(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 144 493 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
22.03.2017 Bulletin 2017/12

(21) Application number: **16786381.0**

(22) Date of filing: **20.04.2016**

(51) Int Cl.:
F01M 9/10 *(2006.01)* ***F01M 1/06*** *(2006.01)*
F01M 9/08 *(2006.01)*

(86) International application number:
PCT/JP2016/062539

(87) International publication number:
WO 2016/175104 (03.11.2016 Gazette 2016/44)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **28.04.2015 JP 2015091475**

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(54) **ENGINE FOR SADDLED VEHICLES AND SADDLED VEHICLE**

(57) A cylinder head attachment portion is provided on a cam holder and includes a bolt hole through which a bolt for fixing a cylinder head to a cylinder is inserted and through which a lubricant oil flows. A protrusion is integrated with the cam holder, protrudes from the cylinder head attachment portion toward an intake valve or an exhaust valve, and guides the lubricant oil flowing from an upper end of the bolt hole. A guide is provided separately from the protrusion and extends toward the intake valve or the exhaust valve. The guide includes a lubricant oil receiver portion. The lubricant oil receiver portion receives the lubricant oil in a position under the protrusion when the lubricant oil flows through the protrusion. An extended portion downwardly extends from a lower end of the protrusion toward the lubricant oil receiver portion in a position apart from the cylinder head attachment portion.

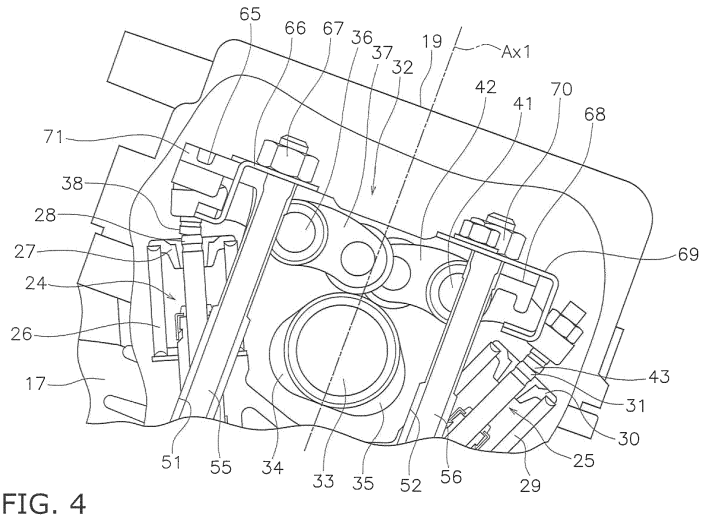

FIG. 4

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Description

TECHNICAL FIELD

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

BACKGROUND ART

[0002] There has been known a type of engine for a straddled vehicle that includes a cylinder and a cylinder head attached to the cylinder. A combustion chamber is formed by the cylinder and the cylinder head. The engine includes an intake port and an intake valve. The intake port continues to the combustion chamber. The intake valve is opened or closed in order to allow or block the flow of intake gas from the intake port to the combustion chamber. The engine includes an exhaust port and an exhaust valve. The exhaust port continues to the combustion chamber. The exhaust valve is opened or closed in order to allow or block the flow of exhaust gas from the combustion chamber to the exhaust port.

[0003] There has been known a type of valve actuating mechanism drives both or either of the intake valve and the exhaust valve by a camshaft. The intake valve is pressed toward the combustion chamber through a rocker arm and so forth in conjunction with rotation of the camshaft. When the intake valve is pressed, mixture gas and air are sucked into the combustion chamber through the intake port. The exhaust valve is pressed toward the combustion chamber through another rocker arm and so forth in conjunction with rotation of the camshaft. When the exhaust valve is pressed toward the combustion chamber, burnt gas is discharged from the combustion chamber to the exhaust port.

[0004] As described above, both or either of the intake valve and the exhaust valve are/is moved by other members or member corresponding thereto. Both or either of the intake valve and the exhaust valve are/is worn at their portions or its portion making contact with the other members or member, and lubrication is required for these contact portions. Especially in straddled vehicles such as a motorcycle, engine rotation speed is high. Therefore, the straddled vehicles are demanded to enhance certainty of lubricating the valves or valve.

[0005] For example, PTL 1 discloses a lubrication structure for valves. In this lubrication structure, a lubrication channel (50) is provided inside the walls of a cylinder block (14), a cylinder head (15), and a head cover (16). Lubricant oil flows through channels (61, 62, 63) provided inside the wall of the head cover (16). The lubricant oil is discharged from an opening (64) continuing to the channel (63) and is supplied to an intake valve (41).

[0006] On the other hand, PTL 2 also discloses a lubrication structure for valves. In this lubrication structure, bolts (108) are disclosed. The bolts (108) are provided for attaching a cam holder (70) together with a cylinder head (27) and a cylinder block (26) to a crankcase (25). An oil channel (109) is provided between the bolt (108) and both of the cylinder head (27) and the cylinder block (26). The oil channel (109) communicates with an oil reservoir (110) provided in a first support wall (70a) of the cam holder (70). A camshaft (65) is provided with a center oil channel (111) communicating with the oil reservoir (110). An intake-side cam (68) is provided with an oil ejection port (112). The oil ejection port (111) communicates with the center oil channel (111) and extends in a radial direction. An exhaust-side cam (69) is provided with an oil ejection port (113). The oil ejection port (113) communicates with the center oil channel (111) and extends in a radial direction. The lubricant oil ejected from the oil ejection ports (112, 113) are supplied to an intake valve stem end (60a).

CITATION LIST

Patent Literature

[0007]

PTL1: Japan Laid-open Patent Application Publication No. 2012-246839

PTL 2: Japan Laid-open Patent Application Publication No. 2008-82311

SUMMARY OF INVENTION

Technical Problems

[0008] However, in the lubrication structure of PTL 1, the lubrication channel (50) is provided inside the walls of the cylinder block (14), the cylinder head (15), and the head cover (16). Hence, increase in manufacturing cost is inevitable. Especially, the head cover (16) is required to be provided with the plural channels (61, 62, 63) extending in different directions. This results in drawbacks that the structure of the head cover (16) is inevitably complicated and that increase in manufacturing cost is inevitable.

[0009] On the other hand, in the lubrication structure of PTL 2, the oil channel (109) is provided by utilizing the hole into which the bolt (108) is inserted, whereby increase in manufacturing cost is inhibited. Additionally, the valves are lubricated by ejecting the lubricant oil from the ejection port (112) provided in the intake-side cam (68) and the ejection port (113) provided in the exhaust-side cam (69). Hence, increase in manufacturing cost is inhibited. In other words, PTL 2 is intended to provide the lubrication structure that increase in manufacturing cost is inhibited by eliminating necessity of processing to form complicated oil channels in the head cover.

[0010] However, as described in PTL 2, in the structure for lubricating the valves through ejection of the lubricant oil, it is not easy to make the lubricant oil accurately reach the valves. Especially, when the engine rotation speed is low, the discharge amount of oil from an oil pump re-

duces and the ejection amount of the lubricant oil from the ejection ports also reduces. Because of this, it is difficult to make the lubricant oil accurately reach the valves. Consequently, a large amount of oil is required for sufficiently supplying the lubricant oil to the valves. In other words, lubrication cannot be efficiently performed.

[0011] Additionally in PTL 2, processing is required respectively for forming the oil channels and the oil reservoir in the cam holder, forming the center oil channel in the camshaft, and forming the oil ejection ports in the cams. Because of this, increase in manufacturing cost is inevitable. Moreover, in PTL 2, the cam holder is provided separately from the cylinder head so as to easily form the oil channels and the oil reservoir in the cam holder. Because of this, the number of components increases. This also poses a possibility of increase in manufacturing cost.

[0012] It is an object of the present invention to, in an engine for a straddled vehicle, inhibit increase in manufacturing cost and stably lubricate a valve through a lubrication channel with a compact construction regardless of conditions of the engine or variation in viscosity of lubricant oil.

Solution to Problems

[0013] An engine for a straddled vehicle according an aspect of the present invention includes a cylinder, a cylinder head, a combustion chamber, an intake port, an exhaust port, an intake valve, an exhaust valve, an intake valve support portion, an exhaust valve support portion, an intake valve pressing portion, an exhaust valve pressing portion, a camshaft, a cam holder and a lubricant oil channel. The cylinder head is attached to the cylinder. The combustion chamber is formed by the cylinder and the cylinder head. The intake port continues to the combustion chamber. The exhaust port continues to the combustion chamber. The intake valve is configured to be opened or closed to allow or block a flow of an intake gas from the intake port to the combustion chamber. The exhaust valve is configured to be opened or closed to allow or block a flow of an exhaust gas from the combustion chamber to the exhaust port. The intake valve support portion is provided on the cylinder head and supports the intake valve. The exhaust valve support portion is provided on the cylinder head and supports the exhaust valve. The intake valve pressing portion is configured to press the intake valve toward the combustion chamber. The exhaust valve pressing portion is configured to press the exhaust valve toward the combustion chamber. The camshaft is configured to move the intake valve pressing portion and the exhaust valve pressing portion. The cam holder supports the camshaft and is integrated with the cylinder head. The lubricant oil channel is a channel through which a lubricant oil is supplied to the intake valve or the exhaust valve so as to lubricate the intake valve or the exhaust valve.

[0014] The lubricant oil channel includes a cylinder head attachment portion, a protrusion, a guide and an extended portion. The cylinder head attachment portion is provided on the cam holder, and includes a bolt hole through which a bolt for fixing the cylinder head to the cylinder is inserted and through which the lubricant oil flows. The protrusion is integrated with the cam holder, protrudes from the cylinder head attachment portion toward the intake valve or the exhaust valve, and guides the lubricant oil flowing thereto from an upper end of the bolt hole. The guide is provided separately from the protrusion and extends toward the intake valve or the exhaust valve. The guide includes a lubricant oil receiver portion. The lubricant oil receiver portion is disposed in a position below the protrusion to receive the lubricant oil flowing thereto through the protrusion. The extended portion extends from a lower end of the protrusion toward the lubricant oil receiver portion in a position apart from the cylinder head attachment portion.

[0015] First, an inventor of the present application conceived of inhibiting increase in manufacturing cost without forming an oil channel in the cylinder head cover. Additionally, the inventor conceived of inhibiting increase in manufacturing cost by integrating the cam holder and the cylinder head and by utilizing the bolt hole as a channel for supplying the lubricant oil to the valve. To inhibit increase in manufacturing cost and stably supply the lubricant oil to the valve even in low speed ration of the engine, the inventor examined a construction to successfully lead the lubricant oil to the vicinity of the valve from the upper end of the bolt hole without ejecting the lubricant oil far to supply the lubricant oil to the valve. Also, to lead the lubricant oil to the valve, the inventor conceived of producing the flow channel of the lubricant oil with a simple structure by reduction in number of components, and simultaneously, conceived of achieving smooth flow of the lubricant oil. Moreover, a large number of components (camshaft, rocker arms, etc.) are disposed in a space enclosed by the cylinder head and the cylinder head cover, and hence, it is required to compactly form the channel for guiding the lubricant oil.

[0016] When the bolt hole is utilized as the channel of the lubricant oil, the lubricant oil flows through the bolt hole from a lower side to an upper side. The lubricant oil then changes its flow direction when flowing out from the upper end of the bolt hole toward the valve. Therefore, when a member provided separately from the cam holder is designed to receive the lubricant oil flowing from the upper end of the bolt hole, it is concerned that the cam holder inevitably has a complicate structure for connecting the separately provided member thereto and this hinders smooth flow of the lubricant oil. Additionally, it is also concerned that compactness in size of the space enclosed by the cylinder head and the cylinder head cover cannot be ensured depending on the structure provided on the cam holder to connect the separately provided member thereto or a structure provided on the separately provided member to attach itself to the cam holder.

[0017] To cope with the aforementioned concerns, the

inventor firstly examined extension of the protrusion integrated with the cam holder from the vicinity of the bolt hole to the valve. With this extension, the lubricant oil can be received with a simple and convenient structure without blocking the flow of the lubricant oil from the upper end of the bolt hole. Additionally, it is not required to provide a member for attaching the protrusion to the cam holder. Hence, the lubrication channel can be compactly formed.

