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(54) ENGINE AND VEHICLE

(57) An axis of a cylinder (Ax1) slants at an angle closer to vertical than to horizontal. In a cylinder head (22), a first support wall (36) supports a valve actuating mechanism. A second support wall (37) is disposed away from the first support wall (36) in a direction of an axis (Ax2) of a camshaft (22). A breather plate (70) together with a ceiling wall (38) of the cylinder head forms a breather compartment (Bc1) therebetween. The breather plate (70) overlaps the valve actuating mechanism (45) as seen from a direction of the axis of the cylinder (Ax1). The breather plate (70) includes a bulged portion (71). A lower end of the bulged portion (71) is closer to a first valve (430) end than an upper end of the bulged portion (70).

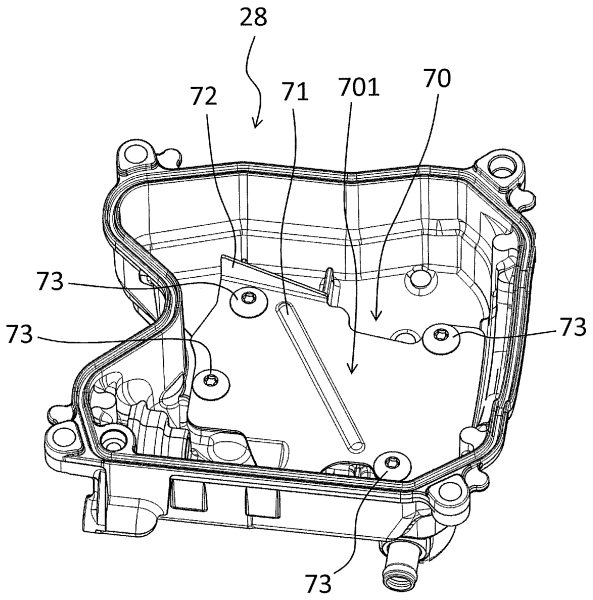


FIG. 6

EP 3 324 011 A1

Description

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

[0002] There are SOHC (Single Over-Head Camshaft) engines that the number of exhaust valves or intake valves is plural. For example, an SOHC engine including two exhaust valves is disclosed in Japan Laid-open Patent Application Publication No. 2011-106464.

[0003] The engine of Japan Laid-open Patent Application Publication No. 2011-106464 is provided with a valve actuating mechanism that opens and closes the two exhaust valves by a camshaft. The valve actuating mechanism is supported by a first support wall and a second support wall, both of which are provided in a cylinder head. More specifically, the valve actuating mechanism includes a rocker shaft supported by the first and second support walls and a rocker arm rotatably attached to the rocker shaft. When one end of the rocker arm is lifted by the camshaft, the other end of the rocker arm is lowered and presses the ends of the exhaust valves.

[0004] In this engine, the camshaft includes oil supply holes (40a, 40b). Contact portions between the rocker arm and the valves are lubricated and cooled by oil discharged from the oil supply holes (40a, 40b).

[0005] Similarly to the engine of Japan Laid-open Patent Application Publication No. 2011-106464, an engine of Japan Laid-open Patent Application Publication No. 2015-10553 is provided with a valve actuating mechanism that opens and closes two exhaust valves. It should be noted that in the engine of Japan Laid-open Patent Application Publication No. 2015-10553, the cylinder head is compactly designed, and a gap between the first support wall and the second support wall is narrow.

[0006] In the engine of Japan Laid-open Patent Application Publication No. 2015-10553, the axis of a cylinder slants at an angle closer to horizontal than to vertical, whereby the contact portions between the two exhaust valves and the rocker arm are submerged in the oil. Therefore, the two exhaust valves and the rocker arm are sufficiently lubricated and cooled.

[0007] On the other hand, when the axis of the cylinder slants at an angle closer to vertical than to horizontal, it is difficult to submerge the contact portions between the two exhaust valves and the rocker arm. Therefore, as with the engine of Japan Laid-open Patent Application Publication No. 2011-106464, oil is required to be supplied thereto from the oil supply holes provided in the camshaft.

[0008] However, as described above, in the engine of Japan Laid-open Patent Application Publication No. 2015-10553, the gap between the first support wall and the second support wall is narrow. This poses a drawback that the oil, discharged from the camshaft, is blocked by the first support wall and is thereby prevented from easily reaching one of the exhaust valves, which is located in adjacent to the first support wall.

[0009] It is an object of the present invention to provide an engine with a cylinder head being compact and enhance lubrication properties of valves in an engine that the number of exhaust valves or intake valves is plural and the axis of a cylinder slants at an angle closer to vertical than to horizontal.

[0010] 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.

[0011] An engine according to a first aspect includes a cylinder, a cylinder head, a camshaft, a valve actuating mechanism, a first valve, a second valve and a breather plate. The cylinder head includes a port and is disposed above the cylinder. The camshaft is provided in the cylinder head. The valve actuating mechanism is provided in the cylinder head. The first valve includes a first valve end to be pressed by the valve actuating mechanism, and opens and closes the port. The second valve includes a second valve end to be pressed by the valve actuating mechanism, and opens and closes the port. The second valve is disposed in alignment with the first valve in a direction of an axis of the camshaft. The breather plate is disposed above the valve actuating mechanism.

[0012] An axis of the cylinder slants at an angle closer to vertical than to horizontal. The cylinder head includes a first support wall, a second support wall and a ceiling wall. The first support wall is disposed closer to the first valve than to the second valve, and supports the valve actuating mechanism. The second support wall is disposed away from the first support wall in the direction of the axis of the camshaft, and supports the valve actuating mechanism. The ceiling wall is disposed above the breather plate. The valve actuating mechanism includes a rocker shaft and a rocker arm. The rocker shaft is supported by the first support wall and the second support wall. The rocker arm is supported by the rocker shaft, and makes contact with the first valve end. The breather plate together with the ceiling wall forms a breather compartment therebetween. The breather plate overlaps the valve actuating mechanism as seen from a direction of the axis of the cylinder. The breather plate includes a bulged portion protruding downward. The bulged portion is located upward of the first valve end, and extends in an up-and-down direction. A lower end of the bulged portion is closer to the first valve end than an upper end of the bulged portion.

[0013] In the engine according to the present aspect, the bulged portion is located upward of the first valve end and extends in the up-and-down direction. Additionally, the lower end of the bulged portion is closer to the first valve end than the upper end of the bulged portion. Therefore, when reaching the bulged portion, oil attached to the breather plate flows along the bulged portion toward the lower end of the bulged portion. Then, the oil downwardly flows from the lower end of the bulged portion, and is supplied to the vicinity of the first valve end. Therefore, even when the first support wall is disposed

in adjacent to the first valve end, oil can be sufficiently supplied to the first valve end. Accordingly, the cylinder head can be made compact, and lubrication properties of the valve can be enhanced.

[0014] The bulged portion may overlap the camshaft as seen from the direction of the axis of the cylinder. In this case, the bulged portion is elongated, whereby oil attached to the breather plate can be efficiently supplied to the first valve end.

[0015] The bulged portion may overlap the camshaft, the rocker arm and the rocker shaft as seen from the direction of the axis of the cylinder. In this case, the bulged portion is elongated, whereby oil attached to the breather plate can be efficiently supplied to the first valve end.

[0016] The breather plate may include a protruding portion protruding downward. The protruding portion may be located on an extending direction of the bulged portion with respect to the bulged portion. The protruding portion may be disposed above the first valve end. In this case, oil downwardly drips from the protruding portion. Hence, the oil can be efficiently supplied to the first valve end.

[0017] A lower end of the protruding portion may be located immediately above the first valve end. In this case, oil can be more efficiently supplied to the first valve end.

[0018] The protruding portion may be formed by downwardly bending portion of the breather plate. The protruding portion may have a downwardly tapered shape. In this case, the protruding portion can be easily formed.

[0019] The bulged portion may straightly extend. In this case, oil can be inhibited from downwardly dripping from an intermediate portion of the bulged portion, while flowing toward the first valve end along the bulged portion. Accordingly, oil can be efficiently supplied to the first valve end.

[0020] The first valve may be disposed away from the camshaft in a first direction that intersects the axis of the cylinder and the axis of the camshaft. At least portion of the first valve end may overlap the first support wall as seen from the first direction. In this case, the first support wall and the first valve are disposed in adjacent to each other, whereby the cylinder head can be made compact. Additionally, oil can be supplied to the first valve end along the bulged portion, whereby the first support wall can be inhibited from hindering oil supply to the first valve end.

[0021] The bulged portion may slant with respect to the axis of the camshaft and may extend in a direction toward the first valve end as seen from the direction of the axis of the cylinder. In this case, oil attached to the breather plate can be efficiently supplied to the first valve end through the bulged portion.

[0022] The cylinder head may include a wall portion that protrudes from the ceiling wall toward the breather plate. The wall portion may form a breather gas pathway in an interior of the breather compartment. The bulged portion may overlap the wall portion as seen from the direction of the axis of the cylinder. In this case, oil can be separated from breather gas in the breather gas pathway.

[0023] The bulged portion may have a shape downwardly recessed from a breather compartment side surface of the breather plate. The cylinder head may further include a seal member that is disposed between the bulged portion and the wall portion. In this case, the bulged portion can be easily formed on the breather plate by stamping or so forth. Additionally, a gap between the breather plate and the wall portion, which is formed on the breather gas pathway side by forming the bulged portion, can be sealed by the seal member. Accordingly, leakage of breather gas through the gap can be inhibited, and degradation of oil separation function can be inhibited in the breather gas pathway.

[0024] The breather gas pathway may include a bending pathway. The wall portion may include an inner sidewall and an outer sidewall. The inner sidewall may be located inside a bending portion of the bending pathway. The outer sidewall may be located outside the bending portion of the bending pathway. The bulged portion may be disposed in a position not overlapping the outer sidewall as seen from the direction of the axis of the cylinder. Breather gas, flowing through the breather pathway, is likely to collide the outer sidewall located outside the inner sidewall located inside the bending portion of the breather pathway. Oil becomes easily separated from breather gas by collision with the wall surface of the breather pathway. Hence, oil is likely to be separated from breather gas on the outer sidewall. Therefore, with the bulged portion being located in a position not overlapping the outer sidewall, leakage of breather gas can be inhibited at the outer sidewall, whereby degradation of oil separation function can be effectively inhibited.

[0025] The lower end of the bulged portion may be closer to the first valve end than the upper end of the bulged portion in the first direction.

[0026] The lower end of the bulged portion may be further away from the camshaft than from the rocker arm in the first direction.

[0027] The lower end of the bulged portion may be closer to the first valve end than the upper end of the bulged portion in the direction of the axis of the camshaft.

[0028] The first valve end may be located on a second directional side of the second valve end, and the second directional side is defined as one directional side of the direction of the axis of the camshaft. The lower end of the bulged portion may be located on the second directional side of the second valve end in the direction of the axis of the camshaft.

[0029] A vehicle according to a second aspect includes the aforementioned engine.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

FIG. 1 is a side view of a straddled vehicle according

to a preferred embodiment.

FIG. 2 is a cross-sectional view of portion of an engine.

FIG. 3 is a perspective view of the interior of a cylinder head.

FIG. 4 is a view of the interior of the cylinder head as seen from a cylinder axial direction.

FIG. 5 is a cross-sectional view of the interior of the cylinder head as seen from a cam axial direction.

FIG. 6 is a perspective view of the a head cover and a breather plate.

FIG. 7 is a perspective view of the breather plate.

FIG. 8 is a side view of the breather plate.

FIG. 9 is a perspective view showing positional arrangement of the breather plate and components in the interior of the cylinder head.

FIG. 10 is a view showing positional arrangement of the cylinder head and the breather plate as seen from the cylinder axial direction.

FIG. 11 is a view of the interior of the head cover as seen from the cylinder axial direction.

FIG. 12 is a cross-sectional view of FIG. 11 taken along XII-XII.

FIG. 13 is a view showing a breather plate according to a first modification.

FIG. 14 is a view showing a breather plate according to a second modifcation.

FIG. 15 is a view showing a breather plate according to a third modification.

FIG. 16 is a view showing a breather plate according to a fourth modification.

FIG. 17 is a view showing a breather plate according to a fifth modification.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] A straddled vehicle 1 according to a preferred embodiment will be hereinafter explained with reference to drawings. FIG. 1 is a side view of the straddled vehicle 1 according to the preferred embodiment. The straddled vehicle 1 according to the present preferred embodiment is a motorcycle. As shown in FIG. 1, the straddled vehicle 1 includes a vehicle body frame 2, a fuel tank 3, a seat 4, an engine 5, a steering device 6, a front wheel 7 and a rear wheel 8.

[0032] The vehicle body frame 2 includes a head pipe 11. The steering device 6 is supported by the head pipe 11 and is thereby turnable. The steering device 6 includes a pair of front suspensions 12. The front suspensions 12 support the front wheel 7 such that the front wheel 7 is rotatable. A handle 13 is connected to an upper portion of the steering device 6. A headlight 14 is disposed in front of the steering device 6.

[0033] The fuel tank 3 is disposed behind the head pipe 11. The seat 4 is disposed behind of the fuel tank 3. The engine 5 is disposed under the fuel tank 3. The rear wheel 8 is rotatably supported by a swing arm 15. The swing arm 15 is supported by the vehicle body frame 2.

[0034] FIG. 2 is a cross-sectional view of portion of the engine 5. It should be noted that in the following explanation, front, rear, left, right, up and down directions are defined as meaning the front, rear, left, right, up and down directions, respectively, based on a condition that the engine 5 is installed in the aforementioned straddled vehicle 1.

