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(71) Applicant: **Yamaha Hatsudoki Kabushiki Kaisha**
Iwata-shi Shizuoka 438-8501 (JP)

(72) Inventor: **ENDO, Taisuke**
Iwata-shi, Shizuoka 438-8501 (JP)

(74) Representative: **Grünecker Patent- und Rechtsanwälte**
PartG mbB
Leopoldstraße 4
80802 München (DE)

(54) **ENGINE**

(57) A cylinder head (11) includes a mating surface (26) to be attached to a head cover (10) through a gasket (25). The mating surface (26) is remote from an exhaust port (36) toward the head cover (10). A shroud (33) includes an opening (51), a mating surface air guide pathway (47) and a wall portion (52). An exhaust pipe (37) is inserted through the opening (51). The mating surface air guide pathway (47) directs part of outdoor air taken by a cooling fan (30) to the mating surface (26) so as to cool the mating surface (26). The wall portion (52) is disposed between the opening (51) and the mating surface air guide pathway (47), while being disposed adjacently to at least part of the opening (51), whereby the wall portion (52) inhibits the outdoor air from being discharged from the opening (51). The mating surface air guide pathway (47) directs part of the outdoor air to in-between of the mating surface (26) and the exhaust port (36).

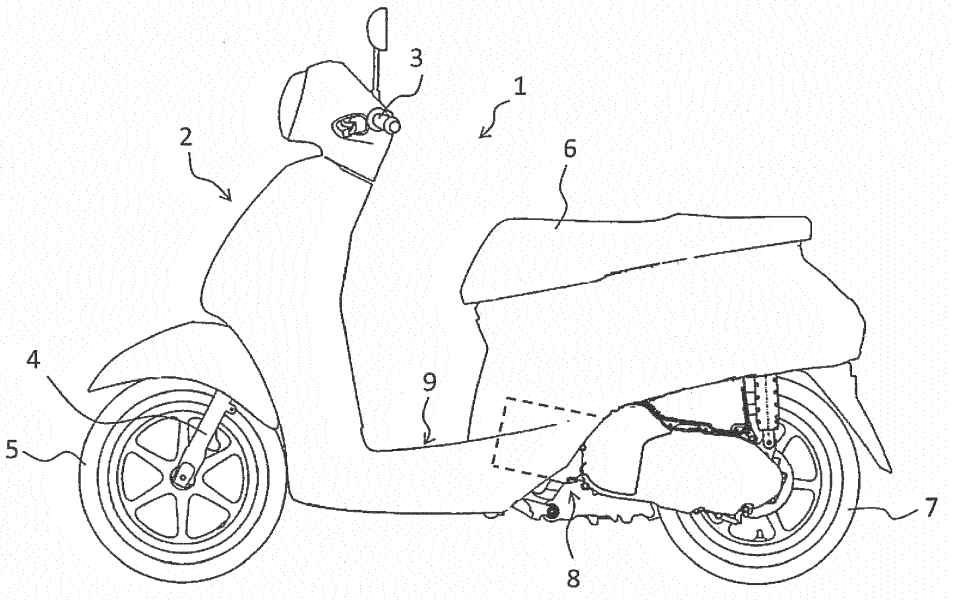

FIG. 1

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Description

[0001] The present invention relates to an engine.

[0002] A forced air cooling engine includes a fan and a shroud as described in, for instance, Japan Laid-open Patent Application Publication No. 2010-223211. The fan is connected to a crankshaft. The shroud covers the surroundings of a cylinder and a cylinder head. In the forced air cooling engine, the fan is rotated by the driving force of the engine, whereby outdoor air is introduced into the shroud so as to hit the cooling fins of the cylinder and those of the cylinder head. Accordingly, the engine is enhanced in cooling efficiency.

[0003] A mating surface of the cylinder head is connected to a head cover through a gasket. A portion of the mating surface, disposed in adjacent to an exhaust port, is likely to be heated to high temperature, because exhaust gas is discharged at high temperature from the exhaust port. The gasket makes contact with the mating surface. Therefore, a portion of the gasket, disposed in adjacent to the exhaust port, is also likely to be heated to high temperature. This possibly results in reduction in durability of the gasket. The gasket can be enhanced in durability when made of high heat resistant material. However, this poses a drawback of cost increase.

[0004] As described above, in the forced air cooling engine, the outdoor air taken into the shroud is directed to the cylinder and the cylinder head. However, the shroud is provided with an opening through which an exhaust pipe is inserted. Therefore, in the well-known forced air cooling engine, the outdoor air is likely to be discharged to the outside through the opening of the shroud even in making an attempt to direct the outdoor air to the mating surface by the fan. Additionally, the outdoor air is likely to be blocked by the exhaust port or the exhaust pipe connected to the exhaust port. Therefore, the amount of outdoor air directed to the mating surface is not sufficient. In other words, it is not easy to enhance the efficiency of cooling the gasket.

[0005] The efficiency of cooling the mating surface of the cylinder head can be indirectly enhanced by increasing the amount of outdoor air to be taken by the fan. In this case, however, increase in size of the fan is required, and deterioration in layout of the fan is inevitable. Alternatively, the driving force of the engine is consumed, whereby fuel efficiency of the engine is inevitably worsened.

[0006] It is an object of the present invention to inhibit cost increase and simultaneously enhance the durability of a gasket by enhancing an efficiency of cooling a mating surface of a cylinder head in a forced air cooling engine. According to the present invention said object is solved by an engine having the features of independent claim 1. Preferred embodiments are laid down in the dependent claims.

[0007] An engine according to an aspect includes a crankshaft, a crankcase, a cylinder, a cylinder head, an exhaust pipe, a head cover, a gasket, a shroud and a cooling fan. The crankcase accommodates the crankshaft. The cylinder is connected to the crankcase. The cylinder head is connected to the cylinder, and includes an exhaust port. The exhaust pipe is connected to the exhaust port. The head cover is attached to the cylinder head. The gasket is interposed between the cylinder head and the head cover. The shroud is disposed about the cylinder head. The cooling fan is connected to the crankshaft and takes an outdoor air into the shroud.

[0008] The cylinder head includes a mating surface attached to the head cover through the gasket. The mating surface is remote from the exhaust port toward the head cover. The shroud includes an opening, a mating surface air guide pathway and a wall portion. The exhaust pipe is inserted through the opening. The mating surface air guide pathway directs part of the outdoor air taken by the cooling fan to in-between of the mating surface and the exhaust port. The wall portion is disposed between the opening and the mating surface air guide pathway, while being disposed adjacently to at least part of the opening. The wall portion inhibits the outdoor air from being discharged from the opening.

[0009] In the engine according to the present aspect, the mating surface is remote from the exhaust port toward the head cover, whereby a space, through which the outdoor air flows, is reliably produced between the mating surface and the exhaust port. Additionally, the mating surface air guide pathway directs the outdoor air taken into the shroud to the in-between of the mating surface and the exhaust port. Therefore, the outdoor air is enabled to reach the mating surface without being blocked by the exhaust port or the exhaust pipe. Moreover, the wall portion of the shroud inhibits the outdoor air from being discharged from the opening. Accordingly, a sufficient amount of outdoor air is enabled to reach the mating surface. Based on the above, according to the present aspect, the mating surface of the cylinder head can be enhanced in cooling efficiency, whereby the gasket can be enhanced in durability while cost increase can be inhibited.

[0010] The engine may further include a camshaft supported by the cylinder head. At least a portion closest to the exhaust port in the mating surface may be located closer to the head cover than a center line of the camshaft. In this case, a large space can be reliably produced between the mating surface and the exhaust port. Accordingly, the outdoor air is enabled to reach the mating surface with as large amount as possible.

[0011] The cylinder head may include a first lateral surface and a second lateral surface connected to the first lateral surface. The exhaust port may be disposed at least in part between the first lateral surface and the second lateral surface. The mating surface air guide pathway may direct the outdoor air from a space adjacent to the first lateral surface to a space adjacent to the second lateral surface through a space between the mating surface and the exhaust port. In this case, the mating surface air guide pathway directs the outdoor air from the space

adjacent to the first lateral surface through the space between the mating surface and the exhaust port. Accordingly, a sufficient amount of outdoor air is enabled to reach the space adjacent to the second lateral surface, i.e., a space to which the outdoor air is not easily supplied.

[0012] The engine may further include a spark plug attached to the first lateral surface. The shroud may further include a plug air guide pathway that directs the outdoor air to the spark plug. In this case, a portion, to which the spark plug is attached, on the first lateral surface can be effectively cooled by the outdoor air directed by the plug air guide pathway.

[0013] The mating surface air guide pathway may include a first pathway and a second pathway. The first pathway may be located adjacently to the first lateral surface. The second pathway may be located between the mating surface and the exhaust port. In this case, the outdoor air flows from the first pathway to the second pathway. Accordingly, the mating surface can be effectively cooled by the outdoor air.

[0014] The second pathway may have a smaller cross-sectional flow area than the first pathway. In this case, it is possible to increase the flow rate of the outdoor air flowing through the second pathway. Accordingly, the mating surface can be enhanced in cooling efficiency.

[0015] The shroud may include a rib partitioning off the plug air guide pathway and the mating surface air guide pathway from each other. In this case, the mating surface air guide pathway is partitioned off from the plug air guide pathway through the rib. Accordingly, the outdoor air is enabled to reach the mating surface through the mating surface air guide pathway with as large amount as possible.

[0016] The rib may include a first rib portion and a second rib portion. The first rib portion may be disposed adjacently to the cylinder. The second rib portion may be disposed adjacently to the cylinder head. The first rib portion and the second rib portion may be provided separately from each other. In this case, the rib can be easily formed.

[0017] The head cover may be made of resin. In this case, weight reduction or cost reduction can be made. Additionally, in the engine according to the present aspect, the highest temperature of the mating surface is lowered by enhancement in cooling efficiency. Accordingly, thermal impact on the head cover is lessened, whereby the head cover made of resin can be used.

[0018] The gasket may be made of synthetic rubber containing an acrylic component. In this case, cost reduction can be made. Additionally, in the engine according to the present aspect, the highest temperature of the gasket is lowered by enhancement in cooling efficiency. Accordingly, thermal impact on the gasket is lessened, whereby the gasket, made of synthetic rubber containing an acrylic component, can be used.

[0019] The cylinder head may include a recess located between the mating surface and the exhaust port. The mating surface air guide pathway may direct the outdoor air to the recess. In this case, the mating surface air guide pathway can be formed in part by utilizing the recess.

[0020] The shroud may include a first component and a second component. The second component may be provided separately from the first component, and may be disposed in an axis direction of the crankshaft with respect to the first component. In this case, the shape of the shroud including the mating surface air guide pathway can be easily formed.

FIG. 1 is a side view of a straddled vehicle according to a preferred embodiment.
FIG. 2 is a cross-sectional view of an engine according to the preferred embodiment.
FIG. 3 is a side view of the engine.
FIG. 4 is a top view of the engine.
FIG. 5 is a front view of the engine.
FIG. 6 is a bottom view of the engine.
FIG. 7 is an enlarged bottom view of the engine.
FIG. 8 is a cross-sectional view of the engine as seen from another side.
FIG. 9 is an enlarged perspective view of the surroundings of an exhaust port of the engine.
FIG. 10 is a perspective view of a structure of an air guide pathway inside a shroud.
FIG. 11 is a side view of an internal structure of the shroud.
FIG. 12 is a perspective view of the internal structure of the shroud.
FIG. 13 is a perspective view of the internal structure of the shroud.
FIG. 14 is an enlarged side view of the surroundings of a cylinder head.
FIG. 15 is an enlarged front view of the surroundings of the cylinder head.

[0021] An engine according to a preferred embodiment will be hereinafter explained with reference to drawings. FIG. 1 is a side view of a straddled vehicle 1 according to the present preferred embodiment. The straddled vehicle 1 according to the present preferred embodiment is a scooter-type vehicle. As shown in FIG. 1, the straddled vehicle 1 includes a vehicle body 2, a handle 3, a steering device 4, a front wheel 5, a seat 6, a rear wheel 7 and an engine 8.

