of this, inside of the timing chain cover 105 is ventilated by intake negative pressure as inside of the timing chain cover 105 is connected with an intake system. Therefore, air ar inside the outer tank 1a is sucked out from the communicating part 42 positioned below the timing chain cover 105, thereby promoting ventilation of inside of the outer tank 1a.

[0029] The embodiment of the invention has been explained so far. However, the specific structures of the respective parts are not limited to those of the embodiment stated above, and various modifications are possible without departing from the gist of the invention.

[0030] For example, in the embodiment stated above, the form is disclosed where only one communicating part is formed. However, as a matter of course, a plurality of communicating parts may be provided at any location where the oil passage is arranged above the communicating parts. Detailed forms such as specific shapes of the oil pan body and the oil separator are not limited to those in the foregoing embodiment, and it is possible to apply various types of forms including existing ones.

[0031] It is possible to use the invention as an oil pan that is applied to an internal combustion engine.

Claims

1. An oil pan (1) for an internal combustion engine (100), the oil pan **characterized by** comprising:

an oil pan body (2) configured to store lubricant;
an oil separator (3) configured to partition inside the oil pan body (2) into an inner tank (1b) and an outer tank (1a), the inner tank (1b) and the outer tank (1a) being configured to communicate with each other through an opening (32); and

a seal member (41) provided in an area above the opening, the seal member (41) being configured to fill a gap between the oil pan body and the oil separator, the seal member (41) having

a communicating part (42), the communicating part (42) being configured to make inside and outside of the outer tank (1a) communicated with each other by cutting out a part of the seal member (41), and an oil passage (102) that connects an oil strainer (101) with an oil pump (103) is arranged above the communicating part (42). 5