[0035] The engine 5 includes a cylinder 21 and a cylinder head 22. The cylinder head 22 is connected to the cylinder 21, and is disposed above the cylinder 21. The cylinder 21 includes a cylinder hole 210. A piston 240 is disposed in the cylinder hole 210. The cylinder head 22 includes a combustion chamber 220. A spark plug 26 is attached to the cylinder head 22. The tip end of the spark plug 26 is disposed to face the combustion chamber 220.

[0036] As shown in FIG. 1, the engine 5 includes a crankcase 23. A crankshaft (not shown in the drawings) is disposed in the crankcase 23. The cylinder 21 is connected to the crankcase 23, and is disposed above the crankcase 23. The cylinder 21 may be provided separately from the crankcase 23. Alternatively, the cylinder 21 may be integrated with the crankcase 23. An axis Ax1 of the cylinder 21 (hereinafter referred to as a cylinder axis Ax1) slants at an angle closer to vertical than to horizontal. In other words, the slant angle of the cylinder axis Ax1 with respect to a horizontal direction is greater than or equal to 45 degrees.

[0037] The cylinder head 22 includes a head body 27 and a head cover 28. The head cover 28 is provided separately from the head body 27. The head cover 28 is connected to the head body 27, and is disposed above the head body 27. It should be noted that the head cover 28 and the head body 27 may be integrated.

[0038] As shown in FIG. 2, the cylinder head 22 is provided with a camshaft 29. The camshaft 29 is supported by the cylinder head 22. A center axis Ax2 of the camshaft 29 (hereinafter referred to as "a cam axis Ax2") is perpendicular to the cylinder axis Ax1.

[0039] The camshaft 29 includes a first end 291 and a second end 292. A sprocket 31 is attached to the first end 291. A cam chain 32 is wound about the sprocket 31. The cam chain 32 is wound about a sprocket of a crankshaft (not shown in the drawings). Rotation of the crankshaft is transmitted to the camshaft 29 through the cam chain 32, whereby the camshaft 29 is rotated. The cylinder head 22 and the cylinder 21 are provided with a cam chain compartment 221. The cam chain 32 is disposed in the cam chain compartment 221.

[0040] The camshaft 29 includes a first intake cam 293, a second intake cam 294 and an exhaust cam 295. The first intake cam 293, the second intake cam 294 and the exhaust cam 295 are disposed in alignment in the cam axial direction (Ax2).

[0041] The camshaft 29 includes oil ejection holes 296. The oil ejection holes 296 are opened in the outer peripheral surface of the first intake cam 293, that of the second intake cam 294 and that of the exhaust cam 295.

Oil is ejected through the oil ejection holes 296, and is thereby supplied to respective portions in the interior of the cylinder head 22.

[0042] FIG. 3 is a perspective view of the interior of the cylinder head 22. FIG. 4 is a view of the interior of the cylinder head 22 as seen from a cylinder axial direction (Ax1). It should be noted that the head cover 28 is not shown in FIGS. 3 and 4.

[0043] As shown in FIGS. 3 and 4, a connection portion 39 for an exhaust pipe 16 shown in FIG. 1 is provided on a front surface 30 of the cylinder head 22. A lateral surface 33 of the cylinder head 22 includes a recessed portion 34. The recessed portion 34 has a shape recessed to the inside of the cylinder head 22 in the cam axial direction (Ax2). The aforementioned spark plug 26 is attached to the lateral surface 33 of the cylinder head 22. The base end of the spark plug 26 is disposed within the recessed portion 34.

[0044] FIG. 5 is a cross-sectional view of the interior of the cylinder head 22 as seen from the cam axial direction (Ax2). As shown in FIGS. 3 to 5, the cylinder head 22 is provided with intake valves 41 and 42, exhaust valves 43 and 44, and a valve actuating mechanism 45. As shown in FIG. 5, the cylinder head 22 includes an intake port 222 and an exhaust port 223, both of which communicate with the combustion chamber 220.

[0045] The exhaust valves 43 and 44 open and close the exhaust port 223. As shown in FIG. 3, the exhaust valves 43 and 44 are disposed in opposition to the front surface 30 of the cylinder head 22. The exhaust valves 43 and 44 include a first exhaust valve 43 and a second exhaust valve 44. The first and second exhaust valves 43 and 44 are disposed in alignment in the cam axial direction (Ax2).

[0046] A first valve spring 48 is attached to the first exhaust valve 43. The first valve spring 48 urges the first exhaust valve 43 in a direction that the first exhaust valve 43 closes the exhaust port 223. The first exhaust valve 43 includes a first valve end 430 to be pressed by the valve actuating mechanism 45.

[0047] A second valve spring 49 is attached to the second exhaust valve 44. The second valve spring 49 urges the second exhaust valve 44 in a direction that the second exhaust valve 44 closes the exhaust port 223. The second exhaust valve 44 includes a second valve end 440 to be pressed by the valve actuating mechanism 45. The first valve end 430 is located in one side (a second directional side) of the second valve end 440 in the cam axial direction (Ax2). In the present preferred embodiment, the first valve end 430 is located on the right side of the second valve end 440.

[0048] The first and second exhaust valves 43 and 44 are disposed away from the camshaft 29 in a direction (a first direction) intersecting the cylinder axis Ax1 and the cam axis Ax2. In the present preferred embodiment, the first and second exhaust valves 43 and 44 are disposed in front of the camshaft 29. The intake valves 41 and 42 are disposed behind the camshaft 29.

[0049] The intake valves 41 and 42 open and close the intake port 222. As shown in FIG. 4, the intake valves 41 and 42 are disposed in opposition to a rear surface 35 of the cylinder head 22. The intake valves 41 and 42 include a first intake valve 41 and a second intake valve 42.

[0050] The first and second intake valves 41 and 42 are disposed in alignment in the cam axial direction (Ax2). A first valve spring 46 is attached to the first intake valve 41. The first valve spring 46 urges the first intake valve 41 in a direction that the first intake valve 41 closes the intake port 222. The first intake valve 41 includes a first valve end (not shown in the drawings) to be pressed by the valve actuating mechanism 45.

[0051] A second valve spring 47 is attached to the second intake valve 42. The second valve spring 47 urges the second intake valve 42 in a direction that the second intake valve 42 closes the intake port 222. As shown in FIG. 5, the second intake valve 42 includes a second valve end 420 to be pressed by the valve actuating mechanism 45.

[0052] As shown in FIGS. 3 and 4, the cylinder head 22 includes a first support wall 36 and a second support wall 37. The first and second support walls 36 and 37 are disposed away from each other in the cam axial direction (Ax2). The first and second support walls 36 and 37 support the valve actuating mechanism 45. The first and second support walls 36 and 37 support the camshaft 29 such that the camshaft 29 is rotatable. As shown in FIG. 2, the first support wall 36 supports the camshaft 29 through a first bearing 51. The second support wall 37 supports the camshaft 29 through a second bearing 52.

[0053] As shown in FIG. 4, the first support wall 36 is disposed in opposition to the recessed portion 34. The first support wall 36 is disposed in adjacent to the first exhaust valve 43. The first support wall 36 is disposed in adjacent to the first intake valve 41. The first intake valve 41 is disposed behind the first support wall 36. The first exhaust valve 43 is disposed in front of the first support wall 36. In short, the first valve end 430 overlaps the first support wall 36 as seen from the front. In other words, the right end of the first valve end 430 is located on the right side of the left end of the first support wall 36. The first support wall 36 includes a recessed portion 360. The recessed portion 360 is opposed to the first exhaust valve 43. The recessed portion 360 overlaps the first exhaust valve 43 as seen from the front.

[0054] The second support wall 37 is disposed in opposition to the sprocket 31. The second support wall 37 is disposed in adjacent to the second exhaust valve 44. The second support wall 37 is disposed in adjacent to the second intake valve 42. The second exhaust valve 44 is disposed between the first support wall 36 and the second support wall 37 in the cam axial direction (Ax2). The second intake valve 42 is disposed between the first support wall 36 and the second support wall 37 in the cam axial direction (Ax2).

[0055] The valve actuating mechanism 45 is a mech-

anism for opening and closing the exhaust valves 43 and 44 and the intake valves 41 and 42. The valve actuating mechanism 45 employs a mechanism of an SOHC (Single OverHead Camshaft) type. The valve actuating mechanism 45 employs a so-called variable valve timing actuating mechanism that switches timing of opening and closing the intake valves 41 and 42.

[0056] As shown in FIG. 5, the valve actuating mechanism 45 includes an exhaust rocker shaft 53 and an exhaust rocker arm 54. The exhaust rocker shaft 53 is disposed in parallel to the camshaft 29. The exhaust rocker shaft 53 is supported by the cylinder head 22. Detailedly, the exhaust rocker shaft 53 is supported by the first and second support walls 36 and 37.

[0057] The exhaust rocker arm 54 is supported by the exhaust rocker shaft 53 while being pivotable about the exhaust rocker shaft 53. The exhaust rocker arm 54 includes a cam contact portion 55. In the present preferred embodiment, the cam contact portion 55 is a roller and is rotatably supported by the exhaust rocker arm 54. The cam contact portion 55 makes contact with the exhaust cam 295.

[0058] The exhaust rocker arm 54 includes valve pressing portions 56 and 57. The valve pressing portions 56 and 57 press the first and second valve ends 430 and 440 while in contact therewith. Detailedly, the valve pressing portions 56 and 57 include a first pressing portion 56 and a second pressing portion 57. The first pressing portion 56 presses the first valve end 430. The second pressing portion 57 presses the second valve end 440.

[0059] When the cam contact portion 55 is pressed and lifted up by the exhaust cam 295, the exhaust rocker arm 54 pivots whereby the valve pressing portions 56 and 57 downwardly press the first and second valve ends 430 and 440. Accordingly, the first and second exhaust valves 43 and 44 are pressed and lowered down, whereby the exhaust port 223 is opened. When the cam contact portion 55 is not being pressed and lifted up by the exhaust cam 295, the first and second exhaust valves 43 and 44 are upwardly pressed by the first and second valve springs 48 and 49, whereby the exhaust port 223 is closed.

[0060] The valve actuating mechanism 45 includes an intake rocker shaft 58 and an intake rocker arm 59. The intake rocker shaft 58 is disposed in parallel to the camshaft 29. The intake rocker shaft 58 is supported by the cylinder head 22. Detailedly, the intake rocker shaft 58 is supported by the first support wall 36 and the second support wall 37.

[0061] As shown in FIG. 4, the intake rocker arm 59 includes a first rocker arm 62 and a second rocker arm 63. The first and second rocker arms 62 and 63 are provided separately from each other. The first and second rocker arms 62 and 63 are disposed in alignment in the cam axial direction (Ax2). The first and second rocker arms 62 and 63 are supported by the intake rocker shaft 58 while being pivotable about the intake rocker shaft 58.

[0062] The first rocker arm 62 includes a first cam contact portion 64. In the present preferred embodiment, the first cam contact portion 64 is a roller and is rotatably supported by the first rocker arm 62. The first cam contact portion 64 makes contact with the first intake cam 293.

[0063] The first rocker arm 62 includes intake valve pressing portions 66 and 67. The intake valve pressing portions 66 and 67 press the first valve end of the first intake valve 41 and the second valve end 420 of the second intake valve 42 while in contact therewith. Detailedly, the intake valve pressing portions 66 and 67 include a first pressing portion 66 and a second pressing portion 67. The tip of the first pressing portion 66 is opposed to the first valve end of the first intake valve 41. The tip of the second pressing portion 67 is opposed to the second valve end 420 of the second intake valve 42.

[0064] The second rocker arm 63 includes a second cam contact portion 65. In the present preferred embodiment, the second cam contact portion 65 is a roller and is rotatably supported by the second rocker arm 63. The second cam contact portion 65 makes contact with the second intake cam 294.

[0065] The valve actuating mechanism 45 includes an urging member 68. The urging member 68 urges the second rocker arm 63 in a direction that the second cam contact portion 65 is pressed onto the camshaft 29. In the present preferred embodiment, the urging member 68 is a coil spring.

[0066] The valve actuating mechanism 45 includes a switch pin member 60 and an actuator 61. The switch pin member 60 is movable in the cam axial direction (Ax2), and is provided to be movable to a first position and a second position. As shown in FIG. 2, when moved to the first position, the switch pin member 60 is disposed in both a hole 620 provided in the first rocker arm 62 and a hole 630 provided in the second rocker arm 63. Accordingly, the switch pin member 60 couples the first rocker arm 62 and the second rocker arm 63 to each other, whereby the first and second rocker arms 62 and 63 pivot unitarily with each other. Therefore, when the switch pin member 60 is located in the first position, the first and second intake valves 41 and 42 perform opening/closing motions in accordance with rotation of the second intake cam 294.

[0067] When moved to the second position, the switch pin member 60 is disposed in the hole 620 of the first rocker arm 62 without being disposed in the hole 630 of the second rocker arm 63. Accordingly, when moved to the second position, the switch pin member 60 decouples the first rocker arm 62 and the second rocker arm 63 from each other, whereby the first and second rocker arms 62 and 63 pivot independently from each other. Therefore, when the switch pin member 60 is located in the second position, the first and second intake valves 41 and 42 perform opening/closing motions in accordance with rotation of the first intake cam 293.