[0018] However, the inventor confronted a problem. When the protrusion is integrated with the cam holder and is extended to a position in which the valve is disposed, the protrusion becomes an obstacle and makes attachment/detachment of the valve quite difficult. When the cam holder is integrated with the protrusion while being separated from the cylinder head, attachment/detachment of the bolt is easily done by detachment of the cam holder. However, this construction bears a possibility of increase in manufacturing cost as described above.

[0019] The inventor made some creative efforts and hit upon an idea to reduce manufacturing cost by integrating the cam holder and the cylinder head, and simultaneously, lead the lubricant oil to the valve with constructions that the protrusion is integrated only at its base end with the cam holder and that the guide is provided separately from the protrusion. Based on the idea, attachment/detachment of the valve can be reliably done only by detachment of the guide. Moreover, compactness in size of the lubrication channel can be maintained, and simultaneously, the lubricant oil flowing from the upper end of the bolt hole can be smoothly supplied to the valve.

[0020] At this phase, the inventor further considered the flow of the lubricant oil to be supplied from the protrusion and be received by the guide. The inventor found that even when the protrusion and the guide are separately provided, it is possible to enhance stability of the flow of the lubricant oil to be supplied from the protrusion and be received by the guide if the lubricant oil receiver portion of the guide is disposed below the protrusion. Additionally, compactness in size of the lubrication channel can be also enhanced by overlapping the protrusion and the guide.

[0021] However, at this phase, the inventor confronted another problem anew. The cause of the problem is the viscosity of the lubricant oil. For example, when the temperature of the engine is low (e.g., immediately after starting of the engine), the temperature of the lubricant oil is also low. When the temperature of the lubricant oil is low, the viscosity of the lubricant oil inevitably becomes high. When the viscosity of the lubricant oil is low, the lubricant oil tends to flow easily. However, when the viscosity of the lubricant oil is high, the lubricant oil tends not to flow easily. Therefore, the inventor found that when the temperature of the engine is low, the lubricant oil cannot be successfully supplied from the protrusion and be received by the lubricant oil receiver portion. In other words, the inventor found that although the following could be partly attributed to integration of the protrusion with the cam holder, when the viscosity of the lubricant oil is high, the lubricant oil cannot successfully flow to the lubricant oil receiver portion, and as shown in FIG. 25 with arrow A1, the lubricant oil inevitably flows along the lower surface of the protrusion (71) and so forth and subsequently flows to the cylinder head attachment portion (46).

[0022] In view of the above, the inventor further made some creative efforts. The inventor produced a construction that the protrusion is provided with the extended portion. The extended portion downwardly extends from the lower end of the protrusion toward the lubricant oil receiver portion in a position apart from the cylinder head attachment portion. This construction enables the lubricant oil to smoothly flow from the extended portion and be received by the lubricant oil receiver portion even when the viscosity of the lubricant oil is high.

[0023] The protrusion may perpendicularly extend with respect to the cylinder head attachment portion. The extended portion may perpendicularly extend from the protrusion. In this construction, the protrusion perpendicularly extends, and this makes it easy to reliably produce the extended portion with a required dimension. When the extended portion has a short dimension, the lubricant oil does not easily drip from the extended portion. By contrast, the extended portion is herein reliably produced with a required dimension, and this enables smooth flow of the lubricant oil. Due to this, the lubricant oil can be stably supplied to the valve, while compactness in size of the protrusion is maintained in a limited space.

[0024] The guide may be disposed without making contact with the extended portion. In this construction, the protrusion and the guide can be compactly produced, and simultaneously, supply of the lubricant oil is enabled.

[0025] The protrusion may include a groove communicating with the bolt hole. The engine may further include a lid portion. The lid portion overlaps not with a tip end of the groove but with a base end of the groove from above in a plan view of the groove. In this construction, the lubricant oil flowing from a lower side to an upper side can be inhibited from pouring out, and the flow direction of the lubricant oil can be appropriately changed. Additionally, the lid portion does not overlap with the tip end of the groove. Hence, the lid portion can be compactly produced. Moreover, even though the lid portion does not overlap with the entire groove, smooth flow of the lubricant oil is enabled because the flow direction of the lubricant oil can be appropriately changed.

[0026] The lid portion may overlap with an entirety of the groove from a base end to a tip end of the groove in the plan view of the groove. Additionally, the lid portion may be integrated with the guide. In this construction, the shape used for the lid portion enables compactness of the guide, and simultaneously, the lubricant oil can be inhibited from flowing out of the groove by covering the entire groove with the lid portion.

[0027] When viewed in a direction of an axis of the cylinder head, the protrusion may not overlap with the intake valve and the exhaust valve. In this construction,

the protrusion does not interfere with the valve. Hence, attachment/detachment of the valve can be easily done.

[0028] When viewed in the direction of the axis of the cylinder head, at least portion of the guide may overlap with the intake valve or the exhaust valve. In this construction, the lubricant oil can be stably supplied to the valve by the guide.

[0029] The guide may be attached to the cam holder by the bolt for fixing the cylinder head to the cylinder. In this construction, the guide can be attached to the cam holder by utilizing the bolt for fixing the cylinder head to the cylinder. Additionally, the guide can be easily disposed in the vicinity of the holder. Due to this, manufacturing cost can be reduced low.

[0030] The guide may include an upper face portion and a lateral face portion. The upper face portion may be attached to an upper surface of the cam holder. The lateral face portion may downwardly extend from the upper face portion. The lubricant oil receiver portion may extend from a lower end of the lateral face portion in a direction separating from the cam holder. In this construction, the lubricant oil can be stably received by the lateral face portion and the lubricant oil receiver portion when the guide is disposed on an upper side of a cylinder axis in a vehicle installed condition that the cylinder axis is arranged in a tilt manner.

[0031] The groove may open in a horizontal direction in the vehicle installed condition. In this construction, the lubricant oil can drip on the lubricant oil receiver portion by causing the lubricant oil to flow in the horizontal direction even when the protrusion is disposed on the upper side of the cylinder axis in the vehicle installed condition.

[0032] The lubricant oil receiver portion may extend from a lower end of the lateral face portion in a direction approaching to the cam holder. In this construction, the lubricant oil can be stably received by the lubricant oil receiver portion even when the protrusion, the guide, and either the intake valve or the exhaust valve are disposed on the lower side of the axis of the cylinder head in the vehicle installed condition.

[0033] The groove may open obliquely downward in the vehicle installed condition. In this construction, the lubricant oil can efficiently drip from the groove.

[0034] A straddled vehicle according to another aspect of the present invention includes the aforementioned engine.

Advantageous Effects of Invention

[0035] According to the present invention, it is possible, in an engine for a straddled vehicle, to inhibit increase in manufacturing cost and stably lubricate a valve through a lubrication channel with a compact construction regardless of conditions of the engine or variation in viscosity of lubricant oil.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

FIG. 1 is a side view of a straddled vehicle.
FIG. 2 is a diagram showing an internal construction of an engine.
FIG. 3 is an enlarged view of an internal construction of a cylinder head.
FIG. 4 is an enlarged view of the internal construction of the cylinder head.
FIG. 5 is a diagram showing the internal construction of the engine.
FIG. 6 is a perspective view of the cylinder head from which a head cover is detached.
FIG. 7 is a perspective view of the cylinder head from which a first guide and a second guide are detached.
FIG. 8 is a view of the cylinder head from which the head cover is detached as viewed in a cylinder axial direction.
FIG. 9 is a side view of the cylinder head from which the head cover is detached.
FIG. 10 is a top view of the cylinder head from which a valve actuating mechanism is detached.
FIG. 11 is a schematic diagram showing a lubricant oil channel of the engine.
FIG. 12 is a perspective view of an intake valve and its surroundings.
FIG. 13 is a perspective view of the intake valve and its surroundings in a condition that the first guide is detached.
FIG. 14 is a side view of the intake valve and its surroundings.
FIG. 15 is a perspective view of the intake valve and its surroundings.
FIG. 16 is a perspective view of the first guide.
FIG. 17 is an enlarged view of a first extended portion and its surroundings.
FIG. 18 is an enlarged view of the first extended portion and its surroundings in a condition that the straddled vehicle tilts down to the rear.
FIG. 19 is a perspective view of an exhaust valve and its surroundings in a condition that the second guide is detached.
FIG. 20 is a perspective view of the exhaust valve and its surroundings in a condition that the second guide is attached.
FIG. 21 is a perspective view of the exhaust valve and its surroundings in the condition that the second guide is attached.
FIG. 22 is a side view of the exhaust valve and its surroundings.
FIG. 23 is a front view of the exhaust valve and its surroundings.
FIG. 24 is a perspective view of the second guide.
FIG. 25 is a diagram for explaining a problem of a related art.

DESCRIPTION OF EMBODIMENTS

[0037] 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 1. 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 1. The straddled vehicle 1 is a so-called sport vehicle. The straddled vehicle 1 includes a fuel tank 2, a seat 3, an engine 4 and a vehicle body frame 5.

[0038] The fuel tank 2, the seat 3 and the engine 4 are supported by the vehicle body frame 5. The fuel tank 2 is disposed in front of the seat 3. The engine 4 is disposed below the fuel tank 2.

[0039] The straddled vehicle 1 includes a head pipe 6, a front fork 7, a front wheel 8, a handle 9 and a headlight unit 10. The head pipe 6 is disposed in front of the fuel tank 2. The front fork 7 includes a steering shaft 15 and suspensions 16. The steering shaft 15 is turnably supported by the head pipe 6. The suspensions 16 are connected to the lower portion of the steering shaft 15.

[0040] The front wheel 8 is rotatably supported by the front fork 7. The handle 9 is connected to the upper portion of the steering shaft 15. The headlight unit 10 is disposed in front of the head pipe 6.

[0041] The straddled vehicle 1 includes a swing arm 11 and a rear wheel 12. The swing arm 11 backwardly extends from the vehicle body frame 5. The swing arm 11 is connected to the vehicle body frame 5 while being pivotable up and down. The rear wheel 12 is rotatably supported by the rear portion of the swing arm 11.

[0042] FIG. 2 is a diagram showing an internal construction of the engine 4. It should be noted that in FIG. 2, the right side corresponds to the front side of the vehicle. It should be noted that in the following explanation, front, rear, left, right, up and down directions in the engine 4 are respectively defined as meaning the front, rear, left, right, up and down directions based on a condition that the engine 4 is installed in the vehicle.

[0043] The engine 4 includes a cylinder unit 13 and a crankcase 14. A cylinder axis Ax1 of the cylinder unit 13 is arranged to tilt relatively to the vertical direction. The cylinder axis Ax1 extends obliquely upward to the front. The tilt angle of the cylinder axis Axl relative to the vertical direction is greater than 0 degrees and less than 90 degrees. The tilt angle of the cylinder axis Ax1 relative to the vertical direction may be greater than 0 degrees and less than 45 degrees.

[0044] The crankcase 14 is disposed below the cylinder unit 13. The crankcase 14 is connected to the lower portion of the cylinder unit 13 and extends backward.

[0045] The cylinder unit 13 includes a cylinder head 17, a cylinder 18 and a head cover 19. The cylinder head 17 is disposed above the cylinder 18. The head cover 19 is disposed above the cylinder head 17. The cylinder 18 is disposed above the crankcase 14. FIG. 3 is an enlarged view of an internal construction of the cylinder head 17. As shown in FIG. 3, the cylinder head 17 includes a combustion chamber 21, an intake port 22 continuing to the combustion chamber 21, and an exhaust port 23 continuing to the combustion chamber 21.

[0046] An intake valve 24 and an exhaust valve 25 are attached to the cylinder head 17. The cylinder head 17 includes an intake valve support portion 171 and an exhaust valve support portion 172. The intake valve support portion 171 supports the intake valve 24. The exhaust valve support portion 172 supports the exhaust valve 25. The intake valve support portion 171 and the exhaust valve support portion 172 are integrally provided on the cylinder head 17. The intake valve 24 is opened or closed in order to allow or block the flow of intake gas from the intake port 22 to the combustion chamber 21. The exhaust valve 25 is opened or closed in order to allow or block the flow of exhaust gas from the combustion chamber 21 to the exhaust port 23.