2. The oil pan according to claim 1 wherein a timing chain cover (105) is arranged above the communicating part (42). 10

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FIG. 1

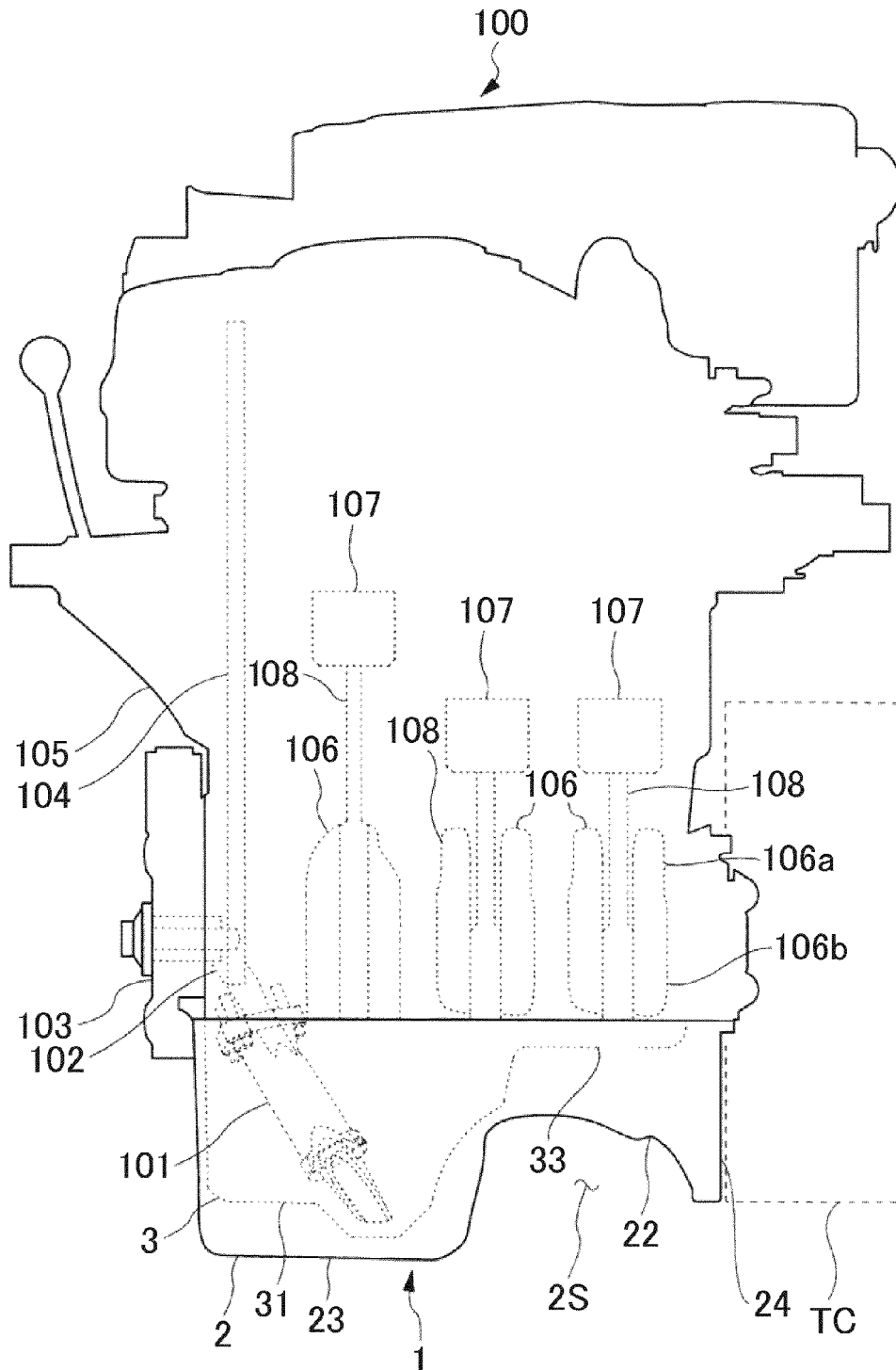


FIG. 2

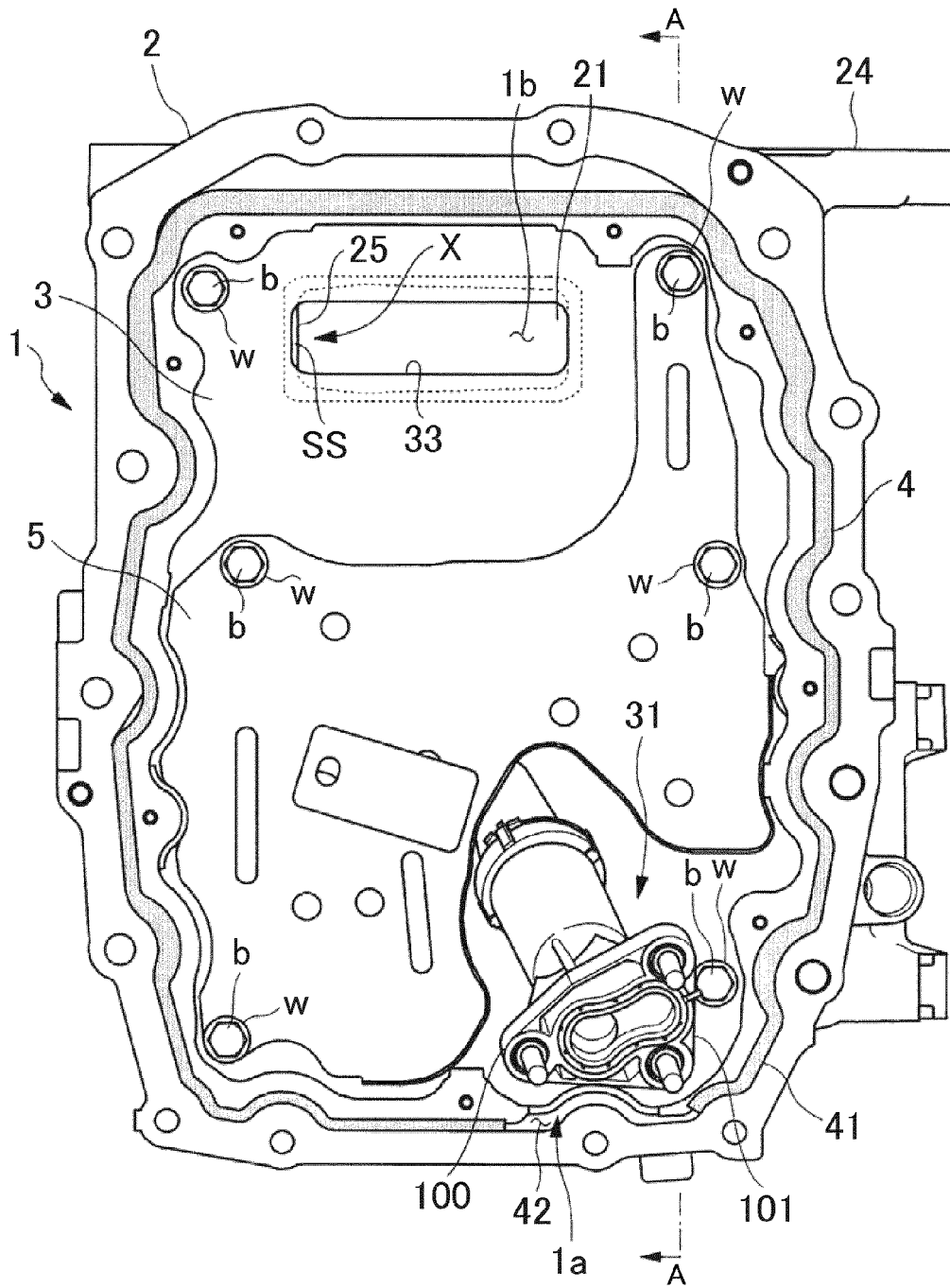


