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(54) Crankcase breather device

(57) A straddle-type vehicle includes: a swing type engine unit (40) that has a crankcase (90), a cylinder (80), and a cylinder head (70) in which a cam shaft (73) is disposed; a cooling water pump (74) that is provided in the cylinder head (70) and includes an impeller (74a) that is rotatably connected to the cam shaft (73) and supplies cooling water to cooling water channels; and a breather device (75) which is disposed adjacent to the cooling water pump (74) and through which an impeller shaft (74b) passes. The breather device (75) includes a breather housing (S1) that has a length along the cylinder center line (C1) that is larger than that of the cooling water pump (74). The breather housing (S1) is positioned further toward the crankcase (90) with respect to the cam shaft (73).

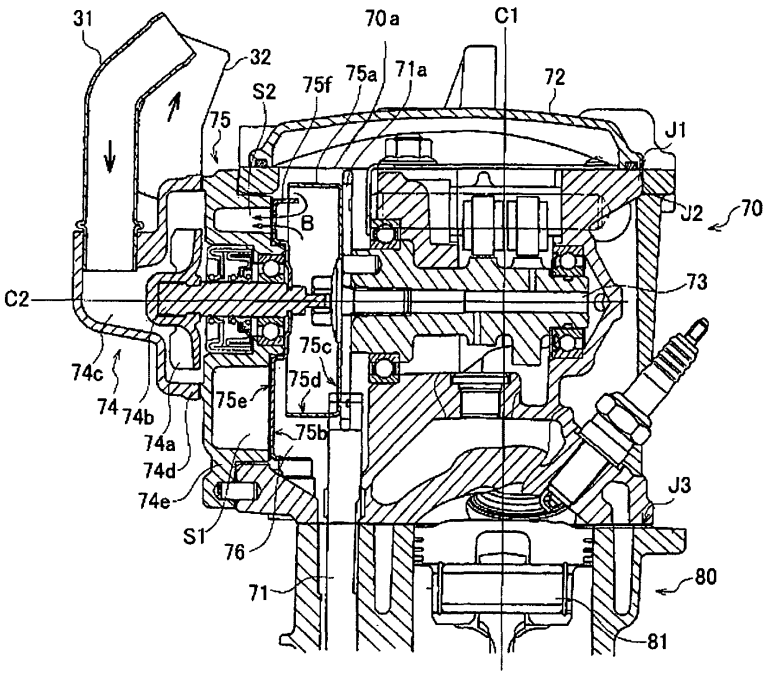

FIG. 5

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a straddle-type vehicle including a breather device that is integrally formed with a coolant pump.

BACKGROUND TO THE INVENTION

[0002] In straddle-type vehicles, such as motorcycles, in order to prevent pressure inside a crankcase or the like from increasing along with increase in the temperature of engine oil, a method is widely used in which a breather device is provided. The breather device discharges gas (blow-by gas) that has accumulated in the crankcase or the like.

[0003] Further, in the case that a breather device is provided in a straddle-type vehicle including a unit swing type engine, a structure has been developed in which the breather device and a coolant pump for pumping out coolant (cooling water) that circulates inside the engine (internal combustion engine) are integrally formed, such as described in, for example, JP-A-04-237831. Such a breather device is integrally formed with a coolant pump having an impeller member connected to a cam shaft (overhead cam shaft) that is provided in a cylinder head.

[0004] More specifically, the breather device is integrally formed with a housing of the coolant pump, and is disposed on a side wall of the cylinder head. The breather device has a generally cylindrical shaped breather housing (labyrinth) in which air and engine oil are separated from the blow-by gas. The breather housing is formed to surround an impeller shaft that causes the impeller member to rotate. As a result of adopting this structure, the breather housing and the impeller member (and the cam shaft) are substantially coaxially aligned. In addition, the breather housing can also be cooled by the coolant.

[0005] However, the above-described breather device that is integrally formed with the coolant pump has the following problem. That is, in order to ensure the function of separating air and engine oil, generally, the size of the breather housing has to be made larger than the size of the coolant pump.

[0006] The coolant pump having the impeller shaft that is coaxially connected to the cam shaft needs to be provided at the location where the cam shaft is disposed, that is, in the cylinder head. When the breather device that is integrally formed with the coolant pump is provided in the cylinder head, because the breather housing and the impeller member (and the cam shaft) are substantially coaxial, a section of the breather device protrudes further than a section of the coolant pump. That is, the dimension of the engine becomes large.

[0007] The invention has been devised in light of the above-described circumstances, and it is an object of the invention to provide a straddle-type vehicle that does not require the dimension of an engine to be made larger when a breather device that is integrally formed with a coolant pump is provided.

SUMMARY OF THE INVENTION

[0008] A first aspect of the invention provides a straddle-type vehicle that includes: an internal combustion engine having a crankcase, a cylinder connected to the crankcase, and a cylinder head that is connected to the cylinder and provided with a cam shaft member; a coolant pump which is provided in the cylinder head and which has an impeller member that is rotatably connected to the cam shaft member and supplies coolant to coolant channels provided in the internal combustion engine; and a breather device which is provided adjacent to the coolant pump and through which the cam shaft member passes. In the straddle-type vehicle, the breather device has a breather housing, and the length of the breather housing along a cylinder center line is larger than that of the coolant pump. The breather housing is positioned further toward the crankcase with respect to the cam shaft member.

[0009] According to the above-described aspect, because the breather housing is positioned further toward the crankcase with respect to the cam shaft, the breather device does not protrude further than the coolant pump. Therefore, the dimension of the engine does not need to be increased and the capacity of the breather housing is not reduced.

[0010] A second aspect of the invention is configured such that, in the first aspect of the invention, a planar shape of at least a section of the breather housing is formed in a circular shape, and the center of the circular shape is offset further toward the crankcase with respect to the cam shaft member.

[0011] A third aspect of the invention is configured such that, in the first aspect of the invention, an opening section is formed in a ceiling section of the cylinder head, a head cover that covers the opening section is further provided on the cylinder head, and a mating surface between the cylinder head and the head cover is generally flat.

[0012] A fourth aspect of the invention is configured such that, in the third aspect of the invention, the cylinder head includes: a head cover side mating surface on a head cover side that abuts against the head cover; and a cylinder side mating surface on a cylinder side that abuts against the cylinder. The head cover side mating surface and the cylinder side mating surface are generally parallel to each other.

[0013] A fifth aspect of the invention is configured such that, in the first aspect of the invention, a gas inflow hole, through which gas in the crankcase flows in, is formed in a side surface on a cylinder side, which is a side surface of the breather housing that is positioned toward the cylinder center line, and the breather device further includes a breather cap that is rotatably connected to the cam shaft. The breather cap includes: a generally circular

shaped base plate that is provided generally in parallel with the side surface on the cylinder side; and a side wall that extends from an outer periphery of the base plate toward the side surface on the cylinder side. The breather cap faces at least a section of the side surface on the cylinder side that includes the gas inflow hole.

[0014] A sixth aspect of the invention is configured such that, in the fifth aspect of the invention, the side surface on the cylinder side is provided with a breather plate that faces the breather cap, the breather plate has a protruding section that protrudes toward the breather cap, and the protruding section overlaps with the side wall at an inner side of the side wall such that there is a distance of separation between the protruding section and the side wall.

[0015] A seventh aspect of the invention is configured such that, in the first aspect of the invention, the internal combustion engine includes an air cleaner, a gas inflow hole, through which gas in the crankcase flows in, is formed in a side surface on the cylinder side, which is a side surface of the breather housing that is positioned toward the cylinder center line. The breather housing includes: a first breather housing that communicates with the gas inflow hole; and a second breather housing that communicates with the first breather housing, and that is connected to a breather pipe that communicates with the air cleaner.

[0016] According to a further aspect of the present invention there is provided a vehicle comprising:

an internal combustion engine having a crankcase, a cylinder connected to the crankcase, a cylinder head connected to the cylinder, and a cam shaft mounted within the cylinder head;
a coolant pump mounted in the cylinder head and comprising an impeller rotatably connected to the cam shaft; and
a breather device positioned adjacent to the coolant pump and further toward the crankcase than the cam shaft and adapted to permit the cam shaft to pass therethrough, wherein the breather device comprises a breather housing having a length along a cylinder center line which is larger than that of the coolant pump.

[0017] At least a section of the breather housing may define a planar circular shape. A center of the circular shape may be offset further toward the crankcase than the cam shaft.

[0018] The vehicle may further comprise a head cover adapted to cover an opening section formed in a ceiling section of the cylinder head. A mating surface between the cylinder head and the head cover may be generally planar.

[0019] The cylinder head may comprise:

a head cover side mating surface on a head cover side that abuts against the head cover; and
a cylinder side mating surface on a cylinder side that abuts against the cylinder, wherein
the head cover side mating surface and the cylinder side mating surface are generally parallel to each other.

[0020] The breather device may further comprise:

a gas inflow hole formed in a side surface of the breather housing and adapted to permit fluid communication from the crankcase. The side surface of the breather housing may be a side surface that is positioned toward the cylinder center line.

[0021] The breather device may further comprise a breather cap rotatably connected to the cam shaft, said breather cap comprising:

a generally circular shaped base plate that is provided generally in parallel with the side surface on the cylinder side; and
a side wall that extends from an outer periphery of the base plate toward the side surface on the cylinder side, and
the breather cap faces at least a section of the side surface on the cylinder side that includes the gas inflow hole.

[0022] The cylinder side surface of the breather housing may be provided with a breather plate that faces the breather cap,
the breather plate may have a protruding section that protrudes toward the breather cap, and
the protruding section may overlap with the side wall at an inner side of the side wall such that there is a distance of separation between the protruding section and the side wall.

[0023] The internal combustion engine may further comprise an air cleaner, and the breather housing comprises:

a first breather housing that communicates with the gas inflow hole; and
a second breather housing that communicates with the first breather housing, and that is connected to a breather pipe that communicates with the air cleaner.

[0024] The vehicle may comprise a straddle-type vehicle.

