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(54) ENGINE FOR SADDLED VEHICLES

(57) The cylinder head includes a cam support portion supporting the camshaft and a cam chain compartment in which the cam chain is disposed. The cylinder head is made of metal. A head cover is made of resin and is attached to the cylinder head. The cylinder head includes a mating surface to be attached to the head cover. The mating surface includes a first mating surface portion, a second mating surface portion, a third mating surface portion and a fourth mating surface portion. The first mating surface portion is adjacent to the cam chain compartment. In a cylinder axial direction of the cylinder head, a directional side from the head cover to the cylinder head is defined as downward, and the opposite directional side thereof is defined as upward. At least portion of the first mating surface portion is located downward of a lower end of the cam support portion. At least portion of the second mating surface portion, at least portion of the third mating surface portion and at least portion of the fourth mating surface portion are located upward of the lower end of the cam support portion.

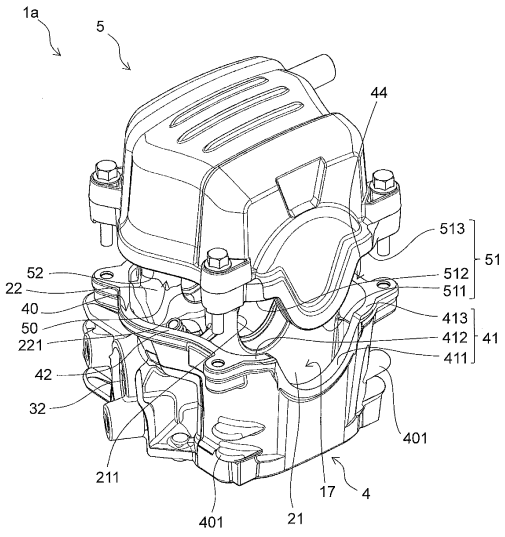

FIG. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to an engine for a straddled vehicle.

BACKGROUND ART

[0002] A head cover is attached to a cylinder head of an engine for a straddled vehicle. For example, in an engine of PTL 1, a head cover made of resin is attached to a cylinder head. With the head cover made of resin, the engine can be made lightweight compared to an engine with a head cover made of metal.

CITATION LIST

Patent Literature

[0003] PTL1: Japan Laid-open Patent Application Publication No. 2014-214665

SUMMARY OF INVENTION

Technical Problems

[0004] To make the weight of the engine further lighter, it is preferable to increase the size of the head cover made of resin and reduce the size of the cylinder head made of metal. However, it is concerned that the head cover made of resin thermally deforms at high temperatures. Thus, due to the drawback of durability, it is difficult to increase the size of the head cover made of resin. Because of this, it is not easy to sufficiently obtain an advantageous effect of lightweight by the head cover made of resin.

[0005] It is an object of the present invention to make it possible in an engine for a straddle vehicle including a head cover made of resin to inhibit degradation in durability of the head cover and make the engine lightweight.

Solution to Problems

[0006] An engine for a straddled vehicle according to an aspect of the present invention includes a camshaft, a cam chain, a cylinder head and a head cover. The cam chain is coupled to the camshaft. The cylinder head includes a cam support portion supporting the camshaft and a cam chain compartment in which the cam chain is disposed. The cylinder head is made of metal. The head cover is made of resin, and is attached to the cylinder head. The cylinder head includes a mating surface to be attached to the head cover.

[0007] The mating surface includes a first mating surface portion, a second mating surface portion, a third mating surface portion and a fourth mating surface portion. The first mating surface portion is adjacent to the cam chain compartment. The third mating surface portion is located on an opposite side of the first mating surface portion. The second mating surface portion connects the first mating surface portion and the third mating surface portion. The fourth mating surface portion is located on an opposite side of the second mating surface portion, and connects the first mating surface portion and the third mating surface portion. In a cylinder axial direction of the cylinder head, a directional side from the head cover to the cylinder head is defined as downward and a directional side from the cylinder head to the head cover is defined as upward. At least portion of the first mating surface portion is located downward of a lower end of the cam support portion. At least portion of the second mating surface portion, at least portion of the third mating surface portion and at least portion of the fourth mating surface portion are located upward of the lower end of the cam support portion.

[0008] In the engine for a straddled vehicle according to the present aspect, at least portion of the first mating surface portion of the cylinder head is located downward of the lower end of the cam support portion, and hence, the head cover can be extended downward by that much. Accordingly, the volume of the cylinder head made of metal can be reduced, whereas the volume of the head cover made of resin can be increased. As a result, the engine can be made lightweight.

[0009] Additionally, the first mating surface portion is adjacent to the cam chain compartment having a relatively low temperature in the cylinder head. Therefore, thermal deformation of the head cover is inhibited even when the head cover made of resin is extended to a position adjacent to the cam chain compartment. Accordingly, degradation in durability of the head cover can be inhibited.

[0010] Moreover, the cylinder head cover made of resin has a lower thermal conductivity than that made of metal. In other words, the cylinder head cover made of resin has higher heat retaining properties than that made of metal. Therefore, the head cover is downwardly extended at the first mating surface portion, whereby heat retaining properties can be enhanced in the cam chain compartment having a low temperature. Accordingly, lubricating oil can be warmed to an appropriate temperature, whereby returning of the lubricating oil can be made better.

[0011] Furthermore, the lubricating oil is warmed, whereby it becomes easy for the lubricating oil to enter the cam support portion. Accordingly, lubrication properties can be enhanced.

[0012] The head cover may include a first edge portion to be mated with the first mating surface portion, a second edge portion to be mated with the second mating surface portion, a third edge portion to be mated with the third mating surface portion, and a fourth edge portion to be mated with the fourth mating surface portion. At least portion of the first edge portion may be located downward of the lower end of the cam support portion. At least por-

tion of the second edge portion, at least portion of the third edge portion, at least portion of the fourth edge portion may be located upward of the lower end of the cam support portion. In this case, the first edge portion can be extended downward of the second edge portion, the third edge portion and the fourth edge portion.

[0013] The cylinder head may include an exhaust port. The second mating surface portion may be located above the exhaust port. The second mating surface portion may be located upward of the first mating surface portion. In this case, temperature easily gets high in a position above the exhaust port. In view of this, the second mating surface portion is disposed upward of the first mating surface portion, and can be thereby disposed away from the exhaust port. Accordingly, thermal influence on the head cover can be alleviated.

[0014] The engine may further include a spark plug. The cylinder head may include a spark plug attachment portion to which the spark plug is attached. The spark plug attachment portion may be disposed on an opposite side of the cam chain compartment in an axial direction of the camshaft. The third mating surface portion may be located above the spark plug attachment portion. The third mating surface portion may be located upward of the first mating surface portion.

[0015] When the third mating surface portion is located above the spark plug attachment portion, interference of the third mating surface portion with the spark plug emerges as a problem if the third mating surface portion is located in a low position. In view of this, the third mating surface portion is disposed upward of the first mating surface portion, whereby interference between the third mating surface portion and the spark plug can be avoided.

[0016] The first mating surface portion may include a recessed portion recessed downward. At least portion of the recessed portion may be located downward of the lower end of the cam support portion. In this case, the first mating surface portion includes the recessed portion, whereby the position of at least portion of the first mating surface portion can be made lower than that of the cam support portion.

[0017] The head cover may include a protruded portion protruded downward. The protruded portion may be attached to the recessed portion. In this case, the volume of the head cover made of resin can be increased by the amount of the protruded portion.

[0018] A lower end of the recessed portion may be located downward of the second mating surface portion, the third mating surface portion and the fourth mating surface portion. In this case, in the head cover, a portion to be fitted to the recessed portion can be extended downwardly of the other portion.

[0019] The second mating surface portion, the third mating surface portion and the fourth mating surface portion may be located upward of the lower end of the cam support portion. In this case, in the head cover, a portion to be fitted to the recessed portion can be extended downward of the other portion.

[0020] The mating surface may downwardly slant from the opposite side of the cam chain compartment to the cam chain compartment in the axial direction of the camshaft. In this case, the mating surface slants, whereby the position of at least portion of the first mating surface portion can be made lower than that of the cam support portion.

[0021] The head cover may include an edge that is attached to the mating surface of the cylinder head. The edge may slant along the mating surface of the cylinder head. In this case, the edge of the head cover slants, whereby the head cover can be extended to a position adjacent to the cam chain compartment.

[0022] The head cover may include a projection that sticks out from an inner surface of the head cover. The projection may be provided to downwardly drip a lubricating oil to the cam chain. In this case, when the head cover exerts high heat retaining properties in the interior thereof, the lubricating oil can be smoothly dripped downward from the projection. Accordingly, lubrication properties can be enhanced.

[0023] The head cover may include a chain restraining portion. The chain restraining portion may stick out from the inner surface of the head cover, and may extend to a position lateral to the cam chain. The chain restraining portion may have a thickness smaller than an interval between a pair of plates of the cam chain or a width of a bushing of the cam chain. In this case, upward disengagement of the cam chain can be prevented by the chain restraining portion. Additionally, the head cover is made of resin, whereby the chain restraining portion can be easily formed with small thickness.

[0024] The engine may be of an SOHC type. In this case, the position of the mating surface of the cylinder head can be made low more easily in the SOHC engine than in a DOHC engine. Therefore, at least portion of the first mating surface portion can be easily located downward of the cam support portion.

[0025] The engine may be of an air cooling type. Here in the engine of the air cooling type, the temperature of the head cover is likely to get higher than that of the lubricating oil. Therefore, the lubricating oil is smoothly circulated, and the head cover can be efficiently cooled by the lubricating oil.

[0026] The head cover may be made of fiber reinforced resin. In this case, the head cover can be inhibited from being deformed by thermal influence.

Advantageous Effects of Invention

[0027] According to the present invention, in an engine for a straddled vehicle including a head cover made of resin, degradation in durability of the head cover can be inhibited, and the engine can be made lightweight.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a side view of a straddled vehicle according to a first exemplary embodiment.

FIG. 2 is a cross-sectional view of portion of an engine for the straddled vehicle according to the first exemplary embodiment.

FIG. 3 is an exploded perspective view of a cylinder head and a head cover of the engine according to the first exemplary embodiment.

FIG. 4 is s side view of the cylinder head and the head cover as seen from a cam chain compartment side.

FIG. 5 is a side view of the cylinder head and the head cover as seen from the opposite side of the cam chain compartment side.

FIG. 6 is a cross-sectional view of the cylinder head and the head cover.

FIG. 7 is a cross-sectional view of FIG. 6 taken along VII-VII.

FIG. 8 is a side view of a straddle vehicle according to a second exemplary embodiment.

FIG. 9 is an exploded perspective view of a cylinder head and a head cover of an engine according to the second exemplary embodiment.

FIG. 10 is s side view of the cylinder head and the head cover as seen from a cam chain compartment side.

FIG. 11 is a side view of the cylinder head and the head cover as seen from the opposite side of the cam chain compartment side.

FIG. 12 is a side view of portion of an engine according to another exemplary embodiment.

FIG. 13 is a side view of portion of the engine according to the another exemplary embodiment.

DESCRIPTION OF EMBODIMENTS

[0029] An exemplary embodiment of the present invention will be hereinafter explained with reference to drawings. FIG. 1 is a side view of a straddled vehicle 100 according to a first exemplary embodiment. In the following explanation, the terms "front", "rear", "left" and "right" are defined as meaning front, rear, left and right directions seen from a rider riding on the straddled vehicle 100. The straddled vehicle 100 is a so-called sport vehicle. The straddled vehicle 100 includes a fuel tank 102, a seat 103, an engine 1a and a vehicle body frame 105.