FIG. 3

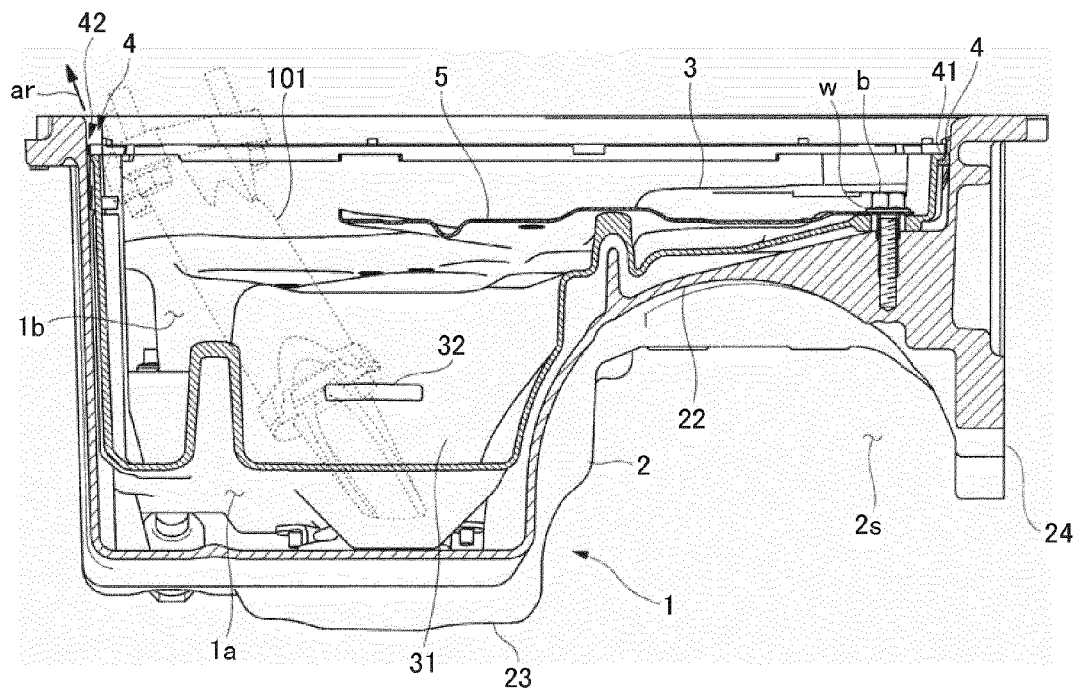


FIG. 4

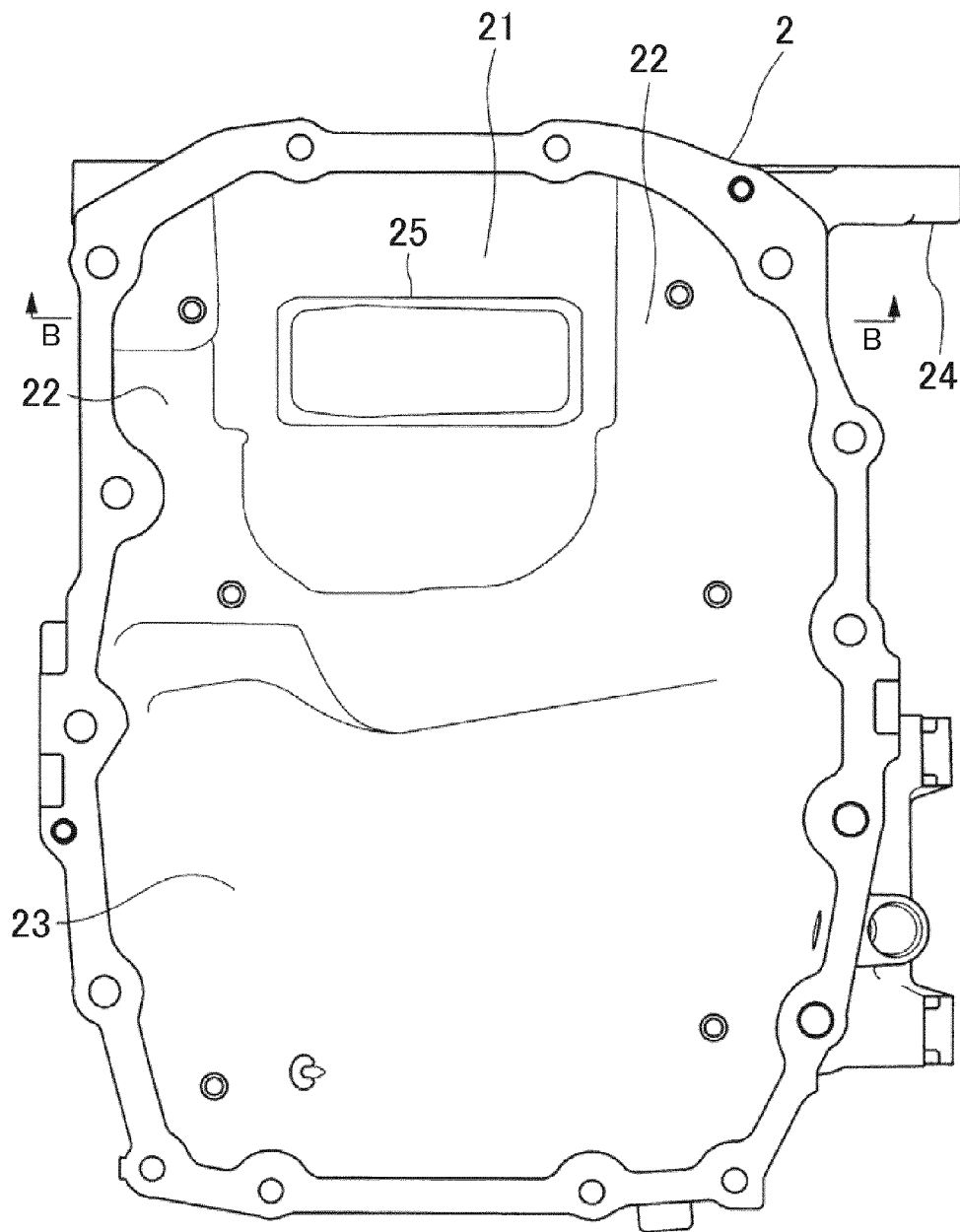
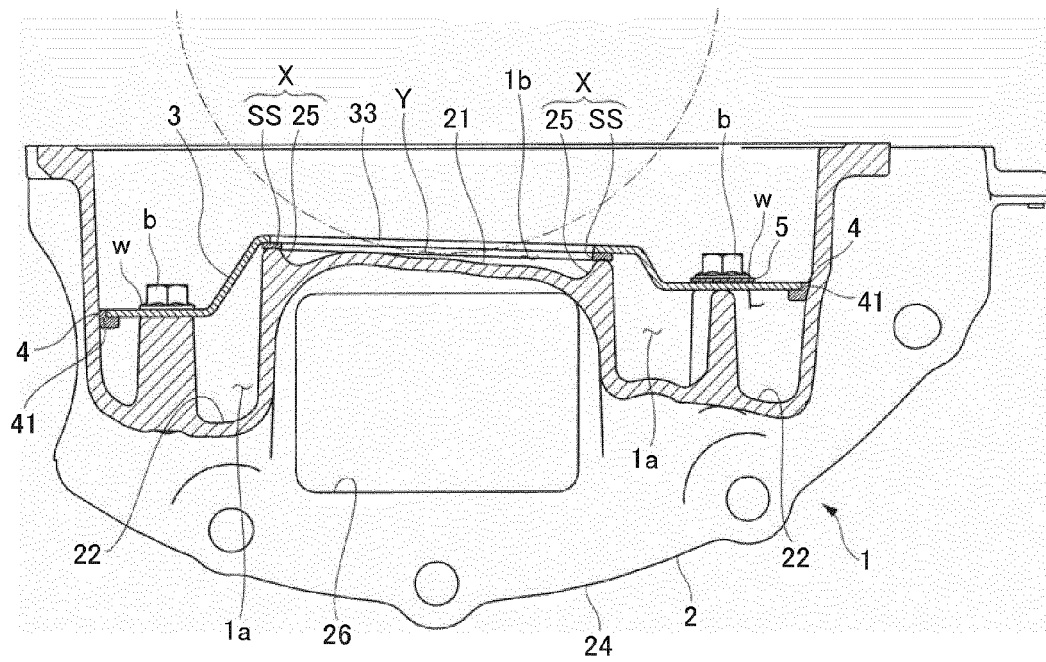


FIG. 5





EUROPEAN SEARCH REPORT

Application Number
EP 15 16 1326

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 10 September 2015	Examiner Van Zoest, Peter
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 15 16 1326

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The members are as contained in the European Patent Office EDP file on
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