[0025] According to a further aspect of the present invention there is provided an internal combustion engine comprising:

a crankcase;
a cylinder connected to the crankcase;
a cylinder head connected to the cylinder;
a cam shaft mounted within the cylinder head;

a coolant pump mounted in the cylinder head and comprising an impeller rotatably connected to the cam shaft; and

a breather device positioned adjacent to the coolant pump and further toward the crankcase than the cam shaft and adapted to permit the cam shaft to pass therethrough, wherein the breather device comprises a breather housing having a length along a cylinder center line which is larger than that of the coolant pump.

[0026] According to the invention, it is possible to provide a vehicle, such as a straddle-type vehicle that does not require the dimension of an engine to be made larger when a breather device that is integrally formed with a coolant pump is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] These and other aspects of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a left side view of a motorcycle, which is a straddle-type vehicle according to an embodiment of the present invention;

FIG. 2 is a left side view of a cylinder head, a cylinder, and a crankcase that form a swing type engine unit that defines an internal combustion engine according to the described embodiment;

FIG. 3 is a schematic cross sectional view of the swing type engine unit along line A-A in FIG. 2;

FIG. 4 is a left side view of the cylinder head according to the embodiment;

FIG. 5 is a cross sectional view of the cylinder head along line B-B in FIG. 4;

FIG. 6 is a schematic plan view of a breather device and a cooling water pump according to the embodiment;

FIG. 7 is a view showing the positional relationship between a first breather housing and a second breather housing according to the embodiment;

FIG. 8 is a cross sectional view of the breather device and the cooling water pump along line C-C in FIG. 6;

FIG. 9 is a cross sectional view of the breather device and the cooling water pump along line D-D in FIG. 6;

FIG. 10 is a view showing the flow of blow-by gas and engine oil in the first breather housing according to the embodiment;

FIG. 11 is a view showing the flow of blow-by gas and engine oil in the second breather housing according to the embodiment;

FIG. 12 is a schematic cross sectional view of a thermostat, the cylinder head, the cylinder, and the crankcase according to the embodiment;

FIG. 13 is a right side view of the cylinder head and the cylinder according to the embodiment; and

FIG. 14 is an overhead view of an air cleaner, the cylinder head, and the cylinder according to the embodiment.

DETAILED DESCRIPTION OF THE DRAWINGS

[0028] Hereinafter, an embodiment of a straddle-type vehicle according to the invention will be described with reference to the drawings. In the following drawings, structural members that are the same or similar are denoted with the same or similar reference numerals. Also, it should be understood that the figures are schematic, and thus the reader should be aware that the relative scale of dimensions and the like may be different from that of the real object.

[0029] Therefore, specific dimensions and the like can be determined based on reference to the following description. In addition, it will be readily apparent that the various figures include sections in which the relationship and scale of respective dimensions etc. are different.

[0030] The overall schematic structure of the straddle-type vehicle according to the embodiment will first be described. FIG. 1 is a left side view of a motorcycle 10 that represents a straddle-type vehicle according to the present embodiment.

[0031] As shown in FIG. 1, the motorcycle 10 is an underbone motorcycle in which a vehicle body frame (not shown in the figures) is disposed at a lower position as compared to a normal motorcycle.

[0032] The motorcycle 10 includes a front wheel 21 and a rear wheel 22, and uses a swing type engine unit 40 to drive the rear wheel 22. The swing type engine unit 40 is disposed below a seat 13 on which a rider sits.

[0033] The swing type engine unit 40 includes a cylinder head 70 and a cylinder 80 that are integrally formed, and a crankcase 90. The cylinder head 70 and the cylinder 80 form a water cooled single cylinder four-stroke engine. The crankcase 90 houses a transmission unit that transmits power generated by the engine to the rear wheel 22.

[0034] An air cleaner 61 is provided in front of the cylinder head 70. The cylinder 80 is positioned to the rear of the cylinder head 70. The crankcase 90 is positioned to the rear of the cylinder 80.

[0035] A front section of the crankcase 90 is, at a lower side thereof, axially supported by the vehicle body frame. An upper side of the crankcase 90 is swingably supported by a cushion or suspension unit 12 fixed to the vehicle body frame.

[0036] FIG. 2 is a left side view of the cylinder head 70, the cylinder 80, and the crankcase 90 that form the swing type engine unit 40.

[0037] In addition to the cylinder head 70, the cylinder 80, and the crankcase 90, FIG. 2 shows the air cleaner 61, a carburetor 62, and an intake manifold 63.

[0038] A head cover 72 is provided at a front end section (a ceiling section) of the cylinder head 70, between the cylinder head 70 and the air cleaner 61. The air cleaner 61 is fixed to the head cover 72.

[0039] The intake manifold 63 is provided between an upper side of the air cleaner 61 and an upper side of the cylinder head 70, and connects the air cleaner 61 and the cylinder head 70. The carburetor 62 is attached to the intake manifold 63.

[0040] An arm 91 is formed on the crankcase 90 such that the arm 91 protrudes toward the front from the lower side of the front section of the crankcase 90. The arm 91 is supported by the vehicle body frame.

[0041] The schematic structure of the swing type engine unit 40 will now be explained. FIG. 3 is a schematic cross sectional view of the swing type engine unit 40 along line A-A in FIG. 2. In FIG. 3, hatching is omitted.

[0042] The cylinder 80 is arranged on a vehicle center line C1 that divides the vehicle width into two substantially equal sections. The cylinder 80 includes a piston 81, a connecting rod 82, and a crankshaft 83.

[0043] The piston 81 is inserted into the cylinder 80. The crankshaft 83 is disposed in the vehicle width direction in the crankcase 90. The connecting rod 82 transmits power of the piston 81 to the crankshaft 83.

[0044] The crankcase 90 houses the crankshaft 83, an alternator 92a, a cooling fan 92b, a starter clutch 93a, a drive pulley 93b, a drive belt 94, a driven pulley 95a, a drive shaft 95c, a gear reduction mechanism 95d, a rear wheel shaft 95e, etc.

[0045] The alternator 92a is connected to the crankshaft 83 at the right side of the vehicle center line C1. The cooling fan 92b is connected to the crankshaft 83 at the right side of the alternator 92a.

[0046] The cooling fan 92b pulls or draws in outside air, and subsequently blows out or discharges the air externally in a radial direction. A section of the cooling fan 92b is covered by a fan shroud 92d that is fixed to the crankcase 90. A radiator 92c is provided on the right side of the cooling fan 92b.

[0047] The outside air is introduced by rotation of the cooling fan 92b, whereby the radiator 92c, the alternator 92a, etc. are cooled. The radiator 92c cools the cooling water heated by the cylinder 80, the cylinder head 70, etc., using the outside air introduced by the cooling fan 92b.

[0048] The starter clutch 93a is connected to the crankshaft 83 at the left side of the vehicle center line C1. The starter clutch 93a transmits power of a cell motor (not shown in the figures) to the crankshaft 83 when the engine is started.

[0049] The starter clutch 93a is provided in a starter clutch housing 93c. The starter clutch housing 93c contains engine oil.

[0050] The drive pulley 93b is connected to the crankshaft 83 at the left side of the starter clutch 93a. The driven pulley 95a is connected to the drive shaft 95c. The drive belt 94 is wound around the drive pulley 93b and the driven pulley 95a. The drive pulley 93b, the drive belt 94, and the driven pulley 95a form a V-belt type automatic transmission mechanism.

[0051] The rear wheel shaft 95e is disposed to the rear of the drive shaft 95c. Driving force of the crankshaft 83 is transmitted to the drive shaft 95c via the drive pulley 93b, the drive belt 94, and the driven pulley 95a, and is then transmitted from the drive shaft 95c to the rear wheel shaft 95e via the gear reduction mechanism 95d.

[0052] The cylinder head 70 includes a cam shaft 73 that is disposed to extend in the vehicle width direction. A cam sprocket 71a is fixed to an end of the cam shaft 73.

[0053] A crank sprocket 93d is fixed to the crankshaft 83, and a cam chain 71 is wound around the crank sprocket 93d and the cam sprocket 71a. The cam chain 71 is housed in a cam chain housing 76.

[0054] A cooling water pump 74 and a breather device 75 that are integrally formed are disposed on the left side of the cylinder head 70. The cooling water pump 74 pumps out the cooling water to cooling water channels formed in the radiator 92c, the cylinder 80, etc.

[0055] Blow-by gas in the crankcase 90 flows through the cam chain housing 76, and then flows into the breather device 75. The breather device 75 separates the blow-by gas into a liquid (engine oil) and a gas (air).

[0056] The engine oil separated from the blow-by gas is returned to the cam chain housing 76. The air separated from the blow-by gas is supplied to the air cleaner 61.

[0057] The structure of the cylinder head 70, the cooling water pump 74, and the breather device 75 will now be described in detail with reference to FIG. 4 to FIG. 11.

[0058] FIG. 4 is a left side view of the cylinder head 70 and the cooling water pump 74. FIG. 4 also shows the radiator 92c and the cooling fan 92b.

[0059] A cooling water pipe 31 is connected between a lower section of the radiator 92c and the cooling water pump 74. The cooling water cooled by the radiator 92c is introduced into the cooling water pump 74 via the cooling water pipe 31.

[0060] A cooling water pipe 32 is connected between a lower side of a front section of the cylinder 80 and the cooling water pump 74. The cooling water pipe 32 leads the cooling water introduced by the cooling water pump 74 into a water jacket formed in the cylinder 80.

[0061] The cooling water heated by the cylinder 80 is supplied to the radiator 92c via a cooling water pipe 33. The cooling water pipe 33 is provided between a thermostat 77 (not shown in FIG. 4, but refer to FIG. 12) that is attached to a right side wall of the cylinder head 70, and an upper section of the radiator 92c.

[0062] Note that a joint 34a is provided at the left side of a rear section of the cylinder head 70, and is connected to an end of a breather pipe 34. The other end of the breather pipe 34 is connected to the air cleaner 61. The breather pipe 34 leads the air separated out from the blow-by gas to the air cleaner 61.