[0030] The fuel tank 102, the seat 103 and the engine 1a are supported by the vehicle body frame 105. The fuel tank 102 is disposed in front of the seat 103. The engine 1a is disposed under the fuel tank 102.

[0031] The straddled vehicle 100 includes a head pipe 106, a front fork 107, a front wheel 108, a handle 109 and a headlight unit 110. The head pipe 106 is disposed in front of the fuel tank 102. The front fork 107 includes a steering shaft 115 and suspensions 116. The steering shaft 115 is turnably supported by the head pipe 106. The suspensions 116 are connected to the lower portion of the steering shaft 115.

[0032] The front wheel 108 is rotatably supported by the front fork 107. The handle 109 is connected to the upper portion of the steering shaft 115. The headlight unit 110 is disposed in front of the head pipe 106.

[0033] The straddled vehicle 100 includes a swing arm 111 and a rear wheel 112. The swing arm 111 backwardly extends from the vehicle body frame 105. The swing arm 111 is connected to the vehicle body frame 105 while being pivotable up and down. The rear wheel 112 is rotatably supported by the rear portion of the swing arm 111.

[0034] FIG. 2 is a cross-sectional view of portion of the engine 1a according to the first exemplary embodiment. In the present exemplary embodiment, the engine 1a is a single-cylinder engine of an air cooling type. It should be noted that the engine 1a may be of a water cooling type. The engine 1a may be a multiple-cylinder engine. As shown in FIG. 2, the engine 1a includes a crankcase 2, a cylinder body 3, a cylinder head 4 and a head cover 5.

[0035] The crankcase 2 accommodates a crankshaft (not shown in the drawings). The cylinder body 3 is connected to the crankcase 2. The cylinder body 3 may be integrated with or separated from the crankcase 2. The cylinder body 3 is provided with a plurality of cooling fins 301. It should be noted that in the drawings, reference numeral 301 is assigned to only portion of the plural cooling fins 301 without being assigned to the other cooling fins 301. The cylinder body 3 accommodates a piston 7. The piston 7 is coupled to the crankshaft through a connecting rod 8.

[0036] It should be noted that in the present exemplary embodiment, in the direction of a cylinder axis Ax1 of the cylinder head 4, one directional side from the head cover 5 to the cylinder head 4 is defined as "downward", whereas the other directional side from the cylinder head 4 to the head cover 5 is defined as "upward".

[0037] The cylinder head 4 is disposed above the cylinder body 3. The cylinder head 4 is attached to the cylinder body 3. The head cover 5 is disposed above the cylinder head 4. The head cover 5 is attached to the cylinder head 4. The head cover 5 is made of resin. This resin may be, for instance, PA (polyamide). Alternatively, this resin may be a type of resin other than PA. The head cover 5 is made of fiber reinforced resin. For example, this fiber reinforced resin may be glass fiber reinforced resin. Alternatively, this fiber reinforced resin may be of a type using a fiber other than glass.

[0038] The cylinder head 4 is made of metal. The cylinder head 4 is made of, for instance, aluminum alloy. It should be noted that the material of which the cylinder head 4 is made is not limited to aluminum alloy and may be another type of metal. The cylinder head 4 may be separated from or integrated with the cylinder body 3.

[0039] The cylinder head 4 includes a combustion

chamber 11. A spark plug 12 is attached to the cylinder head 4. The tip end of the spark plug 12 is disposed to face the combustion chamber 11. The base end of the spark plug 12 is disposed outside the engine 1a.

[0040] A valve actuating mechanism 13 is accommodated in the cylinder head 4 and the head cover 5. The valve actuating mechanism 13 is a mechanism that opens and closes an intake valve and an exhaust valve (both of which are not shown in the drawings). The valve actuating mechanism 13 employs a mechanism of an SOHC (Single OverHead Camshaft) type.

[0041] The valve actuating mechanism 13 includes a camshaft 14, an intake rocker arm 15 and an exhaust rocker arm 16. A center axis Ax2 of the camshaft 14 (hereinafter referred to as "cam axis Ax2") is arranged perpendicular to the cylinder axis Ax1. The camshaft 14 is supported by the cylinder head 4. The camshaft 14 includes a first shaft end 141 and a second shaft end 142. The first shaft end 141 is one end of the camshaft 14 in the direction of the cam axis Ax2. The second shaft end 142 is the other end of the camshaft 14 in the direction of the cam axis Ax2.

[0042] The cylinder head 4 includes a first support wall 21 and a second support wall 22. The first support wall 21 and the second support wall 22 are integrated with the cylinder head 4. The first support wall 21 supports the first shaft end 141 of the camshaft 14. The second support wall 22 supports the second shaft end 142 of the camshaft 14. The first support wall 21 includes a first cam support portion 211. The first cam support portion 211 is a hole provided in the first support wall 21. A first bearing 23 is attached to the first cam support portion 211. The first support wall 21 supports the first shaft end 141 through the first bearing 23.

[0043] The second support wall 22 includes a second cam support portion 221. The second cam support portion 221 is a hole provided in the second support wall 22. A second bearing 24 is attached to the second cam support portion 221. The second support wall 22 supports the second shaft end 142 through the second bearing 24.

[0044] A sprocket 25 is attached to the first shaft end 141. A cam chain 26 is wound about the sprocket 25. In other words, the cam chain 26 is coupled to the camshaft 14 through the sprocket 25.

[0045] The cylinder head 4 and the cylinder body 3 are provided with a cam chain compartment 17. The cam chain 26 is disposed in the cam chain compartment 17. The camshaft 14 is coupled to the crankshaft through the cam chain 26. Rotation of the crankshaft is transmitted to the camshaft 14 through the cam chain 26, whereby the camshaft 14 is rotated. It should be noted in the present exemplary embodiment that in the direction of the cam axis Ax2, a directional side from the second shaft end 142 to the first shaft end 141 is referred to as "cam chain compartment side".

[0046] The camshaft 14 includes an intake cam 143 and an exhaust cam 144. The intake cam 143 and the exhaust cam 144 are disposed in alignment in the direction of the cam axis Ax2. The intake cam 143 and the exhaust cam 144 are disposed between the first support wall 21 and the second support wall 22.

[0047] The intake rocker arm 15 and the exhaust rocker arm 16 are disposed above the camshaft 14. The intake rocker arm 15 is disposed above the intake cam 143. The intake rocker arm 15 makes contact with the intake cam 143. When the camshaft 14 is rotated, the intake rocker arm 15 is pressed by the intake cam 143. Accordingly, the intake rocker arm 15 is pivoted, whereby the intake valve is driven.

[0048] The exhaust rocker arm 16 is disposed above the exhaust cam 144. The exhaust rocker arm 16 makes contact with the exhaust cam 144. When the camshaft 14 is rotated, the exhaust rocker arm 16 is pressed by the exhaust cam 144. Accordingly, the exhaust rocker arm 16 is pivoted, whereby the exhaust valve is driven.

[0049] As shown in FIG. 2, the engine 1a is provided with an oil supply channel 27. The oil supply channel 27 is disposed across the crankcase 2, the cylinder body 3 and the cylinder head 4. The engine 1a includes an oil pump 28. The oil pump 28 supplies lubricating oil to the valve actuating mechanism 13 through the oil supply channel 27. The lubricating oil is supplied to the interior of the cylinder head 4 from the interior of the crankcase 2 through the oil supply channel 27. After lubricating the valve actuating mechanism 13, the lubricating oil returns to the interior of the crankcase 2 through the cam chain compartment 17.

[0050] FIG. 3 is an exploded perspective view of the cylinder head 4 and the head cover 5. FIG. 4 is a side view of the cylinder head 4 and the head cover 5 as seen from the cam chain compartment side. FIG. 5 is a side view of the cylinder head 4 and the head cover 5 as seen from the opposite side of the cam chain compartment side.

[0051] As shown in FIGS. 3 to 5, the cylinder head 4 includes a plurality of cooling fins 401. It should be noted that in the drawings, reference numeral 401 is assigned to only portion of the plural cooling fins 401 without being assigned to the other cooling fins 401. As shown in FIGS. 2 and 5, the cylinder head 4 includes a spark plug attachment portion 31. The spark plug attachment portion 31 is disposed on the opposite side of the cam chain compartment 17 in the axial direction of the camshaft 14. The spark plug 12 is attached to the spark plug attachment portion 31.

[0052] As shown in FIG. 5, the cylinder head 4 includes an exhaust port 32 and an intake port 33. The exhaust port 32 and the intake port 33 are communicated with the aforementioned combustion chamber 11. Fuel and air are supplied to the combustion chamber 11 through the intake port 33. Exhaust gas in the interior of the combustion chamber 11 is discharged through the exhaust port 32.

[0053] As shown in FIG. 3, the cylinder head 4 includes a mating surface 40 to be attached to the head cover 5. The mating surface 40 of the cylinder head 4 is attached

to the head cover 5 through a gasket 34 shown in FIG. 2.

[0054] As shown in FIGS. 3 and 4, the mating surface 40 of the cylinder head 4 includes a first mating surface portion 41, a second mating surface portion 42, a third mating surface portion 43 and a fourth mating surface portion 44. The first mating surface portion 41 is disposed in adjacent to the cam chain compartment 17. The first mating surface portion 41 is located downward of the upper end of the first support wall 21. The first mating surface portion 41 includes a recessed portion 411, a first straight portion 412 and a second straight portion 413. The recessed portion 411 is located between the first straight portion 412 and the second straight portion 413. The recessed portion 411 is recessed downward. The lower end of the recessed portion 411 is located downward of the lower end of the first cam support portion 211. The lower end of the recessed portion 411 is located downward of the second mating surface portion 42, the third mating surface portion 43 and the fourth mating surface portion 44.

[0055] The first straight portion 412 and the second straight portion 413 extend in a direction perpendicular to the cylinder axis Ax1. The first straight portion 412 and the second straight portion 413 are located upward of the lower end of the first cam support portion 211. The first straight portion 412 and the second straight portion 413 are located upward of the cam axis Ax2. The first straight portion 412 and the second straight portion 413 are located downward of the upper end of the first cam support portion 211.

[0056] The second mating surface portion 42 connects the first mating surface portion 41 and the third mating surface portion 43. The second mating surface portion 42 is located above the exhaust port 32. The second mating surface portion 42 is located upward of the lower end of the recessed portion 411. The second mating surface portion 42 is located upward of the lower end of the first cam support portion 211. The second mating surface portion 42 is located upward of the cam axis Ax2. The second mating surface portion 42 is located downward of the upper end of the first cam support portion 211. The second mating surface portion 42 extends in a direction perpendicular to the cylinder axis Ax1. The second mating surface portion 42 is located at the same height as the first straight portion 412 and the second straight portion 413.

[0057] As shown in FIG. 5, the third mating surface portion 43 is located on the opposite side of the first mating surface portion 41. The third mating surface portion 43 is located above the spark plug attachment portion 31. The camshaft 14 is disposed between the first mating surface portion 41 and the third mating surface portion 43. The third mating surface portion 43 is located upward of the lower end of the recessed portion 411. The third mating surface portion 43 is located upward of the lower end of the first cam support portion 211. The third mating surface portion 43 is located upward of the cam axis Ax2. The third mating surface portion 43 is located downward of the upper end of the first cam support portion 211. The third mating surface portion 43 extends in a direction perpendicular to the cylinder axis Ax1. The third mating surface portion 43 is located at the same height as the second mating surface portion 42. The third mating surface portion 43 is located at the same height as the first straight portion 412 and the second straight portion 413.