[0068] The actuator 61 is an electromagnetic solenoid. When electrically supplied, the actuator 61 presses the switch pin member 60 in the cam axial direction (Ax2),

whereby the position of the switch pin member 60 is switched from the second position to the first position. An elastic member 69 is disposed in the hole 620 of the first rocker arm 62. The elastic member 69 urges the switch pin member 60 in a direction from the first position to the second position. When the actuator 61 is stopped being electrically supplied, the position of the switch pin member 60 is returned to the second position from the first position by the elastic force of the elastic member 69.

[0069] Next, a breather plate 70 will be explained in detail. As shown in FIG. 2, the breather plate 70 is attached to the cylinder head 22. The breather plate 70 is disposed above the valve actuating mechanism 45. In a condition that the engine 5 is installed in the straddled vehicle 1, the breather plate 70 is disposed to slant forward and downward.

[0070] The breather plate 70 and a ceiling wall 38 of the cylinder head 22 form a breather compartment Bc1 therebetween. The ceiling wall 38 is disposed above the breather plate 70. The breather plate 70 is disposed between the ceiling wall 38 and the valve actuating mechanism 45. The breather plate 70 and the ceiling wall 38 overlap the valve actuating mechanism 45 as seen from the cylinder axial direction (Ax1).

[0071] FIG. 6 is a perspective view of the head cover 28 and the breather plate 70. As shown in FIG. 6, the breather plate 70 is attached to the head cover 28. FIG. 7 is a perspective view of the breather plate 70. FIG. 8 is a side view of the breather plate 70. FIG. 9 is a perspective view showing positional arrangement of the breather plate 70 and components in the interior of the cylinder head 22.

[0072] As shown in FIGS. 6 to 9, the breather plate 70 includes a bulged portion 71. The bulged portion 71 protrudes downward. In other words, the bulged portion 71 has a shape protruding from a cylinder 21-side surface 701 toward the valve actuating mechanism 45. As shown in FIG. 9, the bulged portion 71 has a shape recessed downward from a breather compartment Bc1-side surface 702. The bulged portion 71 straightly extends. In the condition that the engine 5 is installed in the straddled vehicle 1, the bulged portion 71 is disposed to slant forward and downward. In other words, the bulged portion 71 is disposed to downwardly slant from the camshaft 29 toward the first valve end 430, The bulged portion 71 is integrally provided on the breather plate 70. For example, the bulged portion 71 is formed on the breather plate 70 by stamping.

[0073] As shown in FIG. 7, the breather plate 70 includes a plurality of through holes 703. A plurality of bolts 73 shown in FIG. 6 are inserted into the plurality of through holes 703, respectively, whereby the breather plate 70 is fixed to the head cover 28. It should be noted that the breather plate 70 may be fixed to the head cover 28 by fixation means other than the bolts.

[0074] FIG. 10 is a view showing positional arrangement of the cylinder head 22 and the breather plate 70 as seen from the cylinder axial direction (Ax1). As shown in FIG. 10, the breather plate 70 overlaps the valve actuating mechanism 45 as seen from the cylinder axial direction (Ax1). Detailedly, the breather plate 70 overlaps the intake rocker arm 59 as seen from the cylinder axial direction (Ax1). The breather plate 70 overlaps the exhaust rocker arm 54 as seen from the cylinder axial direction (Ax1).

[0075] The breather plate 70 overlaps the first support wall 36 as seen from the cylinder axial direction (Ax1). The breather plate 70 overlaps the second support wall 37 as seen from the cylinder axial direction (Ax1). The breather plate 70 overlaps the exhaust valves 43 and 44 as seen from the cylinder axial direction (Ax1). The breather plate 70 overlaps the intake valve 42 as seen from the cylinder axial direction (Ax1). The breather plate 70 overlaps the sprocket 31 as seen from the cylinder axial direction (Ax1).

[0076] The bulged portion 71 is located upward of the first valve end 430 and extends in the up-and-down direction. The bulged portion 71 extends from the camshaft 29 toward the first valve end 430 of the first exhaust valve 43. The bulged portion 71 extends in a direction slanting with respect to the cam axis Ax2 as seen from the cylinder axial direction (Ax1). The bulged portion 71 extends in a direction that is oriented from the camshaft 29 to the first valve end 430 and is also oriented from the second support wall 37 to the first support wall 36.

[0077] The bulged portion 71 overlaps the valve actuating mechanism 45 as seen from the cylinder axial direction (Ax1). Detailedly, the bulged portion 71 overlaps the exhaust rocker arm 54 as seen from the cylinder axial direction (Ax1). The bulged portion 71 overlaps the camshaft 29 as seen from the cylinder axial direction (Ax1). The bulged portion 71 overlaps the second support wall 37 as seen from the cylinder axial direction (Ax1). The bulged portion 71 overlaps the intake rocker shaft 58 as seen from the cylinder axial direction (Ax1). The bulged portion 71 overlaps the exhaust rocker shaft 53 as seen from the cylinder axial direction (Ax1).

[0078] The bulged portion 71 includes a first end 711 and a second end 712. The first end 711 is the lower end of the bulged portion 71. The second end 712 is the upper end of the bulged portion 71. The first end 711 is closer to the first valve end 430 than the second end 712. The first end 711 is located forward of the camshaft 29 as seen from the cylinder axial direction (Ax1). The first end 711 is more separated from the camshaft 29 than the exhaust rocker shaft 53 in the back-and-forth direction. The first end 711 is located forward of the exhaust rocker shaft 53 as seen from the cylinder axial direction (Ax1). The first end 711 is closer to the first valve end 430 than the second end 712 in the back-and-forth direction. The first end 711 is located on the right side (the second directional side) of the second valve end 440.

[0079] The second end 712 is located backward of the camshaft 29 as seen from the cylinder axial direction (Ax1). The second end 712 is located backward of the intake rocker shaft 58. The first end 711 is closer to the

first valve end 430 than the second end 712 in the cam axial direction (Ax2).

[0080] As shown in FIG. 7, the breather plate 70 includes a protruding portion 72 that protrudes downward. The protruding portion 72 is located on the extending direction of the bulged portion 71 with respect to the bulged portion 71. In other words, the protruding portion 72 is located on an imaginary line extended from the bulged portion 71. The protruding portion 72 is formed by downwardly bending portion of the breather plate 70, and has a downwardly tapered shape.

[0081] As shown in FIG. 9, the protruding portion 72 is disposed above the first valve end 430. The protruding portion 72 overlaps the first exhaust valve 43 as seen from the cylinder axial direction (Ax1). The protruding portion 72 overlaps the second exhaust valve 44 as seen from the cylinder axial direction (Ax1). A lower end 720 of the protruding portion 72 is located immediately above the first valve end 430.

[0082] FIG. 11 is a diagram of the head cover 28 seen from the head body 27 side. FIG. 12 is a cross-sectional view of FIG. 11 taken along XII-XII. As shown in FIGS. 11 and 12, the head cover 28 includes a wall portion 74 that forms a breather gas pathway BP1 in the interior of the breather compartment Bc1. The wall portion 74 downwardly protrudes from the ceiling wall 38 and extends toward the breather plate 70. The breather plate 70 overlaps the wall portion 74 as seen from the cylinder axial direction (Ax1).

[0083] As shown in FIG. 12, a seal member 75 is disposed between the breather plate 70 and the wall portion 74. The seal member 75 seals between the breather plate 70 and the distal end of the wall portion 74. The seal member 75 is also disposed between the bulged portion 71 and the wall portion 74.

[0084] As shown in FIG. 11, the wall portion 74 is provided such that the breather gas pathway Bp1 has a shape bending plural times between a gas inlet Bp2 and a gas outlet Bp3. Detailedly, the breather gas pathway Bp1 includes a first bending pathway C1, a second bending pathway C2 and a third bending pathway C3. The wall portion 74 includes inner sidewalls 76i, 77i and 78i and outer sidewalls 76o, 77o and 78o. The inner sidewalls 76i, 77i and 78i are located inside the bending portions of the respective bending pathways C1 to C3. The outer sidewalls 76o, 77o and 78o are located outside the bending portions of the respective bending pathways C1 to C3. The outer sidewalls 76o, 77o and 78o are partitions between the breather compartment Bc1 and a space outside the breather compartment Bc1 in the interior of the head cover 28.

[0085] The bulged portion 71 overlaps portion of the wall portion 74 as seen from the cylinder axial direction (Ax1). Detailedly, the bulged portion 71 overlaps the inner sidewall 77i of the second bending pathway C2 as seen from the cylinder axial direction (Ax1). It should be noted that the bulged portion 71 does not overlap the outer sidewall 77o of the second bending pathway C2 as seen from the cylinder axial direction (Ax1). The bulged portion 71 does not overlap the outer sidewall 76o of the first bending pathway C1 as seen from the cylinder axial direction (Ax1). The bulged portion 71 does not overlap the outer sidewall 78o of the third bending pathway C3 as seen from the cylinder axial direction (Ax1).

[0086] As shown in FIG. 9, in the engine 5 according to the preferred embodiment explained above, oil attached to the breather plate 70 downwardly flows along the surface of the breather plate 70 by the weight thereof (Arrow A1). Portion of the oil flowing along the surface of the breather plate 70 is received by the bulged portion 71, and flows toward the first end 711 along the bulged portion 71 (Arrow A2). The oil flows from the bulged portion 71 along the protruding portion 72 (Arrow A3), downwardly drips from the protruding portion 72 toward the first valve end 430 of the first exhaust valve 43 (Arrow A4), and is supplied to the first valve end 430. Therefore, even when the first support wall 36 is disposed in adjacent to the first valve end 430, the oil can be sufficiently supplied to the first valve end 430. Accordingly, the cylinder head 22 can be made compact, and lubrication properties of the first exhaust valve 43 can be enhanced. Additionally, the oil flowing along the bulged portion 71 downwardly drips from the protruding portion 72. Hence, the oil can be efficiently supplied to the first valve end 430.

[0087] The bulged portion 71 is formed on the cylinder 21-side surface 701 of the breather plate 70 by stamping or so forth. Therefore, the bulged portion 71 can be easily formed on the breather plate 70 at low cost. In this case, however, the recessed portion is formed on the breather compartment Bc1-side surface 702 of the breather plate 70. When a gap is herein produced between the recessed portion and the wall portion 74 forming the breather gas pathway Bp1, it is concerned that portion of breather gas leaks out through the gap and this results in degradation of oil separation function in the breather gas pathway Bp1. However, in the present preferred embodiment, the seal member 75 is disposed between the bulged portion 71 and the wall portion 74. Accordingly, leakage of breather gas through the gap can be inhibited, and degradation of oil separation function can be inhibited in the breather gas pathway Bp1.

[0088] As described above, even when the seal member 75 is provided between the wall portion 74 and the bulged portion 71, it is concerned that a slight gap remains and breather gas leaks out therethrough. However, in the present preferred embodiment, the bulged portion 71 is disposed in a position not overlapping the outer sidewalls 76o, 77o and 78o in the respective bending pathways C1 to C3. Breather gas, flowing through the breather gas pathway Bp1, is likely to collide with the outer sidewalls 76o, 77o and 78o located outside the bending portions in comparison with the inner sidewalls 76i, 77i and 78i located inside the bending portions. Oil becomes easily separated from breather gas by collision of breather gas with the wall portion 74. Hence, oil is likely to be separated from breather gas on the outer sidewalls

76o, 77o and 78o. Therefore, leakage of breather gas at the outer sidewalls 76o, 77o and 78o can be inhibited by disposing the bulged portion 71 in the position not overlapping the outer sidewalls 76o, 77o and 78o. Accordingly, degradation of oil separation function can be further effectively inhibited.

[0089] One preferred embodiment has been explained above. Alternatively, the engine 5 may be installed in a type of vehicle different from the straddled vehicle. The valve actuating mechanism 45 included in the engine 5 is not limited to be of an SOHC type and may be of another type such as a DOHC (Double Over-Head Camshaft) type. The valve actuating mechanism 45 is not limited to be a variable valve timing actuating mechanism, and may be of a type that is not provided with a mechanism of switching timing of opening and closing valves.

[0090] The number of exhaust valves is not limited to two, and alternatively, may be greater than two. The number of intake valves is not limited to two, and alternatively, may be greater than two.

[0091] The positional arrangement or shape of the wall portion 74 of the head cover 28 may be changed. Alternatively, the wall portion 74 of the head cover 28 may not be provided.

[0092] The shape of the breather plate 70 may be changed. For example, in the aforementioned preferred embodiment, the protruding portion 72 is formed by bending portion of the breather plate 70. However, a protruding portion may be formed by attaching another member such as a bolt to the breather plate 70. Alternatively, the protruding portion 72 may not be provided.

[0093] The positional arrangement or shape of the bulged portion 71 may be changed. For example, as with a first modification shown in FIG. 13, the bulged portion 71 may have a curved shape. Alternatively, as with a second modification shown in FIG. 14, the bulged portion 71 may have a shape bending at a plurality of positions. Yet alternatively, as with a third modification shown in FIG. 15, the entirety of the bulged portion 71 may be located forward (on the first directional side) of the cam axis Ax2. The entirety of the bulged portion 71 may be located on the right side (the second directional side) of the second exhaust valve 44. Further yet alternatively, as with a fourth modification shown in FIG. 16, the bulged portion 71 may have a bent shape angled forward in the first end 711. In this case, an oil sump can be formed in the bending portion of the bulged portion 71. Still yet alternatively, as with a fifth modification shown in FIG. 17, an angle of the bulged portion 71 with respect to the cam axial direction (Ax2) may be changed. As shown in FIG. 17, the entirety of the bulged portion 71 may be located forward (on the first directional side) of the cam axis Ax2. The entirety of the bulged portion 71 may be located on the left side (the opposite side of the second directional side) of the second exhaust valve 44.