[0047] FIG. 4 is an enlarged view of the internal construction of the cylinder head 17. As shown in FIG. 4, a first valve spring 26 is attached to the intake valve 24. The first valve spring 26 urges the intake valve 24 in a direction that the intake valve 24 closes the intake port 22. The first valve spring 26 is held by a first retainer 27. A first stem end 28 protrudes from the first retainer 27.

[0048] A second valve spring 29 is attached to the exhaust valve 25. The second valve spring 29 urges the exhaust valve 25 in a direction that the exhaust valve 25 closes the exhaust port 23. The second valve spring 29 is held by a second retainer 30. A second stem end 31 protrudes from the second retainer 30.

[0049] FIG. 5 is a diagram showing the internal construction of the engine 4. As shown in FIGS. 4 and 5, the cylinder unit 13 accommodates a valve actuating mechanism 32. The valve actuating mechanism 32 is a mechanism for opening and closing the intake valve 24 and the exhaust valve 25. The valve actuating mechanism 32 employs a mechanism of an SOHC (Single OverHead Camshaft) type.

[0050] FIG. 6 is a perspective view of the cylinder head 17 from which the head cover 19 is detached. FIG. 7 is a perspective view of the cylinder head 17 from which a first guide (to be described) and a second guide (to be described) are detached in FIG. 6. FIG. 8 is a view of the cylinder head 17 from which the head cover 19 is detached as viewed from the direction of the cylinder axis Ax1. FIG. 9 is a side view of the cylinder head 17 from which the head cover 19 is detached.

[0051] The valve actuating mechanism 32 includes a camshaft 33 for driving the intake valve 24 and the exhaust valve 25. The camshaft 33 extends in a vehicle width direction. The camshaft 33 includes a first cam 34 and a second cam 35. The first cam 34 and the second cam 35 are disposed in alignment in the axial direction of the camshaft 33.

[0052] As shown in FIG. 4, the valve actuating mechanism 32 includes a first rocker shaft 36 and a first rocker arm 37. The first rocker arm 37 is supported by the first

rocker shaft 36 while being pivotable about the first rocker shaft 36. The first rocker arm 37 is disposed to be capable of actuating the intake valve 24.

[0053] The first rocker arm 37 is provided with an intake valve pressing portion 38 on its tip. The tip of the intake valve pressing portion 38 is opposed to the first stem end 28 of the intake valve 24.

[0054] In conjunction with pivot of the first rocker arm 37 by the first cam 34, the intake valve pressing portion 38 presses and lowers down the first stem end 28 of the intake valve 24 toward the combustion chamber 21. Accordingly, the intake valve 24 is pressed and lowered down, whereby the intake port 22 is opened. When the intake valve 24 is not being pressed down by the first rocker arm 37, the intake valve 24 is pressed and lifted up by the first valve spring 26, whereby the intake port 22 is closed.

[0055] The valve actuating mechanism 32 includes a second rocker shaft 41 and a second rocker arm 42. The second rocker arm 42 is supported by the second rocker shaft 41 while being pivotable about the second rocker shaft 41. The second rocker arm 42 is disposed to be capable of actuating the exhaust valve 25. The second rocker arm 42 is provided with an exhaust valve pressing portion 43 on its tip. The tip of the exhaust valve pressing portion 43 is opposed to the second stem end 31 of the exhaust valve 25.

[0056] In conjunction with pivot of the second rocker arm 42 by the second cam 35, the exhaust valve pressing portion 43 presses and lowers down the second stem end 31 of the exhaust valve 25 toward the combustion chamber 21. Accordingly, the exhaust valve 25 is pressed and lowered down, whereby the exhaust port 23 is opened. When the exhaust valve 25 is not being pressed and lowered down by the second rocker arm 42, the exhaust valve 25 is pressed and lifted up by the second valve spring 29, whereby the exhaust port 23 is closed.

[0057] The cylinder head 17 includes a cam holder 44. The cylinder head 17 includes an attachment surface 45 to which the head cover 19 is attached. The cam holder 44 protrudes more upward than the attachment surface 45. The cam holder 44 is integrated with the cylinder head 17. The cam holder 44 supports the camshaft 33.

[0058] The camshaft 33 is rotatably supported by the cam holder 44. The first rocker shaft 36 is rotatably supported by the cam holder 44. The second rocker shaft 41 is rotatably supported by the cam holder 44.

[0059] FIG. 10 is a top view of the cylinder head 17 from which the valve actuating mechanism 32 is detached. As shown in FIG. 10, the cam holder 44 includes a first cylinder head attachment portion 46, a second cylinder head attachment portion 47, a third cylinder head attachment portion 48 and a fourth cylinder head attachment portion 49. The first and second cylinder head attachment portions 46 and 47 are aligned in the back-and-forth direction. The third and fourth cylinder head attachment portions 48 and 49 are aligned in the back-and-forth direction. The first and third cylinder head attachment portions 46 and 48 are aligned in the right-and-left direction. The second and fourth cylinder head attachment portions 47 and 49 are aligned in the right-and-left direction.

[0060] The first cylinder head attachment portion 46 is provided with a first bolt hole 51. The second cylinder head attachment portion 47 is provided with a second bolt hole 52. The third cylinder head attachment portion 48 is provided with a third bolt hole 53. The fourth cylinder head attachment portion 49 is provided with a fourth bolt hole 54. The respective bolt holes 51 to 54 extend in the direction of the cylinder axis Ax1 and penetrate the cylinder unit 13.

[0061] Bolts 55 to 58 shown in FIG. 8 are inserted through the bolt holes 51 to 54, respectively. When described in detail, a first bolt 55 is inserted through the first bolt hole 51. A second bolt 56 is inserted through the second bolt hole 52. A third bolt 57 is inserted through the third bolt hole 53. A fourth bolt 58 is inserted through the fourth bolt hole 54. The cylinder unit 13 is fixed to the crankcase 14 by these bolts 55 to 58.

[0062] As shown in FIG. 5, a sprocket 59 is attached to the camshaft 33. The sprocket 59 is meshed with a cam chain 60. Rotation of a crankshaft 61 is configured to be transmitted to the camshaft 33 through the cam chain 60, whereby the camshaft 33 is rotated.

[0063] When installed in a vehicle, the cylinder unit 13 is disposed to tilt relatively to the up-and-down direction such that the cylinder axis Ax1 extends obliquely upward to the front. With this construction, as shown in FIG. 2, the intake valve 24 is disposed on the upper side of the cylinder axis Ax1. The exhaust valve 25 is disposed on the lower side of the cylinder axis Ax1.

[0064] Next, a lubrication structure for the intake valve 24 and the exhaust valve 25 will be explained. FIG. 11 is a schematic diagram showing a lubricant oil channel of the engine 4. As shown in FIG. 11, the engine 4 includes an oil pan 62, an oil pump 63 and a lubricant oil channel 60. The oil pump 63 is driven by rotation of the crankshaft 61. The oil pump 63 draws the lubricant oil from the oil pan 62 and supply the drawn lubricant oil to the lubricant oil channel 60.

[0065] The lubricant oil channel 60 includes a first lubricant oil channel 601, a second lubricant oil channel 602, a third lubricant oil channel 603 and a fourth lubricant oil channel 604. The first lubricant oil channel 601 supplies the lubricant oil for lubricating the intake valve 24 and the exhaust valve 25. The second lubricant oil channel 602 supplies the lubricant oil for lubricating the crankshaft 61. The third lubricant oil channel 603 supplies the lubricant oil for lubricating a main shaft 88 and a drive shaft 89. The fourth lubricant oil channel 604 is connected to the oil pump 63. Each of the first, second and third lubricant oil channels 601, 602 and 603 is connected to the fourth lubricant oil channel 604. The lubricant oil discharged from the oil pump 63 flows through each of the first, second and third lubricant oil channels 601, 602 and

603 via the fourth lubricant oil channel 604.

[0066] The first lubricant oil channel 601 will be hereinafter explained in detail. The first lubricant oil channel 601 includes the first bolt hole 51 of the first cylinder head attachment portion 46 and the second bolt hole 52 of the second cylinder head attachment portion 47. The fourth lubricant oil channel 604 communicates with the first bolt hole 51 and the second bolt hole 52. The lubricant oil is supplied from the fourth lubricant oil channel 604 to the first bolt hole 51 and the second bolt hole 52.

[0067] The first lubricant oil channel 601 includes a first protrusion 71 and a first guide 66. FIG. 12 is a perspective view of the intake valve 24 and its surroundings. FIG. 13 is a perspective view of the intake valve 24 and its surroundings in a condition that the first guide 66 is detached. FIG. 14 is a side view of the intake valve 24 and it surroundings. FIG. 15 is a perspective view of the intake valve 24 and its surroundings.

[0068] The first protrusion 71 and the first guide 66 are disposed together with the intake valve 24 on the upper side of the cylinder axis Ax1. The first protrusion 71 is integrated with the cam holder 44, and protrudes toward the intake valve 24 from the cam holder 44. The first protrusion 71 protrudes from the top of the first cylinder head attachment portion 46. The first protrusion 71 perpendicularly extends with respect to the first cylinder head attachment portion 46. The first protrusion 71 guides the lubricant oil flowing out of the upper end of the first bolt hole 51.

[0069] In the side view, the first protrusion 71 is located above the intake valve 24. In the side view, the first protrusion 71 overlaps with the first rocker arm 37. When viewed in the direction of the cylinder axis Ax1, the first protrusion 71 does not overlap with the intake valve 24. As shown in FIG. 8, the first protrusion 71 is located sideward of the intake valve 24. The first protrusion 71 is located in a higher position than the first retainer 27 of the intake valve 24.

[0070] The first protrusion 71 is provided with a first groove 65. The first groove 65 is provided on the top surface of the first protrusion 71. The first groove 65 extends obliquely upward to the rear from the first bolt hole 51 and bends sideward. The first groove 65 extends toward the intake valve 24. In other words, the first groove 65 opens in a horizontal direction in the vehicle installed condition. The first groove 65 opens in the right-and-left direction in the vehicle installed condition.

[0071] The first groove 65 communicates with the first bolt hole 51. The first bolt hole 51 opens on the top surface of the cam holder 44, and is closed by the first guide 66 and a head 67 of the first bolt 55. The lubricant oil flows through the gap between the first bolt hole 51 and the first bolt 55 and reaches the cam holder 44 of the cylinder head 17. The lubricant oil flows through the first groove 65 and is then supplied to the intake valve 24 while being guide by the first guide 66.

[0072] The first guide 66 is provided separately from the cam holder 44. In other words, the first guide 66 is provided separately from the first protrusion 71. The first guide 66 is attached to the cam holder 44. The first guide 66 is fixed to the cam holder 44 by the first and third bolts 55 and 57. The first guide 66 couples the first and third cylinder head attachment portions 46 and 48. The first guide 66 extends toward the intake valve 24. A portion of the first guide 66 overlaps with the first protrusion 71 in the plan view. FIG. 16 is a perspective view of the first guide 66. As shown in FIG. 16, the first guide 66 has a bent plate shape. The first guide 66 includes a first upper face portion 72, a first lid portion 85, a first lateral face portion 73 and a first lubricant oil receiver portion 74.

[0073] The first upper face portion 72 is attached to the top surface of the cam holder 44. The first upper face portion 72 has a flat plate shape. The first upper face portion 72 is provided with a first hole 721, a second hole 722 and a third hole 723. The first hole 721 is a hole through which the first bolt 55 is inserted. The second hole 722 is a hole through which the third bolt 57 is inserted. The third hole 723 is located between the first hole 721 and the second hole 722. As shown in FIG. 13, the cam holder 44 is provided with a first guide fixing hole 75 in a position between the first bolt hole 51 and the third bolt hole 53. A first fixation bolt 76 shown in FIG. 12 is inserted through the third hole 723 and the first guide fixing hole 75.

[0074] The first lid portion 85 is integrated with the first guide 66. The first lid portion 85 protrudes from the first upper face portion 72. The first lid portion 85 extends in parallel to the upper surface of the first upper face portion 72. In a plan view of the first groove 65, the first lid portion 85 overlaps with the base end of the first groove 65 but does not overlap with the tip end of the first groove 65. It should be noted that the base end of the first groove 65 refers to a portion communicating with the first bolt hole 51. The tip end of the first groove 65 refers to a portion located on the opposite side of the base end in the lubricant oil channel within the first groove 65.