[0063] FIG. 5 is a cross sectional view of the cylinder head 70, the cooling water pump 74, and the breather device 75, along line B-B in FIG. 4.

[0064] As shown in FIG. 5, the cooling water pump 74 includes an impeller 74a, an impeller shaft 74b, a pump

housing 74c, a housing cover 74d, and a housing body 74e.

[0065] The housing body 74e is fixed to the cylinder head 70. The housing cover 74d is fixed to the housing body 74e. The housing body 74e and the housing cover 74d form the pump housing 74c.

[0066] The impeller 74a is fixed to an end of the impeller shaft 74b. The other end of the impeller shaft 74b is fixed to the cam shaft 73. That is, the impeller shaft 74b is disposed coaxially with the cam shaft 73. In the embodiment, the cam shaft 73 and the impeller shaft 74b form an impeller member.

[0067] Therefore, the impeller shaft 74b and the impeller 74a rotate along with the rotation of the cam shaft 73. When the impeller 74a rotates, the cooling water from the cooling water pipe 31 is supplied to the cooling water pipe 32 via the pump housing 74c.

[0068] An opening section 70a is formed in the ceiling section of the cylinder head 70. The head cover 72 covers the opening section 70a. A mating surface J1 of the cylinder head 70 and the head cover 72 is formed to be generally flat.

[0069] The cylinder head 70 has a mating surface J2 where it abuts against the head cover 72, and a mating surface J3 where it abuts against the cylinder 80. The mating surfaces J2 and J3 are generally parallel with each other.

[0070] The structure of the breather device 75 will now be described with reference to FIG. 5. The breather device 75 includes a breather cap 75a, a breather plate 75b, two breather housings S1, S2 (S2 not shown in FIG. 5, but refer to FIG. 6).

[0071] The breather cap 75a is fixed to the cam sprocket 71a. The breather cap 75a rotates along with the rotation of the cam sprocket 71a, the cam shaft 73, and the impeller shaft 74b.

[0072] More specifically, the breather cap 75a includes a base plate 75c and a side wall 75d. The base plate 75c is formed in a generally circular shape, and is provided substantially in parallel with a right side surface 75e of the breather housing S1. The side wall 75d extends from an outer periphery of the base plate 75c toward the right side surface 75e of the breather housing S1.

[0073] The breather plate 75b is formed in a generally circular shape, and is provided on the right side surface 75e of the breather housing S1. An opening section is formed in the housing body 74e so as to surround the impeller shaft 74b. The breather housing S1 is formed by covering the opening section with the breather plate 75b. Accordingly, the breather housing S1 has a generally circular planar shape.

[0074] The length of the breather housing S1 along the vehicle center line C1 is larger than the diameter of the impeller 74a. The center of the breather housing S1 along the vehicle center line C1 is offset toward the crankcase 90 with respect to the center line C2 of the cam shaft 73 along the vehicle width direction.

[0075] An inflow port (not shown in FIG. 5, but refer to FIG. 6) is formed in the breather plate 75b. Blow-by gas B in the cam chain housing 76 flows into the inflow port.

[0076] The breather plate 75b has a protruding section 75f that protrudes toward the breather cap 75a. The protruding section 75f overlaps with the side wall 75d at an inner side of the side wall 75d such that there is a distance of separation between the protruding section 75f and the side wall 75d.

[0077] The detailed structure of the breather device 75 will now be described. FIG. 6 is a schematic plan view of the breather device 75 and the cooling water pump 74. Note that the arrow F shown in FIG. 6 indicates the front of the vehicle. FIG. 7 is a view that shows the positional relationship between the breather housing S1 and the breather housing S2.

[0078] As described above, the housing body 74e and the housing cover 74d form the pump housing 74c and the breather housings S1 and S2. An insertion hole 75n, through which the impeller shaft 74b passes, is formed in the housing body 74e.

[0079] The breather housing S1 has a generally circular planar surface. The pump housing 74c and the breather housing S2 are provided adjacent to the breather housing S1 at the vehicle left side of the breather housing S1. The pump housing 74c has a round and upward protruding planar surface. The breather housing S2 is formed above and adjacent to the pump housing 74c.

[0080] A connecting hole 75g that connects the breather housing S1 and the breather housing S2 is formed at a section where a part of the breather housing S1 overlaps with a part of the breather housing S2.

[0081] An oil return hole 75j, which returns engine oil E that has been separated out from the blow-by gas B to the cam chain housing 76, is formed at the lower side of the breather housing S1. An oil return hole 75i is formed at the lower side of the breather housing S2, and returns the engine oil E that has been separated in the breather housing S2 to the breather housing S1 through the connecting hole 75g.

[0082] As represented in Fig. 7, a center C3 of the breather housing S1 is offset to the rear of the vehicle with respect to the cam shaft center C2.

[0083] FIG. 8 is a cross sectional view of the breather device 75 and the cooling water pump 74 along line C-C in FIG. 6. FIG. 9 is a cross sectional view of the breather device 75 and the cooling water pump 74 along line D-D in FIG. 6.

[0084] An inflow hole 75h, through which the blow-by gas B in the cam chain housing 76 flows in, is formed on the vehicle front side of the breather plate 75b.

[0085] A bearing 75p and an oil seal 75g are provided for the insertion hole 75n.

[0086] As shown in FIG. 9, the breather housing S2 is formed by the housing body 74e and the housing cover 74d, at the left side of the breather housing S1.

[0087] A gas-liquid separating function of the breather device 75, that is, a function of separating the engine oil E from the blow-by gas B will now be described. FIG. 10

is a view showing the flow of the bow-by gas B and the engine oil E in the breather housing S1.

[0088] As shown in FIG. 10, the blow-by gas B that has flowed from the cam chain housing 76 into the breather housing S1 through the inflow hole 75h flows around the insertion hole 75n in the counter clockwise direction, and then is directed to the connecting hole 75g.

[0089] While the blow-by gas B is flowing through the inside of the breather housing S1, the blow-by gas B collides with an inner wall surface of the breather housing S1. At this time, the atomized engine oil E contained in the blow-by gas B adheres to the inner wall surface of the breather housing S1.

[0090] The engine oil E that has adhered flows downwardly along the inner wall surface of the breather housing S1 due to gravity, and is directed to the oil return hole 75j. The breather housing S1 has a circular planar shape, and therefore the engine oil E that adheres to the inner wall surface of the breather housing S1 is effectively directed to the oil return hole 75j.

[0091] FIG. 11 is a view showing the flow of the blow-by gas B and the engine oil E in the breather housing S2.

[0092] As shown in FIG. 11, the blow-by gas B that has flowed from the breather housing S1 into the breather housing S2 through the connecting hole 75g flows in the clockwise direction in the breather housing S2, and is then directed to the joint 34a with the breather pipe 34.

[0093] While the blow-by gas B is flowing through the inside of the breather housing S2, the blow-by gas B collides with an inner wall surface of the breather housing S2. At this time, the atomized engine oil E contained in the blow-by gas B adheres to the inner wall surface of the breather housing S2.

[0094] The engine oil E that has adhered to the inner wall surface of the breather housing S2 flows downwardly along the inner wall surface of the breather housing S2 due to gravity, and is directed to the oil return hole 75i or the connecting hole 75g. The engine oil E that has separated from the blow-by gas B in the breather housing S2 is directed to the oil return hole 75j of the breather housing S1 through the connecting hole 75g.

[0095] The attachment structure of the thermostat 77 will now be described with reference to FIG. 12 to FIG. 14. FIG. 12 is a schematic cross sectional view of the thermostat 77, the cylinder head 70, the cylinder 80, and the crankcase 90.

[0096] As shown in FIG. 12, the thermostat 77 is provided at the right side of the cylinder head 70. In order to adjust the temperature of the cooling water, the thermostat 77 controls the amount of the cooling water supplied to the radiator 92c in accordance with the temperature of the cooling water supplied from the cylinder 80.

[0097] FIG. 13 is a right side view of the cylinder head 70 and the cylinder 80. FIG. 13 also shows the radiator 92c.

[0098] The thermostat 77 is structured integrally with an attachment mechanism 78, and is fixed to the cylinder head 70 using bolts 78a and 78b. That is, the thermostat 77 (the attachment mechanism 78) can be removed from the cylinder head 70.

[0099] FIG. 14 is an overhead view of the air cleaner 61, the cylinder head 70, and the cylinder 80. FIG. 14 also shows a vehicle body frame 51.

[0100] When the cylinder head 70 is removed from the vehicle for maintenance, the thermostat 77 interferes with the vehicle body frame 51. However, the thermostat 77 (the attachment mechanism 78) can be removed from the cylinder head 70. Accordingly, if the thermostat 77 (the attachment mechanism 78) is removed from the cylinder head 70, it is possible to remove the cylinder head 70 from the vehicle.

[0101] According to the exemplary embodiment described herein, the motorcycle 10 includes the swing type engine unit 40, the cooling water pump 74, and the breather device 75. The swing type engine unit 40 includes the crankcase 90, the cylinder 80 that is contiguous with the crankcase 90, and the cylinder head 70 that is contiguous with the cylinder 80. The cam shaft 73 is provided in the cylinder head 70.

[0102] The cooling water pump 74 is provided in the cylinder head 70, and includes the impeller 74a that is rotatably connected to the cam shaft 73 to supply cooling water to the cooling water channels formed inside the swing type engine unit 40.

[0103] The breather device 75 is provided adjacent to the cooling water pump 74, and the impeller shaft 74b passes through the breather device 75. The breather device 75 has the breather housing S1, the length of which along the vehicle center line C1 is larger than that of the cooling water pump 74. The breather housing S1 is provided further toward the crankcase 90 with respect to the cam shaft 73.

[0104] As a result, the breather device 75 does not protrude further than the cooling water pump 74. Therefore, the dimension of the swing type engine unit 40 does not need to be made larger and the capacity of the breather housing S1 is not reduced.