[0022] The handle 3 is coupled to the front wheel 5 through the steering device 4. The seat 6 is supported by the vehicle body 2. A footboard 9 is disposed in front of and directly below the seat 6. The footboard 9 is a portion provided for allowing a rider to put his/her feet thereon. The footboard 9 has a flat shape. However, the footboard 9 may have an upwardly protruding shape in the vehicle width directional middle portion thereof.

[0023] The engine 8 is disposed directly below the seat 6. The engine 8 is pivotably supported by the vehicle body 2. The engine 8 is of a so-called forced air cooling type. The structure of the engine 8 will be hereinafter explained in detail. In the following explanation of the

engine 8, up, down, front, rear, right and left directions are defined as meaning the up, down, front, rear, right and left directions of the engine 8, respectively, based on a condition that the engine 8 is installed in the straddled vehicle 1.

[0024] FIG. 2 is a cross-sectional view of the engine 8. As shown in FIG. 2, the engine 8 includes a head cover 10, a cylinder head 11, a cylinder 12, a piston 13, a crankcase 14 and a crankshaft 15.

[0025] A camshaft 19 is disposed inside the cylinder head 11. The camshaft 19 is supported by the cylinder head 11. A first cam chain sprocket 21 is connected to the camshaft 19. A spark plug 20 is attached to the cylinder head 11.

[0026] The head cover 10 is attached to the cylinder head 11. The head cover 10 is made ofresin. However, the head cover 10 may be made of another material. It should be noted that a direction from the cylinder head 1 1 to the head cover 10 will be referred to as "head cover 10 side". A direction from the cylinder head 11 to the cylinder 12 will be referred to as "cylinder 12 side".

[0027] A gasket 25 is disposed between the cylinder head 11 and the head cover 10. The cylinder head 11 includes a mating surface 26 to which the head cover 10 is attached through the gasket 25. The gasket 25 is interposed between the cylinder head 11 and the head cover 10. The gasket 25 is made of synthetic rubber containing an acrylic component. For example, acrylic acid ester is classified as the acrylic component. However, the gasket 25 may be made of another resin.

[0028] The cylinder head 11 is connected to the cylinder 12. The cylinder 12 includes a plurality of cooling fins 28. The cylinder head 11 includes a plurality of cooling fins 27 (see FIG. 7). The cylinder 12 is connected to the crankcase 14. An axis Ax1 of the cylinder 12 extends in the back-and-forth direction.

[0029] It should be noted that in the present specification, a condition of a constituent element "extending in the back-and-forth direction" is not limited to a condition of the constituent element extending in parallel to the back-and-forth direction. The condition of the constituent element "extending in the back-and-forth direction" refers to a condition that the smaller of two angles formed between the horizontal direction and the extending direction of the constituent element is less than or equal to 45 degrees. In other words, the condition of the constituent element "extending in the back-and-forth direction" encompasses a condition of the constituent element extending in a direction tilting relatively to the horizontal direction. In the present specification, the term "connection" is not limited to direct connection, and encompasses indirect connection. Additionally, the term "connection" is not limited to a condition that separate members are fixed to each other, and encompasses a condition that a plurality of portions in an integrated member continue to each other.

[0030] The piston 13 is disposed inside the cylinder 12. The crankshaft 15 is coupled to the piston 13 through a connecting rod 16. The crankshaft 15 is accommodated in the crankcase 14, and is rotated about an axis Ax2 of the crankshaft 15. It should be noted that in the following explanation, the term "crank axis direction" is defined as meaning the extending direction of the axis Ax2 of the crankshaft 15. On the other hand, the term "cylinder axis direction" is defined as meaning the extending direction of the axis Ax 1 of the cylinder 12.

[0031] The crankshaft 15 is accommodated in the crankcase 14. The connecting rod 16 is connected to the crankshaft 15. The crankshaft 15 includes a first end portion 151, an intermediate portion 152 and a second end portion 153. The intermediate portion 152 is disposed between the first end portion 151 and the second end portion 153 in the crank axis direction.

[0032] A power generator 29 and a cooling fan 30 are attached to the first end portion 151. The power generator 29 is disposed between the crankcase 14 and the cooling fan 30. The power generator 29 generates electric power when driven by the rotation of the crankshaft 15, and charges a battery (not shown in the drawings). Additionally, the power generator 29 functions as a starter motor that starts the engine 8 by the electric power from the battery. In other words, the power generator 29 is a starter-generator. The power generator 29 may function as an assist motor that assists the driving force of the engine 8. The power generator 29 may be of a type without any function as a starter motor.

[0033] The power generator 29 includes a rotor 31 and a stator 32. The rotor 31 is fixed to the first end portion 151, and is rotated together with the crankshaft 15. The stator 32 is fixed to the crankcase 14. The stator 32 is opposed to the rotor 31 in the radial direction thereof. The cooling fan 30 is disposed to be concentric to the crankshaft 15. The cooling fan 30 is a centrifugal fan that feeds air in centrifugal directions.

[0034] A second cam chain sprocket 22 is connected to the intermediate portion 152. A cam chain 23 is wound about the first cam chain sprocket 21 and the second cam chain sprocket 22. The cylinder head 11, the cylinder 12 and the crankcase 14 are provided with a can chain compartment 24 in the interior thereof. The cam chain 23 is disposed in the cam chain compartment 24.

[0035] A transmission 17 is disposed laterally to the engine 8. The second end portion 153 is coupled to the transmission 17. Detailed, the transmission 17 is a continuously variable transmission, and the second end portion 153 is connected to a drive pulley of the transmission 17. However, the transmission 17 may be a dual-clutch transmission.

[0036] The engine 8 includes a shroud 33. The shroud 33 covers the crankcase 14, the cylinder 12 and the cylinder head 11. The shroud 33 is made of resin. However, the shroud 33 may be made of another material. The shroud 33 is disposed laterally to the cooling fan 30. The shroud 33 includes a vent hole 330. The vent hole 330 overlaps the cooling fan 30 in the crank axis direction. When the cooling fan 30 is rotated, outdoor air is taken

into the shroud 33 through the vent hole 330.

[0037] FIG. 3 is a side view of the engine 8. FIG. 4 is a top view of the engine 8. FIG. 5 is a front view of the engine 8. FIG. 6 is a bottom view of the engine 8.

[0038] As shown in FIGS. 3 to 6, the shroud 33 is disposed laterally to the crankcase 14. The shroud 33 overlaps the crankcase 14 as seen from the crank axis direction. The shroud 33 is disposed in the surroundings of the cylinder head 11. The shroud 33 is disposed above, below, right, and left of the cylinder head 11. The shroud 33 overlaps the cylinder head 11 as seen from the crank axis direction. The shroud 33 overlaps the cylinder head 11 as seen from a direction perpendicular to the crank axis Ax2 and the cylinder axis Ax1.

[0039] FIG. 7 is an enlarged bottom view of the engine 8. It should be noted that FIG. 7 shows part of the shroud 33 in a cross-sectional representation. As shown in FIG. 7, the cylinder head 11 includes a first lateral surface 111, a second lateral surface 112 and a third lateral surface 113. The first lateral surface 111 is disposed to face one lateral side. The second lateral surface 112 is disposed to face downward. The second lateral surface 112 is connected to the first lateral surface 111. The third lateral surface 113 is disposed to face the other lateral side. The third lateral surface 113 is connected to the second lateral surface 112.

[0040] In the present preferred embodiment, the first lateral surface 111 is disposed to face rightward. The third lateral surface 113 is disposed to face leftward. The spark plug 20 is attached to the first lateral surface 111. The cylinder head 11 further includes a fourth lateral surface disposed to face upward, although this is not shown in the drawings.

[0041] The cylinder head 11 includes an exhaust port 36. The exhaust port 36 is disposed at least in part between the first lateral surface 111 and the second lateral surface 112. The exhaust port 36 protrudes from a portion between the first lateral surface 111 and the second lateral surface 112 in the cylinder head 11. The exhaust port 36 protrudes downward and sideward. In the present preferred embodiment, the exhaust port 36 protrudes downward and rightward. However, the layout of the exhaust port 36 may be changed. An oxygen sensor 38 is attached to the exhaust port 36. An exhaust pipe 37 shown in FIGS. 3 and 5 is connected to the exhaust port 36.

[0042] FIG. 8 is a cross-sectional view of the engine 8 including the exhaust port 36. The mating surface 26 of the cylinder head 11 is remote from the exhaust port 36 toward the head cover 10. On the first lateral surface 111 side, the mating surface 26 is located closer to the head cover 10 than a center line Ax3 of the camshaft 19. In the mating surface 26, at least a portion 260 closest to the exhaust port 36 is located closer to the head cover 10 than the center line Ax3 of the camshaft 19.

[0043] As shown in FIG. 7, the cylinder head 11 includes a flange portion 41, a first wall surface 40a and a second wall surface 40b. The flange portion 41 is provided on the head cover 10-side end of the cylinder head 11. The mating surface 26 is provided on the flange portion 41. The first wall surface 40a is located between the flange portion 41 and the second wall surface 40b. The flange portion 41 protrudes from the first wall surface 40a in a perpendicular direction to the cylinder axis. The second wall surface 40b is located on the cylinder 12 side of the first wall surface 40a. The second wall surface 40b is provided with the aforementioned cooling fins 27.

[0044] FIG. 9 is an enlarged view of the surroundings of the exhaust port 36. As shown in FIGS. 7, 8 and 9, the cylinder head 11 includes a recess 39 located between the mating surface 26 and the exhaust port 36. The recess 39 is disposed between the flange portion 41 and the exhaust port 36. The recess 39 is provided on a corner portion between the first lateral surface 111 and the second lateral surface 112.

[0045] As shown in FIGS. 7 and 9, the exhaust port 36 is disposed to be remote from the flange portion 41 toward the cylinder 12. The first wall surface 40a includes a portion 400 located between the exhaust port 36 and the flange portion 41 in the cylinder axis direction. The recess 39 is composed of the portion 400, a surface 360 and a surface 410. The portion 400 is located between the exhaust port 36 and the flange portion 41 in the first wall surface 40a. The surface 360 is the head cover 10-side surface of the exhaust port 36. The surface 410 is the cylinder 12-side surface of the flange portion 41.

[0046] Detailed, the flange portion 41 includes a boss portion 42. The boss portion 42 protrudes from the first wall surface 40a in the perpendicular direction to the cylinder axis Ax1. The recess 39 is disposed between the boss portion 42 and the exhaust port 36. A bolt 43 (see FIG. 5) is inserted through the boss portion 42 in order to fix the head cover 10 to the cylinder head 11.

[0047] FIG. 10 is a view of an air guide pathway structure inside the shroud 33. FIG. 10 omits illustration of part of the shroud 33. As shown in FIG. 10, the shroud 33 includes a fan accommodation portion 45, a plug air guide pathway 46 and a mating surface air guide pathway 47. The aforementioned cooling fan 30 is disposed in the fan accommodation portion 45. The fan accommodation portion 45 communicates with the external space through the vent hole 330.

[0048] The plug air guide pathway 46 communicates with the fan accommodation portion 45. The plug air guide pathway 46 extends from the fan accommodation portion 45 to the spark plug 20, while passing through a lateral side of the cylinder 12 and the cylinder head 11. The plug air guide pathway 46 is disposed adjacently to the cylinder 12, the cylinder head 11 and the spark plug 20. The plug air guide pathway 46 directs outdoor air to the spark plug 20. Accordingly, the spark plug 20 and a portion, to which the spark plug 20 is attached, in the cylinder head 11 are cooled.

[0049] The shroud 33 includes a plug hole 48. The plug hole 48 is disposed in a corresponding position to the spark plug 20 in the shroud 33. As shown in FIG. 3, a

plug cord 49 is inserted through the plug hole 48 so as to be connected to the spark plug 20.

[0050] The mating surface air guide pathway 47 communicates with the fan accommodation portion 45. The mating surface air guide pathway 47 extends from the fan accommodation portion 45 to a portion between the mating surface 26 and the exhaust port 36, while passing through the lateral side of the cylinder 12 and the cylinder head 11. Detailed, the mating surface air guide pathway 47 extends from the fan accommodation portion 45 to the recess 39 between the mating surface 26 and the exhaust port 36, while passing through the lateral side of the cylinder 12 and the cylinder head 11.