[0075] The first lateral face portion 73 downwardly extends from the first upper face portion 72. The first lateral face portion 73 extends to a lower position than the first protrusion 71. The first lubricant oil receiver portion 74 horizontally protrudes from the lower end of the first lateral face portion 73. In other words, the first lubricant oil receiver portion 74 backwardly protrudes from the lower end of the first lateral face portion 73. When described in detail, the first lubricant oil receiver portion 74 extends obliquely upward to the rear from the lower end of the first lateral face portion 73. In a plan view, the first lubricant oil receiver portion 74 overlaps with portion of the first protrusion 71.

[0076] The first lubricant oil receiver portion 74 is located under the first protrusion 71 and receives the lubricant oil flowing thereto through the first groove 65. The first protrusion 71 includes a first extended portion 77 downwardly protruding toward the first lubricant oil receiver portion 74. The first extended portion 77 vertically extends from the first protrusion 71. In a position apart

from the first cylinder head attachment portion 46, the first extended portion 77 downwardly extends from the lower end of the first protrusion 71 toward the first lubricant oil receiver portion 74. The first guide 66 does not make contact with the first extended portion 77. FIG. 17 is an enlarged view of the first extended portion 77 and its surroundings. The first lubricant oil receiver portion 74 is disposed to receive the lubricant oil dripping from the first extended portion 77. The first lubricant oil receiver portion 74 is disposed under the first extended portion 77. In other words, in the plan view, the first lubricant oil receiver portion 74 overlaps with the first extended portion 77.

[0077] The first extended portion 77 has a downwardly tapered shape. In the vehicle installed condition, the lowest point of the first extended portion 77 is located right above the first lubricant oil receiver portion 74. The first extended portion 77 includes a bottom 771 and a slope 772. In the vehicle installed condition, the bottom 771 is located right above the first lubricant oil receiver portion 74. In the vehicle installed condition, the bottom 771 includes the lowest point of the first extended portion 77. The slope 772 is located further away from the cam holder 44 than the bottom 771. The slope 772 tilts from the top of the first extended portion 77 toward the bottom 771. The slope 772 extends from a position not overlapping with the first lubricant oil receiver portion 74 in a plan view to a position overlapping with the first lubricant oil receiver portion 74 in the plan view.

[0078] As shown in FIG. 18, the lowest point of the first extended portion 77 is set such that the lubricant oil can be supplied to the first lubricant oil receiver portion 74 even when the straddled vehicle tilts down to the rear and thereby the cylinder axis Ax1 is arranged in parallel to the vertical direction. In other words, when the cylinder axis Ax1 is arranged in parallel to the vertical direction, the lowest point of the first extended portion 77 is located right above the first lubricant oil receiver portion 74.

[0079] The first lubricant oil receiver portion 74 extends from the lower end of the first lateral face portion 73 in a direction separating from the cam holder 44. The first lubricant oil receiver portion 74 extends obliquely upward. When viewed in the direction of the cylinder axis Ax1, the first lubricant oil receiver portion 74 overlaps with the intake valve 24. Detailedly, when viewed in the direction of the cylinder axis Ax1, the first lubricant oil receiver portion 74 overlaps with the first retainer 27. When viewed in the direction of the cylinder axis Ax1, the first lubricant oil receiver portion 74 overlaps with the first protrusion 71. When viewed in the direction of the cylinder axis Ax1, the first lubricant oil receiver portion 74 overlaps with the end of the first groove 65.

[0080] The first lubricant oil receiver portion 74 is disposed over a range from a position under the first extended portion 77 to a position over the first retainer 27. The first lubricant oil receiver portion 74 downwardly tilts toward the position over the first retainer 27. The first lubricant oil receiver portion 74 receives the lubricant oil dripping from the first extended portion 77 and leads the lubricant oil toward the first retainer 27.

[0081] The first lubricant oil receiver portion 74 is disposed for dripping the lubricant oil on a portion of the first retainer 27, i.e., a portion located above the center of the first retainer 27. In other words, the first lubricant oil receiver portion 74 is disposed for dripping the lubricant oil on a portion of the first retainer 27, i.e., a portion located closer to the cam holder 44 than the center of the first retainer 27.

[0082] FIG. 19 is a perspective view of the exhaust valve 25 and its surroundings in a condition that a second guide 69 is detached. As shown in FIG. 19, the cylinder head 17 includes a second protrusion 78. The second protrusion 78 and the second guide 69 are disposed together with the exhaust valve 25 on the lower side of the cylinder axis Ax1. The second protrusion 78 is integrated with the cam holder 44, and protrudes toward the exhaust valve 25 from the cam holder 44. The second protrusion 78 protrudes from the top of the second cylinder head attachment portion 47. The second protrusion 78 perpendicularly extends with respect to the second cylinder head attachment portion 47. The second protrusion 78 guides the lubricant oil flowing out of the upper end of the second bolt hole 52.

[0083] FIGS. 20 and 21 are perspective views of the exhaust valve 25 and its surroundings. FIG. 22 is a side view of the exhaust valve 25 and its surroundings. FIG. 23 is a front view of the exhaust valve 25 and its surroundings. In the side view, the second protrusion 78 is located over the exhaust valve 25. In the side view, the second protrusion 78 overlaps with the second rocker arm 42. When viewed in the direction of the cylinder axis Ax1, the second protrusion 78 does not overlap with the exhaust valve 25. The second protrusion 78 is located sideward of the exhaust valve 25. The second protrusion 78 is located in a higher position than the second retainer 30 of the exhaust valve 25.

[0084] The second protrusion 78 is provided with a second groove 68 that communicates with the second bolt hole 52. The second groove 68 is provided on the top surface of the second protrusion 78. The second groove 68 extends obliquely downward from the second bolt hole 52. The second groove 68 extends toward the exhaust valve 25. The second groove 68 opens obliquely downward in the vehicle installed condition.

[0085] The second guide 69 is attached to the cam holder 44. The second bolt hole 52 opens on the top surface of the cam holder 44, and is closed by the second guide 69 and a head 70 of the second bolt 56. The lubricant oil flows through the gap between the second bolt hole 52 and the second bolt 56 and reaches the cam holder 44 of the cylinder head 17. The lubricant oil flows through the second groove 68 and is then supplied to the exhaust valve 25 while being guided by the second guide 69.

[0086] The second guide 69 is provided separately from the cam holder 44. The second guide 69 is provided

separately from the first guide 66. The second guide 69 is fixed to the cam holder 44 by the second bolt 56 and the fourth bolt 58. The second guide 69 couples the second and fourth cylinder head attachment portions 47 and 49. The second guide 69 extends toward the exhaust valve 25. FIG. 24 is a perspective view of the second guide 69. As shown in FIG. 24, the second guide 69 has a bent plate shape. The second guide 69 includes a second upper face portion 79, a second lid portion 86, a second lateral face portion 80 and a second lubricant oil receiver portion 81.

[0087] The second upper face portion 79 is attached to the top surface of the cam holder 44. The second upper face portion 79 has a flat plate shape. The second upper face portion 79 is provided with a first hole 791, a second hole 792 and a third hole 793. The first hole 791 is a hole through which the second bolt 56 is inserted. The second hole 792 is a hole through which the fourth bolt 58 is inserted. The third hole 793 is located between the first hole 791 and the second hole 792. As shown in FIG. 19, the cam holder 44 is provided with a second guide fixing hole 82 in a position between the second bolt hole 52 and the fourth bolt hole 54. A second fixation bolt 83 shown in FIG. 20 is inserted through the third hole 793 and the second guide fixing hole 82.

[0088] The second lid portion 86 is integrated with the second guide 69. The second lid portion 86 extends in parallel to the upper surface of the second upper face portion 79. In a plan view of the second groove 68, the second lid portion 86 overlaps with the entirety of the second groove 68 from its base end to its tip end. It should be noted that the base end of the second groove 68 refers to a portion communicating with the second bolt hole 52. The tip end of the second groove 68 refers to a portion located on the opposite side of the base end in the lubricant oil channel within the second groove 68.

[0089] The second lateral face portion 80 downwardly extends from the second upper face portion 79. The second lateral face portion 80 is opposed to the end of the second groove 68. The second lateral face portion 80 covers the end of the second groove 68 in the horizontal direction. The second lubricant oil receiver portion 81 protrudes from the lower end of the second lateral face portion 80. The second lubricant oil receiver portion 81 protrudes from the lower end of the second lateral face portion 80 in a direction approaching to the cam holder 44.

[0090] The second lubricant oil receiver portion 81 is located under the second protrusion 78 and receives the lubricant oil flowing thereto through the second groove 68. In a plan view, the second lubricant oil receiver portion 81 overlaps with the second protrusion 78. The second protrusion 78 includes a second extended portion 84 downwardly protruding toward the second lubricant oil receiver portion 81.

[0091] The second extended portion 84 vertically extends from the second protrusion 78. The second guide 69 does not make contact with the second extended portion 84. In a position apart from the second cylinder head attachment portion 47, the second extended portion 84 downwardly extends from the lower end of the second protrusion 78 toward the second lubricant oil receiver portion 81. The second extended portion 84 is disposed eccentrically to one of a pair of lateral surfaces of the second protrusion 78, i.e., to the lateral surface located closer to the exhaust valve 25. One of the lateral surfaces of the second extended portion 84 downwardly extends from the aforementioned lateral surface located closer to the exhaust valve 25. The other of the lateral surfaces of the second extended portion 84 is located right below the second groove 68.

[0092] The second lubricant oil receiver portion 81 is disposed under the second extended portion 84 so as to receive the lubricant oil dripping from the second extended portion 84. In other words, in a plan view, the second lubricant oil receiver portion 81 overlaps with the second extended portion 84.

[0093] In the vehicle installed condition, the lowest point of the second extended portion 84 is located right above the second lubricant oil receiver portion 81. Additionally, the lowest point of the second extended portion 84 is set such that the lubricant oil can be supplied to the second lubricant oil receiver portion 81 even when the straddled vehicle tilts down to the rear and thereby the cylinder axis Ax1 is arranged in parallel to the vertical direction. In other words, when the cylinder axis Ax1 is arranged in parallel to the vertical direction, the lowest point of the second extended portion 84 is located right above the second lubricant oil receiver portion 81.

[0094] The second lubricant oil receiver portion 81 extends from the lower end of the second lateral face portion 80 in the direction approaching to the cam holder 44. The second lubricant oil receiver portion 81 extends obliquely downward. When viewed in the direction of the cylinder axis Ax1, the second lubricant oil receiver portion 81 overlaps with the exhaust valve 25. Detailedly, when viewed in the direction of the cylinder axis Ax1, the second lubricant oil receiver portion 81 overlaps with the second retainer 30.

[0095] The second lubricant oil receiver portion 81 is disposed over a range from a position under the second extended portion 84 to a position over the second retainer 30. The second lubricant oil receiver portion 81 downwardly tilts toward the position over the second retainer 30. The second lubricant oil receiver portion 81 receives the lubricant oil dripping from the second extended portion 84 and leads the received lubricant oil toward the second retainer 30.

[0096] The second lubricant oil receiver portion 81 is disposed for dripping the lubricant oil on a portion of the second retainer 30, i.e., a portion located above the center of the second retainer 30. In other words, the second lubricant oil receiver portion 81 is disposed for dripping the lubricant oil on a portion of the second retainer 30, i.e., a portion located closer to the cam holder 44 than the center of the second retainer 30.

[0097] In the engine 4 according to the present exem-

plary embodiment, the lubricant oil flows through the first groove 65 after flowing out of the first bolt hole 51, then flows along the end of the first protrusion 71, and drips from the first extended portion 77. When dripping, the lubricant oil is received by the first lubricant oil receiver portion 74 and/or the first lateral face portion 73. The received lubricant oil flows along the first lubricant oil receiver portion 74, and drips from the first lubricant oil receiver portion 74 on the first retainer 27 of the intake valve 24. Accordingly, the lubricant oil is supplied to the first stem end 28 of the intake valve 24.