[0058] As shown in FIG. 3, the fourth mating surface portion 44 is located on the opposite side of the second mating surface portion 42. The fourth mating surface portion 44 connects the first mating surface portion 41 and the third mating surface portion 43. The fourth mating surface portion 44 is located above the intake port 33. The camshaft 14 is disposed between the second mating surface portion 42 and the fourth mating surface portion 44. The fourth mating surface portion 44 is located upward of the lower end of the recessed portion 411. The fourth mating surface portion 44 is located upward of the lower end of the first cam support portion 211. The fourth mating surface portion 44 is located upward of the cam axis Ax2. The fourth mating surface portion 44 is located downward of the upper end of the first cam support portion 211. The fourth mating surface portion 44 extends in a direction perpendicular to the cylinder axis Ax1. The fourth mating surface portion 44 is located at the same height as the second mating surface portion 42. The fourth mating surface portion 44 is located at the same height as the third mating surface portion 43. The fourth mating surface portion 44 is located at the same height as the first straight portion 412 and the second straight portion 413.

[0059] As shown in FIG. 3, the head cover 5 includes an edge 50 to be attached to the mating surface 40 of the cylinder head 4. The edge 50 of the head cover 5 is attached to the mating surface 40 of the cylinder head 4 through the gasket 34. The edge 50 of the head cover 5 includes a first edge portion 51. The first edge portion 51 is attached to the first mating surface portion 41 of the cylinder head 4.

[0060] The first edge portion 51 includes a protruded portion 511, a first straight portion 512 and a second straight portion 513. The protruded portion 511 is located between the first straight portion 512 and the second straight portion 513. The protruded portion 511 is protruded downward. The protruded portion 511 is attached to the recessed portion 411. The lower end of the protruded portion 511 is located downward of the cam axis Ax2. The first straight portion 512 and the second straight portion 513 extend in a direction perpendicular to the cylinder axis Ax1. The first straight portion 512 and the second straight portion 513 are located upward of the cam axis Ax2. The first straight portion 512 is attached to the first straight portion 412 of the cylinder head 4. The second straight portion 513 is attached to the second straight portion 413 of the cylinder head 4.

[0061] The edge 50 of the head cover 5 includes a second edge portion 52. The second edge portion 52 is attached to the second mating surface portion 42 of the

cylinder head 4. The second edge portion 52 extends in a direction perpendicular to the cylinder axis Ax1. The second edge portion 52 is located upward of the lower end of the protruded portion 511. The second edge portion 52 is located at the same height as the first straight portion 512 and the second straight portion 513.

[0062] As shown in FIG. 5, the edge 50 of the head cover 5 includes a third edge portion 53. The third edge portion 53 is attached to the third mating surface portion 43 of the cylinder head 4. The third edge portion 53 extends in a direction perpendicular to the cylinder axis Ax1. The third edge portion 53 is located upward of the lower end of the protruded portion 511. The third edge portion 53 is located at the same height as the second edge portion 52. The third edge portion 53 is located at the same height as the first straight portion 512 and the second straight portion 513.

[0063] The edge 50 of the head cover 5 includes a fourth edge portion 54. The fourth edge portion 54 is attached to the fourth mating surface portion 44 of the cylinder head 4. The fourth edge portion 54 extends in a direction perpendicular to the cylinder axis Ax1. The fourth edge portion 54 is located upward of the lower end of the protruded portion 511. The fourth edge portion 54 is located at the same height as the second edge portion 52. The fourth edge portion 54 is located at the same height as the third edge portion 53. The fourth edge portion 54 is located at the same height as the first straight portion 512 and the second straight portion 513.

[0064] FIG. 6 is a cross-sectional view of the cylinder head 4 and the head cover 5. As shown in FIG. 6, the head cover 5 includes a plurality of projections 55. The plural projections 55 downwardly stick out from the inner surface of the head cover 5. The tips of the projections 55 face the cam chain 26. In the interior of the engine, the lubricating oil is drawn from the interior of the crankcase 22 by an oil pump (not shown in the drawings) and is supplied to the interior of the head cover 5. The lubricating oil supplied to the interior of the head cover 5 flows along the projections 55 and downwardly drips toward the cam chain 26. Accordingly, the lubricating oil is supplied to the cam chain 26.

[0065] The head cover 5 includes a chain restraining portion 56. The chain restraining portion 56 downwardly sticks out from the inner surface of the head cover 5 and extends to a position lateral to the cam chain 26. Therefore, even when upwardly disengaged from the sprocket 25, the cam chain 26 makes contact with the chain restraining portion 56 whereby upward disengagement of the cam chain 26 is restrained. Accordingly, upward disengagement of the cam chain 26 can be prevented.

[0066] FIG. 7 is a cross-sectional view of FIG. 6 taken along VII-VII. As shown in FIG. 7, the tip of the chain restraining portion 56 has a thin plate shape. The thickness of the tip of the chain restraining portion 56 is smaller than a gap between a pair of plates 261 and 262 of the cam chain 26. The tip of the chain restraining portion 56 is disposed in opposition to a bushing 263 disposed between the pair of plates 261 and 262 of the cam chain 26. The thickness of the tip of the chain restraining portion 56 is smaller than the width of the bushing 263.

[0067] In the engine 1a for a straddled vehicle according to the present exemplary embodiment explained above, the recessed portion 411 of the first mating surface portion 41 of the cylinder head 4 is located downward of the first cam support portion 211, and hence, the protruded portion 511 of the head cover 5 can be extended downward by that much. Accordingly, the volume of the cylinder head 4 made of metal can be reduced, whereas the volume of the head cover 5 made of resin can be increased. As a result, the engine 1a can be made lightweight.

[0068] The first mating surface portion 41 is disposed in adjacent to the cam chain compartment 17 having a relatively low temperature in the cylinder head 4. Therefore, thermal deformation of the head cover 5 is inhibited even when the protruded portion 511 of the head cover 5 made of resin is extended to a position adjacent to the cam chain compartment 17. Accordingly, degradation in durability of the head cover 5 can be inhibited.

[0069] The head cover 5 made of resin has higher heat retaining properties than the cylinder head 4 made of metal. Therefore, the heat retaining properties inside the cylinder head 4 are enhanced by increase in volume of the head cover 5 made of resin. Thus, the temperature of the lubricating oil is increased inside the cylinder head 4, whereby the viscosity of the lubricating oil is lowered. In other words, the lubricating oil can be smoothly circulated inside the cylinder head 4. As a result, friction loss can be reduced, while efficiency of recovering the lubricating oil can be enhanced.

[0070] The second mating surface portion 42 is located above the exhaust port 32, whereby the temperature thereof is likely to be high. In view of this, the second mating surface portion 42 is disposed upward of the first mating surface portion 41, and can be thereby disposed away from the exhaust port 32. Accordingly, thermal influence on the head cover 5 from the exhaust port 32 can be alleviated.

[0071] The third mating surface portion 43 is located above the spark plug attachment portion 31. Therefore, if the third mating surface portion 43 is located in a low position, interference thereof with the spark plug 12 emerges as a problem. In view of this, the third mating surface portion 43 is disposed upward of the first mating surface portion 41, and can be thereby disposed away from the spark plug attachment portion 31. Accordingly, interference between the third mating surface portion 43 and the spark plug 12 can be avoided.

[0072] The engine 1a according to the present exemplary embodiment is an SOHC engine. The position of the mating surface 40 of the cylinder head 4 can be made low in the SOHC engine 1a more easily than in a DOHC engine. Therefore, the recessed portion 411 of the first mating surface portion 41 can be easily located downward of the support wall.

[0073] The engine 1a according to the present exemplary embodiment is of an air cooling type. In the engine of the air cooling type, the temperature of the head cover 5 is likely to get higher than that of the lubricating oil. Therefore, when the lubricating oil is smoothly circulated, the head cover 5 can be efficiently cooled by the lubricating oil.

[0074] When the head cover 5 exerts high heat retaining properties in the interior thereof, the viscosity of the lubricating oil becomes low. Therefore, the lubricating oil can be smoothly dripped downward from the projections 55. Accordingly, lubrication properties can be enhanced.

[0075] The head cover 5 is provided with the chain restraining portion 56. The thickness of the tip of the chain restraining portion 56 is smaller than the gap between the pair of plates 261 and 262 of the cam chain 26. In the present exemplary embodiment, the head cover 5 is made of resin. Therefore, the chain restraining portion 56 can be easily formed with small thickness.

[0076] Next, a straddled vehicle according to a second exemplary embodiment will be explained. FIG. 8 is a side view of a straddled vehicle 200 according to the second exemplary embodiment. As shown in FIG. 8, the straddled vehicle 200 according to the second exemplary embodiment is a scooter type vehicle. The straddled vehicle 200 includes a steering device 201, a vehicle body 202, a power unit 203, a front wheel 204, a rear wheel 205 and a seat 206.

[0077] The steering device 201 includes a front fork 207. The front fork 207 supports the front wheel 204 such that the front wheel 204 is rotatable. A handle 208 is provided on the upper portion of the steering device 201.

[0078] The vehicle body 202 includes a front cover 231, a leg shield 232, a rear cover 233 and a lower cover 234. The front cover 231 covers the steering device 201 from the front. The leg shield 232 covers the steering device 201 from the back. The leg shield 232 is attached to the front cover 231. The rear cover 233 is disposed behind the leg shield 232. The rear cover 233 is disposed under the seat 206. The lower cover 234 is disposed between the leg shield 232 and the rear cover 233. The upper surface of the lower cover 234 includes a footboard 235. The footboard 235 is disposed such that the legs of a rider are put thereon. The footboard 235 has a flat shape. The footboard 235 may be entirely flat in a vehicle width direction. Alternatively, the footboard 235 may have an upwardly protruding shape in the vehicle width directional middle portion thereof.

[0079] The power unit 203 is disposed under the seat 206. The power unit 203 is pivotably supported by the vehicle body 202. The power unit 203 supports the rear wheel 205 such that the rear wheel 205 is rotatable. The power unit 203 includes an engine 1b. The engine 1b includes the cylinder head 4 and the head cover 5. The cylinder head 4 and the head cover 5 are disposed under the seat 206. The cylinder axis Ax1 of the cylinder head 4 is arranged approximately horizontally. For example, an angle of the cylinder axis Ax1 with respect to a horizontal direction is greater than or equal to 0 degrees and less than or equal to 45 degrees.

[0080] FIG. 9 is an exploded perspective view of the engine 1b according to the second exemplary embodiment. FIG. 10 is a side view of the cylinder head 4 and the head cover 5 as seen from the cam chain compartment 17 side. FIG. 11 is a side view of the cylinder head 4 and the head cover 5 as seen from the opposite side of the cam chain compartment 17 side.

[0081] As shown in FIGS. 9 to 11, similarly to the first exemplary embodiment, the cylinder head 4 includes the first mating surface portion 41, the second mating surface portion 42, the third mating surface portion 43 and the fourth mating surface portion 44, and the first mating surface portion 41 includes the recessed portion 411. Similarly to the first exemplary embodiment, the head cover 5 includes the first edge portion 51, the second edge portion 52, the third edge portion 53 and the fourth edge portion 54, and the first edge portion 51 includes the protruded portion 511.

[0082] The head cover 5 according to the second exemplary embodiment has a shape up-and-down directionally thinner than that according to the first exemplary embodiment. For example, as shown in FIG. 10, the distance from the upper end of the head cover 5 to the first straight portion 512 of the first edge portion 51 is shorter than that from the first straight portion 412 of the first mating surface portion 41 of the cylinder head 4 to the lower end of the cylinder head 4. As shown in FIG. 11, the distance from the upper end of the head cover 5 to the third edge portion 53 is shorter than that from the third mating surface portion 43 of the cylinder head 4 to the lower end of the cylinder head 4.