[0094] The bulged portion 71 may be provided for guiding oil to the valve ends of the intake valves 41 and 42. The bulged portion 71 may be formed by attaching another member, which is separated from the breather plate 70, to the breather plate 70.

[0095] In the aforementioned preferred embodiment, one exhaust rocker arm 54 makes contact with two valve ends 430 and 440. However, two exhaust rocker arms may make contact with two valve ends on a one-to-one basis. This is also true of the intake rocker arm 59.

Claims

1. An engine comprising:

a cylinder (21);
a cylinder head (22) including at least one first and second port (222,223), the cylinder head (22) being disposed above the cylinder (21);
a camshaft (29) provided in the cylinder head (22);
a valve actuating mechanism (45) provided in the cylinder head (22);
at least one first valve (41,43) including a first valve end (430) to be pressed by the valve actuating mechanism (45), the first valve (41,43) is configured to open and close the first port (222,223);
at least one second valve (42,44) including a second valve end (440) to be pressed by the valve actuating mechanism (45), the second valve (42,44) being disposed in alignment with the first valve (41,43) in a direction of an axis (Ax2) of the camshaft (29), the second valve (42,44) is configured to open and close the second port (222,223); and
a breather plate (70) disposed above the valve actuating mechanism (45), wherein an axis (Ax1) of the cylinder (21) slants at an angle closer to vertical than to horizontal,
the cylinder head (22) includes
a first support wall (36) disposed closer to the first valve (41,43) than to the second valve (42,44), the first support wall (36) supporting the valve actuating mechanism (45).
a second support wall (37) disposed away from the first support wall (36) in the direction of the axis (Ax2) of the camshaft (29), the second support wall (37) supporting the valve actuating mechanism (45), and
a ceiling wall (38) disposed above the breather plate (70),
the valve actuating mechanism (45) includes
a rocker shaft (53,58) supported by the first support wall (36) and the second support wall (37), and
a rocker arm (54,59) supported by the rocker shaft (53,58), the rocker arm (54,59) making contact with the first valve end (430),
the breather plate (70) together with the ceiling

wall (38) forms a breather compartment (Bc1) therebetween,
the breather plate (70) overlaps the valve actuating mechanism (45) as seen from a direction of the axis (Ax1) of the cylinder (21),
the breather plate (70) includes a bulged portion (71) protruding downward,
the bulged portion (71) is located upward of the first valve end (430),
the bulged portion (71) extending in an up-and-down direction, and
a lower end of the bulged portion (71) is closer to the first valve end (430) than an upper end of the bulged portion (71).

2. The engine according to claim 1, wherein the bulged portion (71) overlaps the camshaft (29) as seen from the direction of the axis (Ax1) of the cylinder (21).

3. The engine according to claim 1 or 2, wherein the bulged portion (71) overlaps the camshaft (29), the rocker arm (54,59) and the rocker shaft (53,58) as seen from the direction of the axis (Ax1) of the cylinder (21).

4. The engine according to any of claims 1 to 3, wherein the breather plate (70) includes a protruding portion (72) protruding downward, and
the protruding portion (72) is located on an extending direction of the bulged portion (71) with respect to the bulged portion (71), the protruding portion (72) being disposed above the first valve end (430).

5. The engine according to claim 4, wherein a lower end of the protruding portion (72) is located immediately above the first valve end (430).

6. The engine according to claim 4 or 5, wherein the protruding portion (72) is formed by downwardly bending portion of the breather plate (70), the protruding portion (72) having a downwardly tapered shape.

7. The engine according to any of claims 1 to 6, wherein the bulged portion (71) straightly extends.

8. The engine according to any of claims 1 to 7, wherein the first valve (41,43) is disposed away from the camshaft (29) in a first direction, the first direction intersecting the axis (Ax1) of the cylinder (21) and the axis (Ax2) of the camshaft (29), and
at least portion of the first valve end (430) overlaps the first support wall (36) as seen from the first direction.

9. The engine according to any of claims 1 to 8, wherein the bulged portion (71) slants with respect to the axis (Ax2) of the camshaft (29) and extends in a direction toward the first valve end (430) as seen from the direction of the axis (Ax1) of the cylinder (21).

10. The engine according to any of claims 1 to 9, wherein the cylinder head (22) includes a wall portion (74), the wall portion (74) protruding from the ceiling wall (38) toward the breather plate (70),
the wall portion (74) forms a breather gas pathway (Bp1) in an interior of the breather compartment (Bc1), and
the bulged portion (71) overlaps the wall portion (74) as seen from the direction of the axis (Ax1) of the cylinder (21).

11. The engine according to claim 10, wherein the bulged portion (71) has a shape downwardly recessed from a breather compartment (Bc1)-side surface (702) of the breather plate (70), and
the cylinder head (22) further includes a seal member (75), the seal member (75) being disposed between the bulged portion (71) and the wall portion (74).

12. The engine according to claim 10 or 11, wherein the breather gas pathway (Bp1) includes a bending pathway {C1,C2,C3},
the wall portion (74) includes
an inner sidewall (76i,77i,78i) located inside a bending portion of the bending pathway (C1,C2,C3), and
an outer sidewall (76o,77o,78o) located outside the bending portion of the bending pathway (C1,C2,C3), and
the bulged portion (71) is disposed in a position not overlapping the outer sidewall (76o,77o,78o) as seen from the direction of the axis (Ax1) of the cylinder (21).

13. The engine according to any of claims 1 to 12, wherein the first valve (41,43) is disposed away from the camshaft (29) in a first direction, the first direction intersecting the axis (Ax1) of the cylinder (21) and the axis (Ax2) of the camshaft (29), and
the lower end of the bulged portion (71) is closer to the first valve end (430) than the upper end of the bulged portion (71) in the first direction.

14. The engine according to any of claims 1 to 13, wherein the first valve (41,43) is disposed away from the camshaft (29) in a first direction, the first direction intersecting the axis (Ax1) of the cylinder (21) and the axis (Ax2) of the camshaft (29), and
the lower end of the bulged portion (71) is further away from the camshaft (29) than from the rocker arm (54,59) in the first direction.

15. The engine according to any of claims 1 to 14, wherein the lower end of the bulged portion (71) is closer to the first valve end (430) than the upper end of the

bulged portion (71) in the direction of the axis (Ax2) of the camshaft (29).

16. The engine according to any of claims 1 to 15, wherein the first valve end (430) is located on a second directional side of the second valve end (440), the second directional side being defined as one directional side of the direction of the axis (Ax2) of the camshaft (29), and
the lower end of the bulged portion (71) is located on the second directional side of the second valve end (440) in the direction of the axis (Ax2) of the camshaft (29).

17. A vehicle comprising the engine according to any of claims 1 to 16.

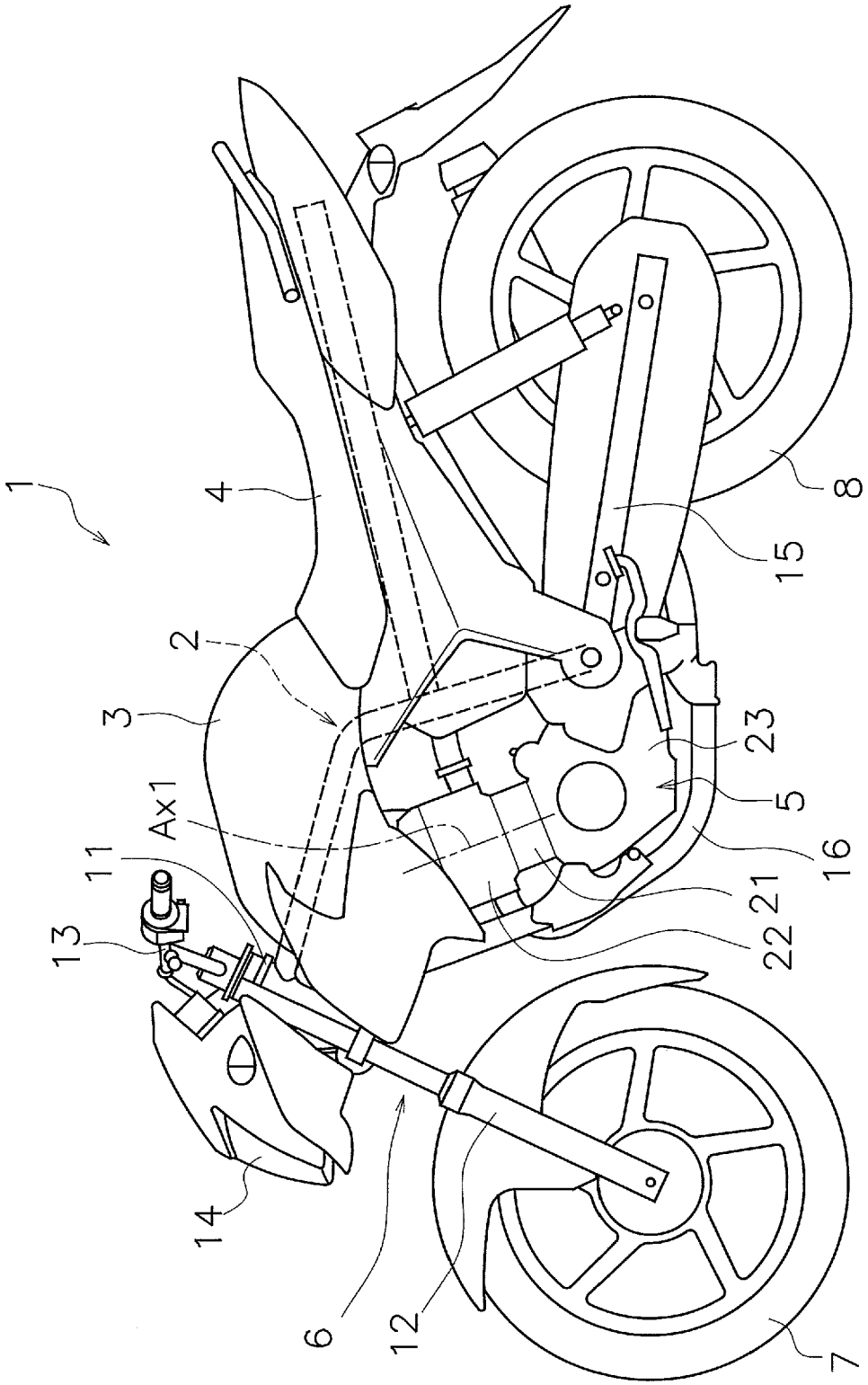
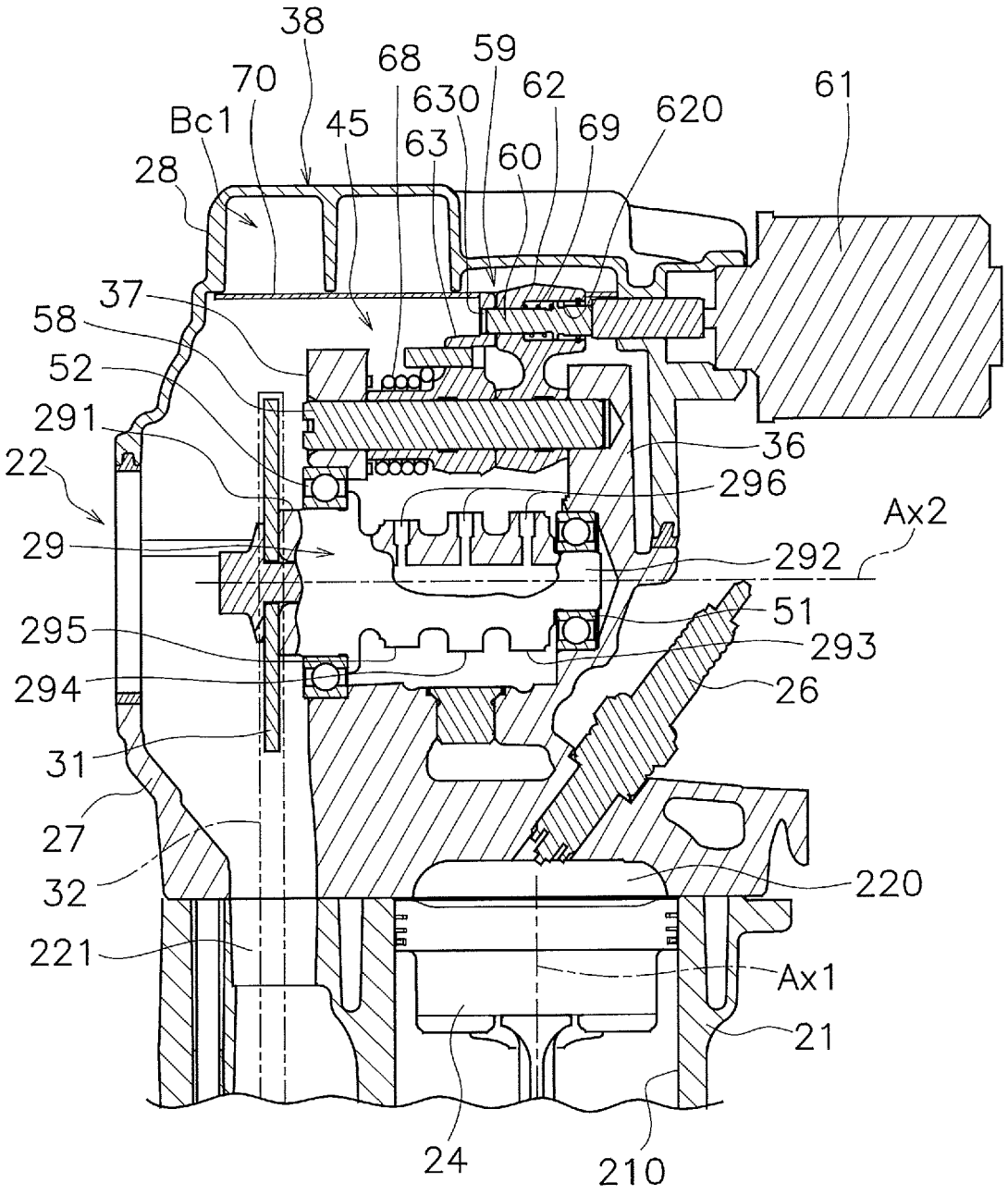