[0098] On the other hand, the lubricant oil flows through the second groove 68 after flowing out of the second bolt hole 52, then flows along the end of the second protrusion 78, and drips from the second extended portion 84. When dripping, the lubricant oil is received by the second lubricant oil receiver portion 81 and/or the second lateral face portion 80. The received lubricant oil flows along the second lubricant oil receiver portion 81, and drips from the second lubricant oil receiver portion 81 on the second retainer 30 of the exhaust valve 25. Accordingly, the lubricant oil is supplied to the second stem end 31 of the exhaust valve 25.

[0099] As described above, in the engine 4 according to the present exemplary embodiment, the lubricant oil can be lead to the intake valve 24 by the first groove 65 of the first protrusion 71 and the first guide 66. With this construction, the lubricant oil can be stably and efficiently supplied to the intake valve 24. Additionally, the first protrusion 71 and the first guide 66 can be easily provided compared to when the head cover 19 and the camshaft 33 are provided with channels in their interiors. Accordingly, increase in manufacturing cost can be inhibited. Additionally, the first guide 66 is made of sheet metal. Hence, manufacturing cost can be reduced.

[0100] When viewed in the axial direction of the cylinder head 17, the first protrusion 71 does not overlap with the intake valve 24. Therefore, the first protrusion 71 does not interfere with the intake valve 24. Hence, attachment/detachment of the intake valve 24 is easily done.

[0101] The lubricant oil flows through the first groove 65, then flows along the first extended portion 77 of the first protrusion 71, and drips on the first lubricant oil receiver portion 74. This construction enables the lubricant oil to stably drip on the first lubricant oil receiver portion 74.

[0102] When viewed in the axial direction of the cylinder head 17, portion of the first lubricant oil receiver portion 74 overlaps with the intake valve 24. This construction enables the lubricant oil to accurately drip from the first lubricant oil receiver portion 74 on the intake valve 24.

[0103] The first guide 66 is provided separately from the cam holder 44. With this construction, even when the first guide 66 is disposed while overlapping with the intake valve 24, attachment/detachment of the intake valve 24 can be easily done by detaching the first guide 66. Additionally, the first guide 66, provided separately from the cam holder 44, makes it possible to avoid a situation that the first guide 66 interferes with a tool or the hands of a worker in processing to form the intake valve support portion 171 and the exhaust valve support portion 172 on the cylinder head 17. Accordingly, easiness in processing the cylinder head 17 can be enhanced.

[0104] The first guide 66 is attached to the cam holder 44. Hence, the first guide 66 can be easily disposed closely to the cam holder 44. Accordingly, manufacturing cost can be reduced low.

[0105] The first groove 65 is provided on the top surface of the first protrusion 71, and is made in the shape of a groove. Hence, processing to form the first groove 65 is easily done.

[0106] Advantageous effects of the first groove 65 of the first protrusion 71 and the first guide 66 have been explained above. The advantageous effects are similarly true to the second groove 68 of the second protrusion 78 and the second guide 69.

[0107] 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 scope of the present invention.

[0108] The term "straddled vehicle" encompasses a motorcycle, an all-terrain vehicle and a snowmobile. Additionally, the term "motorcycle" encompasses a scooter and a moped. The motorcycle may include two or more front wheels. Alternatively, the motorcycle may include two or more rear wheels.

[0109] The intake valve 24 may be an exhaust valve configured to open and close the exhaust port 23. The exhaust valve 25 may be an intake valve configured to open and close the intake port 22. The number of the intake valves 24 herein provided is not limited to one and may be plural. The number of the exhaust valves 25 herein provided is not limited to one and may be plural. The mechanism herein employed for the valve actuating mechanism 32 is not limited to be of the SOHC type and may be of a DOHC (Double OverHead Camshaft) type.

[0110] One of the first and second protrusions 71 and 78 may not be provided. One of the first and second guides 66 and 69 may not be provided.

[0111] When viewed in the axial direction of the cylinder head 17, the first protrusion 71 may overlap with the intake valve 24. When viewed in the axial direction of the cylinder head 17, the second protrusion 78 may overlap with the exhaust valve 25. When viewed in the axial direction of the cylinder head 17, the first guide 66 may not overlap with the intake valve 24. When viewed in the axial direction of the cylinder head 17, the second guide 69 may not overlap with the exhaust valve 25.

[0112] The first guide 66 may be integrated with the cam holder 44. The second guide 69 may be integrated with the cam holder 44. The first groove 65 may open in a direction other than the horizontal direction in the vehicle installed condition. The second groove 68 may open in a direction other than an obliquely downward direction in the vehicle installed condition.

[0113] The first groove 65 may not be limited to have a groove shape, and may have another shape such as a hole shape. The second groove 68 may not be limited to have a groove shape, and may have another shape such as a hole shape.

[0114] The terms and expressions, as used herein, are provided for the purpose of explanation, not of limitation to interpretation. It is to be recognized that there is no intention to exclude any equivalents of the features herein illustrated and described, and various modifications are possible within the scope claimed in the present invention. The present invention can be embodied in many different forms. The present disclosure should be considered to provide the principle embodiments of the present invention. Those embodiments are herein described with the understanding of not intending to limit the present invention to the embodiments herein described and/or illustrated. Thus, the present invention is not to be limited to those embodiments herein described. The present invention even encompasses all the embodiments including equivalent elements, modifications, deletions, combinations, improvements and/or changes, which could be recognized by a person skilled in the art based on the present disclosure. A limitation in a claim should be broadly interpreted based on terms used in the claim, and should not be limited to any of the embodiments described in the present specification or during prosecution of the present application.

Industrial Applicability

[0115] According to the present invention, it is possible, in an engine for a straddled vehicle, to inhibit increase in manufacturing cost and stably lubricate a valve through a lubrication channel with a compact construction regardless of conditions of the engine or variation in viscosity of lubricant oil.

Reference Signs List

[0116]

17	Cylinder head
24	Intake valve
25	Exhaust valve
33	Camshaft
44	Cam holder
71	First protrusion
78	Second protrusion
66	First guide
69	Second guide
77	First extended portion
84	Second extended portion
74	First lubricant oil receiver portion
81	Second lubricant oil receiver portion

Claims

1. An engine for a straddled vehicle, comprising:

a cylinder;
a cylinder head attached to the cylinder;
a combustion chamber formed by the cylinder and the cylinder head;
an intake port continuing to the combustion chamber;
an exhaust port continuing to the combustion chamber;
an intake valve configured to open or close a flow of an intake gas from the intake port to the combustion chamber;
an exhaust valve configured to open or close a flow of an exhaust gas from the combustion chamber to the exhaust port;
an intake valve support portion provided on the cylinder head, the intake valve support portion supporting the intake valve;
an exhaust valve support portion provided on the cylinder head, the exhaust valve support portion supporting the exhaust valve;
an intake valve pressing portion configured to press the intake valve toward the combustion chamber;
an exhaust valve pressing portion configured to press the exhaust valve toward the combustion chamber;
a camshaft configured to move the intake valve pressing portion and the exhaust valve pressing portion;
a cam holder supporting the camshaft, the cam holder being integrated with the cylinder head; and
a lubricant oil channel through which a lubricant oil is supplied to the intake valve or the exhaust valve, wherein
the lubricant oil channel includes

a cylinder head attachment portion provided on the cam holder, the cylinder head attachment portion including a bolt hole through which a bolt for fixing the cylinder head to the cylinder is inserted and through which the lubricant oil flows,
a protrusion integrated with the cam holder, the protrusion protruding from the cylinder head attachment portion toward the intake valve or the exhaust valve, the protrusion guiding the lubricant oil flowing from an upper end of the bolt hole,
a guide provided separately from the protrusion, the guide extending toward the intake valve or the exhaust valve, the guide including a lubricant oil receiver portion, the lubricant oil receiver portion being disposed

in a position under the protrusion to receive the lubricant oil flowing through the protrusion, and
an extended portion downwardly extending from a lower end of the protrusion toward the lubricant oil receiver portion in a position apart from the cylinder head attachment portion.

2. The engine for a straddled vehicle according to claim 1, wherein
the protrusion perpendicularly extends with respect to the cylinder head attachment portion, and
the extended portion perpendicularly extends from the protrusion.

3. The engine for a straddled vehicle according to claim 1 or 2, wherein the guide is disposed without making contact with the extended portion.

4. The engine for a straddled vehicle according to any of claims 1 to 3, wherein
the protrusion includes a groove communicating with the bolt hole, and
the engine further comprises a lid portion, the lid portion overlapping not with a tip end of the groove but with a base end of the groove from above in a plan view of the groove.

5. The engine for a straddled vehicle according to any of claims 1 to 3, wherein
the protrusion includes a groove communicating with the bolt hole,
the engine further comprises a lid portion overlapping with an entirety of the groove from a base end to a tip end of the groove from above in a plan view of the groove, and
the lid portion is integrated with the guide.

6. The engine for a straddled vehicle according to any of claims 1 to 5, wherein when viewed in a direction of an axis of the cylinder head, the protrusion does not overlap with the intake valve and the exhaust valve.

7. The engine for a straddled vehicle according to any of claims 1 to 6, wherein when viewed in the direction of the axis of the cylinder head, at least portion of the guide overlaps with the intake valve or the exhaust valve.

8. The engine for a straddled vehicle according to any of claims 1 to 7, wherein the guide is attached to the cam holder by a bolt for fixing the cylinder head to the cylinder.

9. The engine for a straddled vehicle according to any of claims 1 to 8, wherein
the guide includes an upper face portion and a lateral face portion, the upper face portion being attached to an upper surface of the cam holder, the lateral face portion downwardly extending from the upper face portion, and
the lubricant oil receiver portion extends from a lower end of the lateral face portion in a direction separating from the cam holder.

10. The engine for a straddled vehicle according to claim 7, wherein the protrusion, the guide, and either the intake valve or the exhaust valve are disposed on an upper side of the axis of the cylinder head in a vehicle installed condition in which the axis of the cylinder head is arranged to tilt relatively to a vertical direction.

11. The engine for a straddled vehicle according to claim 10, wherein
the protrusion includes a groove communicating with the bolt hole, and
the groove opens in a horizontal direction in the vehicle installed condition.

12. The engine for a straddled vehicle according to any of claims 1 to 8, wherein
the guide includes an upper face portion and a lateral face portion, the upper face portion being attached to an upper surface of the cam holder, the lateral face portion downwardly extending from the upper face portion, and
the lubricant oil receiver portion extends from a lower end of the lateral face portion in a direction approaching to the cam holder.

13. The engine for a straddled vehicle according to claim 12, wherein the protrusion, the guide, and either the intake valve or the exhaust valve are disposed on a lower side of the axis of the cylinder head in a vehicle installed condition in which the axis of the cylinder head is arranged to tilt relatively to a vertical direction.

14. The engine for a straddled vehicle according to claim 13, wherein
the protrusion includes a groove communicating with the bolt hole, and
the groove opens obliquely downward in the vehicle installed condition.

15. A straddled vehicle, comprising:

the engine recited in any of claims 1 to 14.