[0083] Regarding the other points, the engine 1b according to the second exemplary embodiment is similar to the engine 1a according to the first exemplary embodiment, and the other points will not be explained. In the engine 1b according to the second exemplary embodiment, it is also possible to achieve advantageous effects similar to those achieved in the engine 1a according to the first exemplary embodiment.

[0084] One exemplary embodiment of the present invention has been explained above. However, the present invention is not limited to the aforementioned exemplary embodiment, and a variety of changes can be made without departing from the gist of the present invention.

[0085] The term "straddled vehicle" encompasses a motorcycle, an all-terrain vehicle and a snowmobile. Additionally, the term "motorcycle" encompasses a sport type motorcycle, an off-road type motorcycle, a scooter and a moped. The number of the front or rear wheels of the motorcycle is not limited to one, and may be plural.

[0086] The shape of the mating surface 40 of the cylinder head 4 is not limited to that in the aforementioned exemplary embodiments, and may be changed. For example, FIGS. 12 and 13 are side views of portion of an engine 1c according to another exemplary embodiment. In FIG. 12, the right side corresponds to the cam chain

compartment side, whereas the left side corresponds to the opposite side of the cam chain compartment 17. As shown in FIGS. 12 and 13, the mating surface 40 of the cylinder head 4 may downwardly slant from the opposite side of the cam chain compartment 17 to the cam chain compartment side in the axial direction of the camshaft 14.

[0087] In this case, the first mating surface portion 41 may not be provided with the protruded portion 511 described in the aforementioned exemplary embodiments. In other words, the entirety of the first mating surface portion 41 may extend in a direction perpendicular to the cylinder axis Ax1. The entirety of the first mating surface portion 41 may be located downward of the lower end of the first cam support portion 211.

[0088] The second mating surface portion 42 may downwardly slant from the opposite side of the cam chain compartment 17 to the cam chain compartment side in the axial direction of the camshaft 14. In other words, the second mating surface portion 42 may slant obliquely upward from the first mating surface portion 41 to the opposite side of the cam chain compartment 17. Therefore, the second mating surface portion 42 may be located upward of the first mating surface portion 41.

[0089] The third mating surface portion 43 may be located upward of the first mating surface portion 41. The third mating surface portion 43 may be located upward of the lower end of the first cam support portion 211. The third mating surface portion 43 may be located upward of the camshaft 14. The third mating surface portion 43 may be located upward of the first mating surface portion 41. The third mating surface portion 43 may extend in a direction perpendicular to the cylinder axis Ax1.

[0090] The fourth mating surface portion 44 may downwardly slant from the opposite side of the cam chain compartment 17 to the cam chain compartment side in the axial direction of the camshaft 14. In other words, the fourth mating surface portion 44 may slant obliquely upward from the first mating surface portion 41 to the opposite side of the cam chain compartment 17. Therefore, the fourth mating surface portion 44 may be located upward of the first mating surface portion 41.

[0091] The edge 50 of the head cover 5 may slant along the mating surface 40 of the cylinder head 4. Detailedly, the second edge portion 52 may slant along the second mating surface portion 42. Similarly to the second edge portion 52, the fourth edge portion 54 may slant along the fourth mating surface portion 54.

[0092] In this case, the mating surface 40 of the cylinder head 4 slants, whereby the position of the first mating surface portion 41 can be made lower than that of the first cam support portion 211. Additionally, the edge 50 of the head cover 5 slants, whereby the position of the first edge portion 51 of the head cover 5 can be made low, and the head cover 5 can be extended to a position adjacent to the cam chain compartment 17. Accordingly, it is possible to obtain advantageous effects similar to those achieved in the aforementioned exemplary embodiments.

INDUSTRIAL APPLICABILITY

[0093] According to the present invention, in an engine for a straddled vehicle including a head cover made of resin, degradation in durability of the head cover can be inhibited, and the engine can be made lightweight.

REFERENCE SIGNS LIST

[0094]

14	Camshaft
26	Cam chain
211	Cam support portion
17	Cam chain compartment
4	Cylinder head
5	Head cover
40	Mating surface
41	First mating surface portion
32	Exhaust port
42	Second mating surface portion
12	Spark plug
31	Spark plug attachment portion
43	Third mating surface portion
411	Recessed portion
511	Protruded portion
50	Edge
55	Projection
56	Chain restraining portion

Claims

1. An engine for a straddled vehicle comprising:

a camshaft;
a cam chain coupled to the camshaft;
a cylinder head made of metal, the cylinder head including a cam support portion supporting the camshaft and a cam chain compartment in which the cam chain is disposed; and
a head cover made of resin, the head cover being attached to the cylinder head, wherein
the cylinder head includes a mating surface to be attached to the head cover,
the mating surface includes a first mating surface portion, a second mating surface portion, a third mating surface portion and a fourth mating surface portion,
the first mating surface portion is adjacent to the cam chain compartment,
the third mating surface portion is located on an opposite side of the first mating surface portion,
the second mating surface portion connects the first mating surface portion and the third mating surface portion,

the fourth mating surface portion is located on an opposite side of the second mating surface portion, the fourth mating surface portion connects the first mating surface portion and the third mating surface portion, and
where in a cylinder axial direction of the cylinder head, a directional side from the head cover to the cylinder head is defined as downward and a directional side from the cylinder head to the head cover is defined as upward,

at least portion of the first mating surface portion is located downward of a lower end of the cam support portion, and
at least portion of the second mating surface portion, at least portion of the third mating surface portion and at least portion of the fourth mating surface portion are located upward of the lower end of the cam support portion.

2. The engine for a straddled vehicle according to claim 1, wherein
the head cover includes

a first edge portion to be mated with the first mating surface portion,
a second edge portion to be mated with the second mating surface portion,
a third edge portion to be mated with the third mating surface portion, and
a fourth edge portion to be mated with the fourth mating surface portion,

at least portion of the first edge portion is located downward of the lower end of the cam support portion, and
at least portion of the second edge portion, at least portion of the third edge portion, at least portion of the fourth edge portion are located upward of the lower end of the cam support portion.

3. The engine for a straddled vehicle according to claim 1 or 2, wherein
the cylinder head includes an exhaust port,
the second mating surface portion is located above the exhaust port, and
the second mating surface portion is located upward of the first mating surface portion.

4. The engine for a straddled vehicle according to any of claims 1 to 3, further comprising:

a spark plug, wherein
the cylinder head includes a spark plug attachment portion to which the spark plug is attached,
the spark plug attachment portion is disposed on an opposite side of the cam chain compartment in an axial direction of the camshaft,
the third mating surface portion is located above the spark plug attachment portion, and
the third mating surface portion is located upward of the first mating surface portion.

5. The engine for a straddled vehicle according to any of claims 1 to 4, wherein the first mating surface portion includes a recessed portion, the recessed portion is recessed downward, and at least portion of the recessed portion is located downward of the lower end of the cam support portion.

6. The engine for a straddled vehicle according to claim 5, wherein
the head cover includes a protruded portion, the protruded portion is protruded downward, and the protruded portion is attached to the recessed portion.

7. The engine for a straddled vehicle according to claim 5 or 6, wherein a lower end of the recessed portion is located downward of the second mating surface portion, the third mating surface portion and the fourth mating surface portion.

8. The engine for a straddled vehicle according to any of claims 5 to 7, wherein the second mating surface portion, the third mating surface portion and the fourth mating surface portion are located upward of the lower end of the cam support portion.

9. The engine for a straddled vehicle according to any of claims 1 to 4, wherein the mating surface downwardly slants from the opposite side of the cam chain compartment to the cam chain compartment in the axial direction of the camshaft.

10. The engine for a straddled vehicle according to claim 9, wherein the head cover includes an edge, the edge is attached to the mating surface of the cylinder head, and the edge slants along the mating surface of the cylinder head.

11. The engine for a straddled vehicle according to any of claims 1 to 10, wherein the head cover includes a projection, and the projection sticks out from an inner surface of the head cover so as to downwardly drip a lubricating oil to the cam chain.

12. The engine for a straddled vehicle according to any of claims 1 to 11, wherein
the head cover includes a chain restraining portion, the chain restraining portion sticks out from the inner surface of the head cover, the chain restraining portion extends to a position lateral to the cam chain, and the chain restraining portion has a thickness smaller than an interval between a pair of plates of the cam chain or a width of a bushing of the cam chain.

13. The engine for a straddled vehicle according to any of claims 1 to 12, wherein the engine is of an SOHC type.

14. The engine for a straddled vehicle according to any of claims 1 to 13, wherein the engine is of an air cooling type.

15. The engine for a straddled vehicle according to any of claims 1 to 14, wherein the head cover is made of fiber reinforced resin.