[0105] Further, according to the embodiment, the mating surface J1 of the cylinder head 70 and the head cover 72 that covers the opening section 70a of the cylinder head 70 is formed to be generally flat. Accordingly, the machining of the head cover 72 and the cylinder head 70 is easy. Thus, the manufacturing cost for ensuring the accuracy of the mating surface of the cylinder head 70 and the head cover 72 is reduced.

[0106] Furthermore, according to the embodiment, the mating surface J2 of the cylinder head 70 and the head cover 72 is generally parallel with the mating surface J3 of the cylinder head 70 and the cylinder 80. As a result, when the cylinder head 70 is under maintenance, the cylinder head 70 is securely fixed to a workbench or the like. Thus, the maintenance of the cylinder head 70 can be more easily performed.

[0107] According to the embodiment, the inflow hole 75h, through which the blow-by gas B in the crankcase 90 (the cam chain housing 76) flows in, is formed on the

right side surface 75e of the breather housing S1. The breather device 75 further includes the breather cap 75a that is rotatably connected to the cam shaft 73. The breather cap 75a includes the base plate 75c and the side wall 75d, and faces the right side surface 75e of the breather housing S1.

[0108] Accordingly, the breather cap 75a that rotates together with the cam shaft 73 covers the inflow hole 75h such that the engine oil thrown off by the cam shaft 73 does not enter the inflow hole 75h, and at the same time, the engine oil that has adhered to the breather cap 75a can be shed by centrifugal force.

[0109] According to the embodiment, two breather housings are formed, i.e., the breather housing S1 that communicates with the inflow hole 75h, and the breather housing S2 that communicates with the breather housing S1 and the breather pipe 34. Therefore, the engine oil E is efficiently separated from the blow-by gas B, as compared to a structure having one breather housing.

[0110] Hereinabove, one embodiment of the invention is described. However, it is to be understood that the invention is not limited by the description and the drawings that form one section of the disclosure. From the disclosure, it will be obviously apparent to those skilled in the art that the invention permits various alternative embodiments, examples and working technologies.

[0111] In the above-described embodiment, the swing type engine unit 40 is used as an internal combustion engine. However, the engine is not limited to the swing type engine unit 40, and it is sufficient that the motorcycle is provided with the breather device 75 formed integrally with the cooling water pump 74.

[0112] Further, although the breather housing S1 has a generally circular planar shape in the above-described embodiment, the breather housing S1 may have a polygonal shape or the like, and is not limited to a generally circular shape.

[0113] As will be readily apparent, the invention includes various modified embodiments not described here like those described above. Accordingly, the invention is defined by only the specific aspects of the invention set forth in the claims that are reasonably given by the above description.

Description of the Reference Numerals and Signs

[0114] S1, S2: Breather housing, J1-J3: Mating surface, 10: Motorcycle, 12: Cushion unit, 13: Seat, 21: Front wheel, 22: Rear wheel, 31-33: Cooling water pipe, 34: Breather pipe, 34a: Joint, 40: Swing type engine unit, 51: Vehicle body frame, 61: Air cleaner, 62: Carburetor, 63: Intake manifold, 70: Cylinder, 71: Cam chain, 71a: Cam sprocket, 73: Cam shaft, 74: Cooling water pump 74a: Impeller, 74b: Impeller shaft, 74c: Pump housing, 74d: Housing cover, 74e: Housing body, 75: Breather device, 75a: Breather cap, 75b: Breather plate, 75c: Base plate, 75d: Side wall, 75e: Right side surface, 75f: Protruding section, 75g: Connecting hole, 75h: Inflow hole, 75i: Oil return hole, 75j: Oil return hole, 75n: Insertion hole, 75p: Bearing, 75q: Oil seal, 76: Cam chain housing, 77: Thermostat, 78: Mounting mechanism, 78a, 78b: Bolt, 80: Cylinder, 81: Piston, 82: Connecting rod, 83: Crankshaft, 90: Crankcase, 91: Arm, 92a: Alternator, 92b: Cooling fan, 92c: Radiator, 92d: Fan shroud, 93a: Starter clutch, 93b: Drive pulley, 93c: Starter clutch housing, 93d: Crank sprocket, 94: Drive belt, 95a: Driven pulley, 95c: Drive shaft, 95d: Gear reduction mechanism, 95e: Rear wheel shaft

Claims

1. A vehicle (10) comprising:

an internal combustion engine (40) having a crankcase (90), a cylinder (80) connected to the crankcase, a cylinder head (70) connected to the cylinder (80), and a cam shaft (73) mounted within the cylinder head (70);
a coolant pump (74) mounted in the cylinder head (70) and comprising an impeller (74a) rotatably connected to the cam shaft (73); and
a breather device (75) positioned adjacent to the coolant pump (74) and further toward the crankcase (90) than the cam shaft (73) and adapted to permit the cam shaft (73) to pass therethrough, wherein the breather device (75) comprises a breather housing (S1) having a length along a cylinder center line (C1) which is larger than that of the coolant pump (74).

2. The vehicle (10) according to claim 1, wherein at least a section of the breather housing (S1) defines a planar circular shape, and a center of the circular shape is offset further toward the crankcase (90) than the cam shaft (73).

3. The vehicle (10) according to claim 1 or 2, further comprising a head cover (72)adapted to cover an opening section (70a) formed in a ceiling section of the cylinder head, wherein a mating surface (J1) between the cylinder head (70) and the head cover (72) is generally planar.

4. The vehicle (10) according to claim 3, wherein the cylinder head(70) comprises:

a head cover side mating surface (J2) on a head cover side that abuts against the head cover (72); and
a cylinder side mating surface (J3) on a cylinder side that abuts against the cylinder (80), wherein the head cover side mating surface (J2) and the cylinder side mating surface (J3) are generally parallel to each other.

5. The vehicle (10) according to any preceding claim, wherein the breather device (75) further comprises a gas inflow hole (75h) formed in a cylinder side surface of the breather housing (S1) and adapted to permit fluid communication from the crankcase (90).

6. The vehicle (10) according to claim 5, wherein the breather device (75) further comprises a breather cap (75a) rotatably connected to the cam shaft (73), said breather cap (75a) comprising:

a generally circular shaped base plate (75c) that is provided generally in parallel with the side surface (75e) on the cylinder side; and
a side wall (75d) that extends from an outer periphery of the base plate (75c) toward the side surface (75e) on the cylinder side, and
the breather cap (75a) faces at least a section of the side surface (75e) on the cylinder side that includes the gas inflow hole (75h).

7. The vehicle (10) according to claim 6, wherein
the cylinder side surface of the breather housing (S1) is provided with a breather plate (75b) that faces the breather cap (75a),
the breather plate (75b) has a protruding section (75f) that protrudes toward the breather cap (75a), and
the protruding section (75f) overlaps with the side wall (75d) at an inner side of the side wall such that there is a distance of separation between the protruding section (75f) and the side wall (75d).

8. The vehicle (10) according to any preceding claim, wherein the internal combustion engine (40) further comprises an air cleaner (61), and the breather housing comprises:

a first breather housing (S1) that communicates with the gas inflow hole (75h); and
a second breather housing (S2) that communicates with the first breather housing (S1), and that is connected to a breather pipe (34) that communicates with the air cleaner (61).

9. An internal combustion engine (40) comprising:

a crankcase (90);
a cylinder (80) connected to the crankcase (90);
a cylinder head (70) connected to the cylinder (80);
a cam shaft (73) mounted within the cylinder head (70) ;
a coolant pump (74) mounted in the cylinder head (70) and comprising an impeller (74a) rotatably connected to the cam shaft (73); and
a breather device (75) positioned adjacent to the coolant pump (74) and further toward the crankcase (90) than the cam shaft (73) and adapted to permit the cam shaft (73) to pass therethrough, wherein the breather device (75) comprises a breather housing (S1) having a length along a cylinder center line (C1) which is larger than that of the coolant pump (74).

10. A straddle-type vehicle (10) comprising:

an internal combustion engine (40) having a crankcase (90), a cylinder (80) connected to the crankcase(90), and a cylinder head (70) that is connected to the cylinder (80) and provided with a cam shaft member (73);
a coolant pump (74), provided in the cylinder head (70), that has an impeller member (74a) that is rotatably connected to the cam shaft member (73) and supplies coolant to coolant channels provided in the internal combustion engine (40); and
a breather device (75), provided adjacent to the coolant pump (74), through which the cam shaft member (73) passes, wherein
the breather device (75) has a breather housing (S1), the length of the breather housing along a cylinder center line (C1) being larger than that of the coolant pump (74), and
the breather housing (S1) is positioned further toward the crankcase (90) with respect to the cam shaft member (73).