FIG. 1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630
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61
Bc1
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69
620
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36
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Ax2
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26
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220
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Ax1
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24
210

FIG. 2

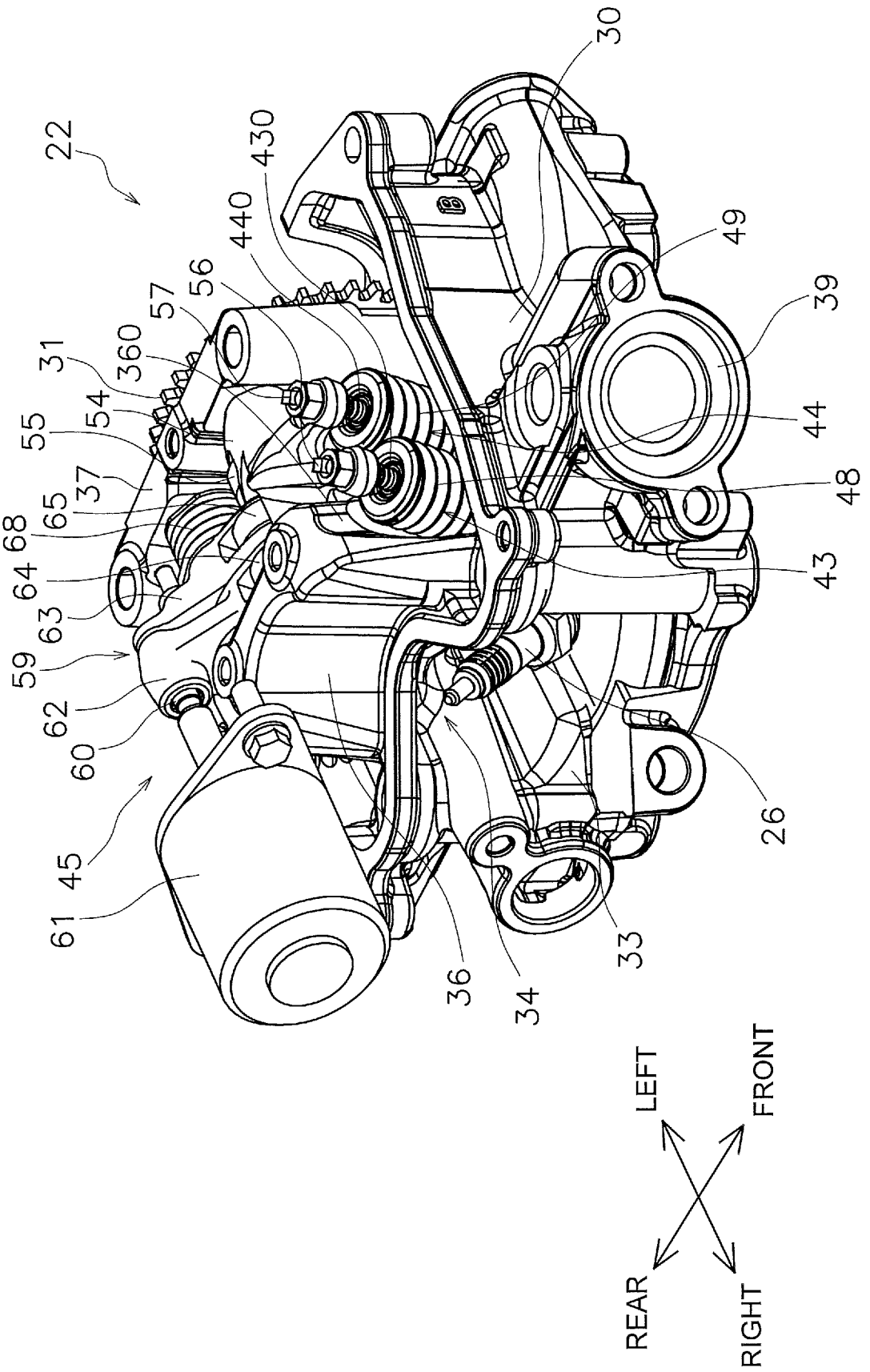
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FIG. 3

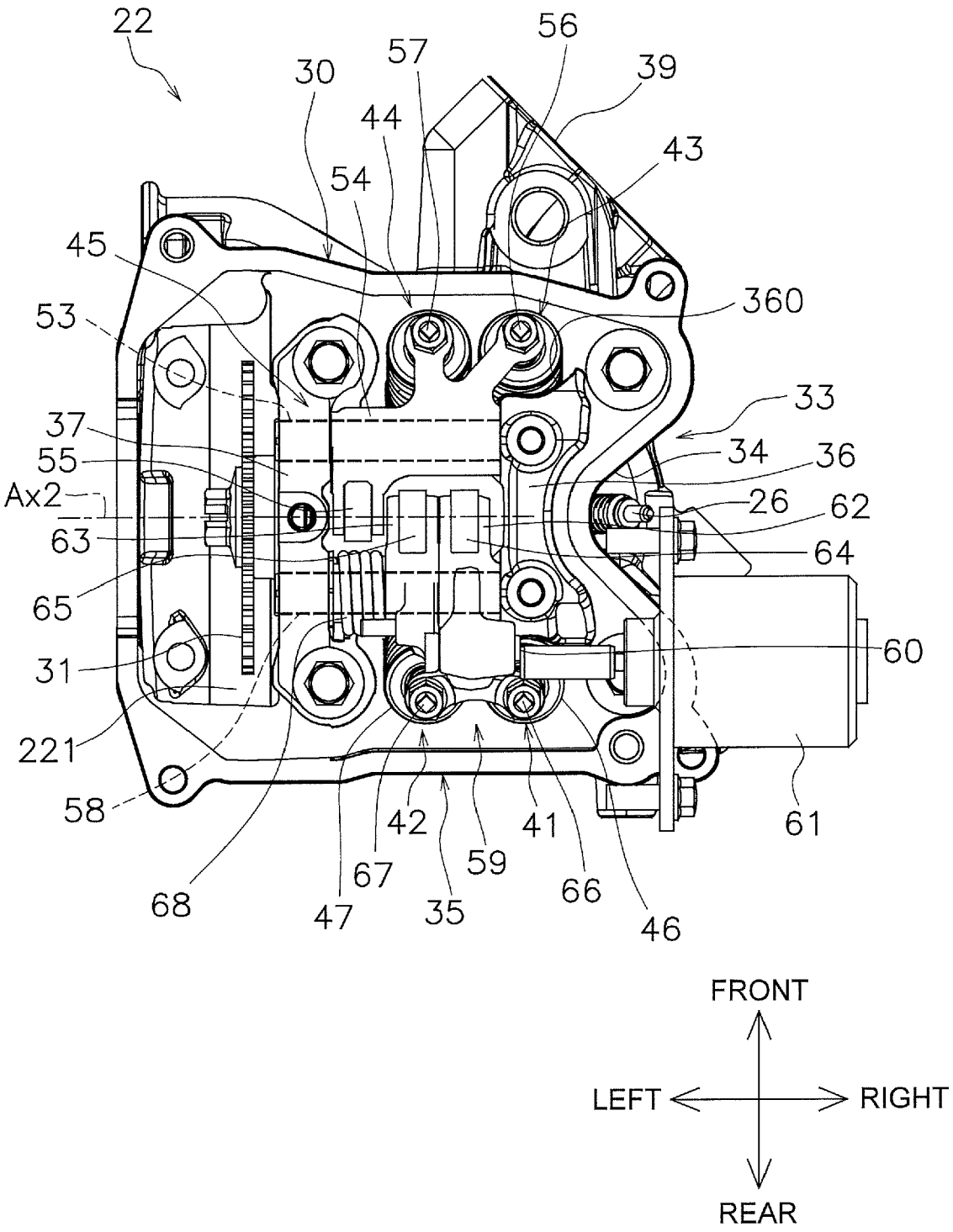
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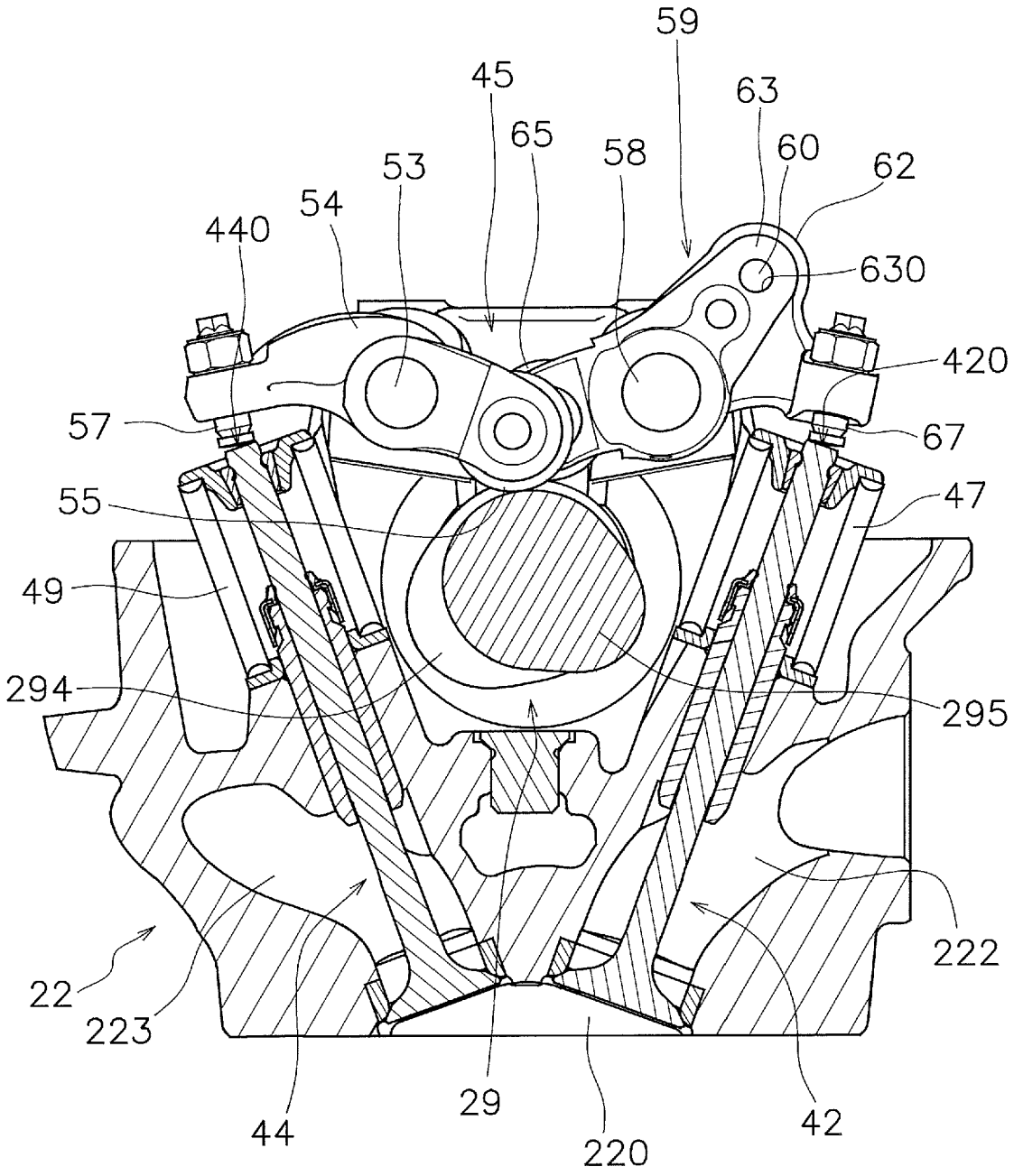
FIG. 4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62
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FIG. 5