[0051] The mating surface air guide pathway 47 is disposed adjacently to the cylinder 12 and the cylinder head 11. The mating surface air guide pathway 47 directs part of the outdoor air taken by the cooling fan 30 to the recess 39. The mating surface air guide pathway 47 directs the outdoor air from a space adjacent to the first lateral surface 111 to a space adjacent to the second lateral surface 112 through a space inside the recess 39. The outdoor air is thus directed to the mating surface 26, whereby the mating surface 26 is cooled.

[0052] The shroud 33 includes an opening 51. The opening 51 is disposed in a corresponding position to the exhaust port 36 in the shroud 33. As shown in FIG. 3, the exhaust pipe 37 is inserted through the opening 51. The shroud 33 includes a first component 34 and a second component 35. The first and second components 34 and 35 are provided separately from each other. However, part or entirety of the first and second components 34 and 35 may be integrated.

[0053] As shown in FIG. 10, the first component 34 includes the plug hole 48. The first component 34 includes the opening 51. The opening 51 is disposed directly below the mating surface air guide pathway 47. The first component 34 covers the first lateral surface 111. The first component 34 covers part of the surroundings of the cylinder 12 and part of the surroundings of the cylinder head 11. Detailed, the first component 34 covers at least part of the first lateral surface 111. The first component 34 covers at least part of the second lateral surface 112. The first component 34 covers at least part of the third lateral surface 113. The first component 34 covers at least part of the fourth lateral surface (not shown in the drawings).

[0054] The second component 35 includes the aforementioned vent hole 330. The second component 35 covers the cooling fan 30 in the crank axis direction and the radial direction of the cooling fan 30. The second component 35 is disposed laterally to the crankcase 14 and the cylinder 12.

[0055] As shown in FIG. 4, the first component 34 includes a cylinder cover 341 and a crankcase cover 342. The cylinder cover 341 covers part of the surroundings of the cylinder 12 and part of the surroundings of the cylinder head 11. The crankcase cover 342 is disposed in the crank axis direction with respect to the crankcase 14. The second component 35 is disposed in the crank axis direction with respect to the first component 34. Detailed, the second component 35 is disposed in the crank axis direction with respect to the crankcase cover 342.

[0056] The first component 34 includes a first portion 34a and a second portion 34b. The first and second portions 34a and 34b are provided separately from each other. The first component 34 is split right and left into the first and second portions 34a and 34b through a split line 34c. However, the first component 34 may be provided as an integrated member.

[0057] FIG. 11 is a side view of an internal structure of the shroud 33. FIGS. 12 and 13 are perspective views of the internal structure of the shroud 33. It should be noted that FIGS. 11 to 13 omit illustration of the second portion 34b.

[0058] As shown in FIGS. 11 to 13, the shroud 33 includes a wall portion 52. The wall portion 52 is disposed adjacently to at least part of the opening 51, and is also disposed between the mating surface air guide pathway 47 and the opening 51. The wall portion 52 extends along the mating surface air guide pathway 47. The wall portion 52 extends from the fan accommodation portion 45 to a position between the mating surface 26 and the exhaust port 36, while passing through the lateral side of the cylinder 12 and the cylinder head 11. The wall portion 52 inhibits the outdoor air from being discharged from the opening 51. The wall portion 52 is provided on the first component 34. As shown in FIG. 6, the wall portion 52 is disposed between the cooling fins 27 of the cylinder head 11 and the inner wall of the shroud 33 as seen in a bottom view of the engine 8.

[0059] The shroud 33 includes a rib 53. The rib 53 protrudes from the inner surface of the shroud 33 in the crank axis direction. The rib 53 is disposed between the plug air guide pathway 46 and the mating surface air guide pathway 47 so as to partition off the both pathways 46 and 47 from each other. The rib 53 extends from the fan accommodation portion 45 to the plug hole 48, while passing through the lateral side of the cylinder 12 and the cylinder head 11. The rib 53 and the wall portion 52 compose part of the mating surface air guide pathway 47.

[0060] The rib 53 includes a first rib portion 54 and a second rib portion 55. The first rib portion 54 is disposed adjacently to the cylinder 12. The second rib portion 55 is disposed adjacently to the cylinder head 11. The first rib portion 54 is provided on the second component 35. The second rib portion 55 is provided on the first component 34. Therefore, the first and second rib portions 54 and 55 are provided separately from each other. The first and second rib portions 54 and 55 are disposed to be flush with each other.

[0061] As shown in FIGS. 11 to 13, the shroud 33 is provided with a seal groove 56 on the end thereof. As shown in FIG. 7, a seal member 57 is attached to the seal groove 56. The seal member 57 is made of resin such as rubber or so forth. However, the seal member 57 may be made of another material. The end of the

shroud 33 is abutted and connected to the flange portion 41 of the cylinder head 11 through the seal member 57.

[0062] As shown in FIGS. 11 to 13, the shroud 33 includes a corner cover portion 58. The corner cover portion 58 covers the portion between the mating surface 26 and the exhaust port 36. The corner cover portion 58 covers the boss portion 42 of the flange portion 41 and the recess 39. The corner cover portion 58 includes a curved portion 59. The curved portion 59 has a shape fitted to the boss portion 42 of the flange portion 41. The curved portion 59 is connected to the boss portion 42 through the seal member 57.

[0063] The mating surface air guide pathway 47 includes a first pathway 61 and a second pathway 62. The first pathway 61 is disposed adjacently to the first lateral surface 111. The first pathway 61 is composed of the wall portion 52 and the rib 53. The second pathway 62 is located between the mating surface 26 and the exhaust port 36. The second pathway 62 is disposed adjacently to the recess 39. The second pathway 62 is formed by the corner cover portion 58. The second pathway 62 has a smaller cross-sectional flow area than the first pathway 61. The second pathway 62 is disposed adjacently to the second lateral surface 112. As shown in FIG. 15, the shroud 33 includes a sensor hole 63. The oxygen sensor 38 is inserted through the sensor hole 63. The second pathway 62 communicates with the sensor hole 63. The sensor hole 63 is located downstream of the recess 39 in the stream of air flowing through the second pathway 62.

[0064] FIG. 14 is an enlarged side view of the surroundings of the cylinder head 11. FIG. 15 is an enlarged front view of the surroundings of the cylinder head 11. In the engine 8 according to the present preferred embodiment, when the cooling fan 30 is rotated together with the crankshaft 15, the outdoor air is taken into the shroud 33 through the vent hole 330. As depicted with arrow A1 in FIGS. 10, 14 and 15, the outdoor air is directed in part from the fan accommodation portion 45 to the spark plug 20 through the plug air guide pathway 46. Accordingly, the spark plug 20 and a portion located about the spark plug 20 in the cylinder head 11 are cooled.

[0065] Additionally, the outdoor air is directed in part from the fan accommodation portion 45 to the portion between the mating surface 26 and the exhaust port 36 through the mating surface air guide pathway 47. Detailed as depicted with arrow A2, the outdoor air, while being guided by the first pathway 61, passes through the lateral side of the cylinder 12 and flows through the space adjacent to the first lateral surface 111 of the cylinder head 11.

[0066] Subsequently, as depicted with arrow A3, the outdoor air, while being guided by the second pathway 62, flows from the space adjacent to the first lateral surface 111 to the space adjacent to the second lateral surface 112 through the space inside the recess 39. Consequently, a portion of the mating surface 26, located adjacent to the exhaust port 36, is cooled.

[0067] In the engine 8 according to the present preferred embodiment, the mating surface 26 is remote from the exhaust port 36 toward the head cover 10, whereby a space, through which the outdoor air flows, is reliably produced between the mating surface 26 and the exhaust port 36. Additionally, the mating surface air guide pathway 47 directs the outdoor air taken into the shroud 33 to in-between of the mating surface 26 and the exhaust port 36. Therefore, the outdoor air is enabled to reach the mating surface 26 without being blocked by the exhaust port 36 or the exhaust pipe 37. Additionally, the wall portion 52 of the shroud 33 inhibits the outdoor air from being discharged from the opening 51. Accordingly, a sufficient amount of outdoor air is enabled to reach the mating surface 26. Based on the above, according to the present invention, the mating surface 26 of the cylinder head 11 can be enhanced in cooling efficiency, whereby the gasket 25 can be enhanced in durability while cost increase can be inhibited.

[0068] In the mating surface 26, at least the portion closest to the exhaust port 36 is located closer to the head cover 10 than the center line Ax3 of the camshaft 19. Therefore, a large space can be reliably produced between the mating surface 26 and the exhaust port 36. Accordingly, the outdoor air is enabled to reach the mating surface 26 with as large amount as possible.

[0069] The mating surface air guide pathway 47 directs the outdoor air from the space adjacent to the first lateral surface 111 to the space adjacent to the second lateral surface 112 through the space between the mating surface 26 and the exhaust port 36. Therefore, the mating surface air guide pathway 47 guides the outdoor air from the space adjacent to the first lateral surface 111 through the space between the mating surface 26 and the exhaust port 36. Accordingly, a sufficient amount of outdoor air is enabled to reach the space adjacent to the second lateral surface 112, i.e., a space to which the outdoor air is not easily supplied.

[0070] The second pathway 62 has a smaller cross-sectional flow area than the first pathway 61. Therefore, it is possible to increase the flow rate of the outdoor air flowing through the second pathway 62. Accordingly, the mating surface 26 can be enhanced in cooling efficiency.

[0071] The mating surface air guide pathway 47 is partitioned off from the plug air guide pathway 46 through the rib 53. Accordingly, the outdoor air is enabled to reach the mating surface 26 through the mating surface air guide pathway 47 with as large amount as possible.

[0072] The first and second rib portions 54 and 55 are provided separately from each other. Therefore, the rib 53 can be easily formed. However, the first and second rib portions 54 and 55 may be integrated with each other.

[0073] The head cover 10 is made of resin. Accordingly, cost reduction can be made. Additionally, in the engine 8 according to the present preferred embodiment, the highest temperature of the mating surface 26 is lowered by enhancement in cooling efficiency. Accordingly, thermal impact on the head cover 10 is lessened, whereby

the head cover 10 made of resin can be used.

[0074] The gasket 25 is made of synthetic rubber containing an acrylic component such as acrylic acid ester. Therefore, cost reduction can be made. Additionally, in the engine 8 according to the present preferred embodiment, the highest temperature of the gasket 25 is lowered by enhancement in cooling efficiency. Accordingly, thermal impact on the gasket 25 is lessened, whereby the gasket 25, made of synthetic rubber containing an acrylic component, can be used.

[0075] The shroud 33 includes the first and second components 34 and 35 provided separately from each other. Therefore, the shape of the shroud 33 including the mating surface air guide pathway 47 can be easily formed.

[0076] One preferred embodiment of the present invention has been explained above. However, the present invention is not limited to the aforementioned preferred embodiment, and a variety of changes can be made without departing from the gist of the present invention.

[0077] The straddled vehicle 1 is not limited to a scooter-type vehicle, and alternatively, may be a moped or a sport-type vehicle. The straddled vehicle 1 is not limited to a motorcycle, and alternatively, may be an all-terrain vehicle or a snowmobile. The number of front wheels is not limited to one, and alternatively, may be two or greater. The number of rear wheels is not limited to one, and alternatively, may be two or greater.

[0078] The structure of the engine 8 may be changed. For example, the shapes and/or layouts of the components of the engine 8 such as the cooling fan 30, the cam chain 23 and the power generator 29 may be changed. The layout of the engine 8 may be changed. For example, the cylinder axis Ax1 may extend in the vehicle up-and-down direction.

[0079] The shape of the shroud 33 may be changed. For example, the shape of the mating surface air guide pathway 47 may be changed. The shape of the plug air guide pathway 46 may be changed. In the mating surface 26, at least the portion closest to the exhaust port 36 may be disposed closer to the cylinder 12 than the center line Ax3 of the camshaft 19. The second pathway 62 may have a cross-sectional flow area equal to or larger than that of the first pathway 61.

[0080] The shape and/or layout of the recess 39 may be changed. Alternatively, the recess 39 may be omitted. The shape and/or layout of the wall portion 52 may be changed. The shape and/or layout of the rib 53 may be changed. Alternatively, the rib 53 may be omitted. The first and second rib portions 54 and 55 may be integrated.