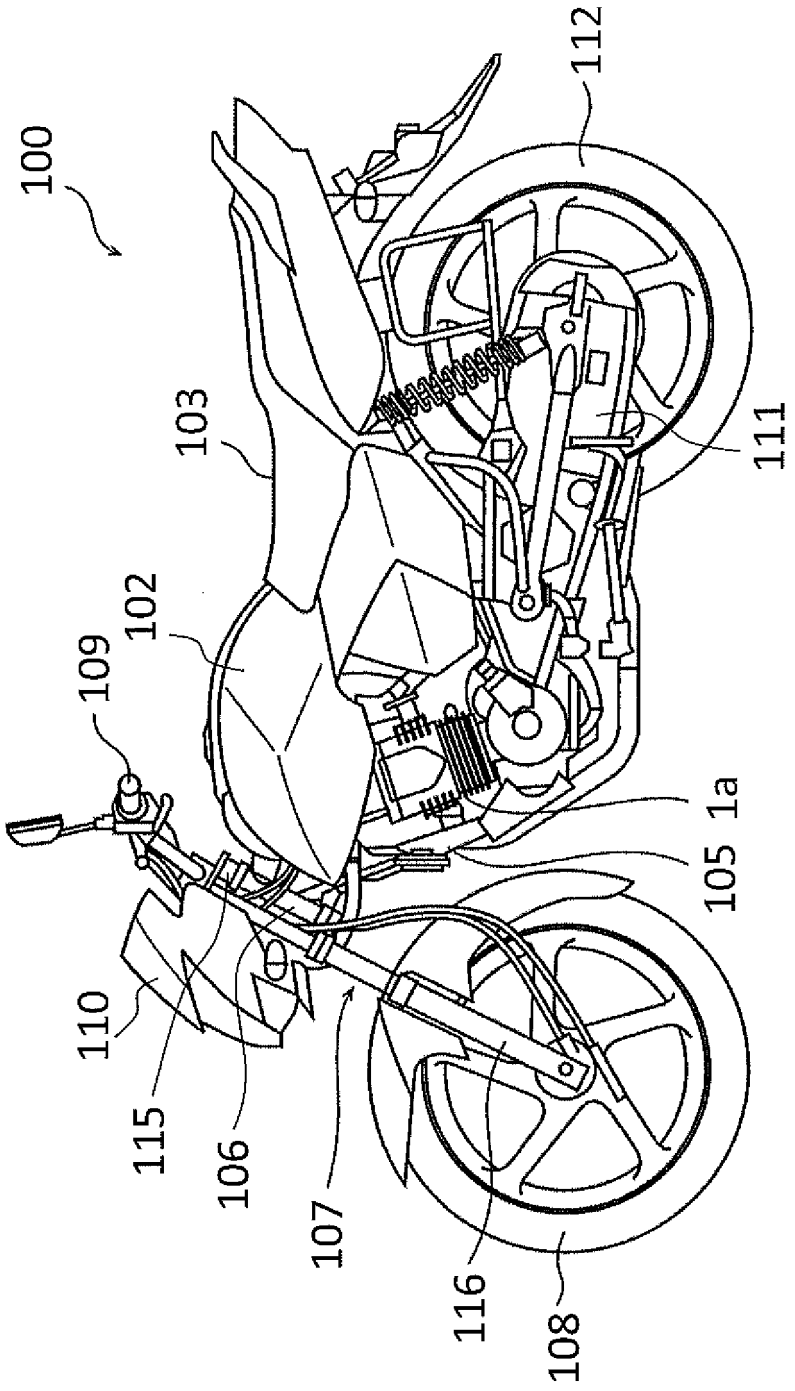

FIG. 1

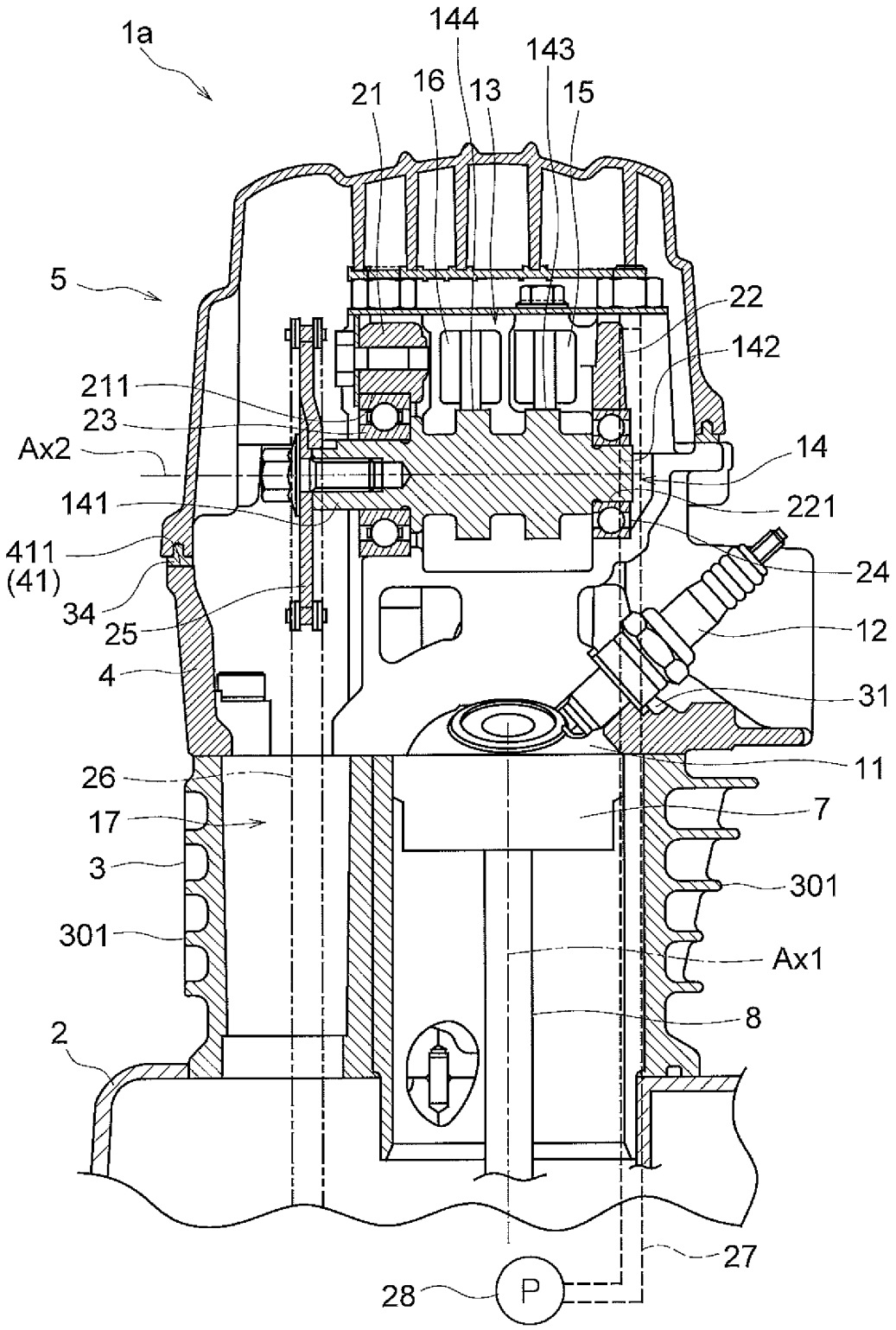
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FIG. 2

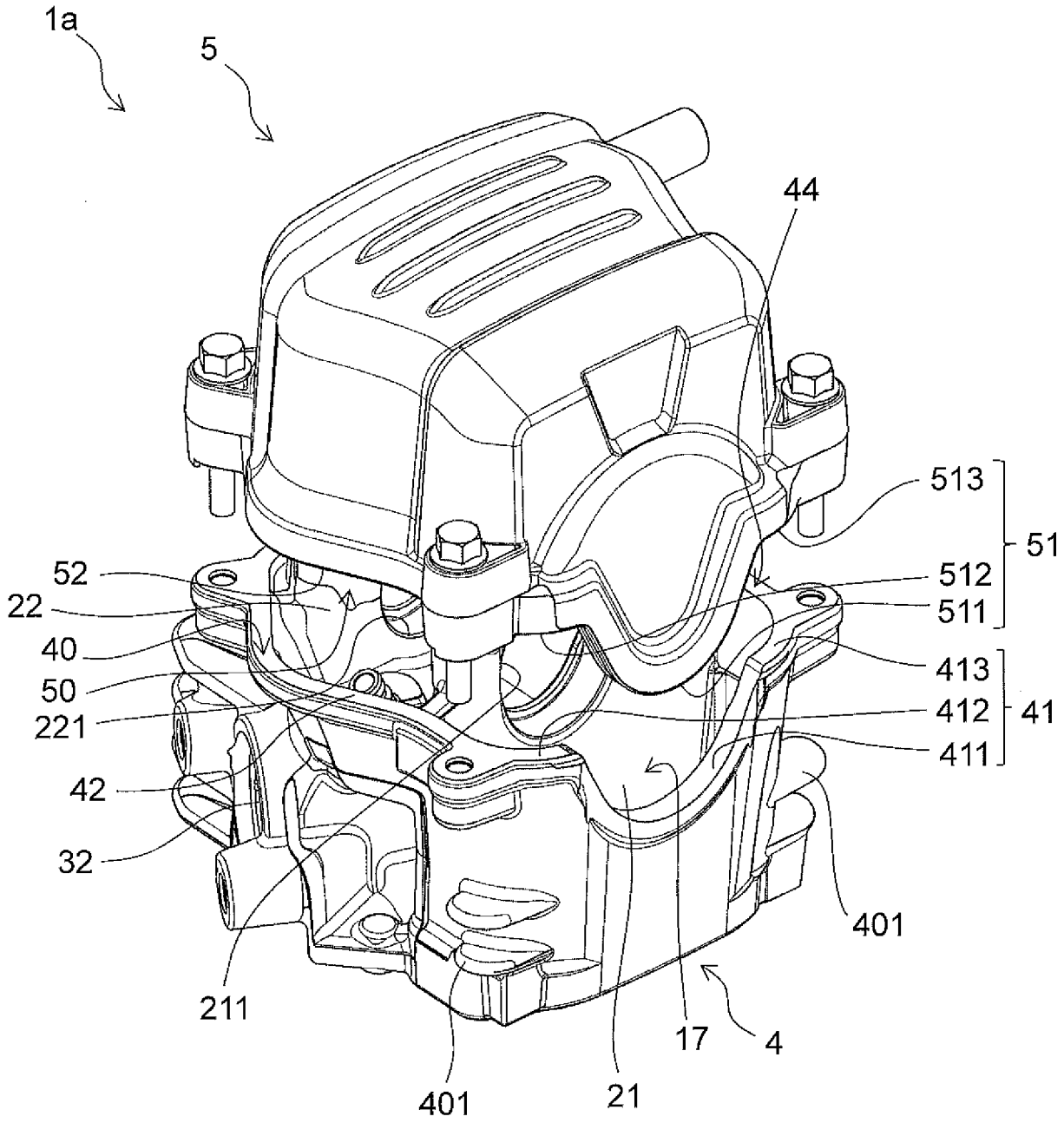
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FIG. 3