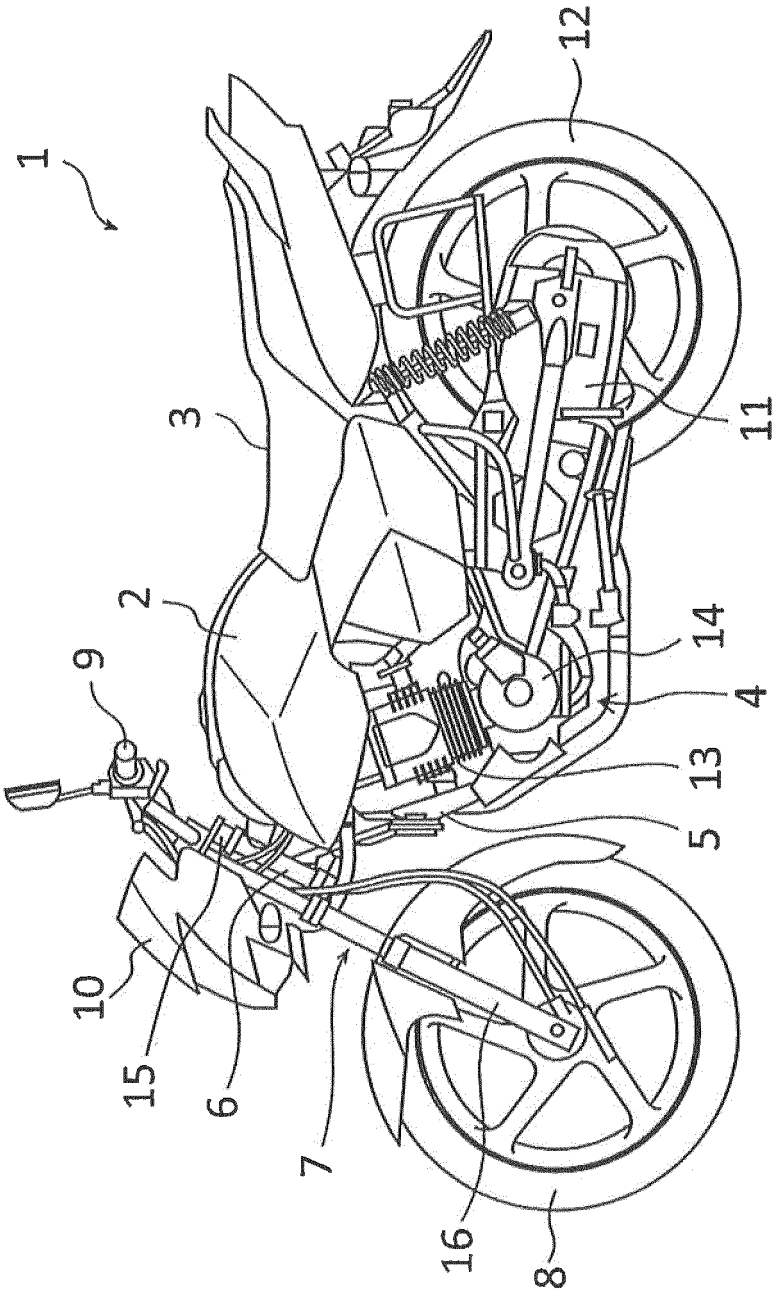

FIG. 1

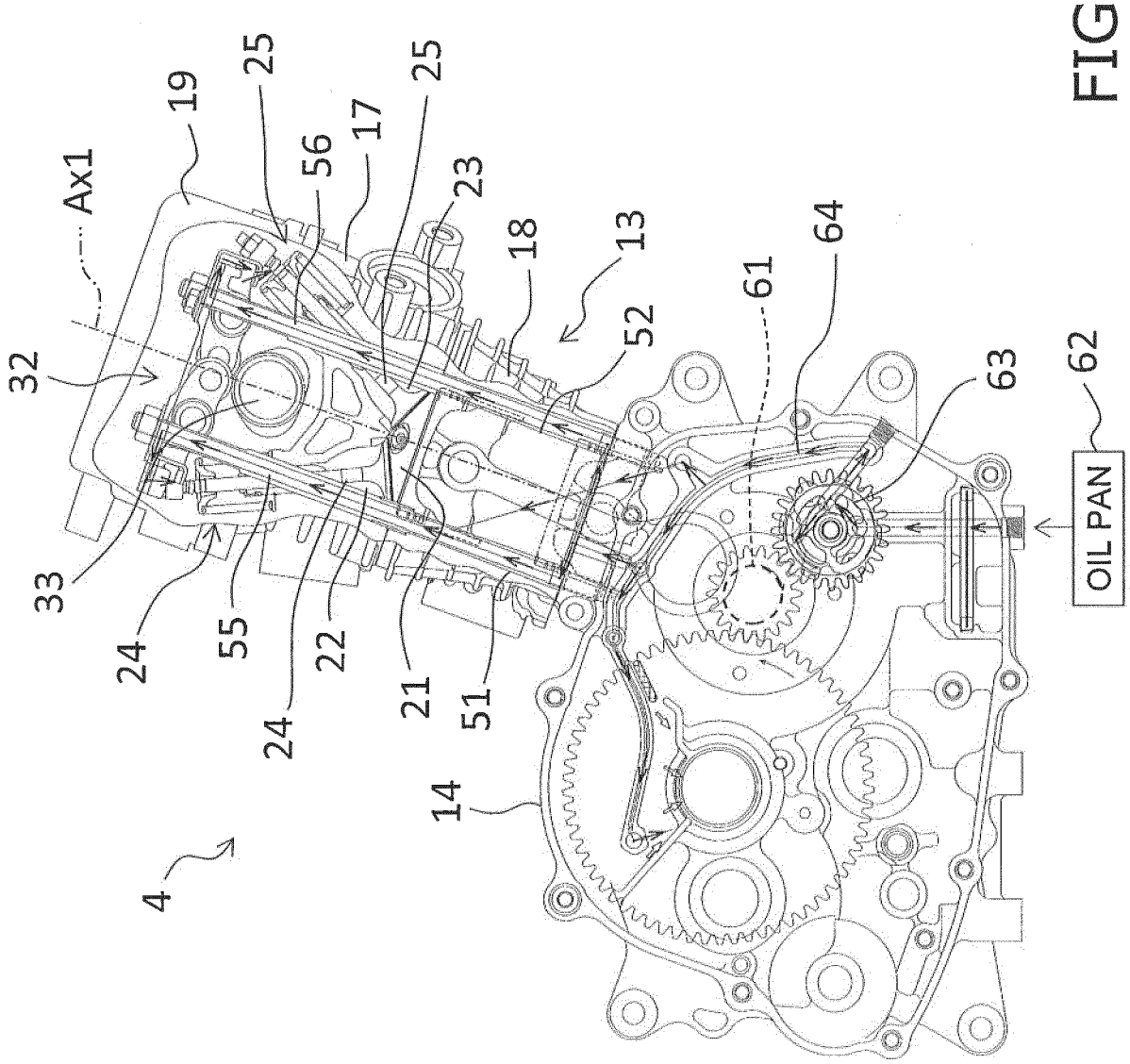
Ax1
19
25
56
17
25
23
18
13
64
61
52
63
62
OIL PAN
32
33
24
55
22
24
21
51
14
4

FIG. 2

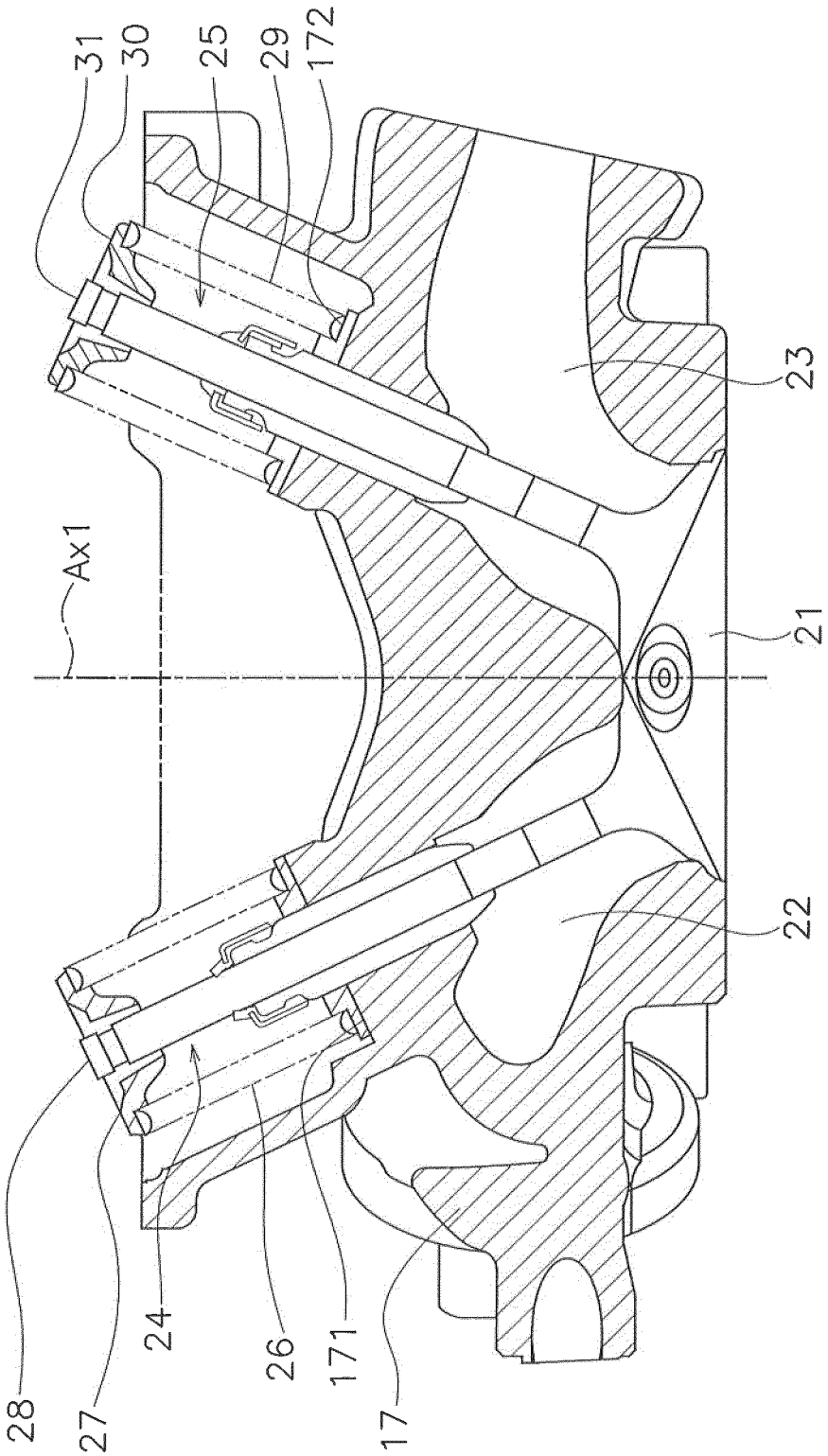

FIG. 3

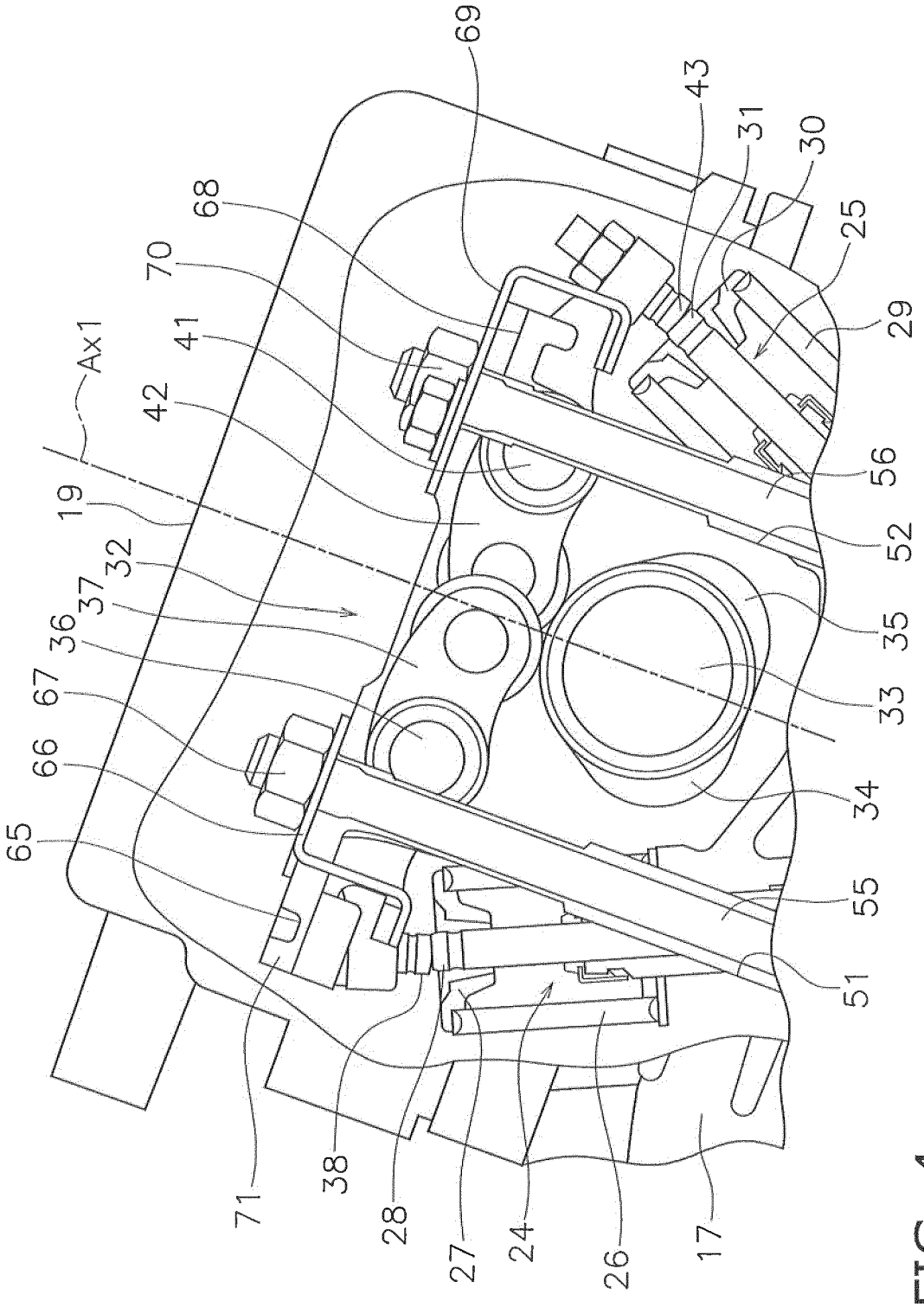
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FIG. 4