Claims

1. An engine (8) comprising:

a crankshaft (15);
a crankcase (14) accommodating the crankshaft (15);
a cylinder (12) connected to the crankcase (14);
a cylinder head (11) connected to the cylinder (12), the cylinder (12) including an exhaust port (36);
an exhaust pipe (37) connected to the exhaust port (36);
a head cover (10) attached to the cylinder head (11);
a gasket (25) interposed between the cylinder head (11) and the head cover (10);
a shroud (33) disposed about the cylinder head (11); and
a cooling fan (30) for taking an outdoor air into the shroud (33), the cooling fan (30) being connected to the crankshaft (15), wherein
the cylinder head (11) includes a mating surface (26), the mating surface (26) being attached to the head cover (10) through the gasket (25),
the mating surface (26) is remote from the exhaust port (36) toward the head cover (10),
the shroud (33) includes

an opening (51) through which the exhaust pipe (37) is inserted,
a mating surface air guide pathway (47) directing part of the outdoor air taken by the cooling fan (30) to in-between of the mating surface (26) and the exhaust port (36), and
a wall portion (52) disposed between the mating surface air guide pathway (47) and the opening (51), the wall portion (52) being disposed adjacently to at least part of the opening (51), the wall portion (52) inhibiting the outdoor air from being discharged from the opening (51).

2. An engine (8) according to claim 1, further comprising:

a camshaft (19) supported by the cylinder head (11), wherein
at least a portion closest to the exhaust port (36) in the mating surface (26) is located closer to the head cover (10) than a center line (Ax3) of the camshaft (19).

3. An engine (8) according to claim 1 or 2, wherein
the cylinder head (11) includes

a first lateral surface (111), and
a second lateral surface (112) connected to the first lateral surface (111),

the exhaust port (36) is disposed at least in part between the first lateral surface (111) and the second lateral surface (112), and
the mating surface air guide pathway (47) directs the

outdoor air from a space adjacent to the first lateral surface (111) to a space adjacent to the second lateral surface (112) through a space between the mating surface (26) and the exhaust port (36).

4. An engine (8) according to claim 3, further comprising:

a spark plug (20) attached to the first lateral surface (1 1 1).

5. An engine (8) according to claim 4, wherein the shroud (33) further includes a plug air guide pathway (46), the plug air guide pathway (46) directing the outdoor air to the spark plug (20).

6. An engine (8) according to any of claims 3 to 5, wherein the mating surface air guide pathway (47) includes
a first pathway (61) located adjacently to the first lateral surface (111), and
a second pathway (62) located between the mating surface (26) and the exhaust port (36).

7. An engine (8) according to claim 6, wherein the second pathway (62) has a smaller cross-sectional flow area than the first pathway (61).

8. An engine (8) according to claim 5, wherein the shroud (33) includes a rib (53) partitioning off the plug air guide pathway (46) and the mating surface air guide pathway (47) from each other.

9. An engine (8) according to claim 8, wherein
the rib (53) includes

a first rib portion (54) disposed adjacently to the cylinder (12), and
a second rib portion (55) disposed adjacently to the cylinder head (11), and

the first rib portion (54) and the second rib portion (55) are provided separately from each other.

10. An engine (8) according to any of claims 1 to 9, wherein the head cover (10) is made of resin.

11. An engine (8) according to any of claims 1 to 10, wherein the gasket (25) is made of synthetic rubber containing an acrylic component.

12. An engine (8) according to any of claims 1 to 11, wherein
the cylinder head (11) includes a recess (39) located between the mating surface (26) and the exhaust port (36), and
the mating surface air guide pathway (47) directs the outdoor air to the recess (39).

13. An engine (8) according to any of claims 1 to 12, wherein the shroud (33) includes
a first component (34), and
a second component (35) provided separately from the first component (34), the second component (35) being disposed in an axis direction of the crankshaft (15) with respect to the first component (34).

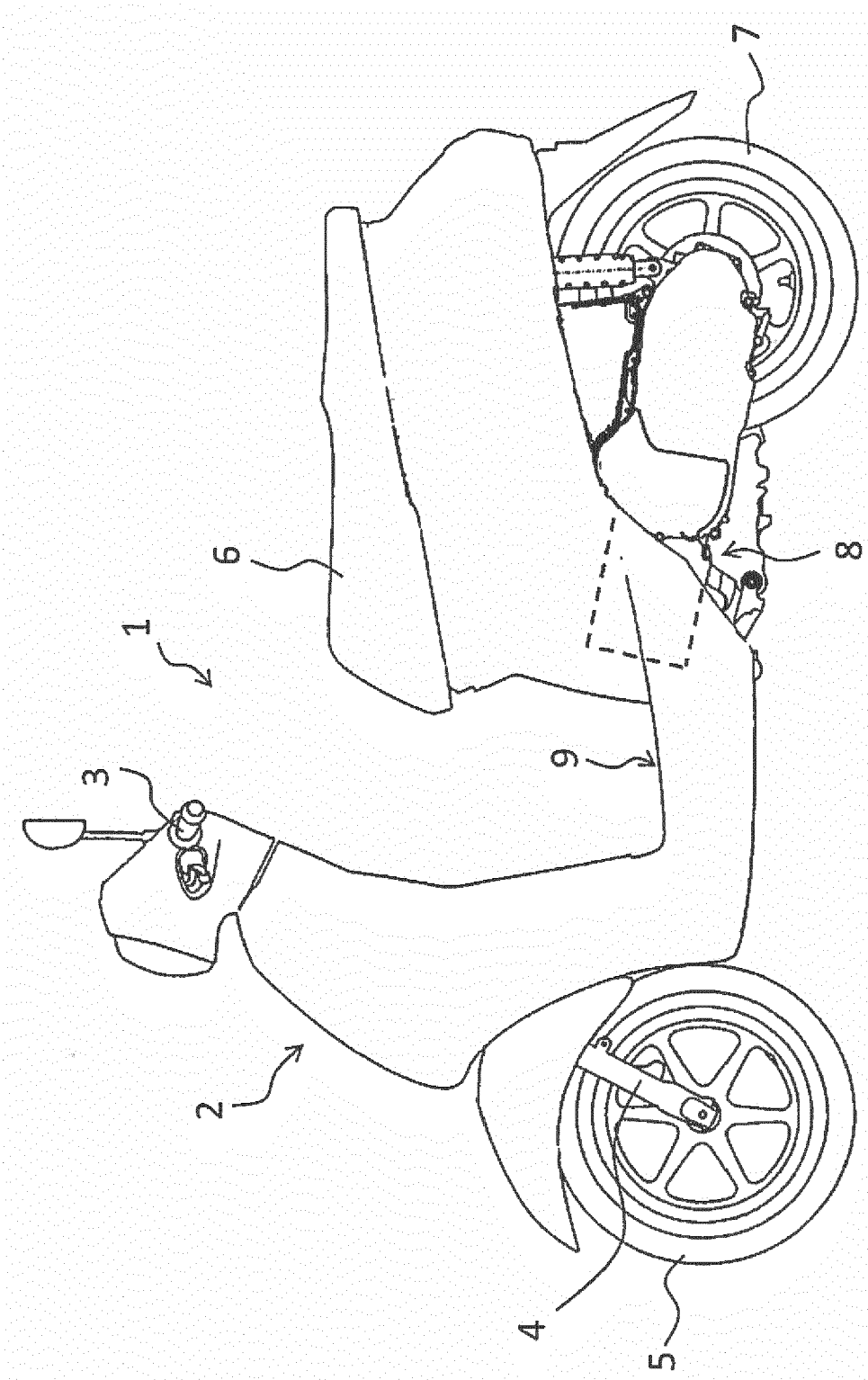
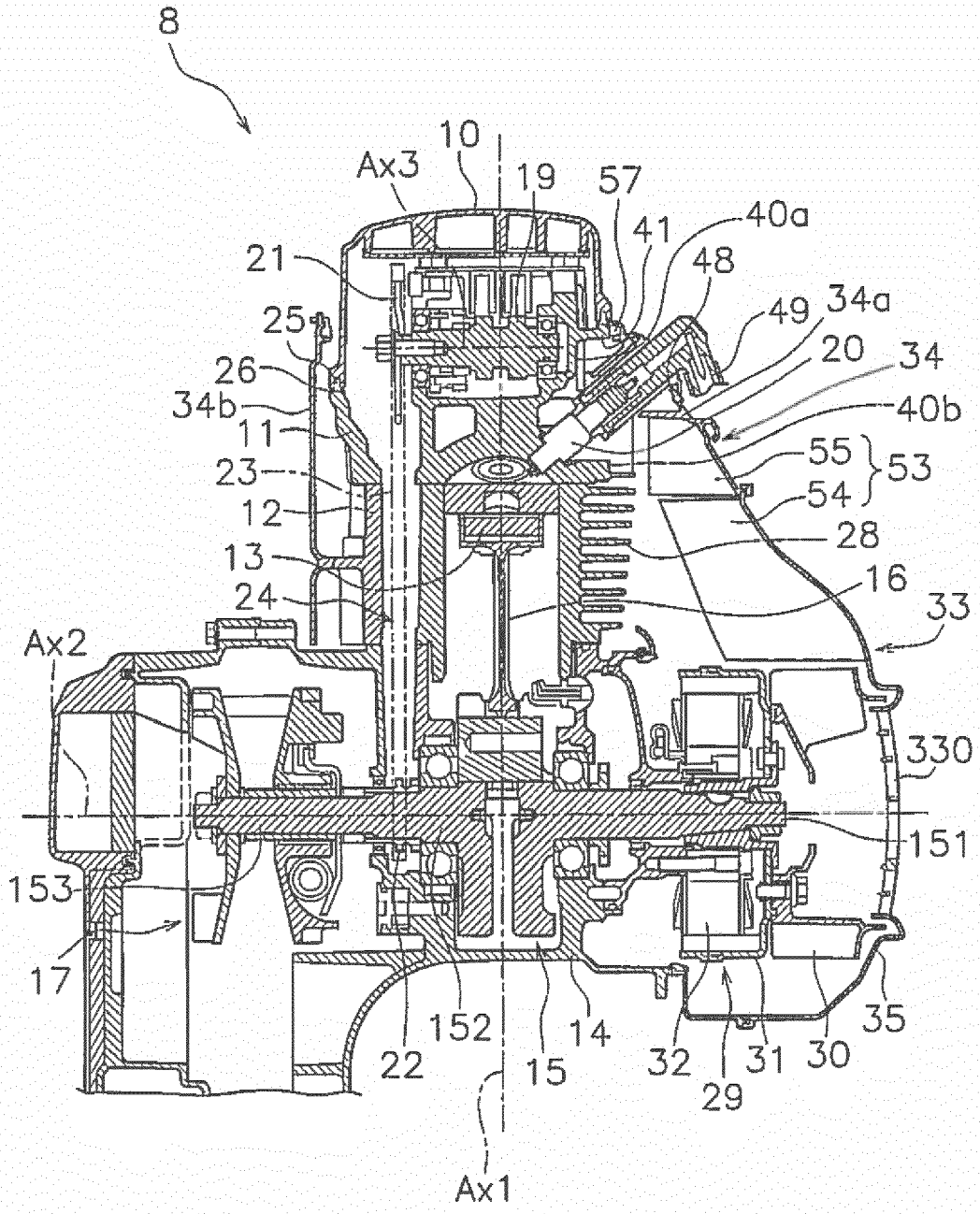


FIG. 1


8
Ax3
10
19
57
41
40a
48
49
34a
20
34
40b
55
53
54
28
16
33
330
151
21
25
26
34b
11
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Ax2
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17
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152
14
15
32
29
31
30
35
Ax1