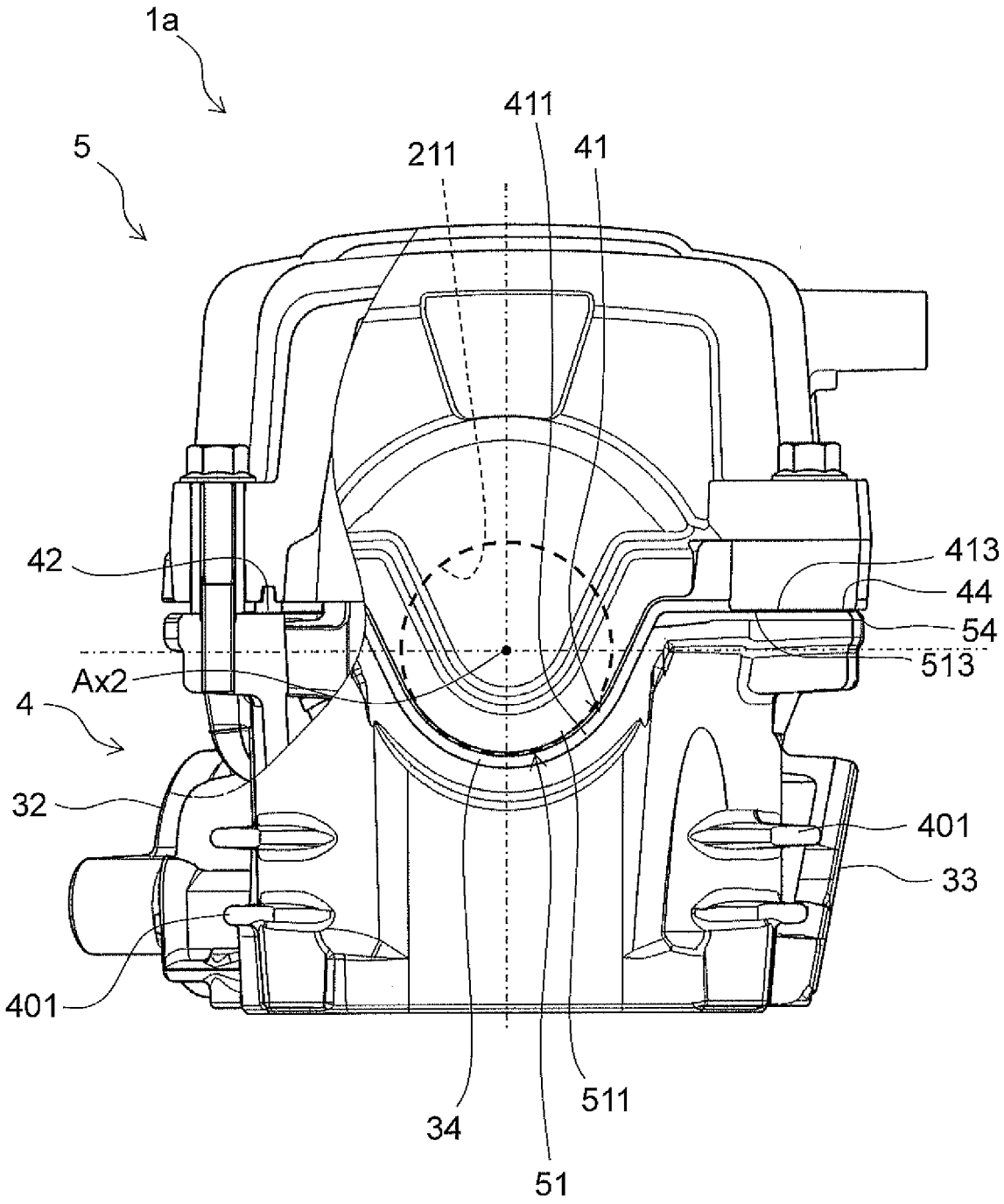

FIG. 4

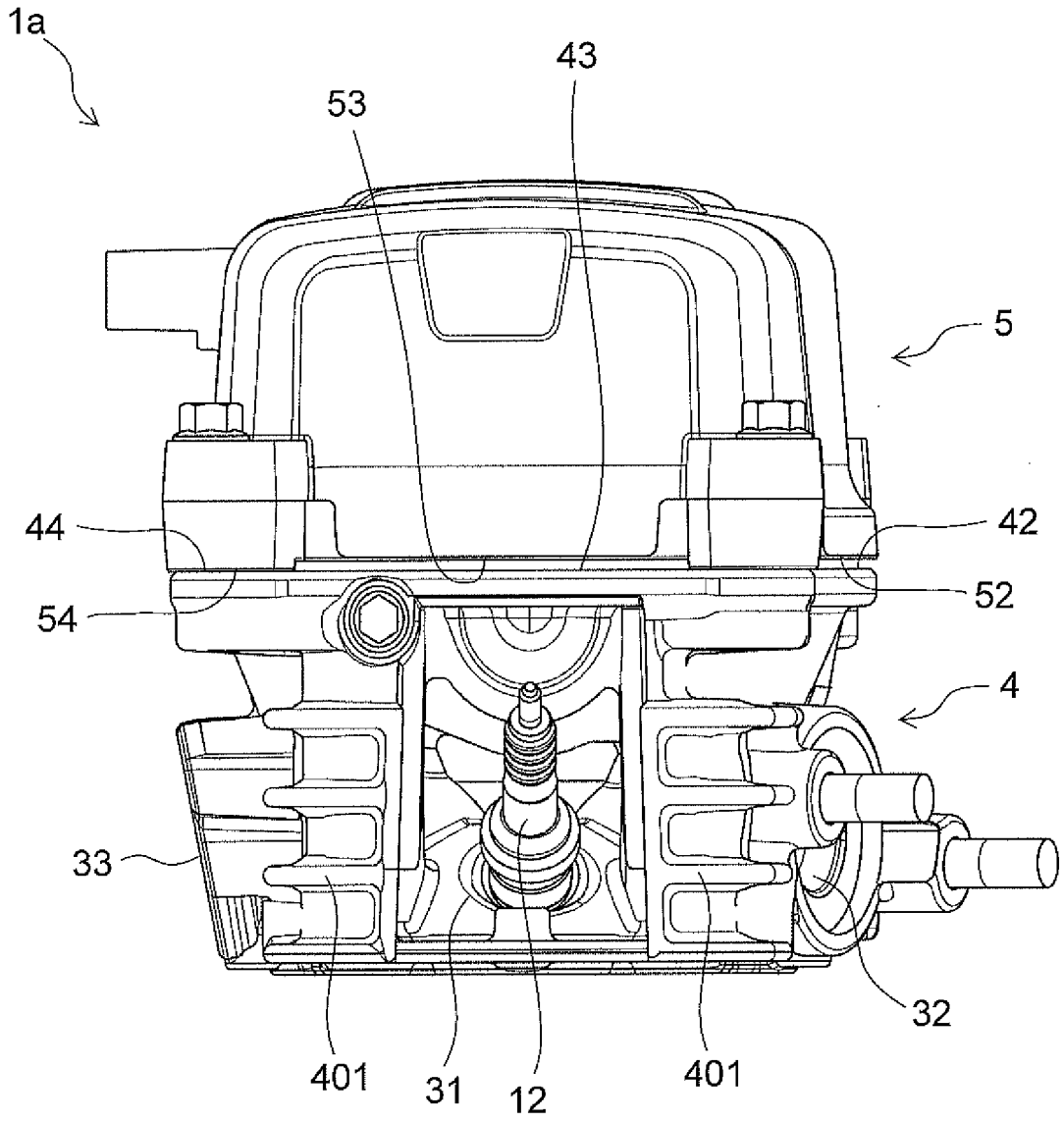

FIG. 5

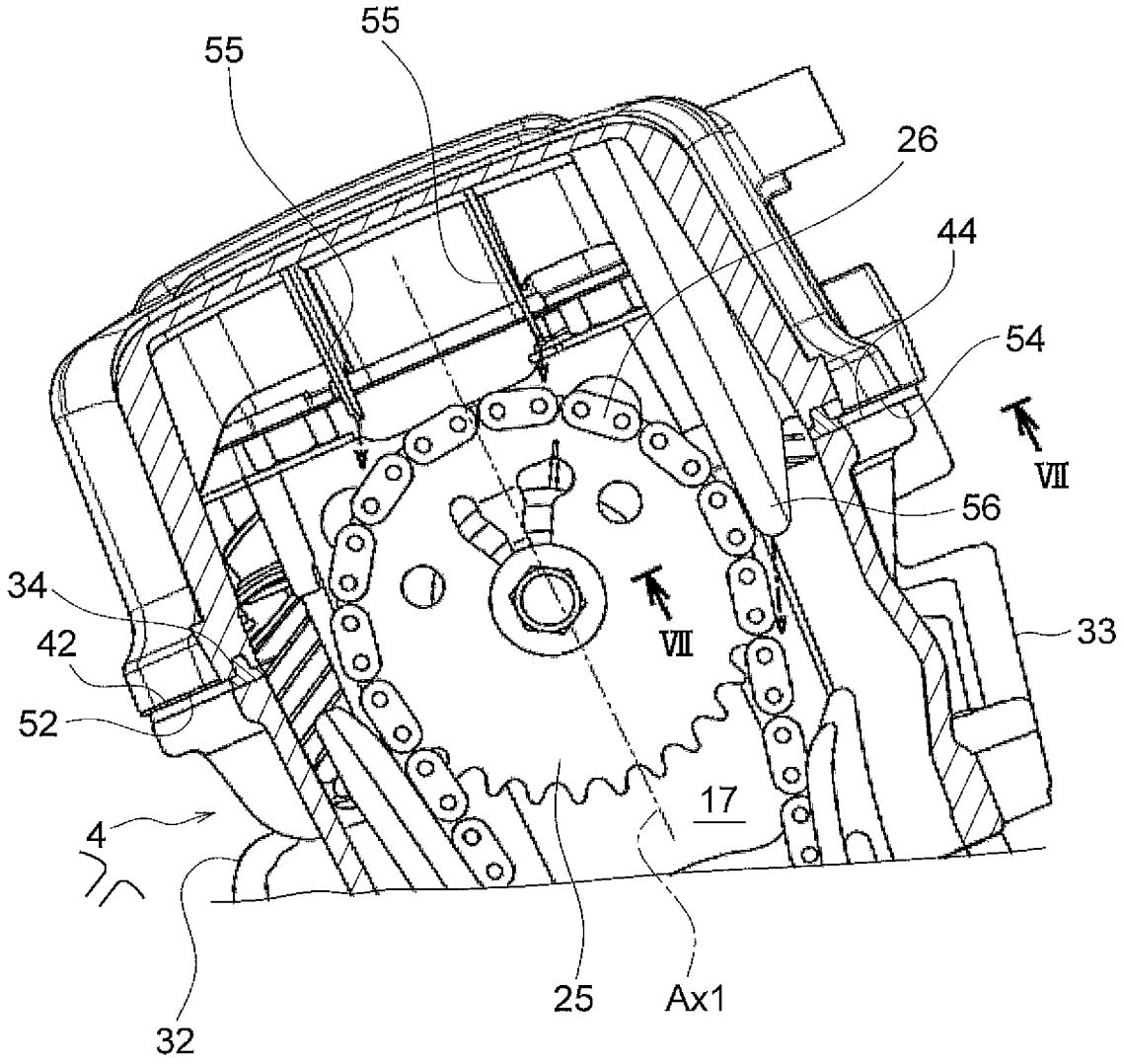

FIG. 6

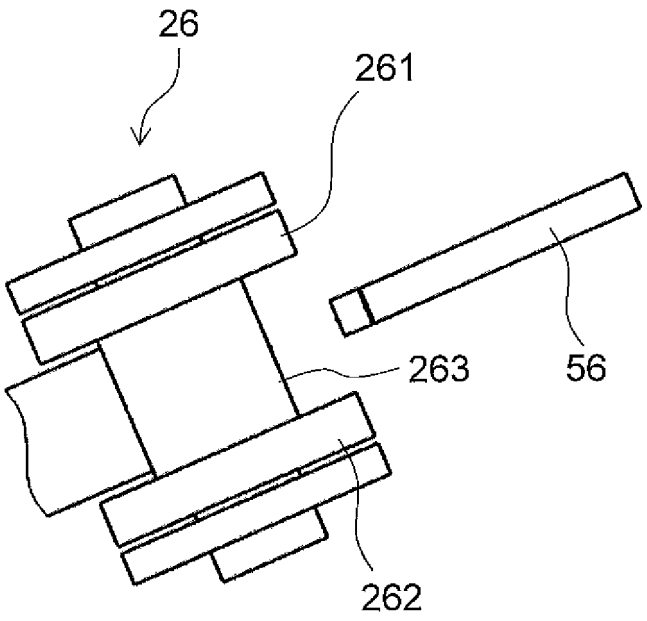