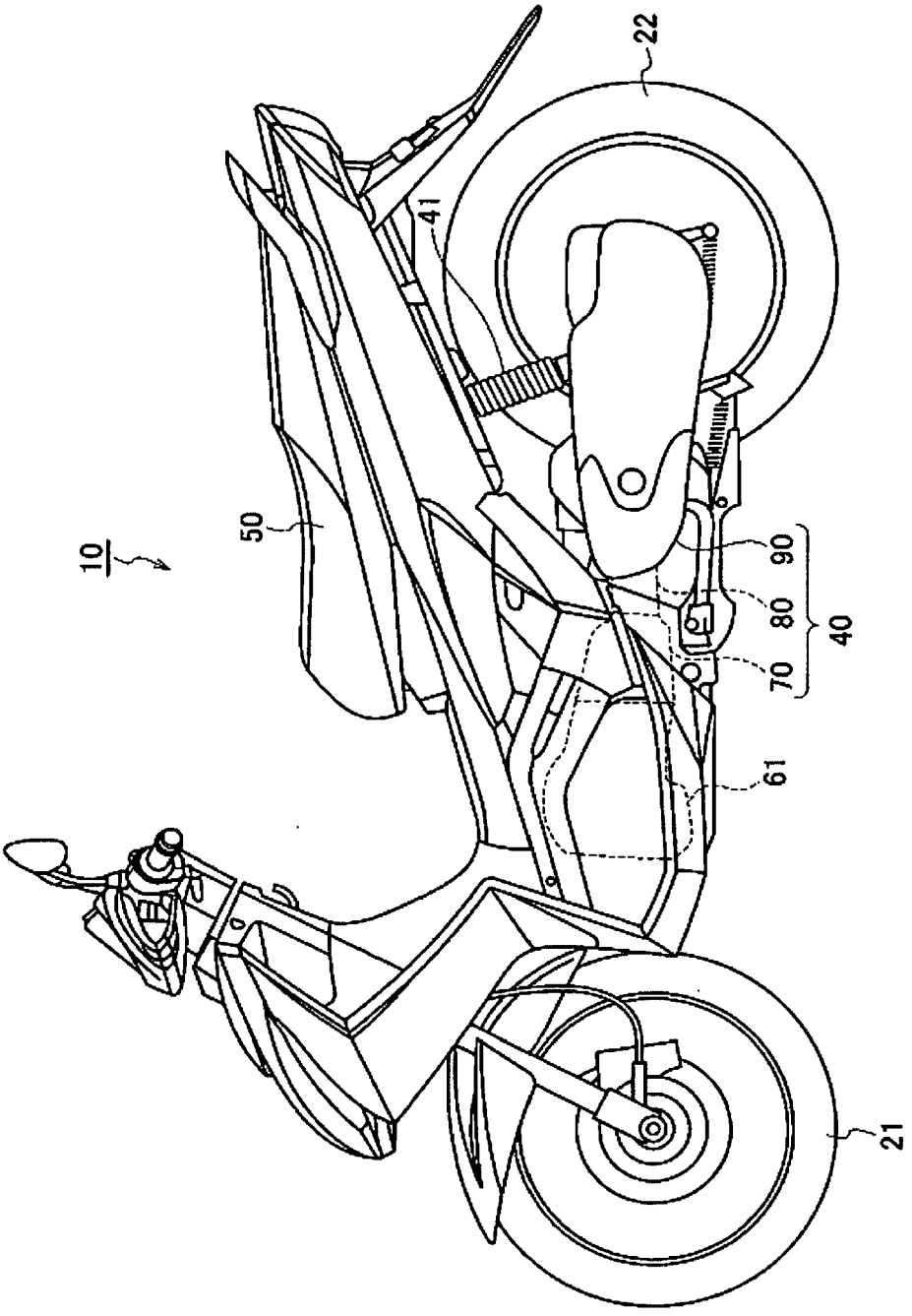


FIG. 1

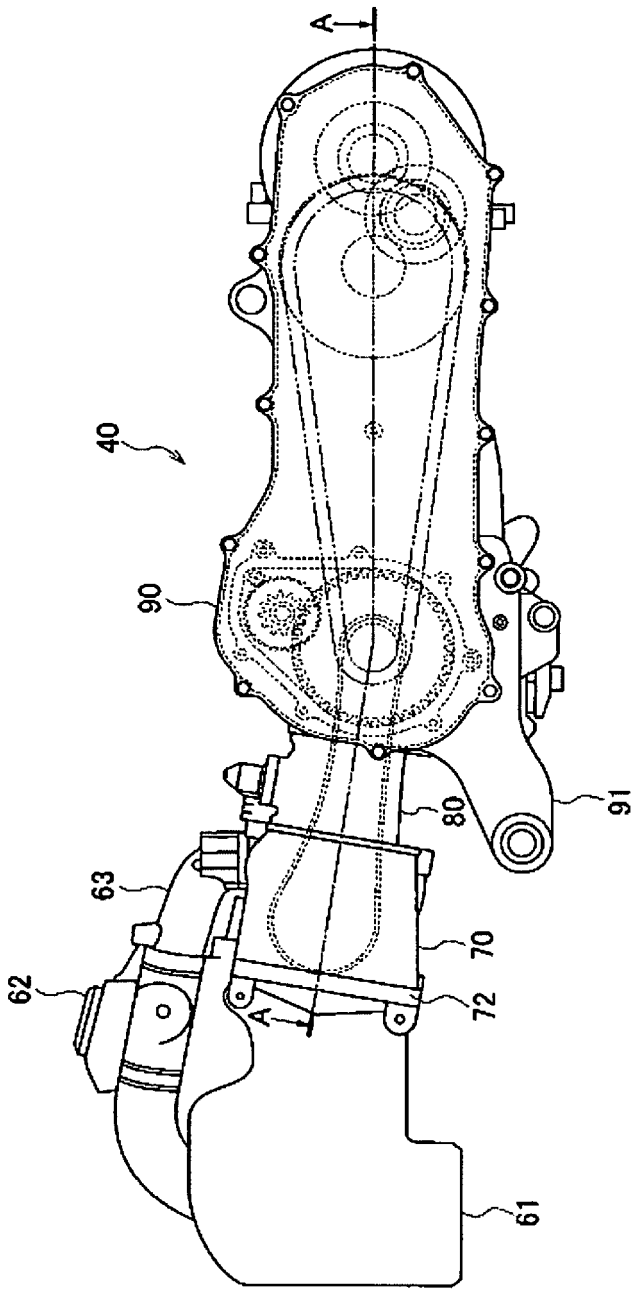


FIG. 2

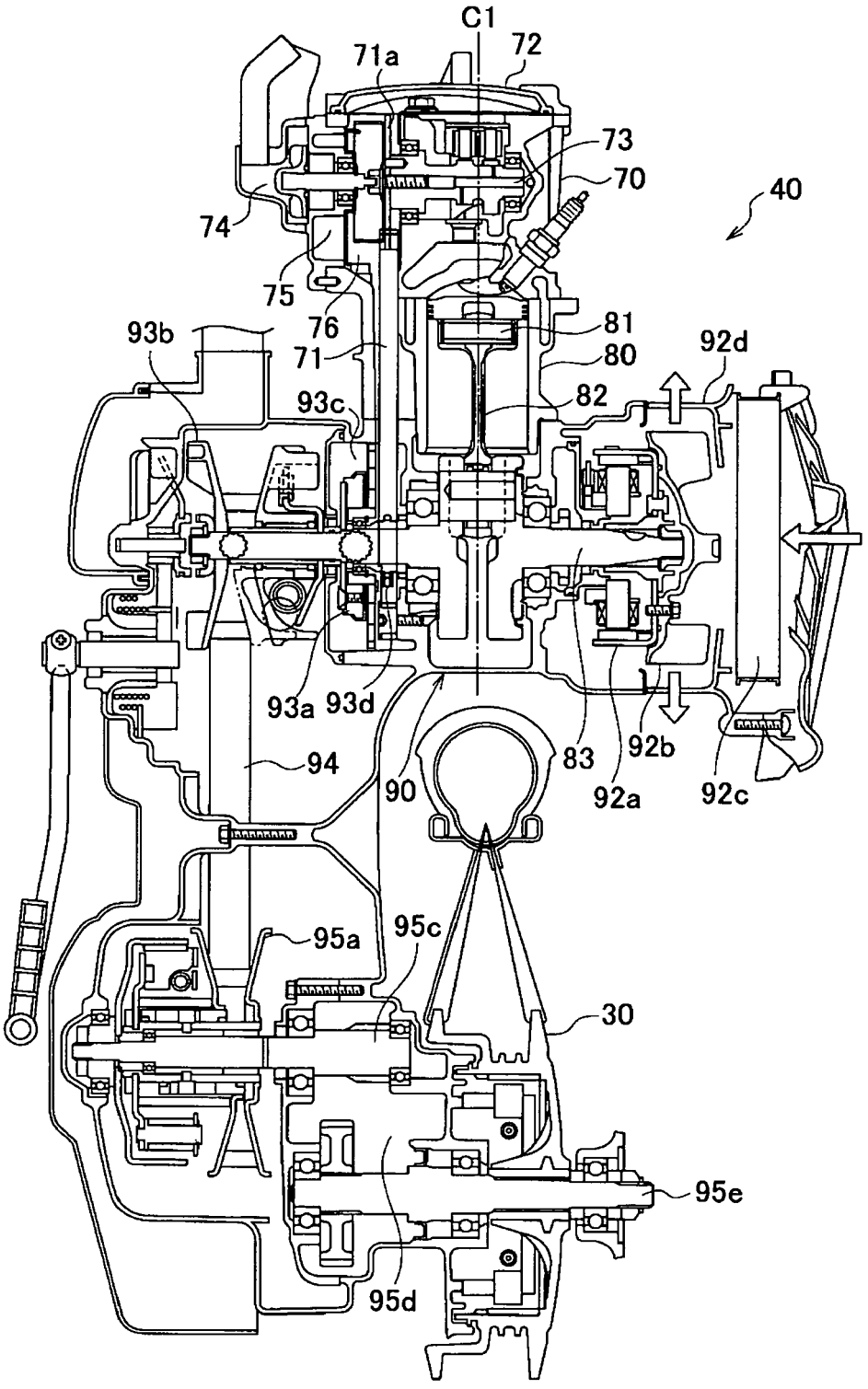

C1
71a
72
73
70
40
74
75
76
71
93b
81
80
92d
82
93c
93a
93d
94
90
83
92b
92a
92c
95a
95c
30
95e
95d