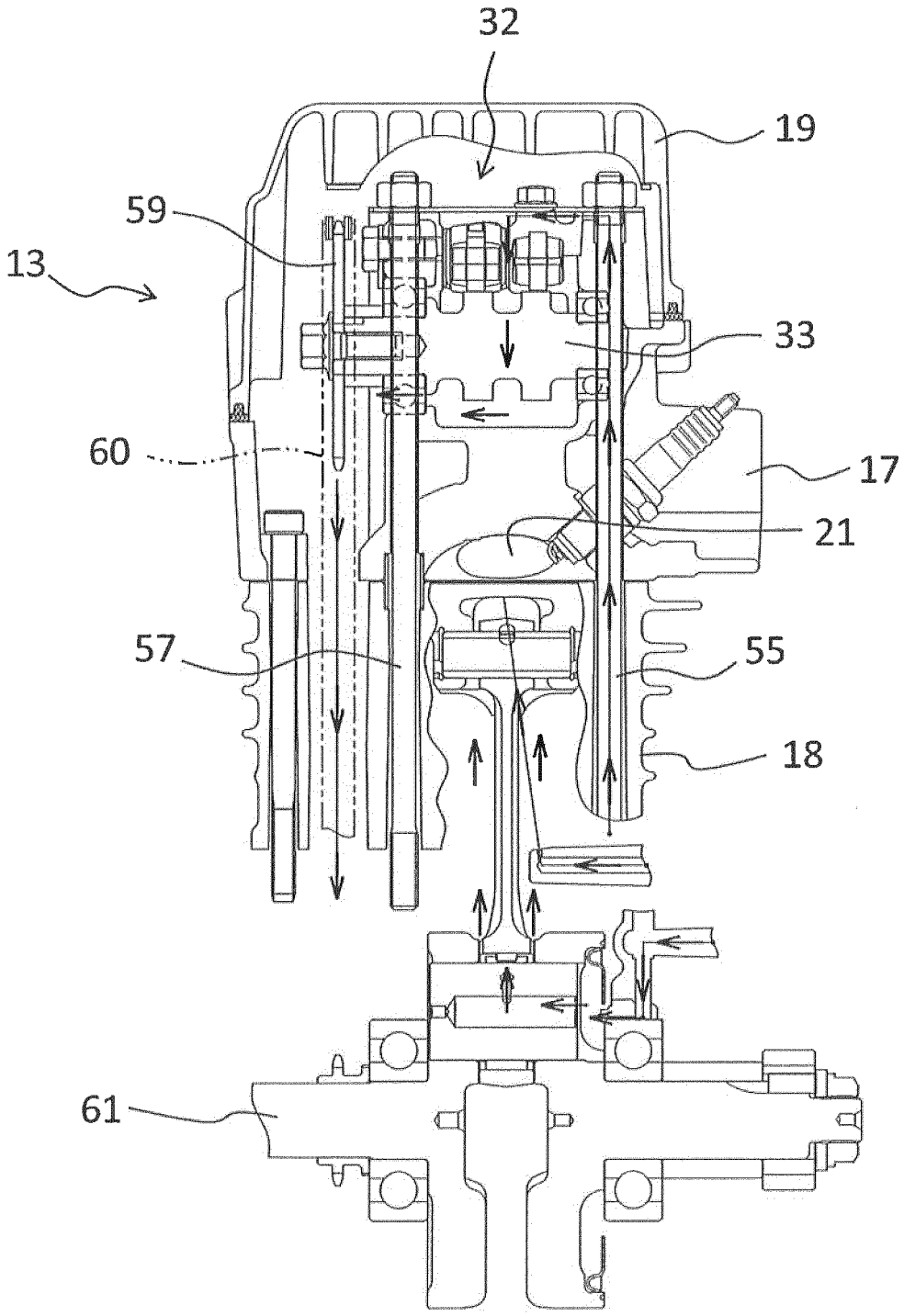

FIG. 5

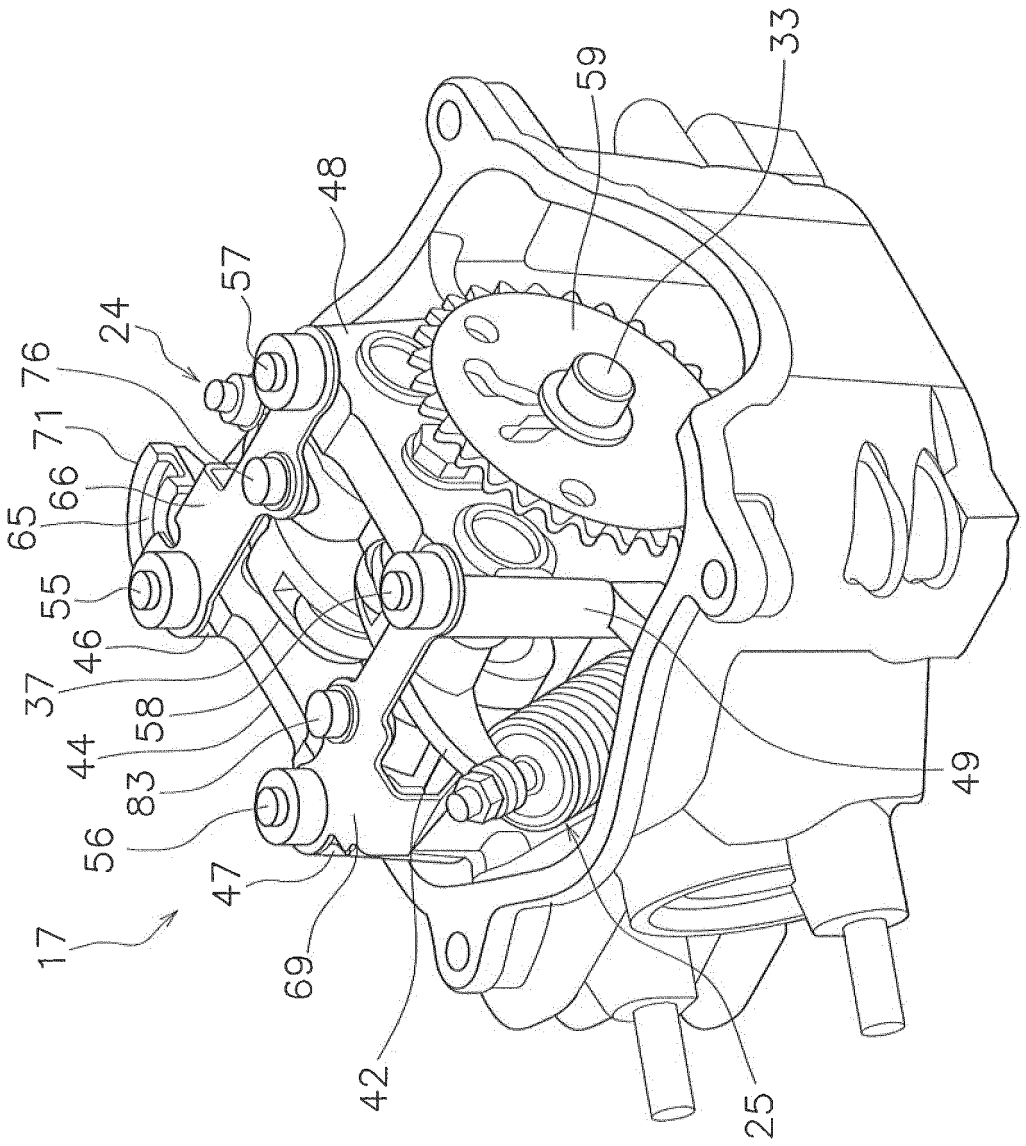

FIG. 6

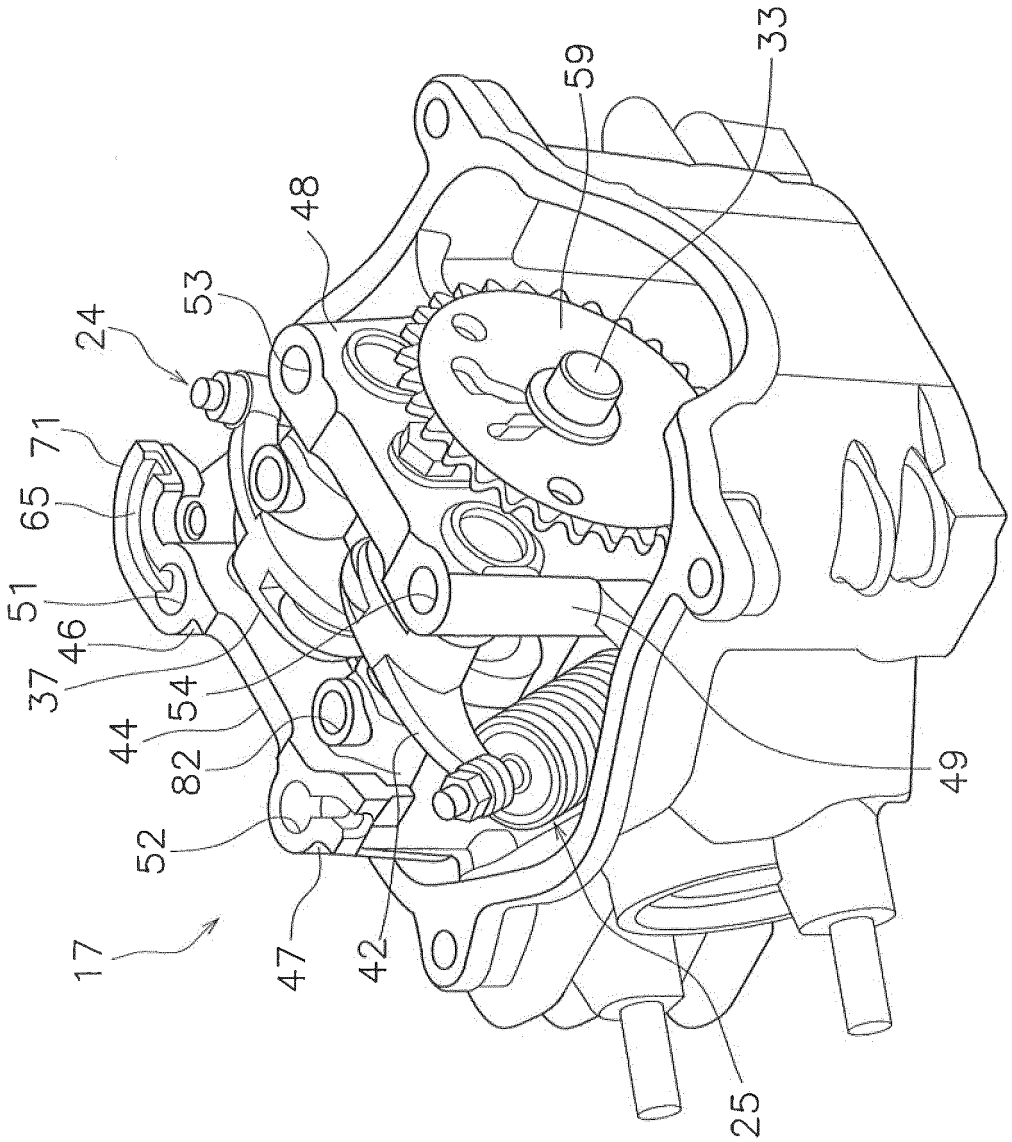

FIG. 7

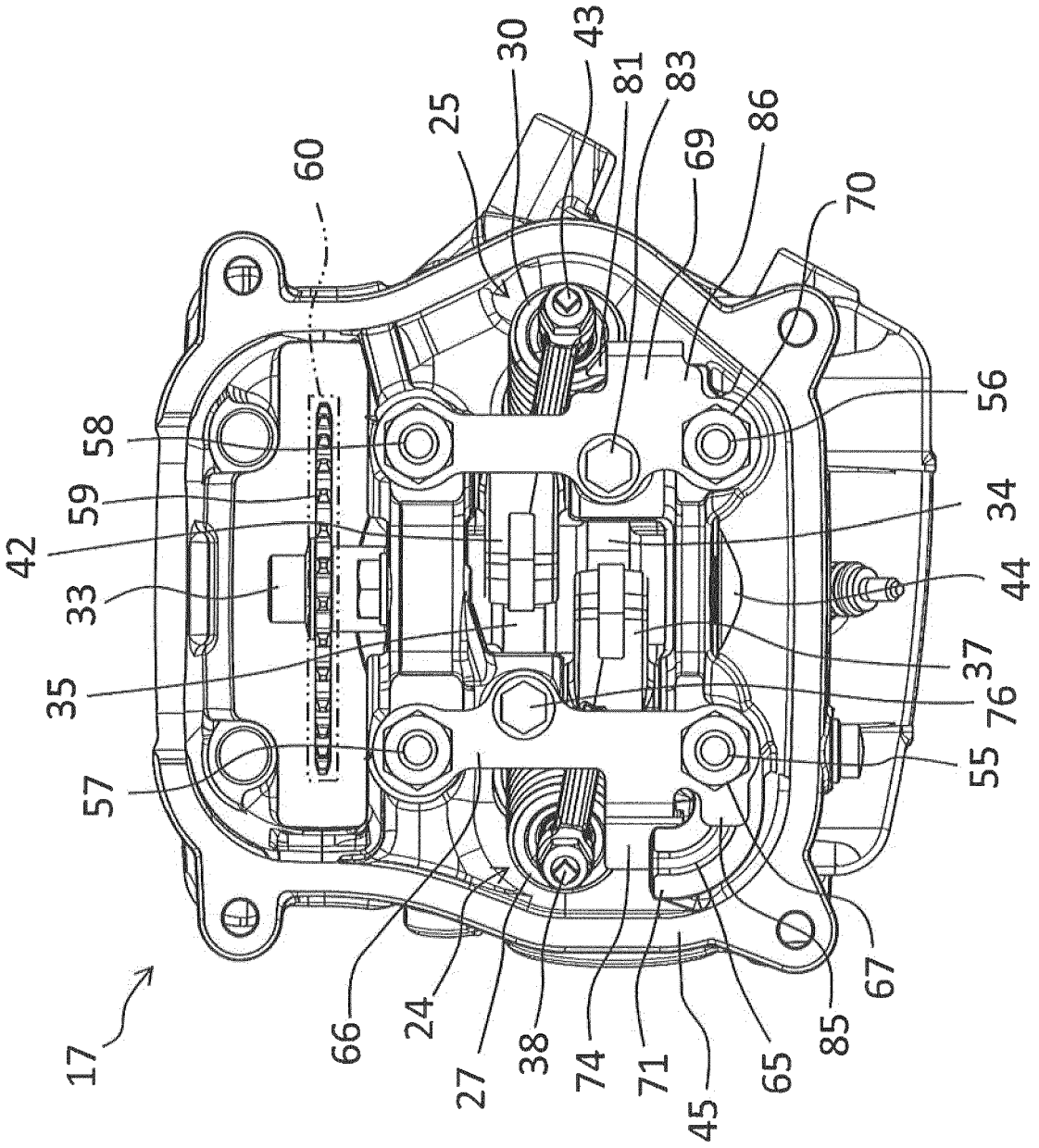