FIG. 7

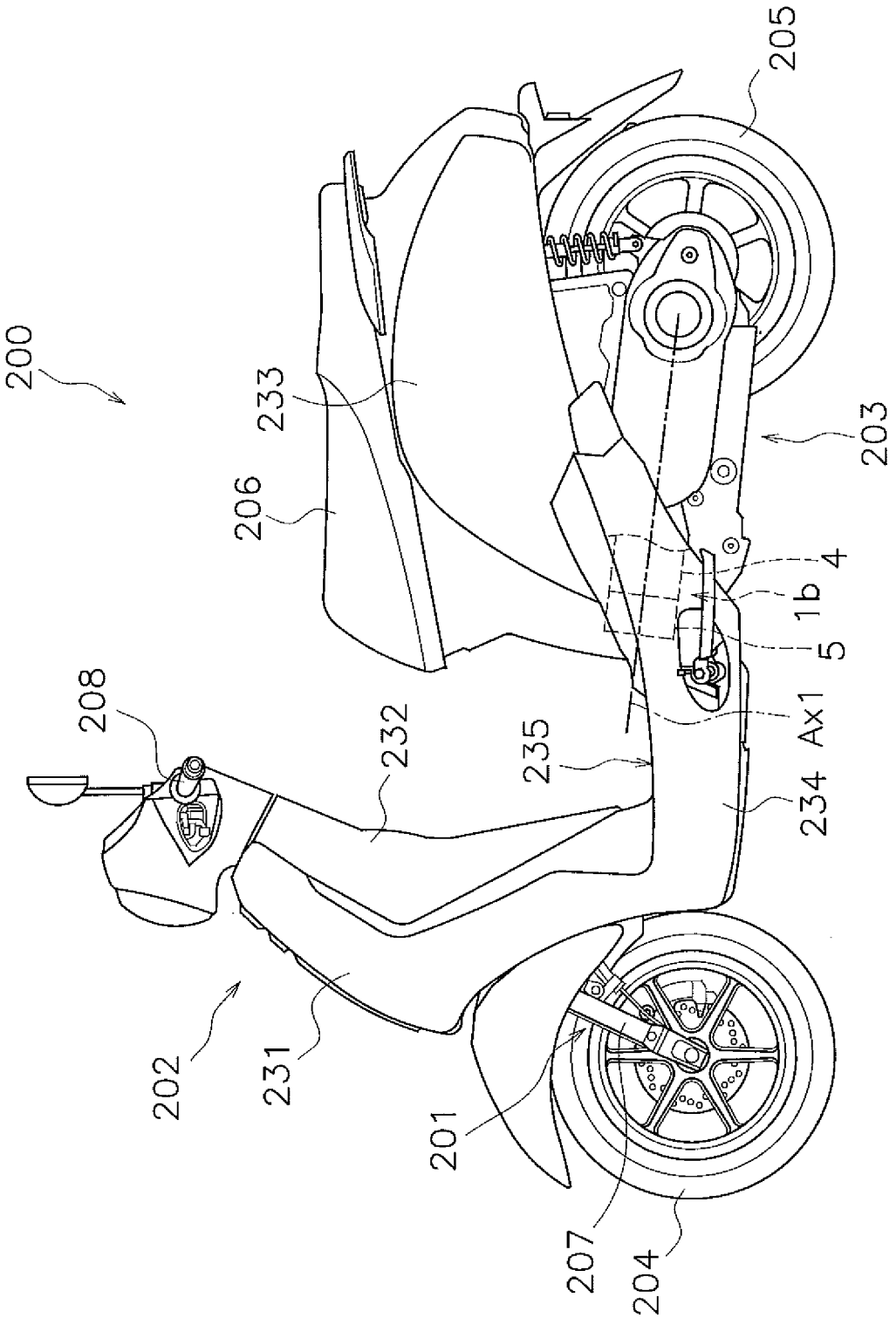

FIG. 8

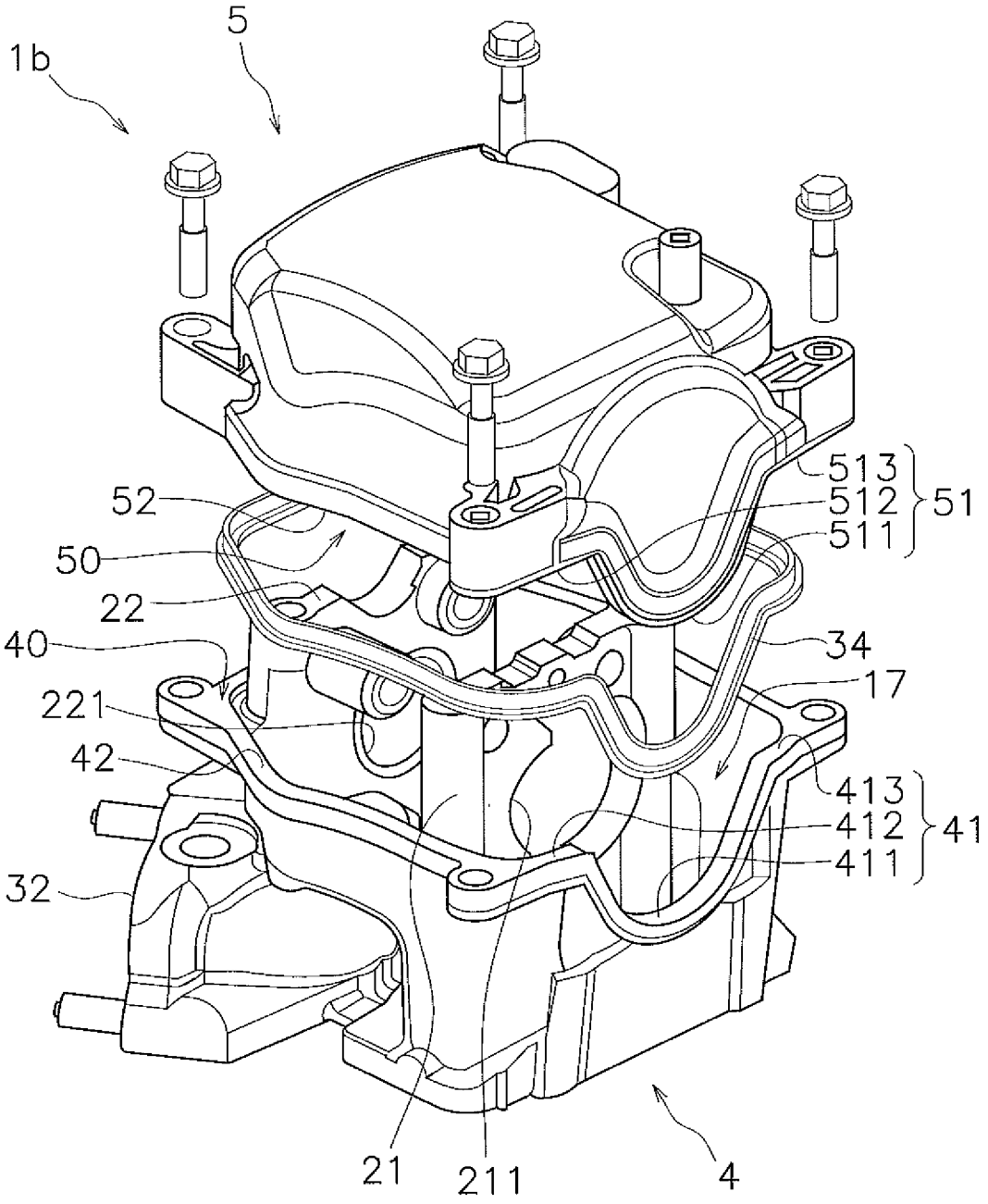
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FIG. 9