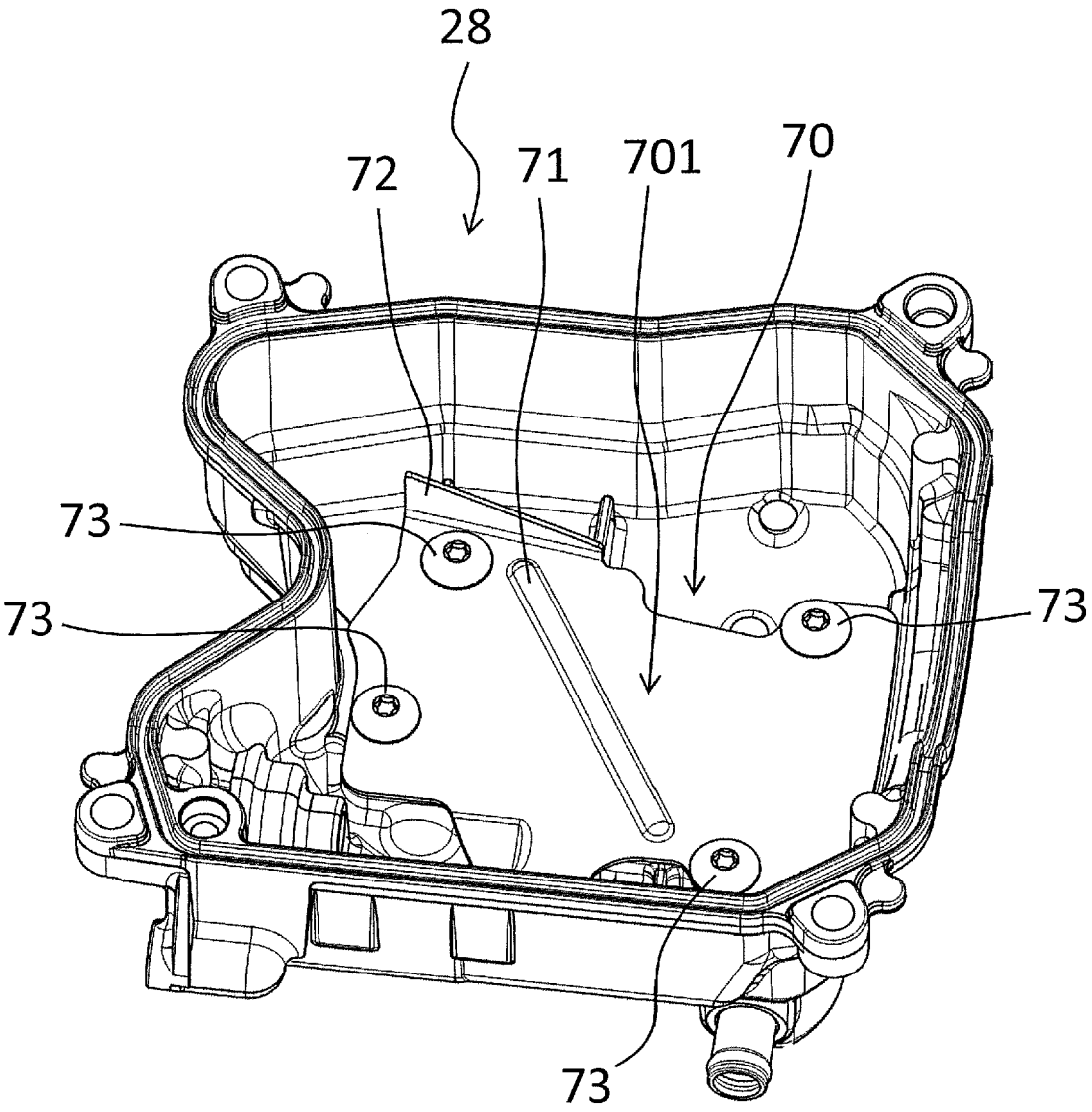


FIG. 6

FIG. 7

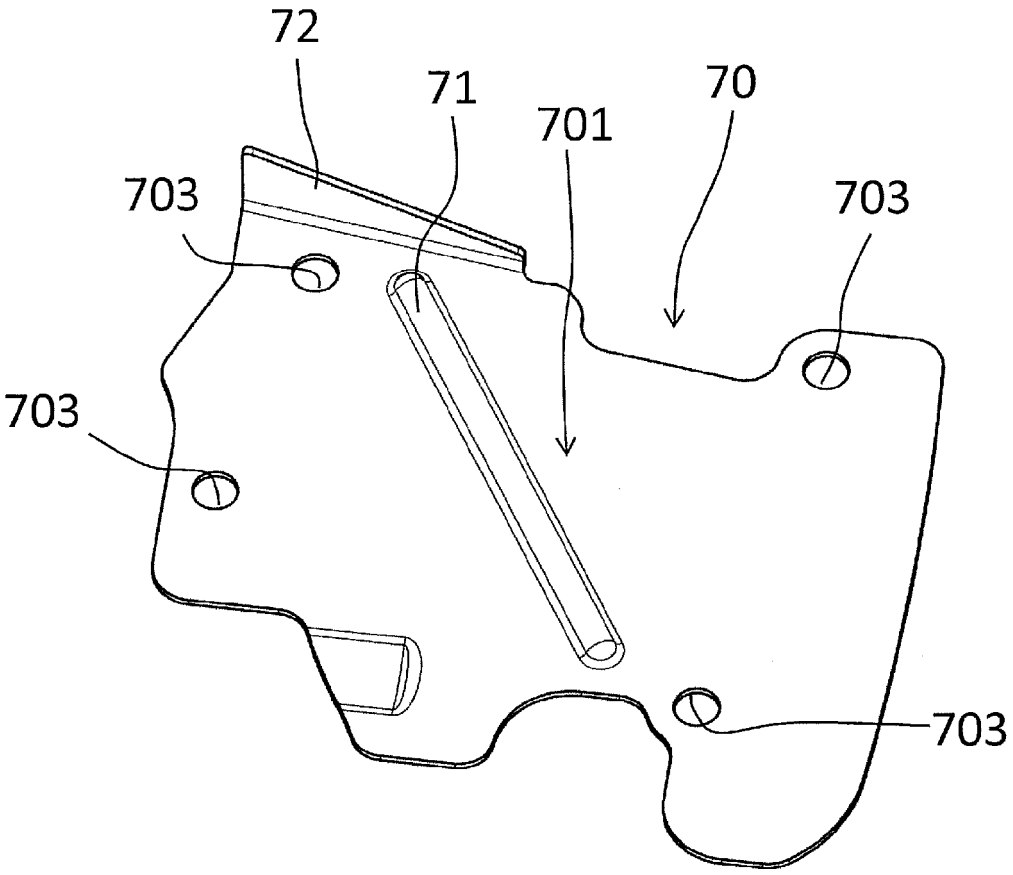
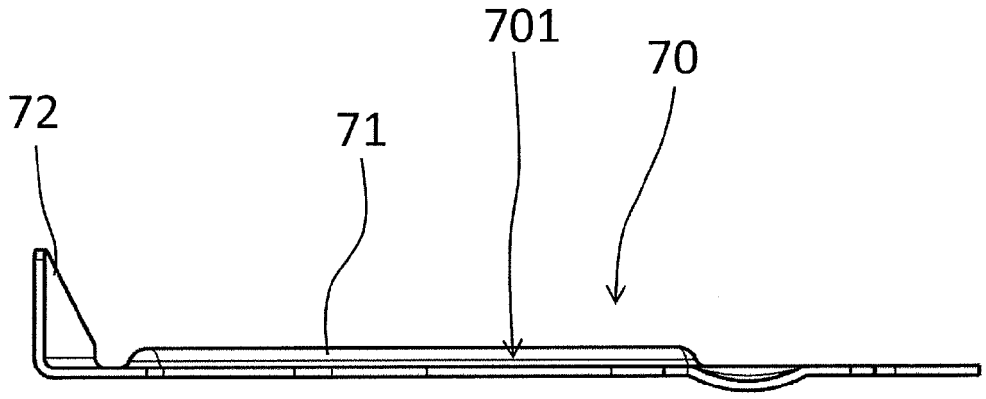