FIG. 2

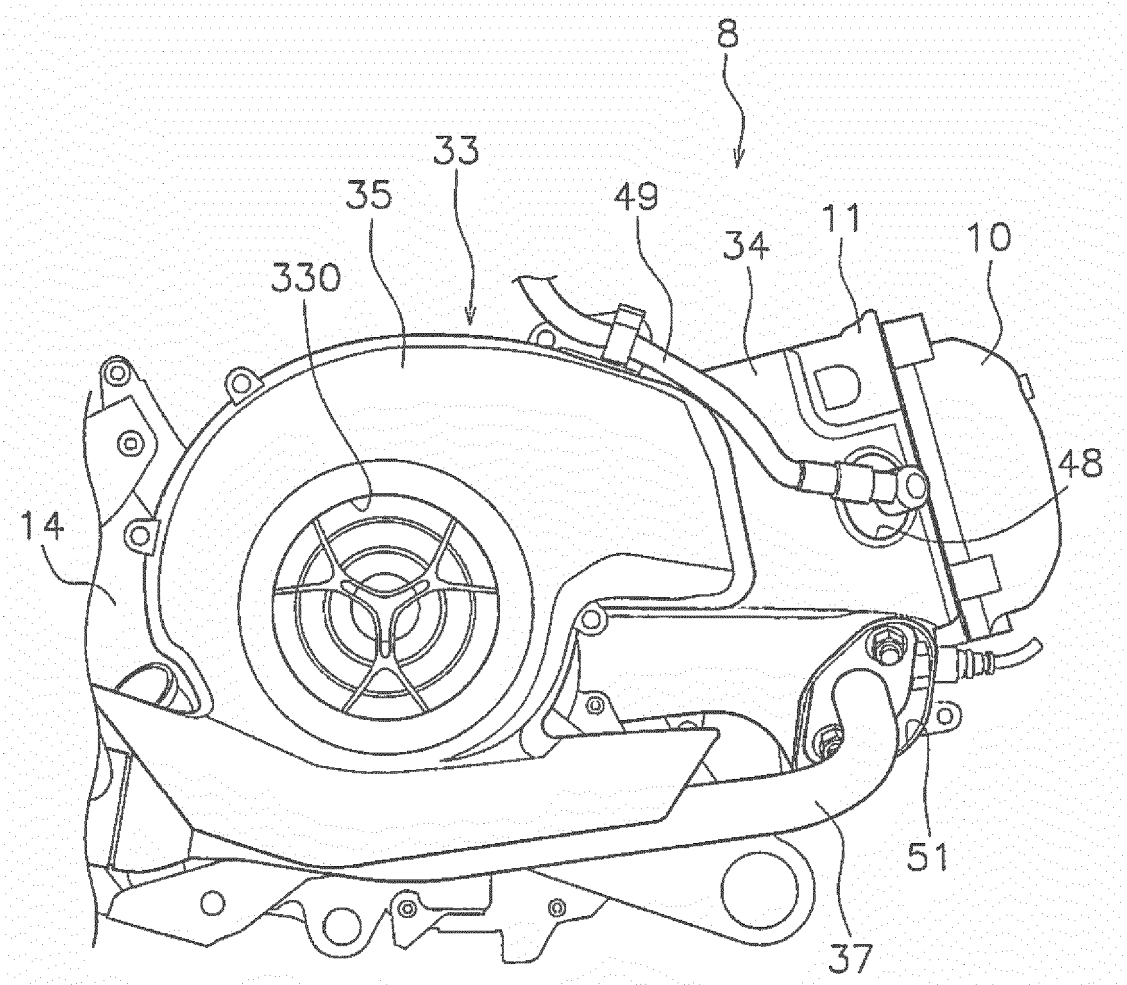

FIG. 3

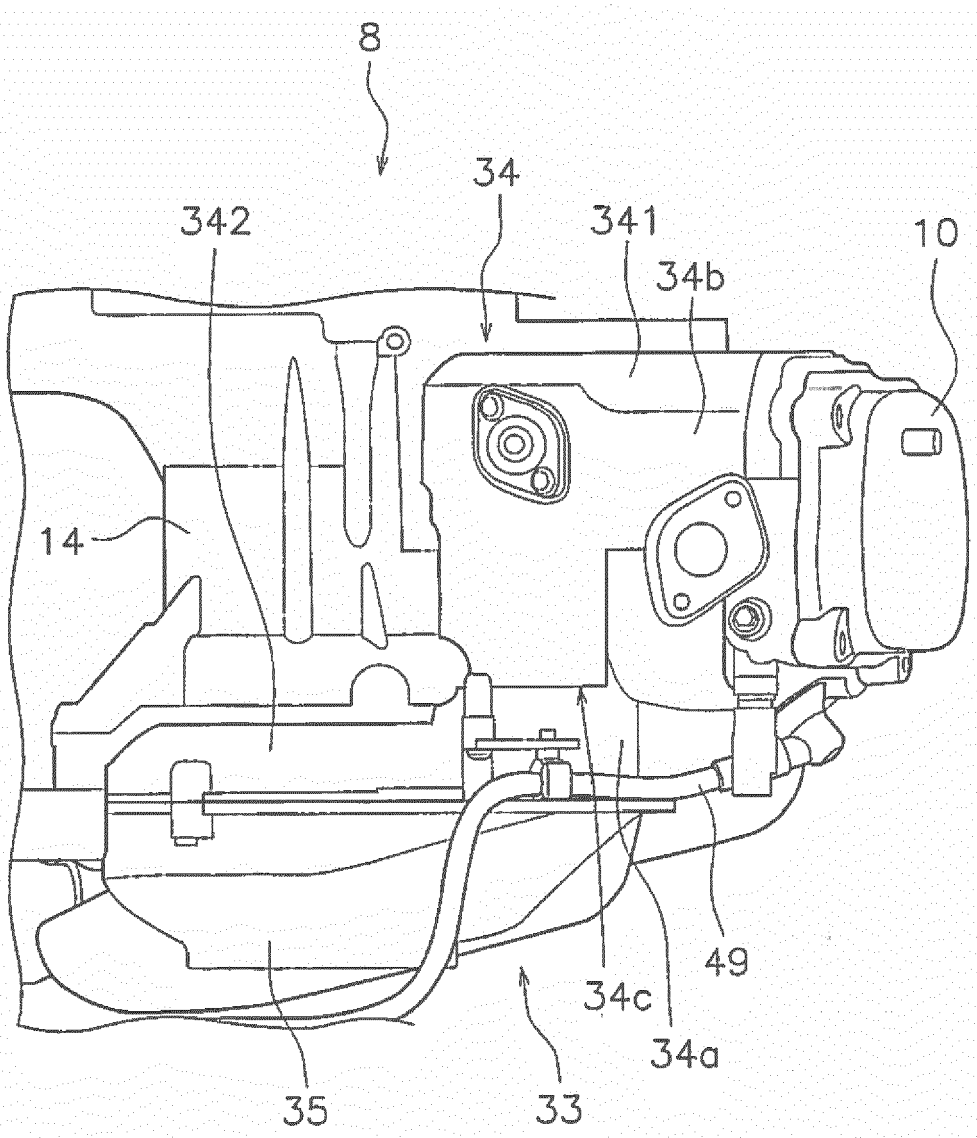

FIG. 4

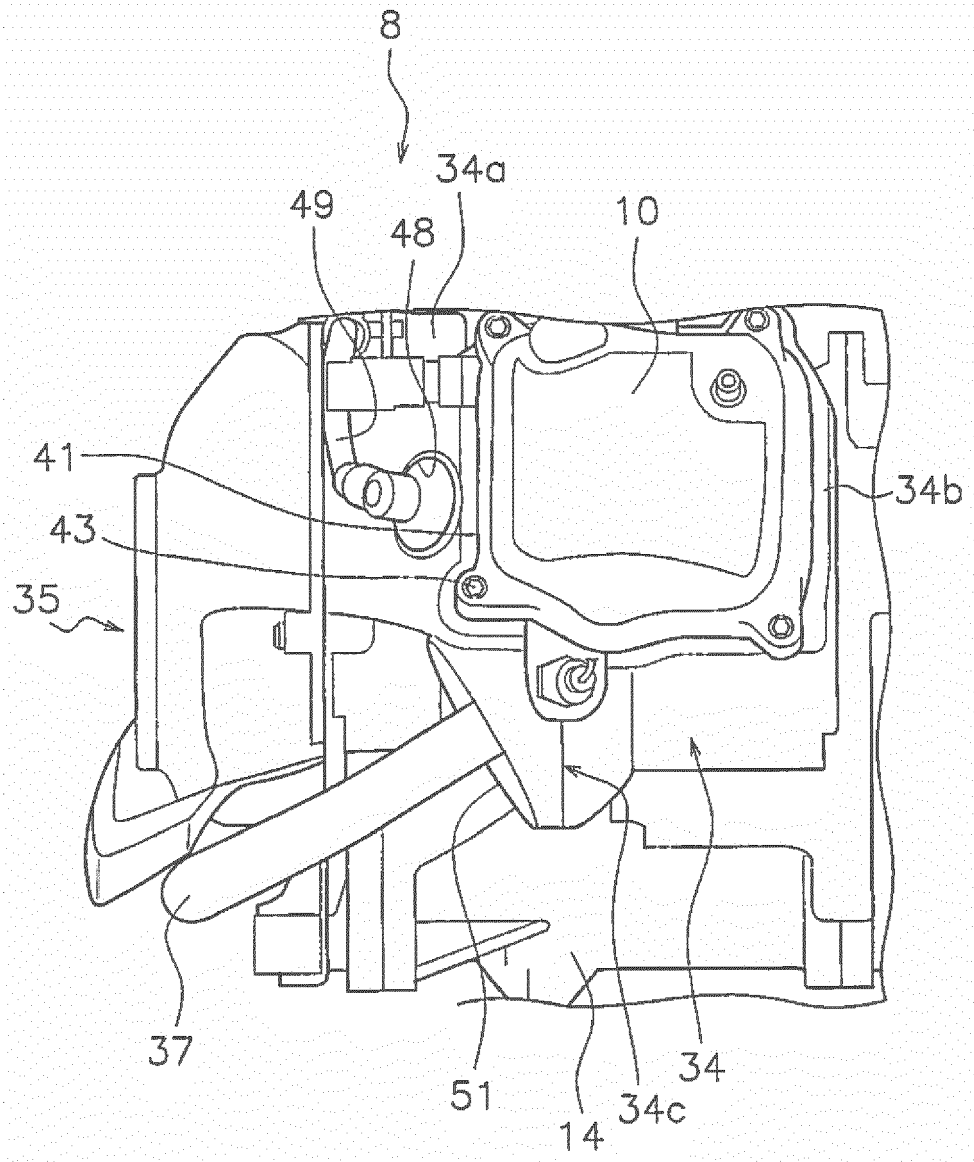

FIG. 5

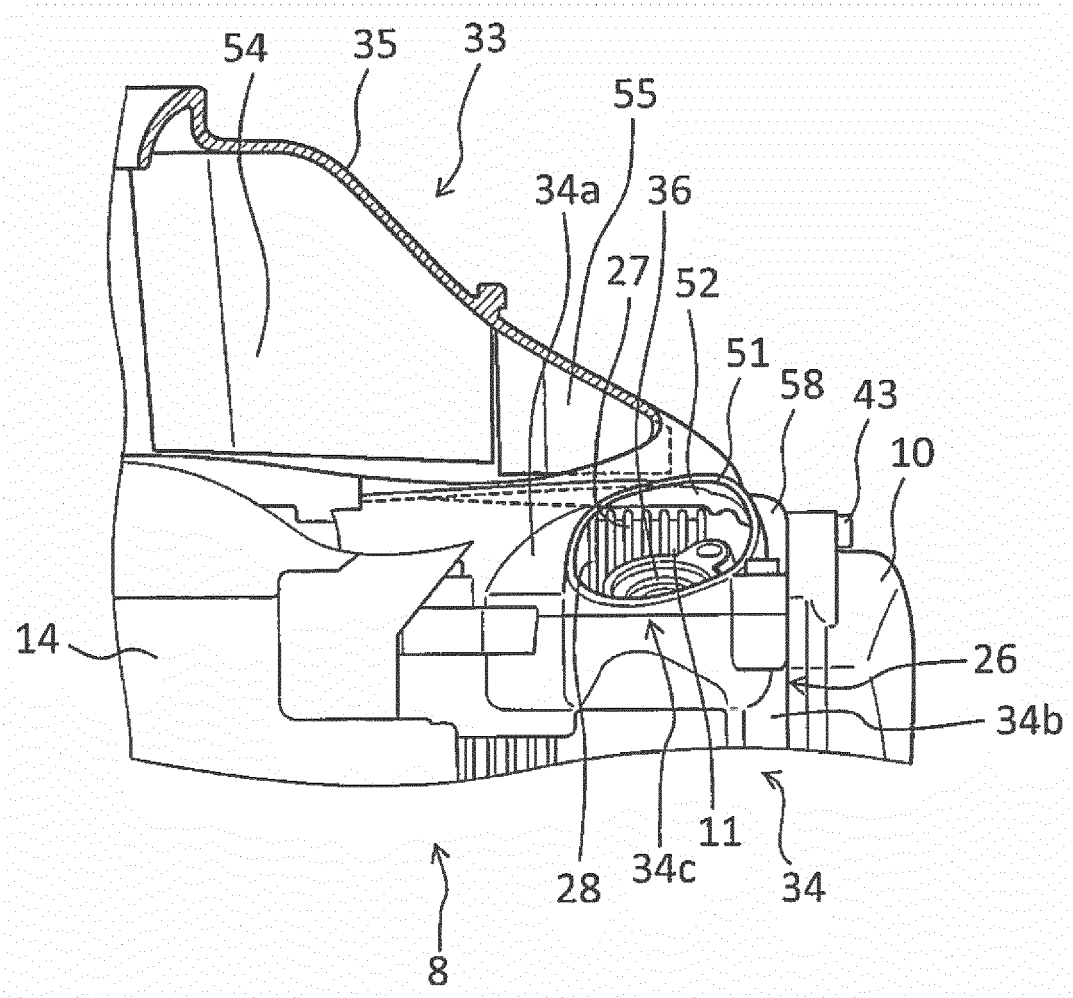

FIG. 6

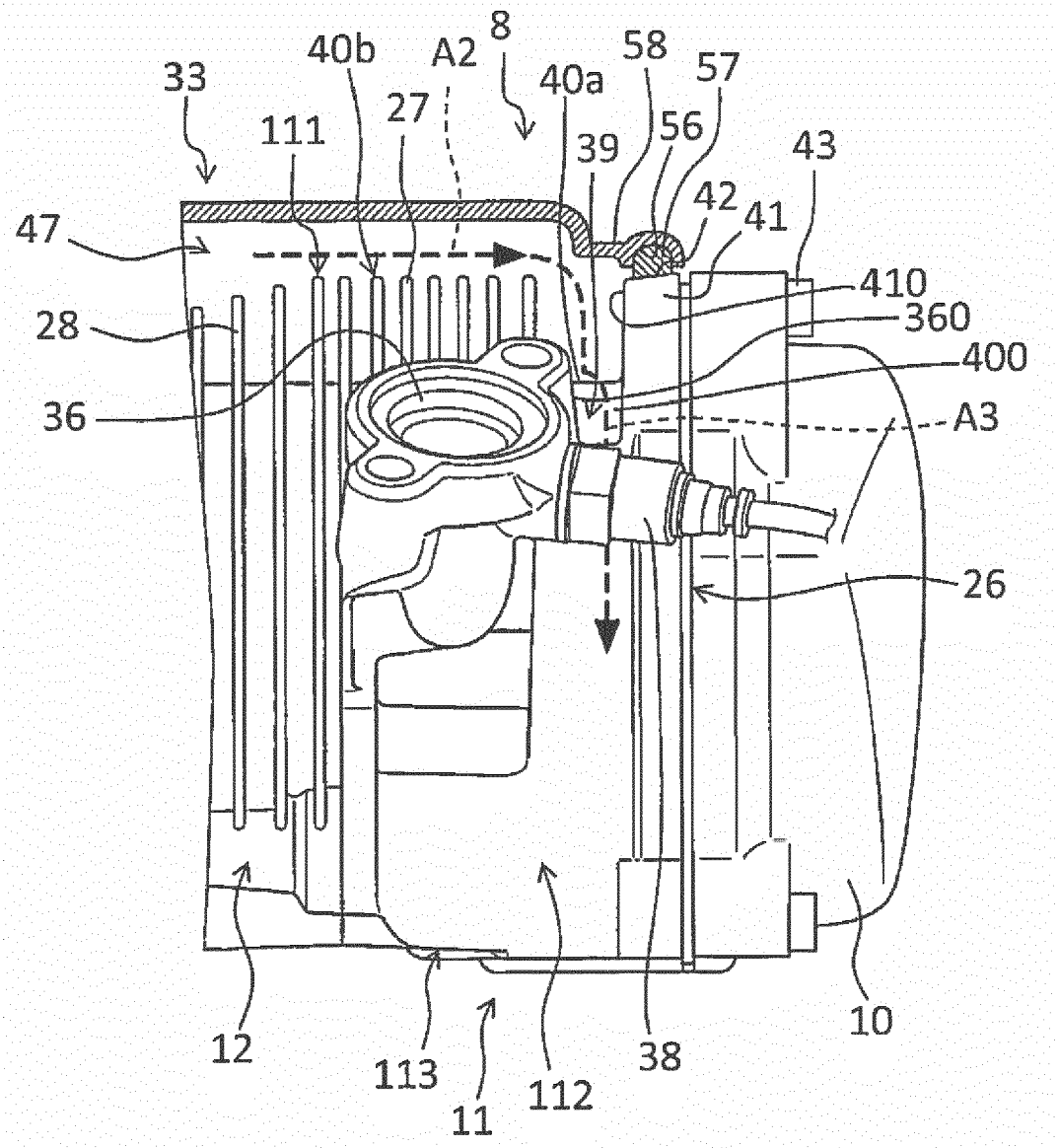
33
40b
A2
8
58
57
111
27
40a
56
39
43
42
41
47
410
28
360
400
36
A3
26
12
113
11
112
38
10