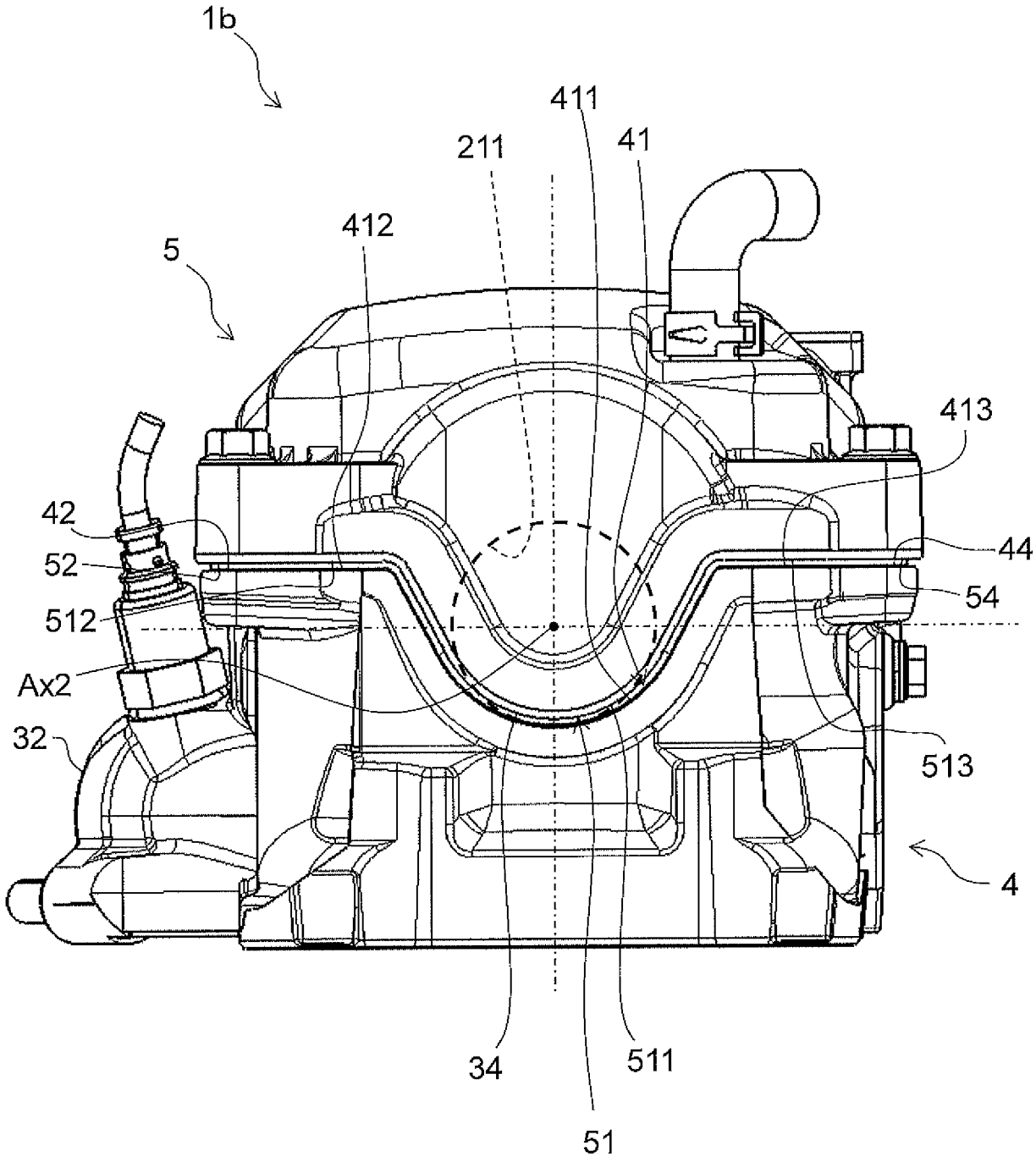

FIG. 10

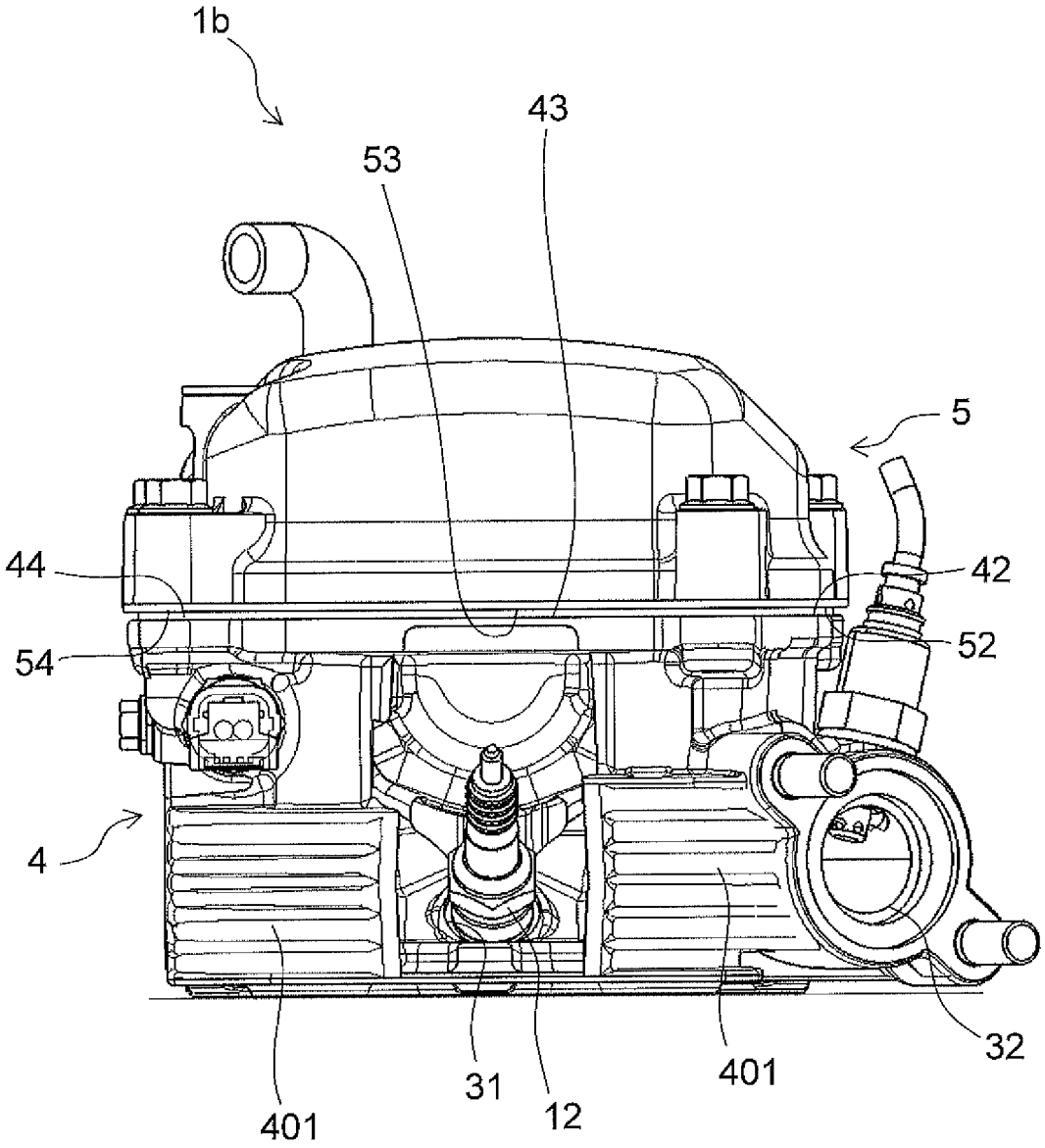

FIG. 11

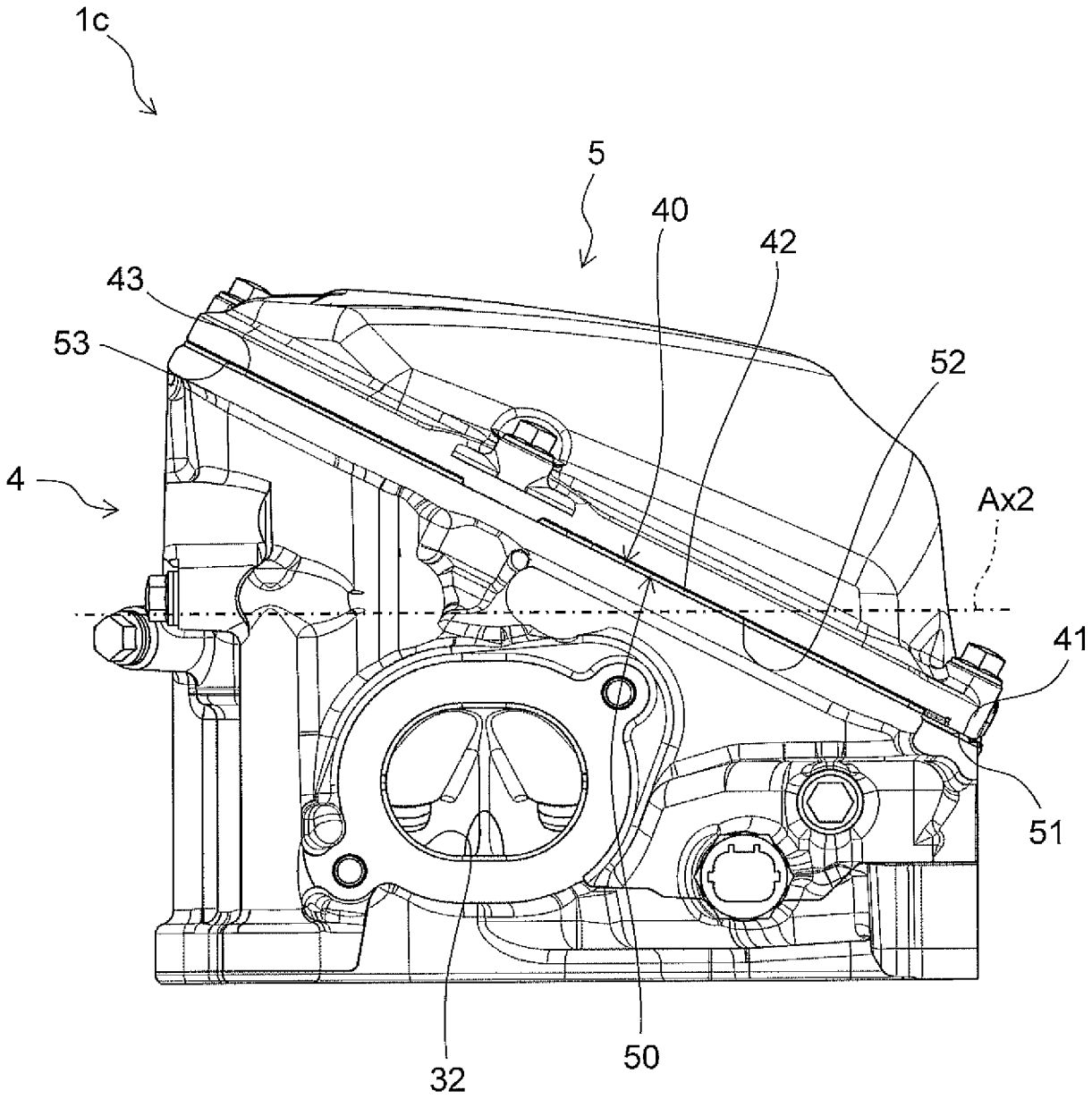

FIG. 12

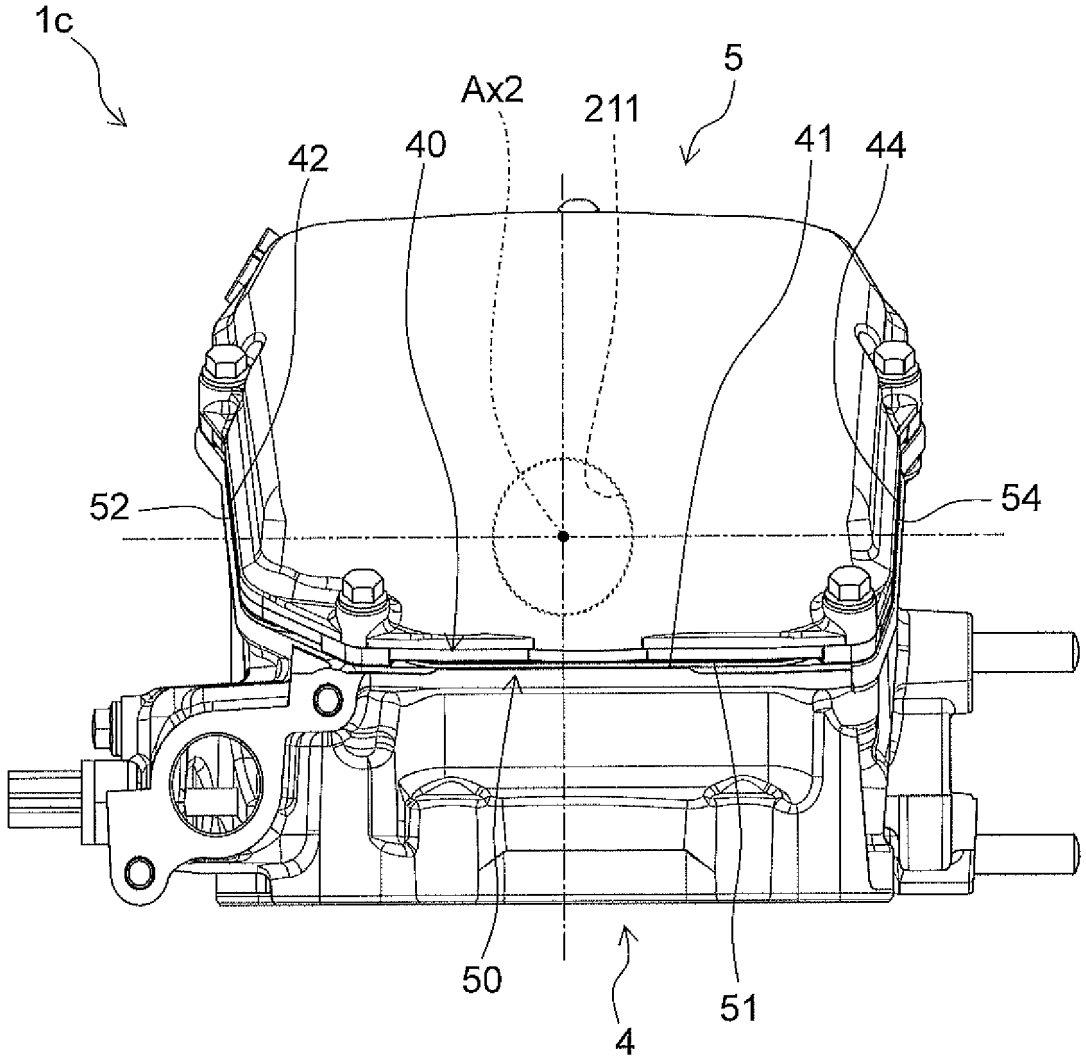

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/078705

A. CLASSIFICATION OF SUBJECT MATTER
F02F1/24(2006.01)i, *F02F1/42*(2006.01)i, *F02F7/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02F1/24, F02F1/42, F02F7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2004-278447 A (Honda Motor Co., Ltd.), 07 October 2004 (07.10.2004), paragraphs [0014], [0056] to [0057], [0062], [0071] to [0075]; fig. 1, 4 to 5, 7 to 9, 11 & EP 1460238 A2 paragraphs [0013], [0055] to [0056], [0061], [0070] to [0074]; fig. 1, 4 to 5, 7 to 9, 11 & CN 1530521 A	1-11,13-15 12
Y	JP 11-182368 A (Honda Motor Co., Ltd.), 06 July 1999 (06.07.1999), paragraphs [0010], [0021]; fig. 1 (Family: none)	1-11,13-15

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 October 2016 (25.10.16)	01 November 2016 (01.11.16)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/078705

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2014-214717 A (Honda Motor Co., Ltd.), 17 November 2014 (17.11.2014), paragraph [0030]; fig. 1 to 3 (Family: none)	1-11,13-15
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 043769/1988(Laid-open No. 148034/1989) (Suzuki Motor Co., Ltd.), 13 October 1989 (13.10.1989), page 8, line 3 to page 9, line 4; fig. 4 (Family: none)	9-11,13-15
Y	JP 06-213066 A (Franz, Laimböck), 02 August 1994 (02.08.1994), fig. 1 & EP 599802 A1 fig. 1	9-11,13-15
Y	JP 53-131344 A (Toyota Motor Co., Ltd.), 16 November 1978 (16.11.1978), page 2, lower left column, line 14 to lower right column, line 1; page 2, lower right column, line 13 to page 3, upper left column, line 6; fig. 1 & US 4124011 A column 2, lines 11 to 13; column 2, lines 24 to 36; fig. 1	11,13-15
Y	JP 2007-077893 A (Nissan Diesel Motor Co., Ltd.), 29 March 2007 (29.03.2007), paragraph [0012]; fig. 2 (Family: none)	11,13-15
Y	JP 09-144994 A (Nissan Motor Co., Ltd.), 03 June 1997 (03.06.1997), paragraph [0003]; fig. 7 to 9 (Family: none)	15
Y	JP 2014-163334 A (Mahle Filter Systems Japan Corp.), 08 September 2014 (08.09.2014), paragraph [0018]; fig. 1 to 2 & US 2014/0238331 A1 paragraphs [0026] to [0027]; fig. 1 to 2 & EP 2787209 A1 & CN 104005879 A	15

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REFERENCES CITED IN THE DESCRIPTION

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