FIG. 8



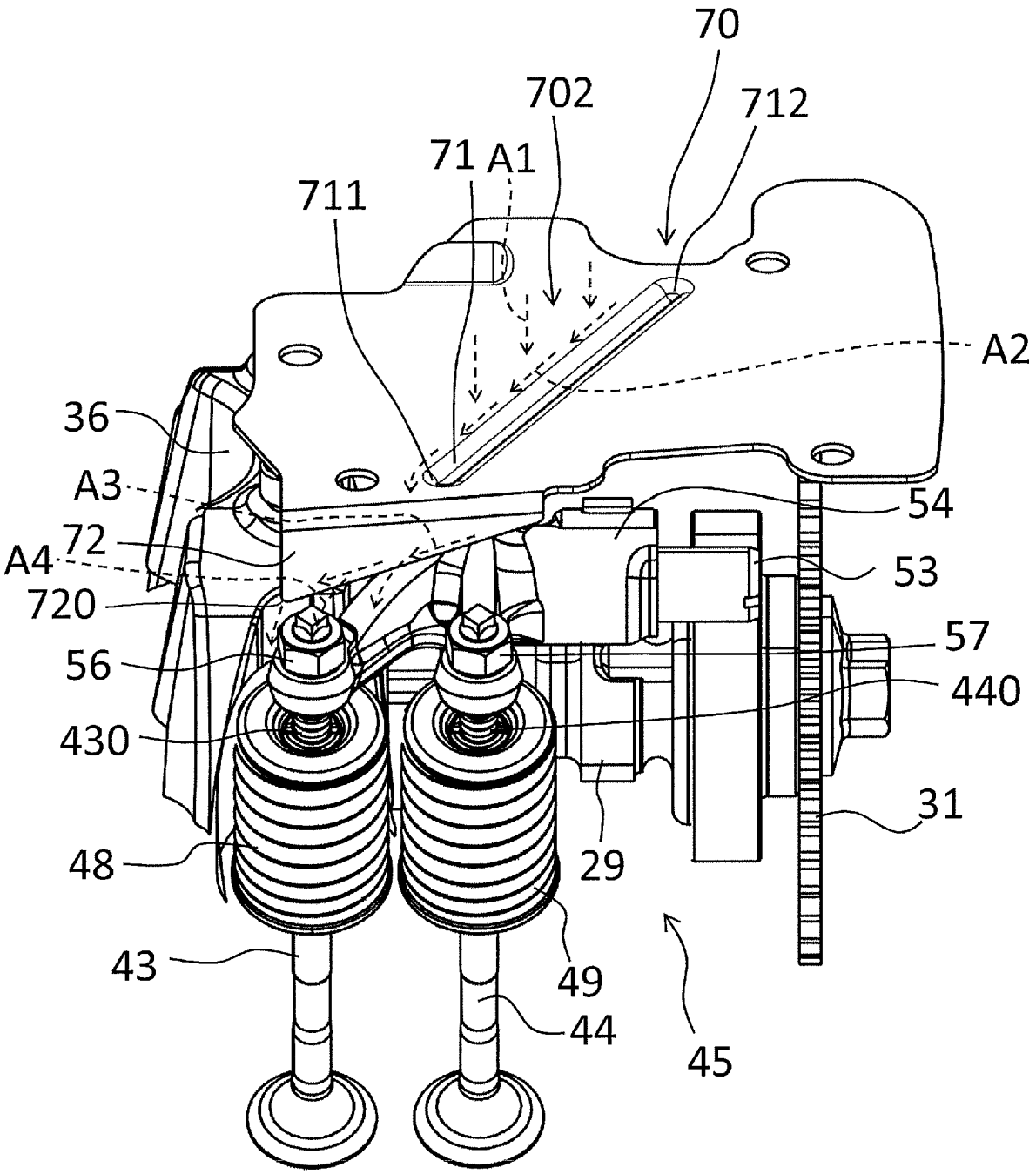

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FIG. 9

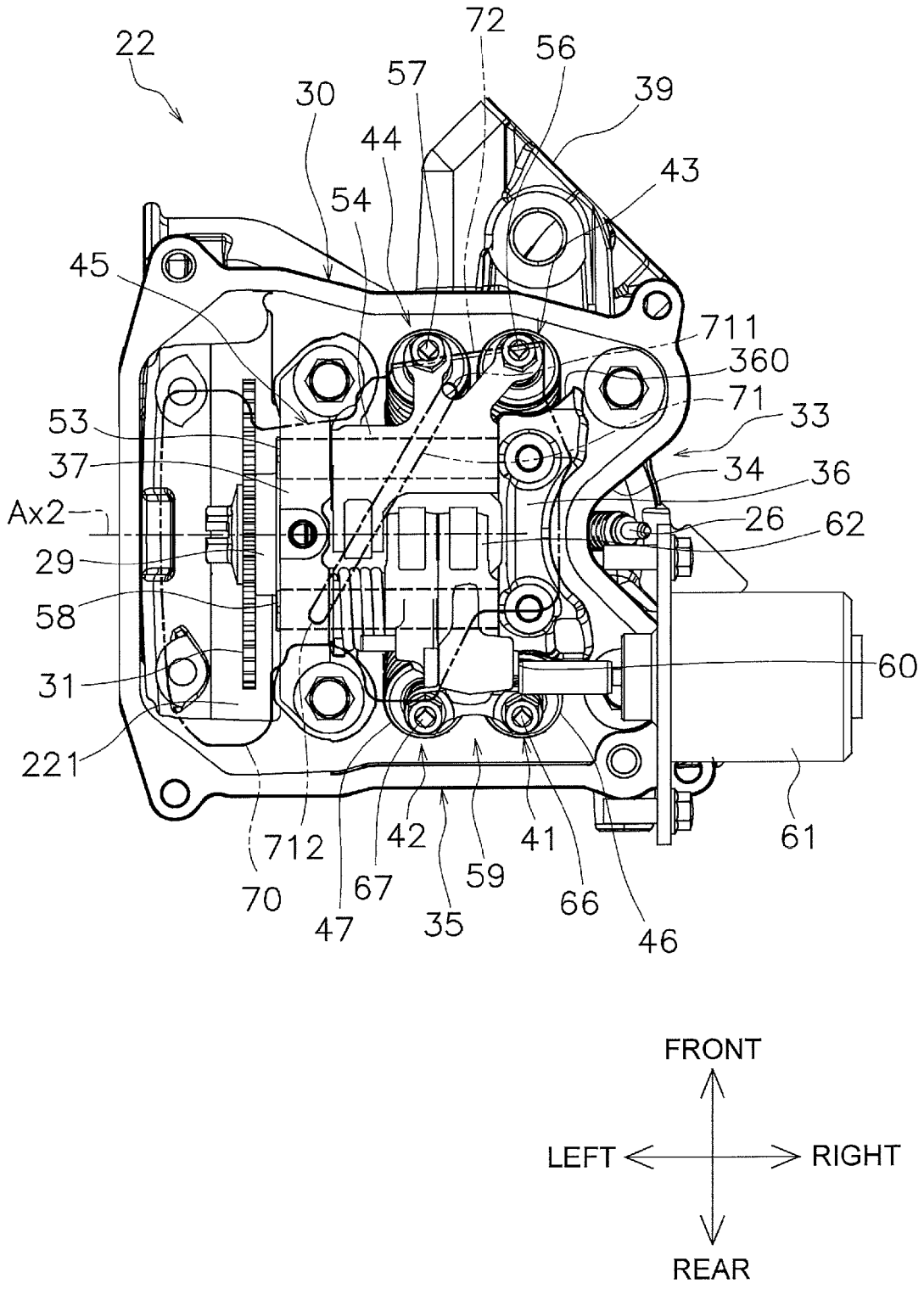
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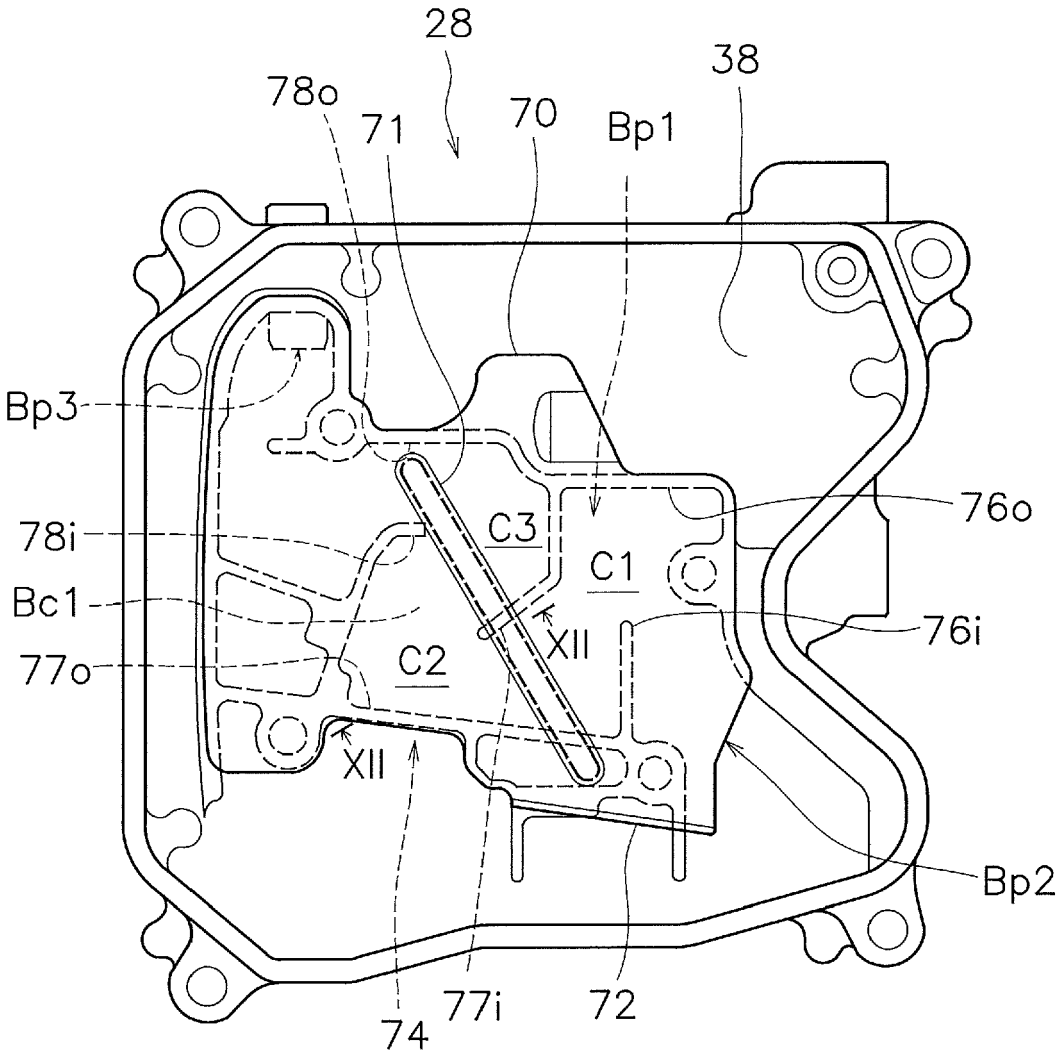
FIG. 10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78o
71
70
Bp1
38
Bp3
78i
Bc1
77o
C3
C1
C2
XII
XII
76o
76i
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74
77i
72

FIG. 11

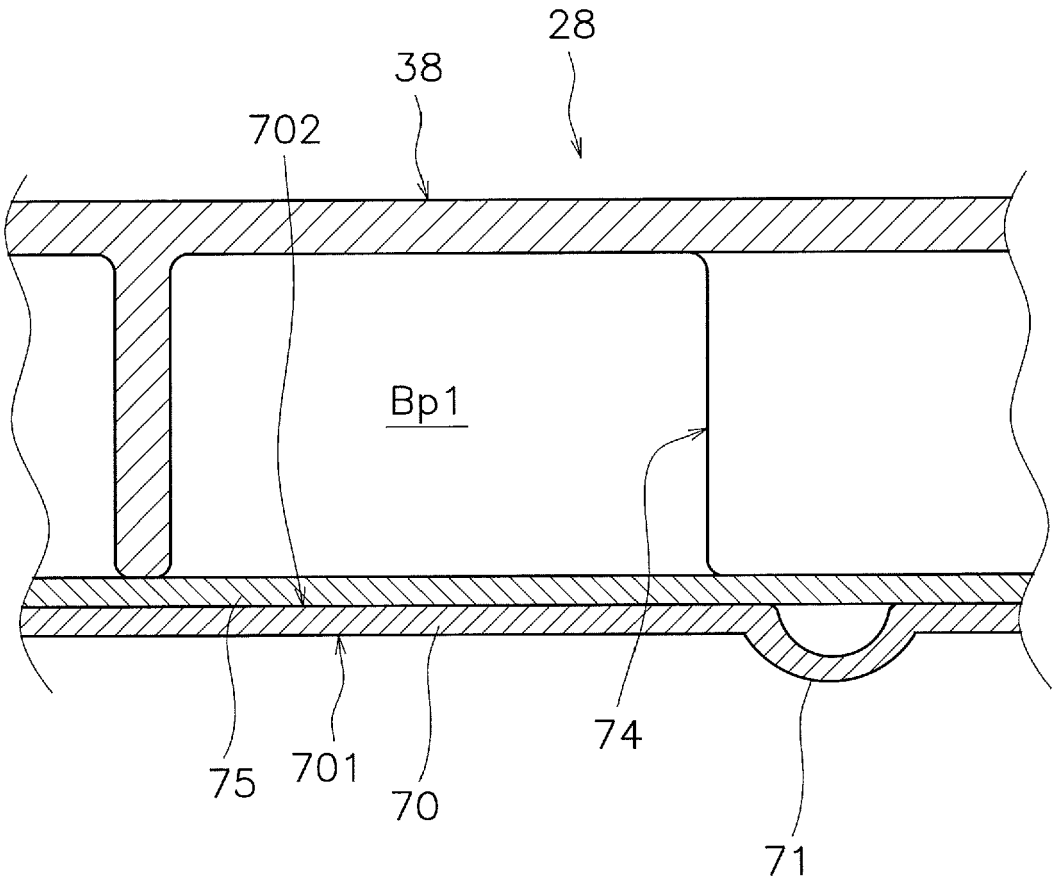

FIG. 12

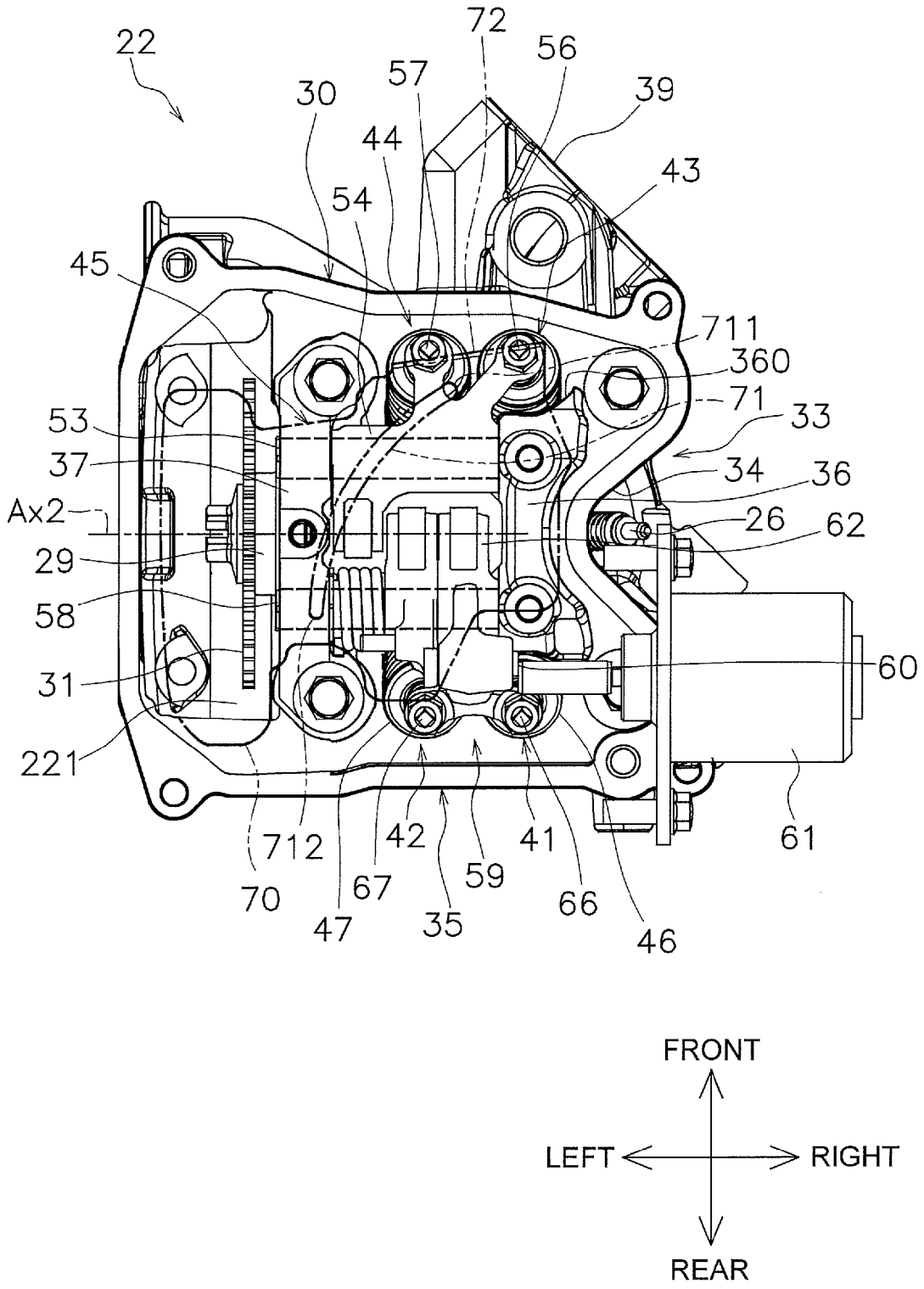
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FIG. 13