FIG. 3

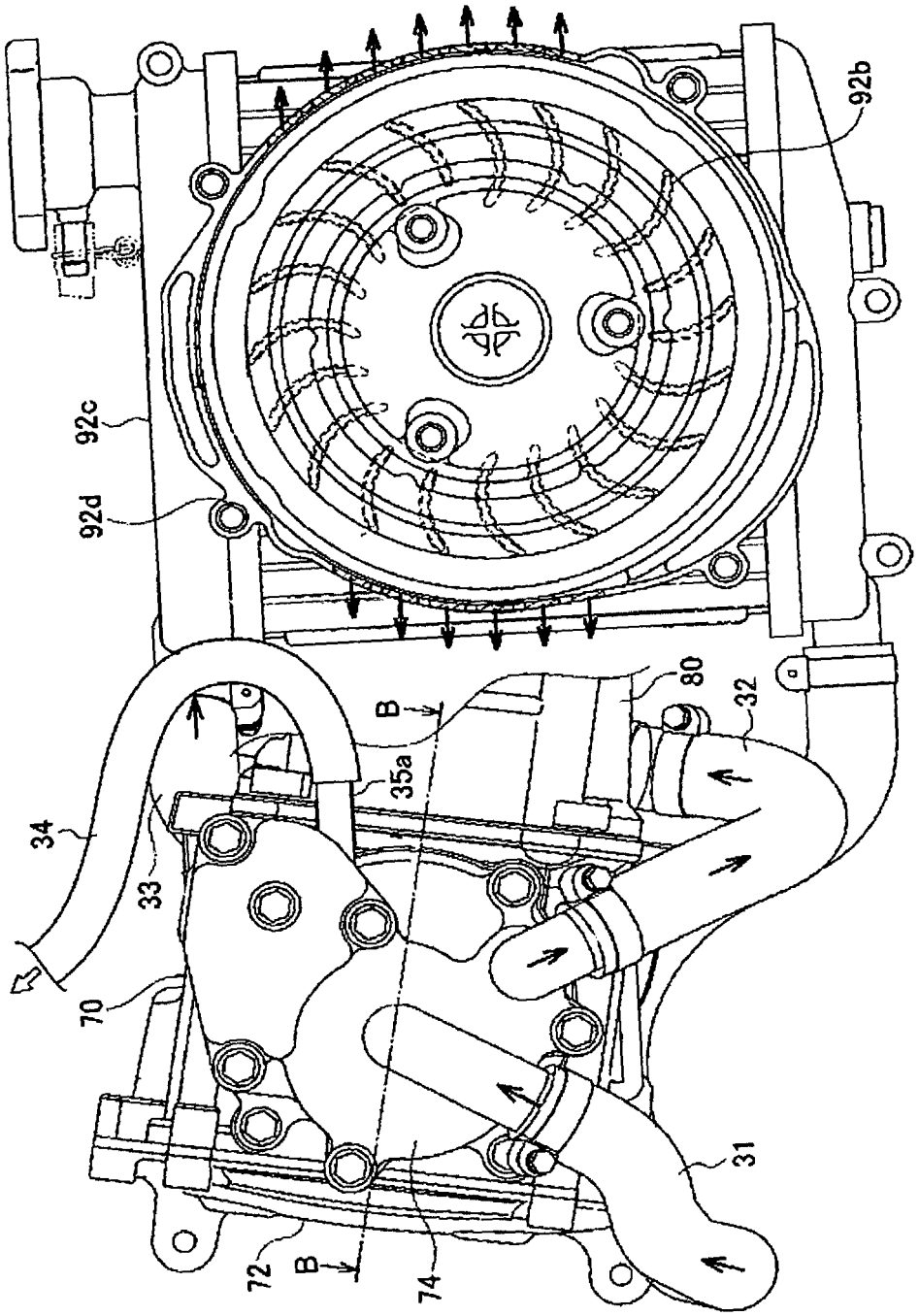
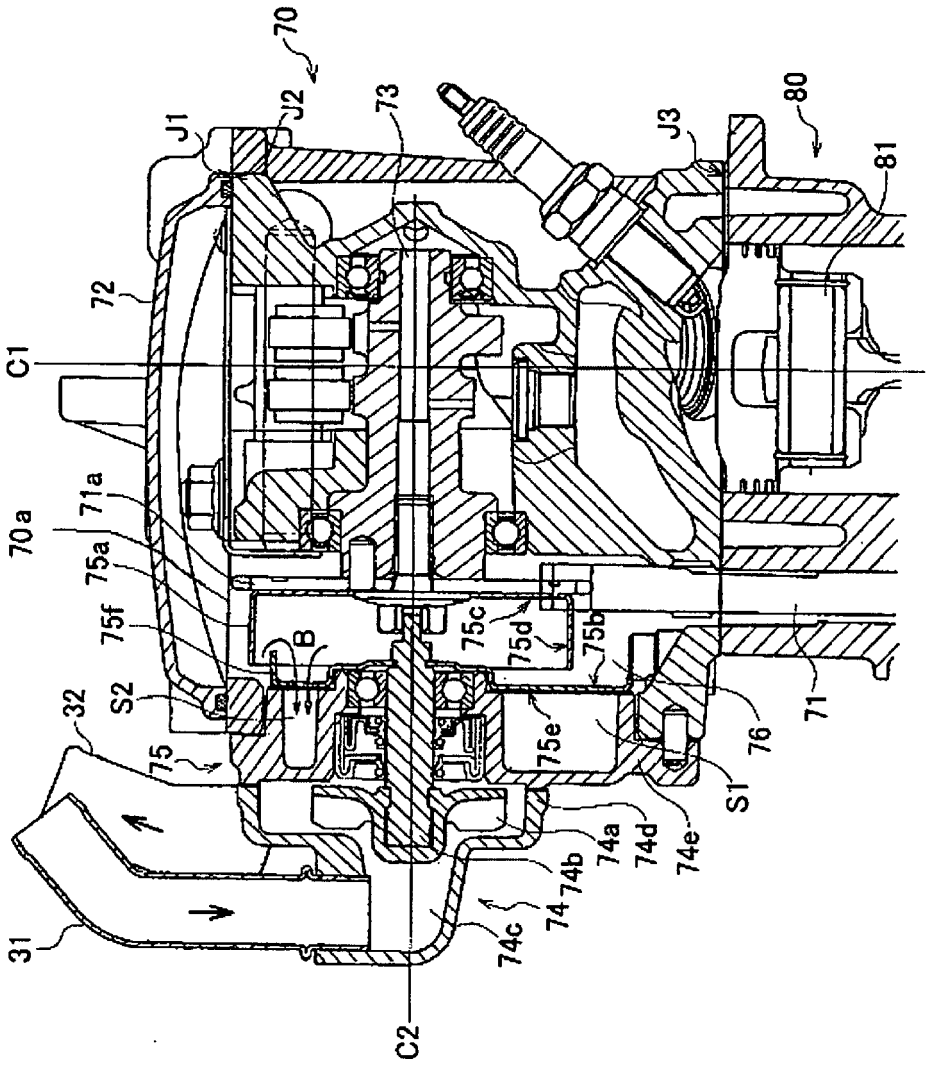


FIG. 4


70
J1
J2
73
J3
80
81
72
C1
71a
70a
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75f
B
75c
75d
75b
S2
32
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75e
76
71
S1
74a
74d
74e
74b
74
74c
31
C2