FIG. 7

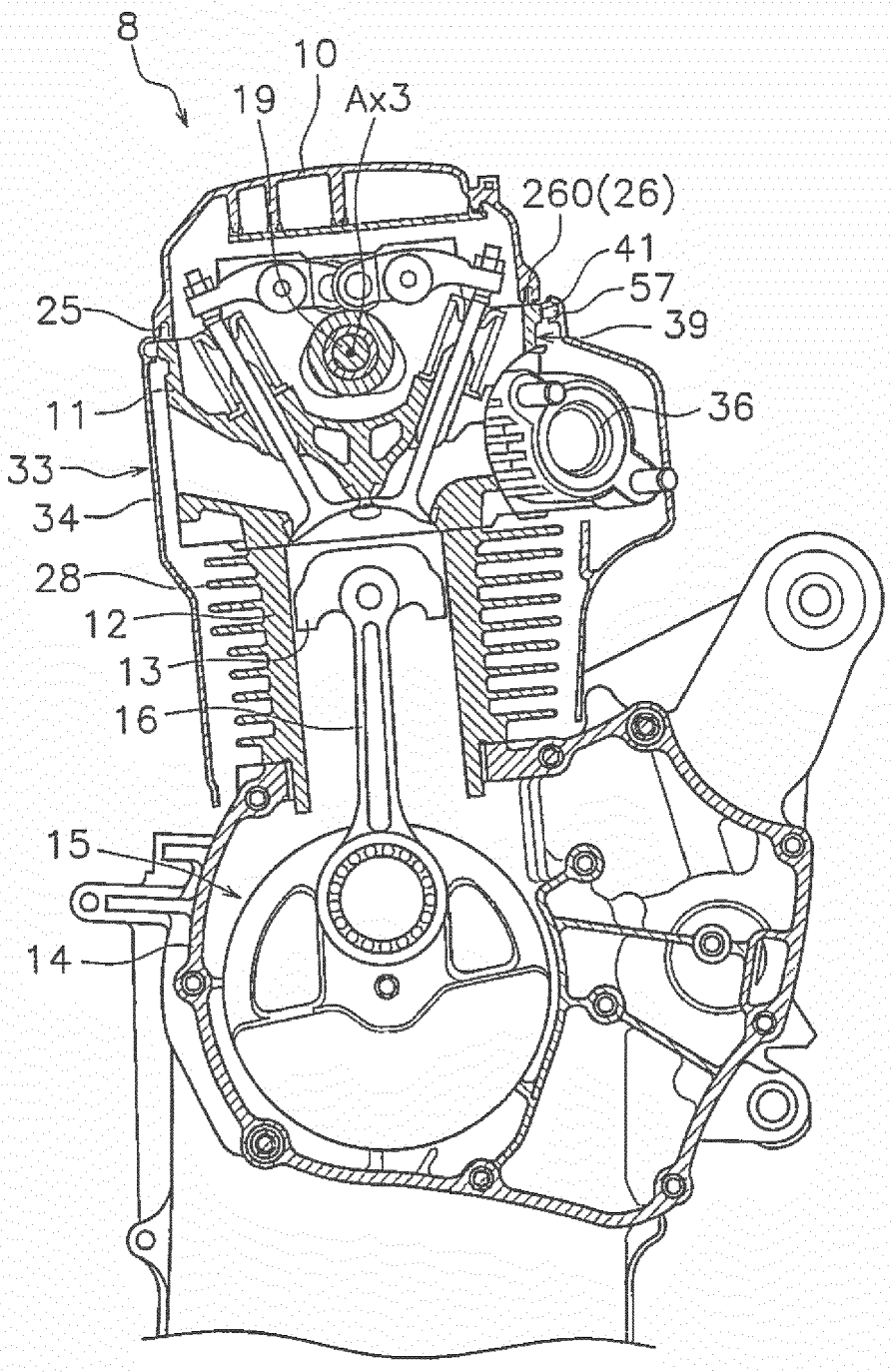

FIG. 8

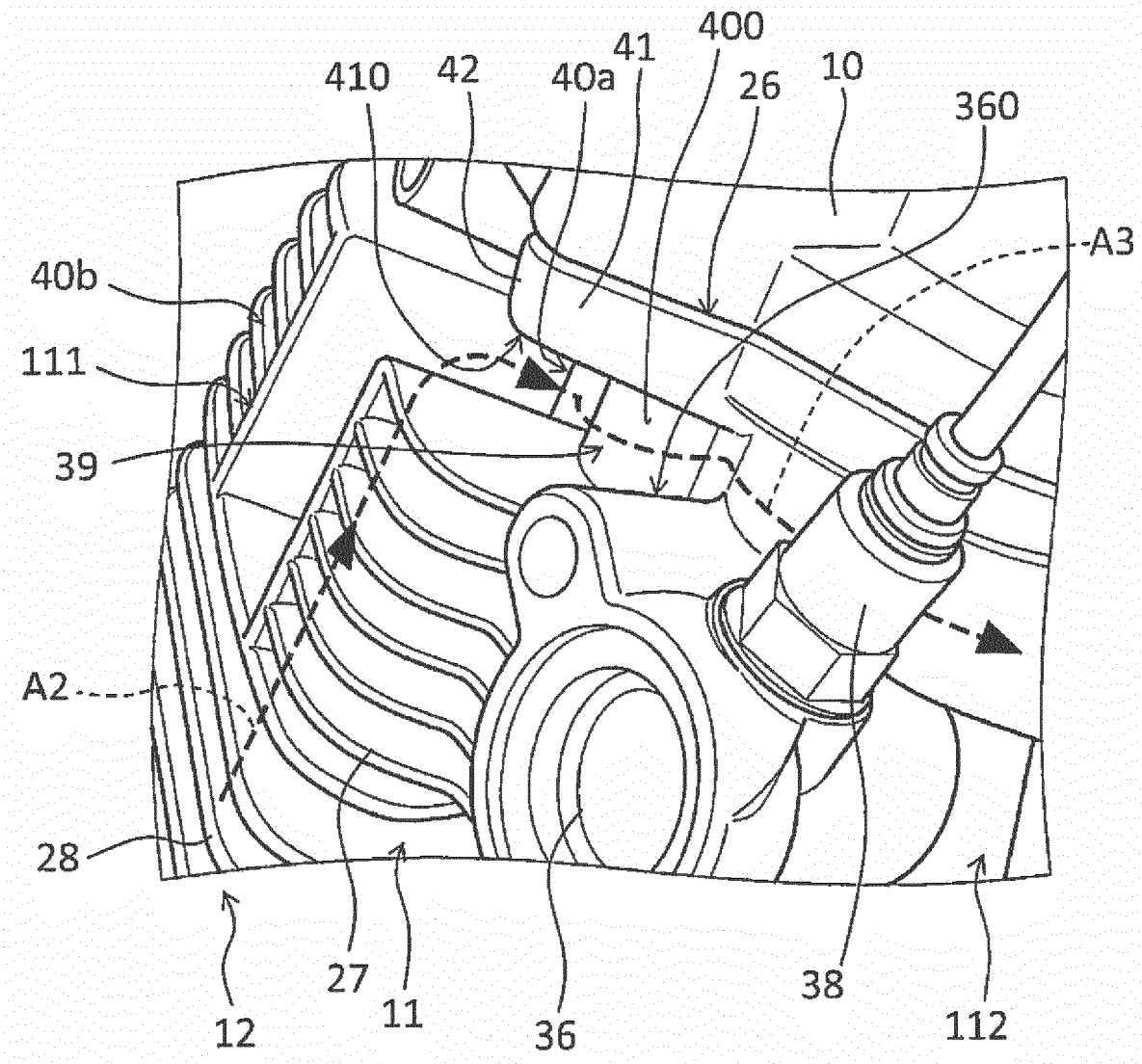

FIG. 9

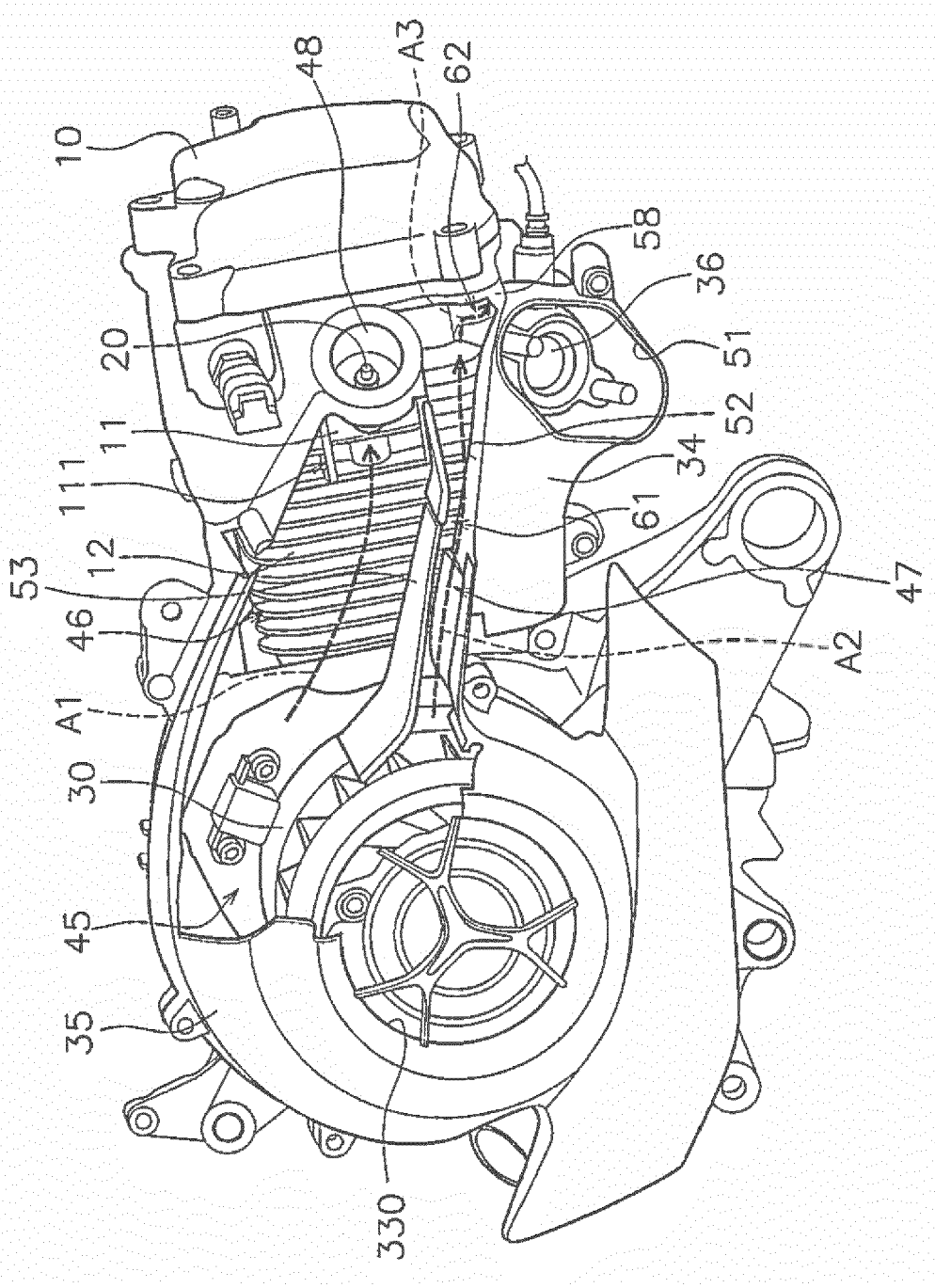

FIG. 10

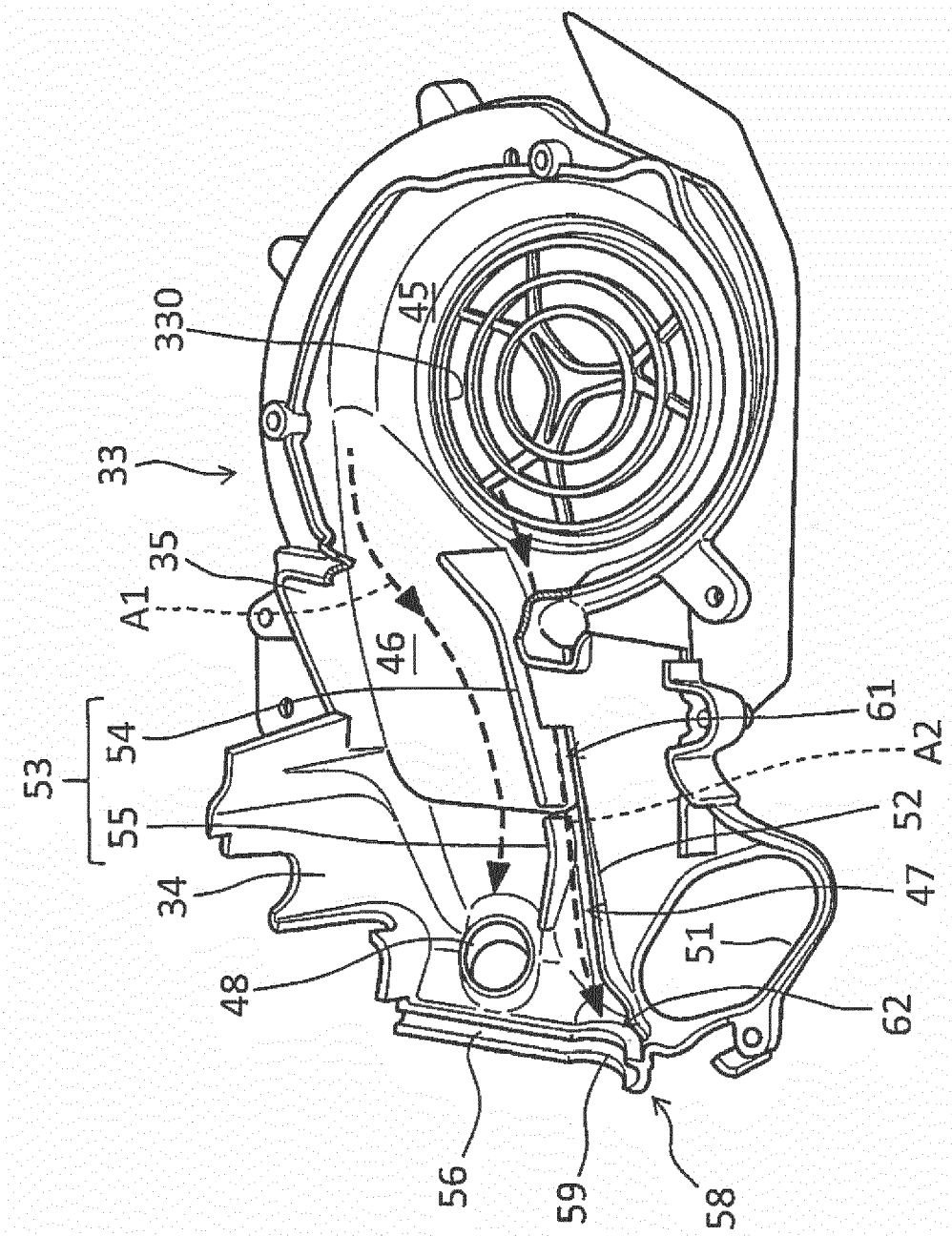

FIG. 11

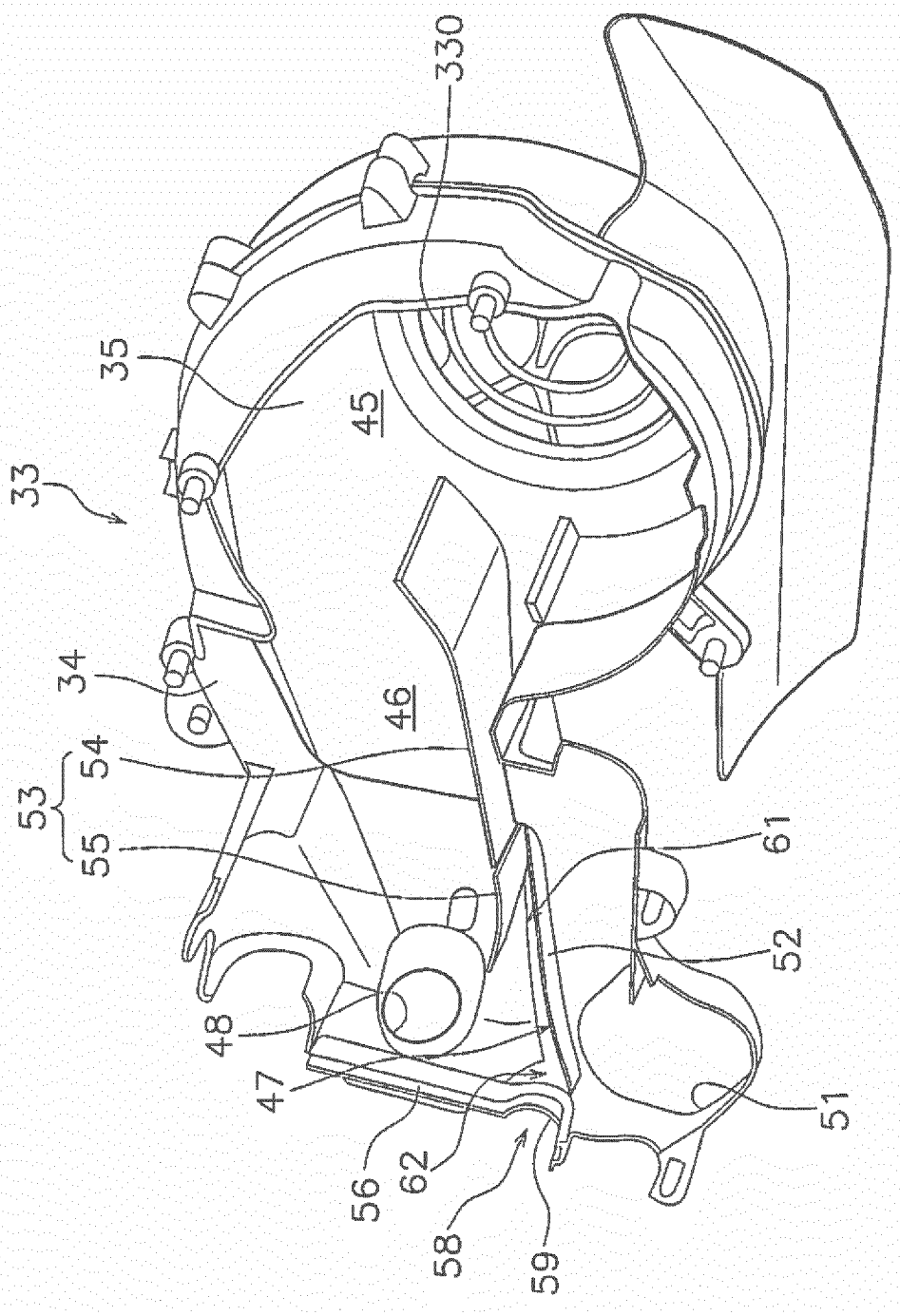

FIG. 12

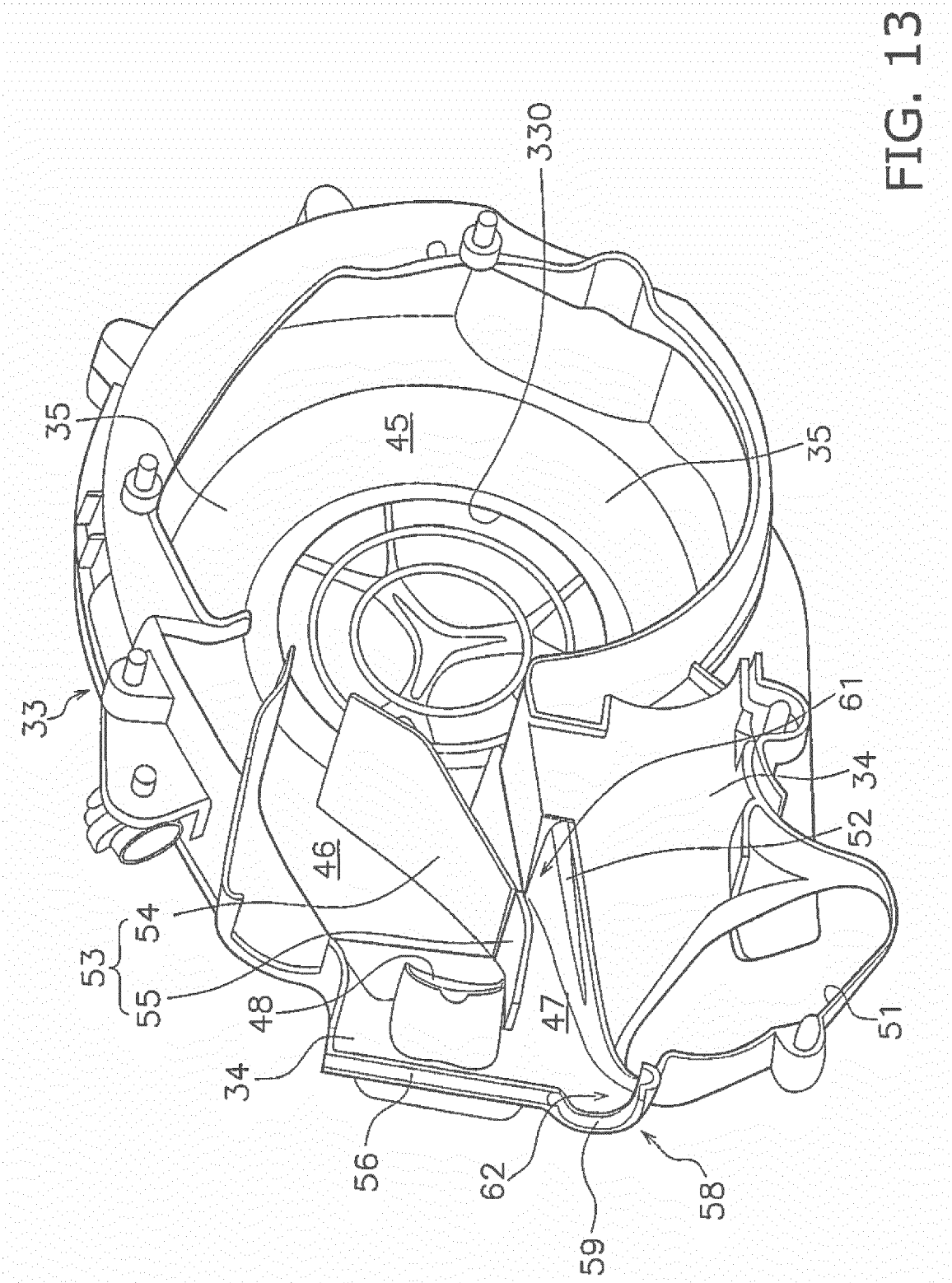

FIG. 13

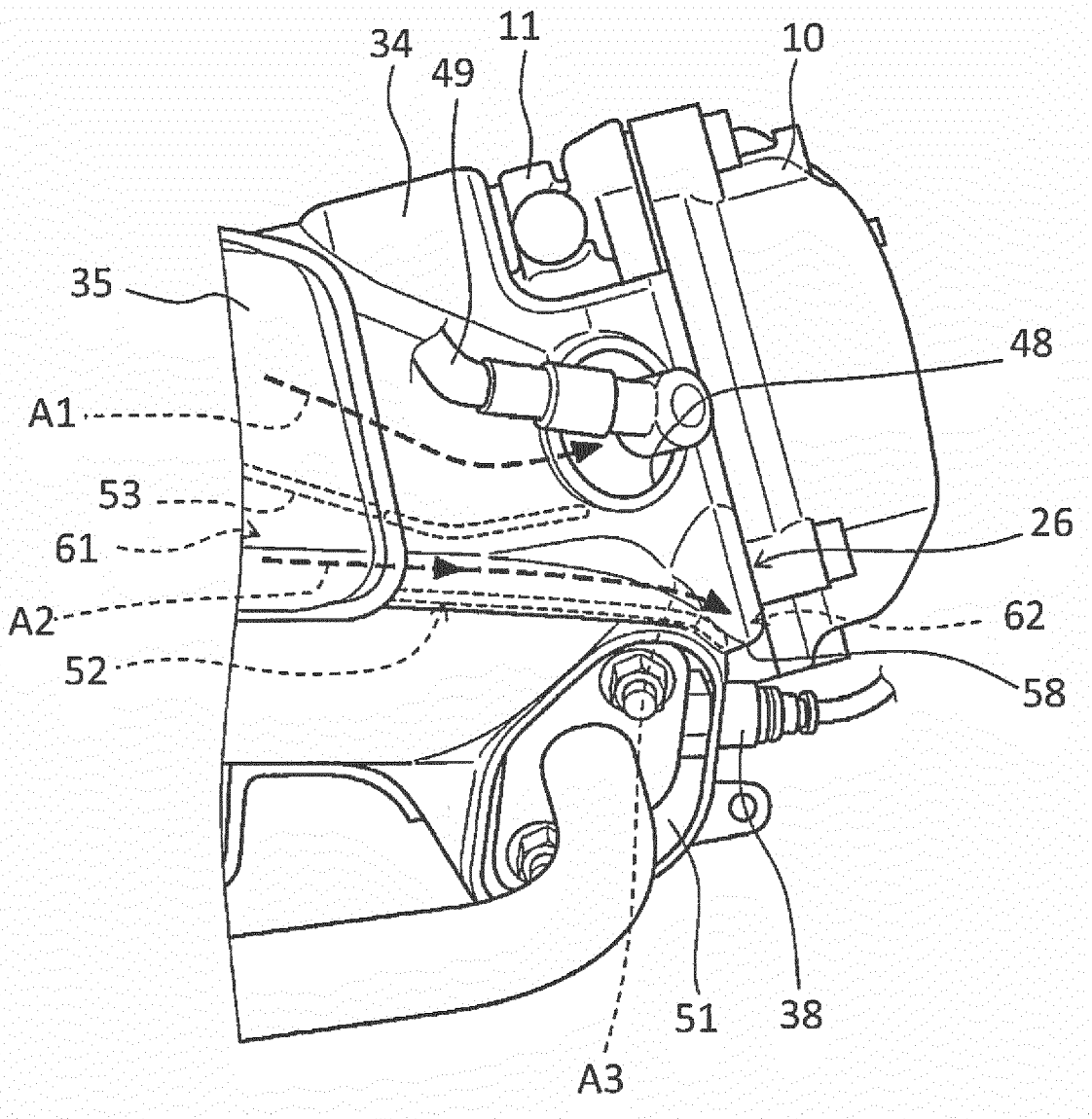

FIG. 14

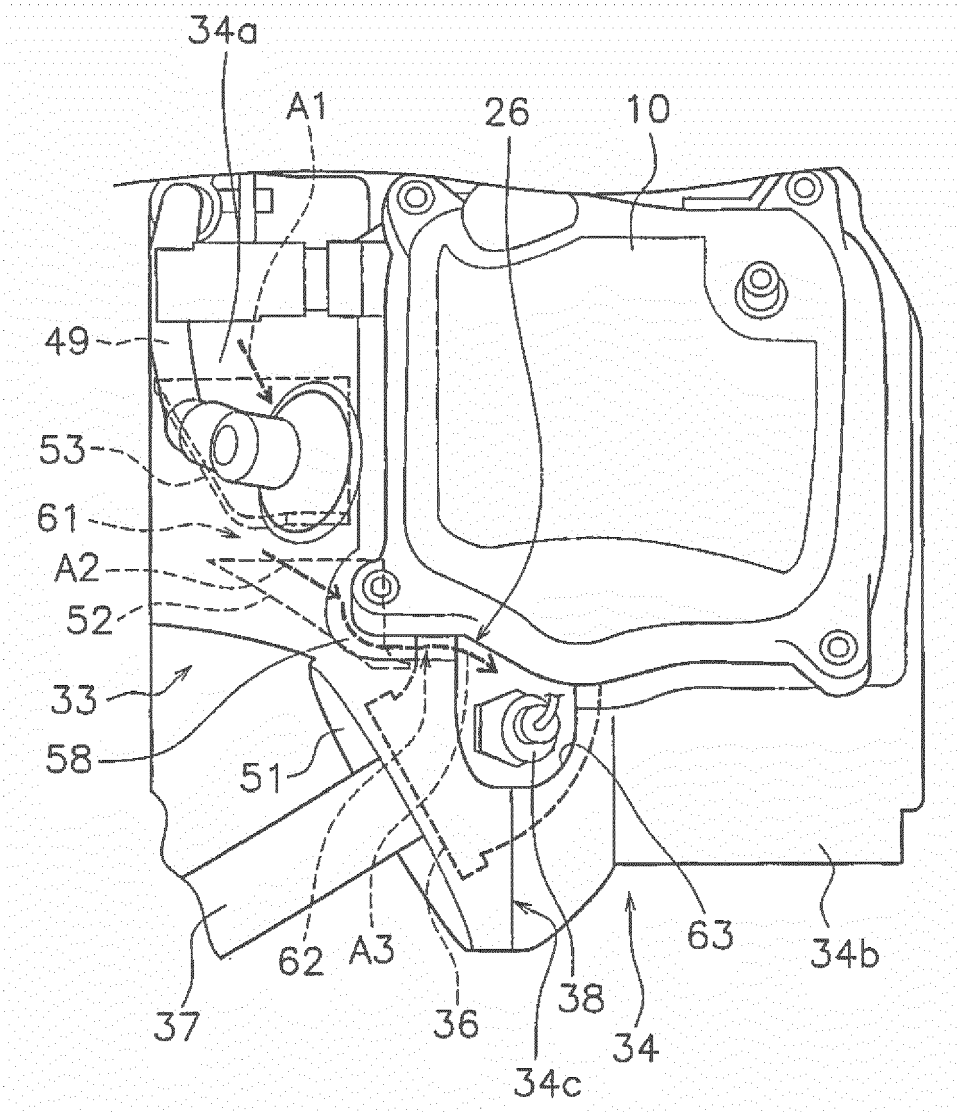

FIG. 15

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EUROPEAN SEARCH REPORT

Application Number
EP 18 18 8436

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	JP S58 183815 A (YAMAHA MOTOR CO LTD) 27 October 1983 (1983-10-27) * paragraphs [0001] - [0003] * * figures 1-4 * -----	1-8, 10-13 9	INV. F01P1/08 F01P5/06 ADD. F01P1/10
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A	WO 2007/080653 A1 (HONDA MOTOR CO LTD [JP]; KUBOTA RYO [JP]; MIMURA MASAHIDE [JP]; FUNAYA) 19 July 2007 (2007-07-19) * figures 1-6 * -----	1-13	

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F01P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 November 2018	Schwaller, Vincent

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

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