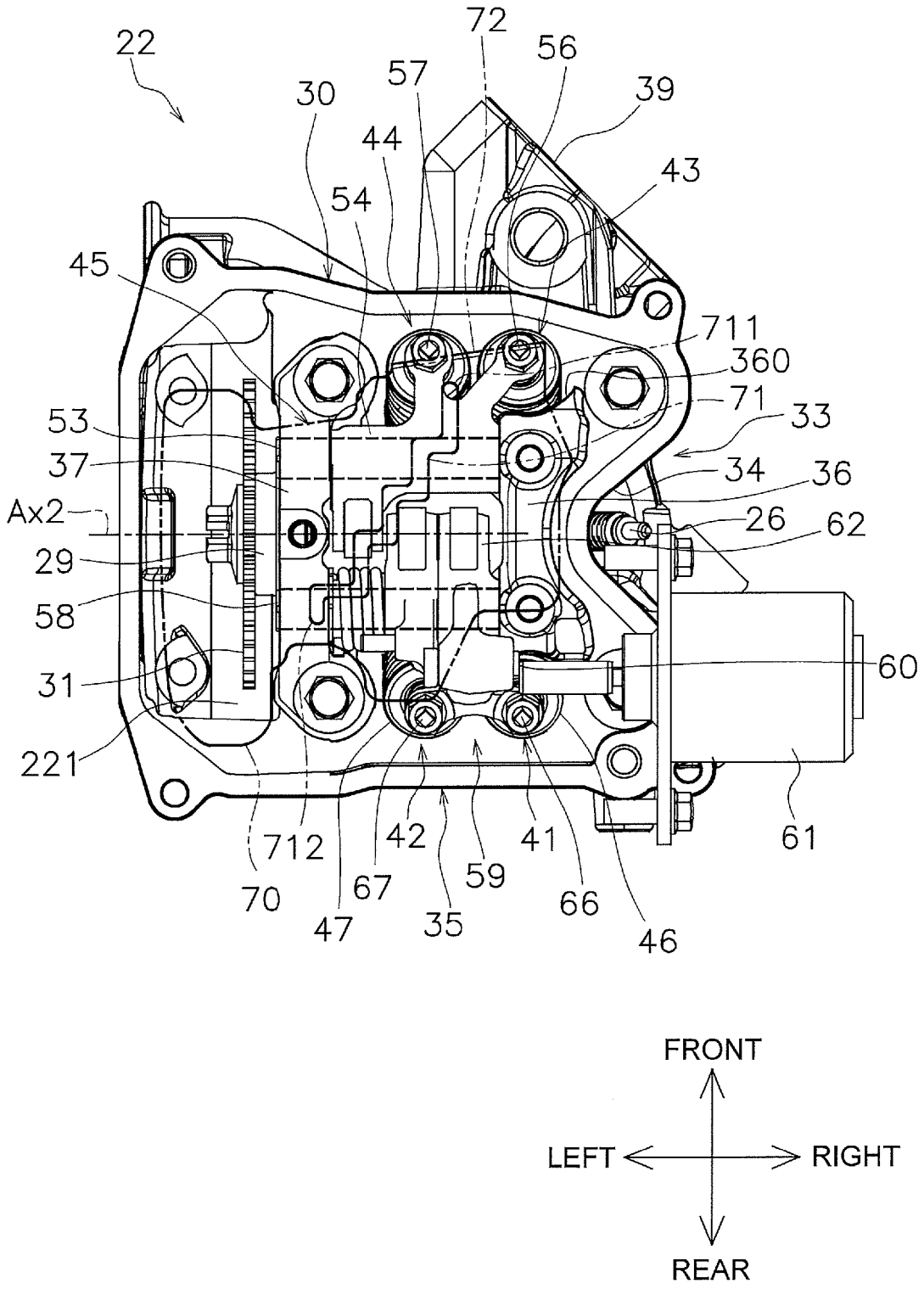
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FIG. 14

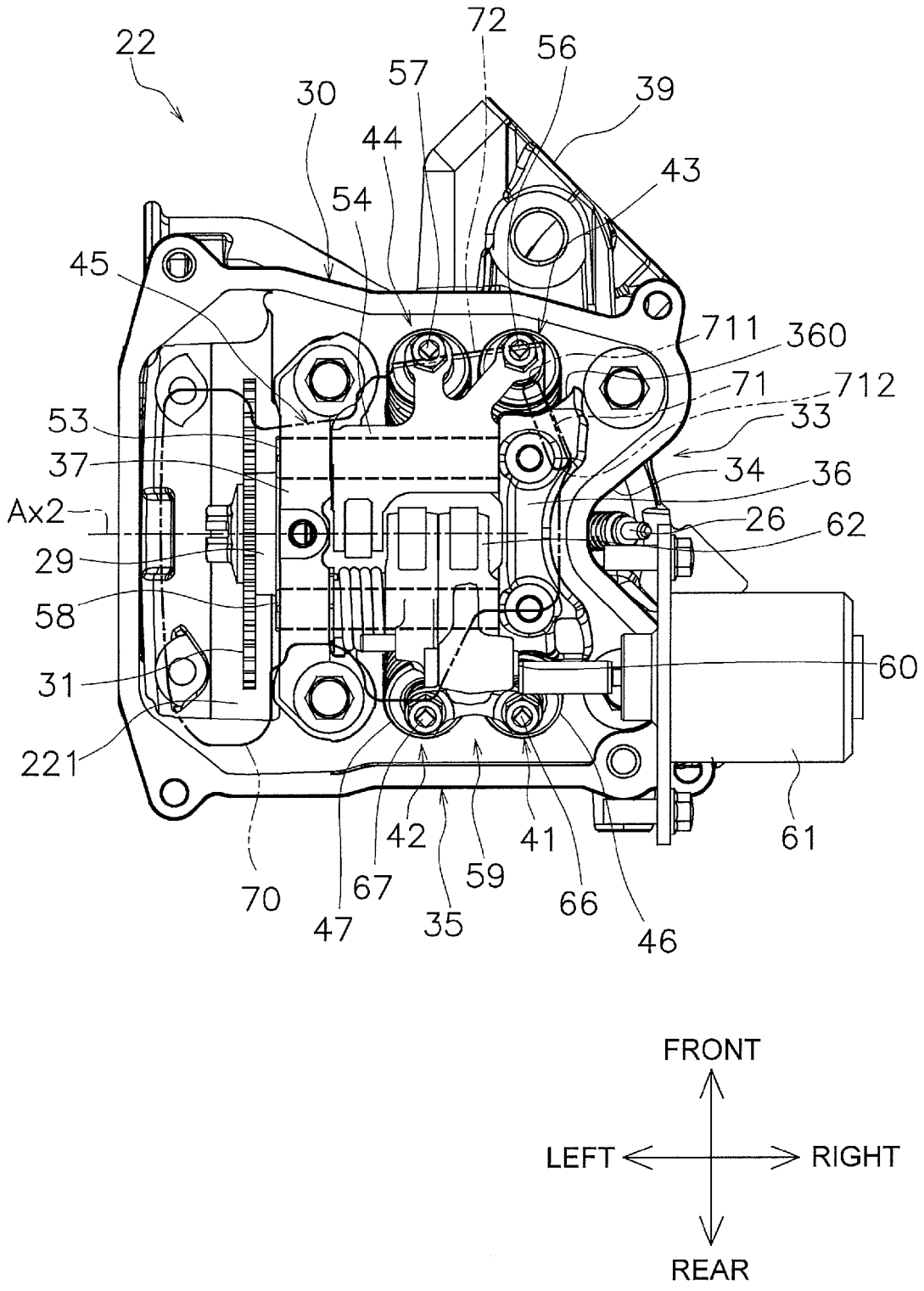
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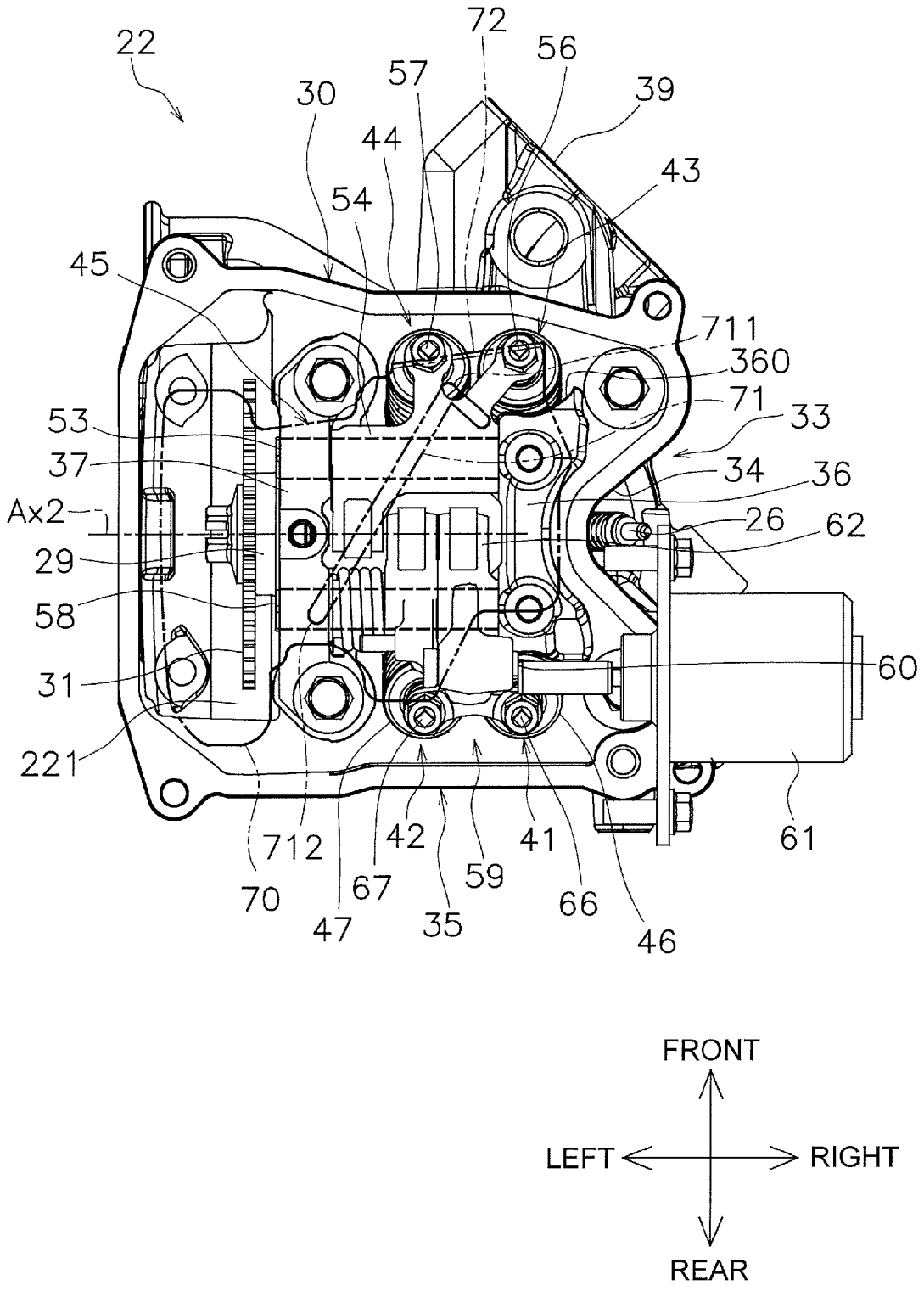
FIG. 15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FRONT
LEFT
RIGHT
REAR

FIG. 16

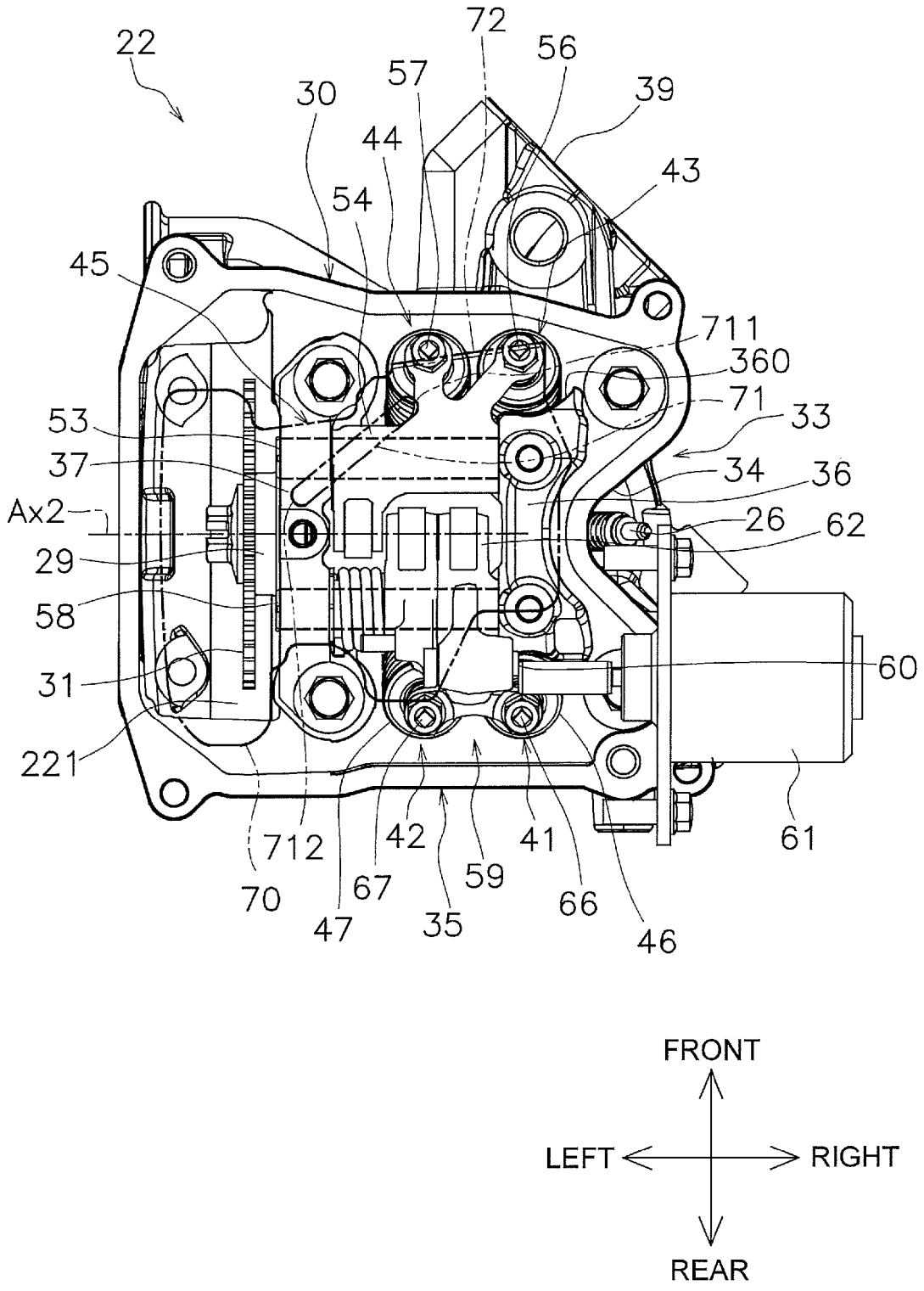
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FIG. 17

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 1839

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Place of search	Date of completion of the search	Examiner
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