FIG. 5

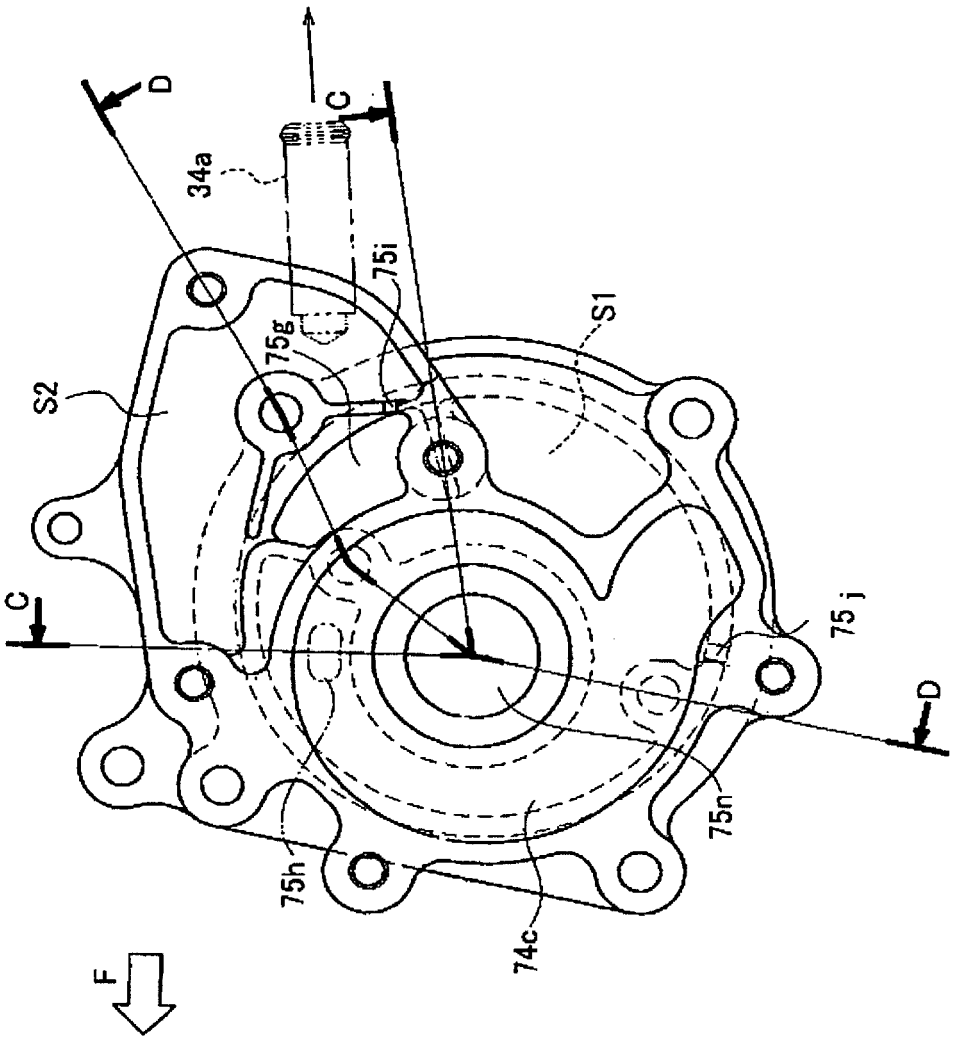

FIG. 6

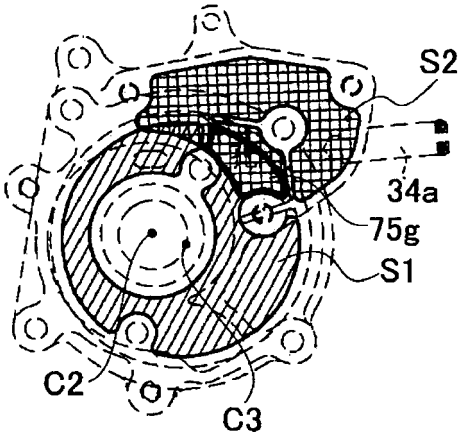

FIG. 7

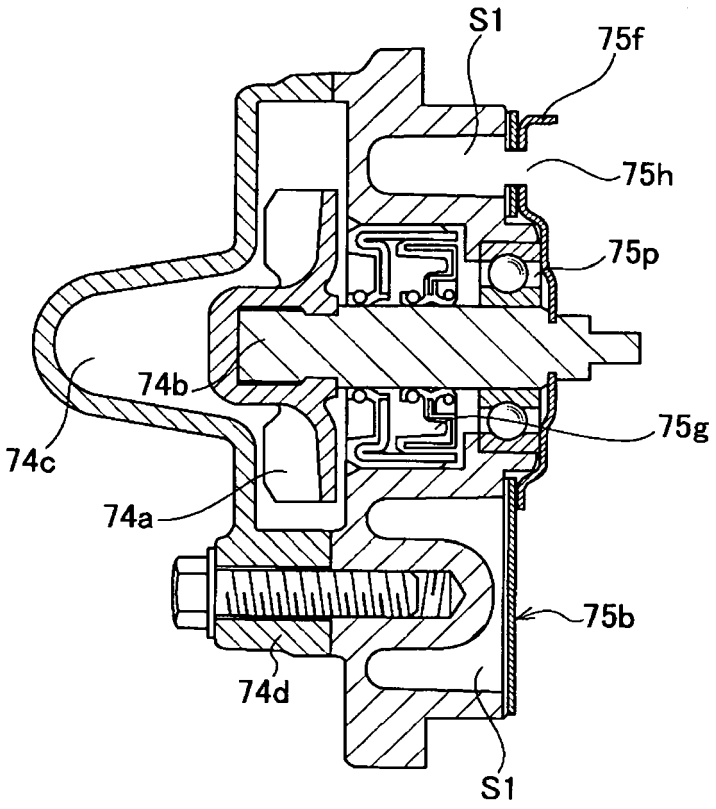

FIG. 8

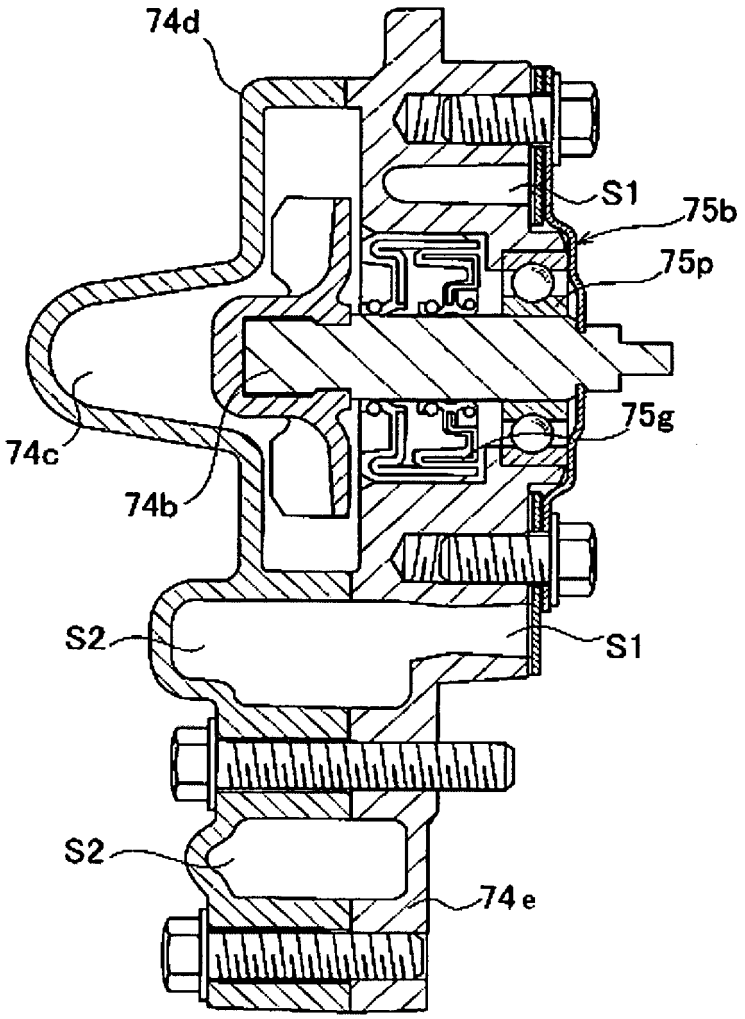

FIG. 9

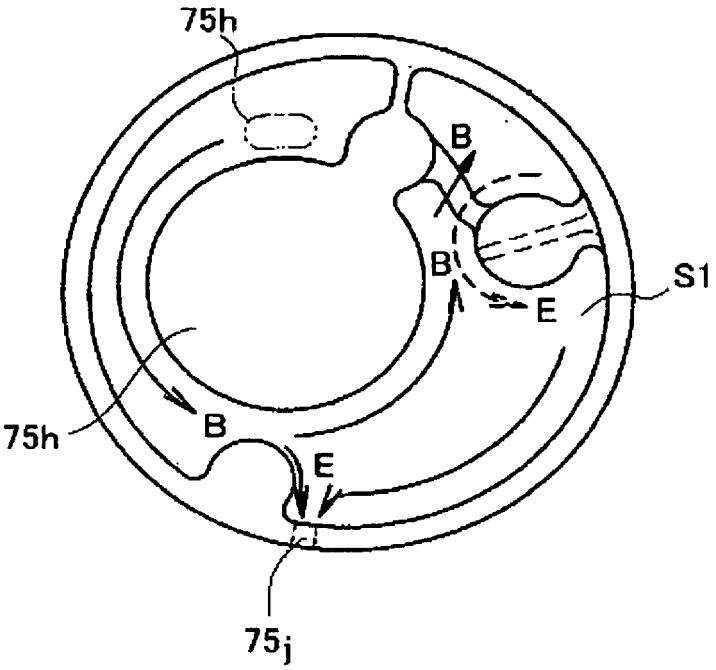

FIG. 10

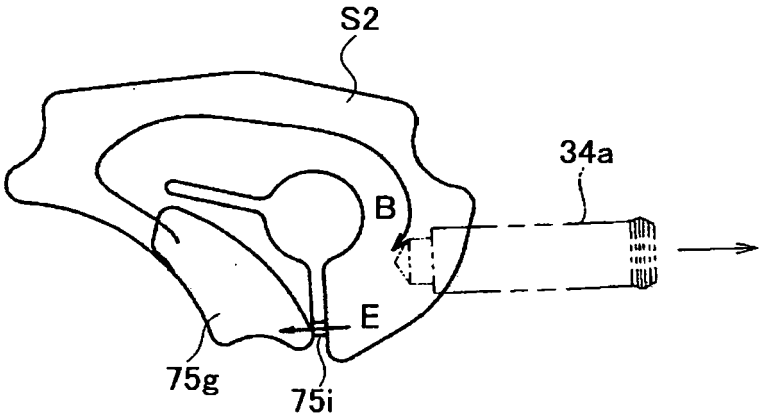

FIG. 11

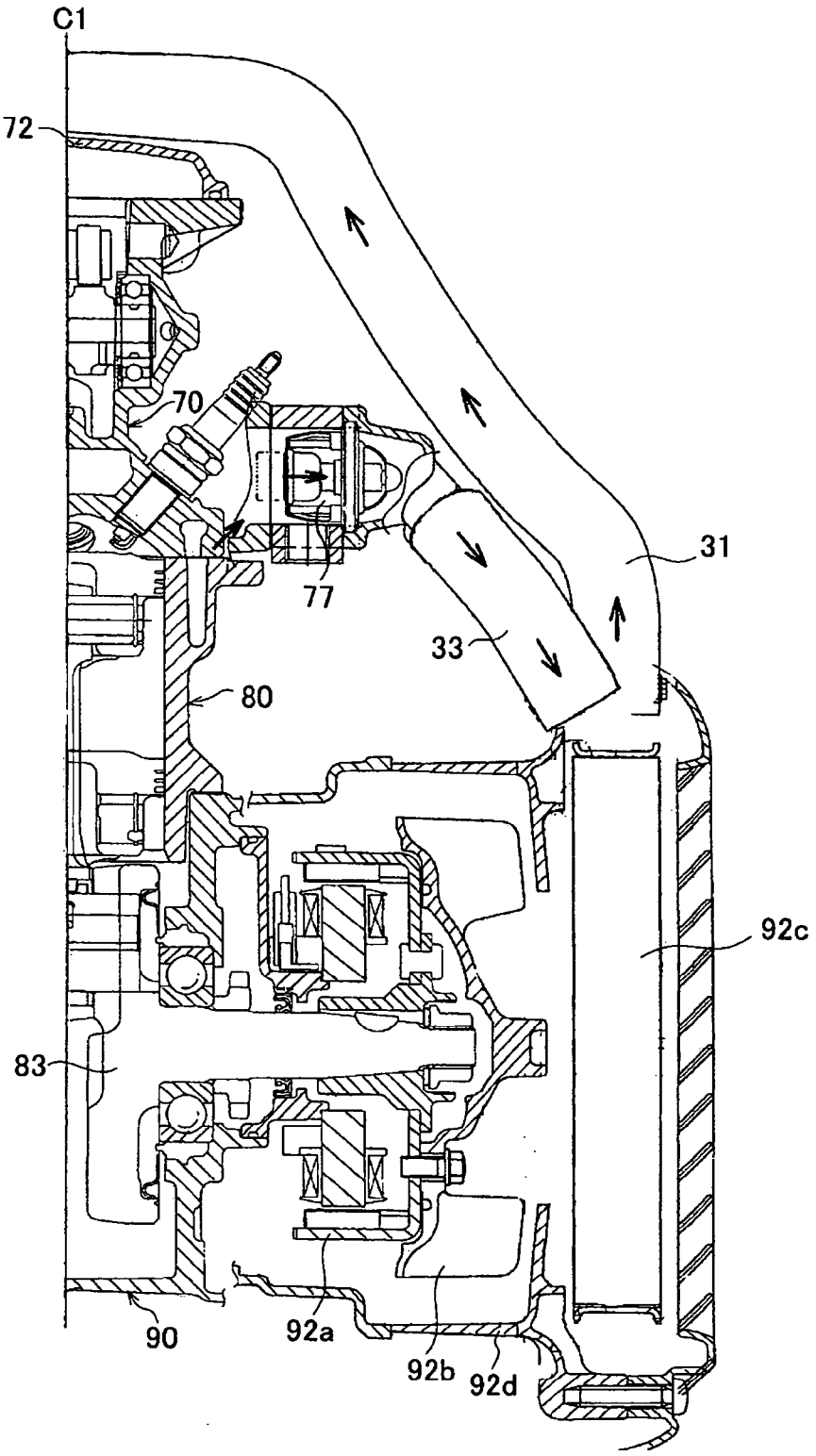

FIG. 12

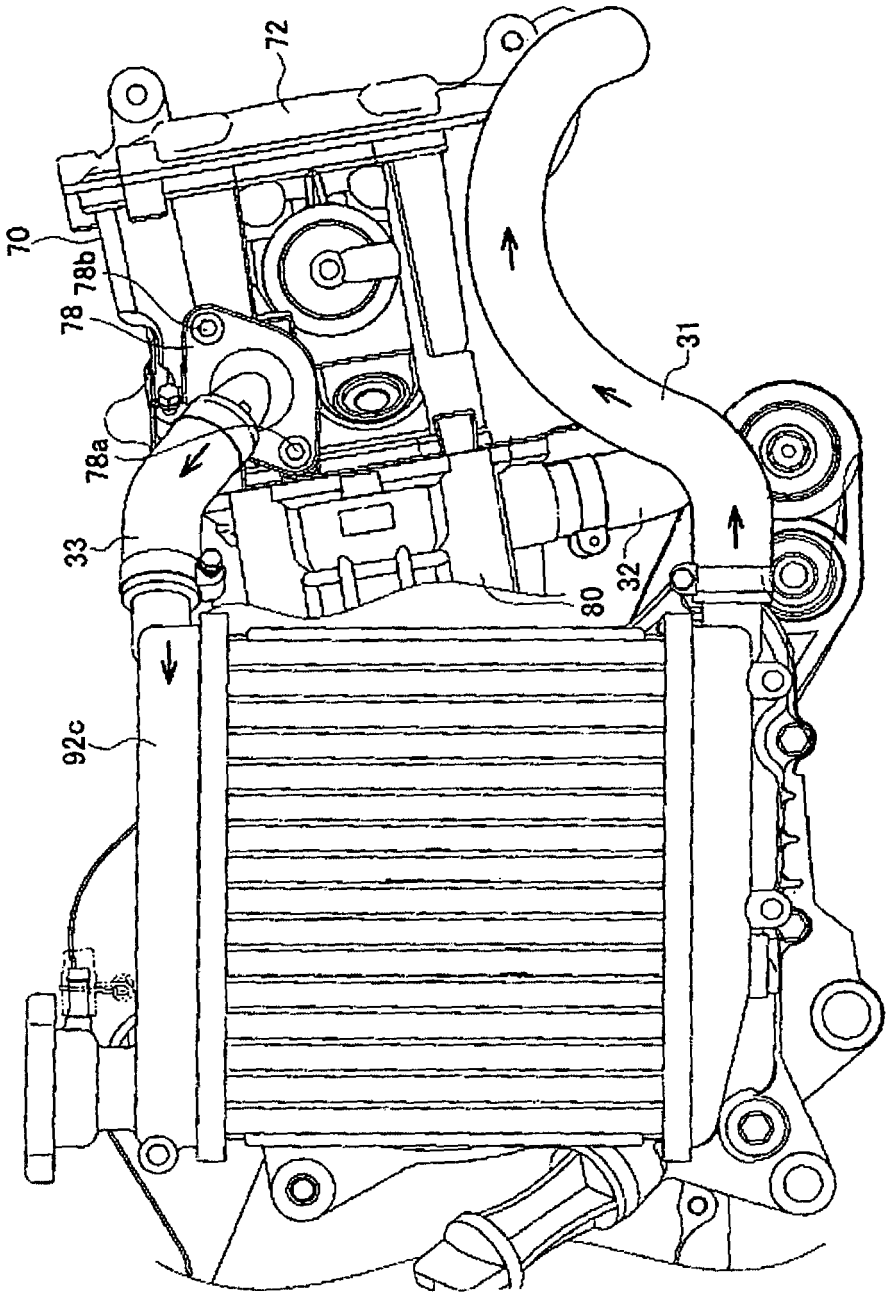

FIG. 13

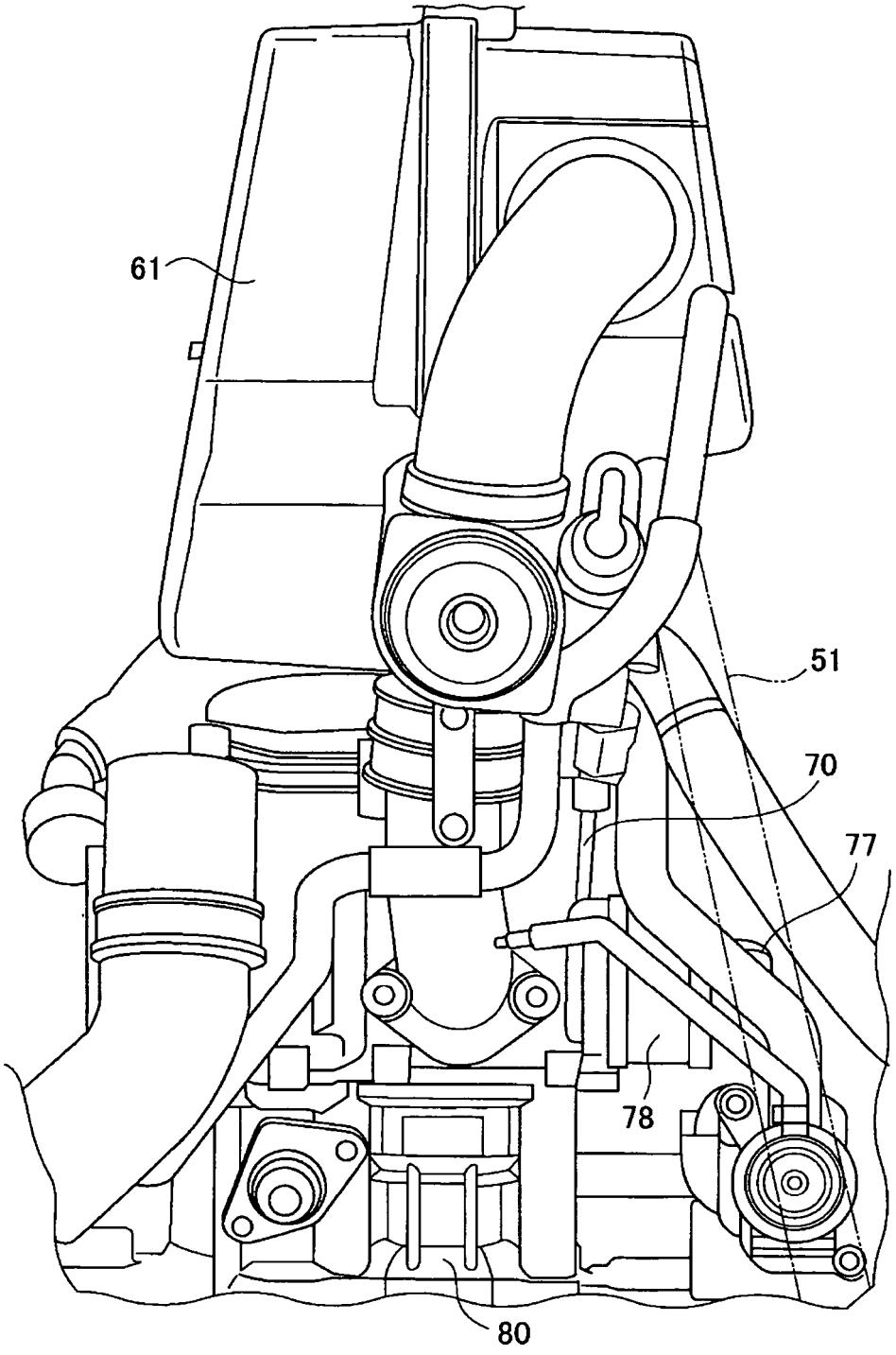

FIG. 14

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 25 0439

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 03 199609 A (YAMAHA MOTOR CO LTD) 30 August 1991 (1991-08-30) * abstract *	1,3,9,10	INV. F01M13/04
D,A	JP 04 237831 A (YAMAHA MOTOR CO LTD) 26 August 1992 (1992-08-26) * abstract *	1	
A	US 2003/010311 A1 (KURIHARA KATSUMI [JP] ET AL) 16 January 2003 (2003-01-16) * column 1, line 53 - column 2, line 19; figures *	1	
A	US 4 922 881 A (TAMBA SHINICHI [JP] ET AL) 8 May 1990 (1990-05-08) * column 1, line 58 - column 2, line 41; figures *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F01M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 May 2008	Vedoato, Luca

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 25 0439

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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14-05-2008

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REFERENCES CITED IN THE DESCRIPTION

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