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FIG. 8

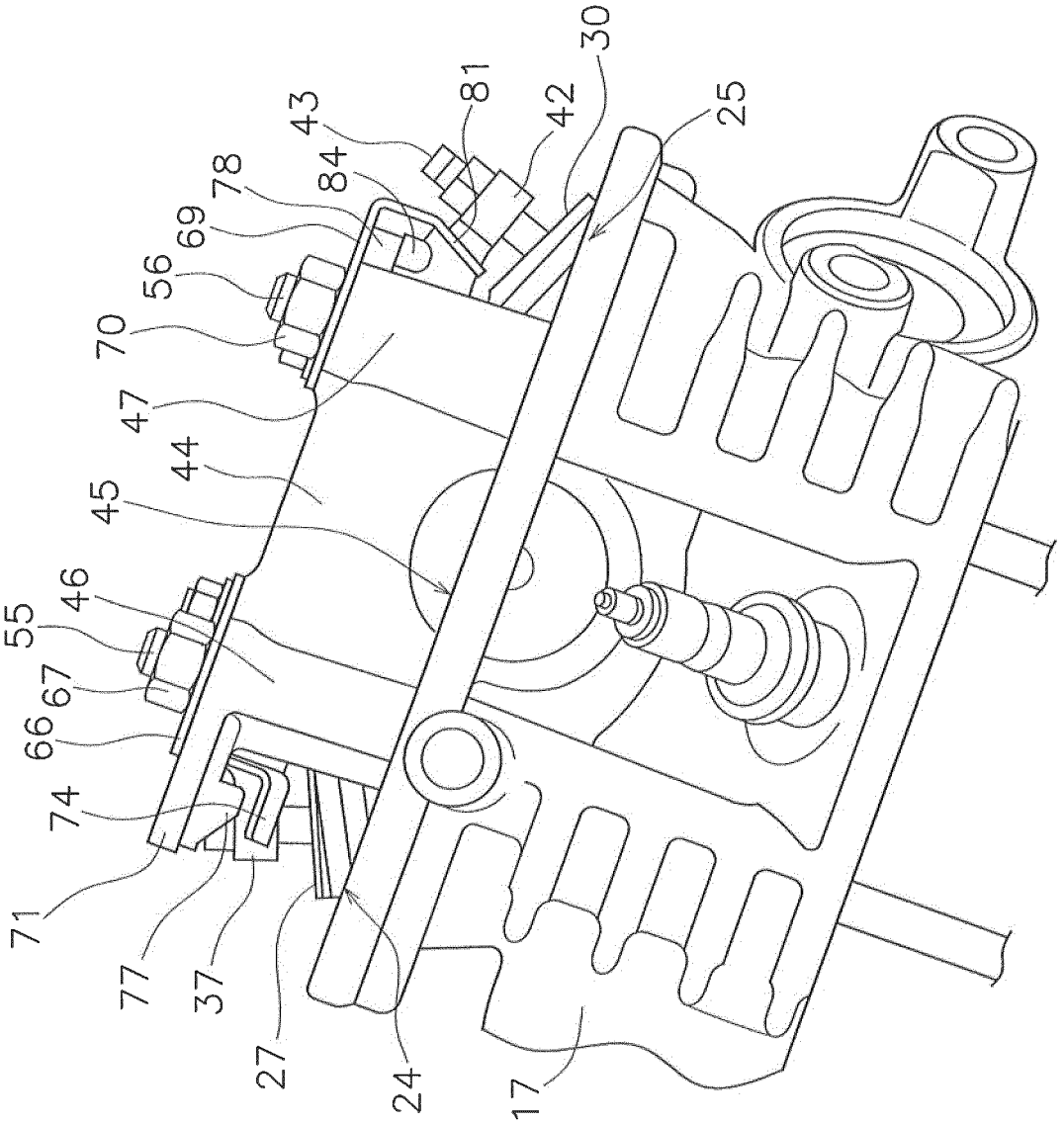

FIG. 9

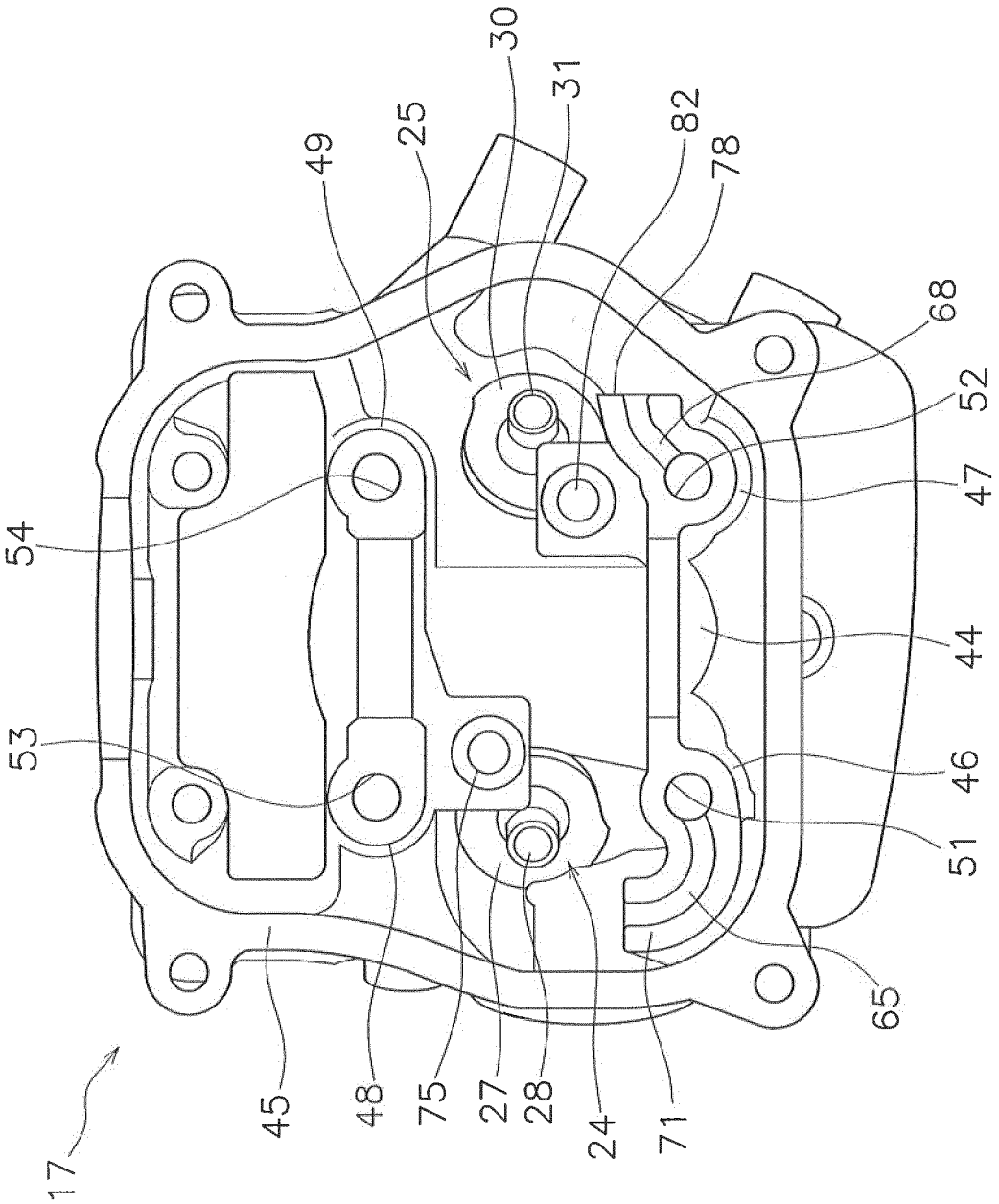

FIG. 10

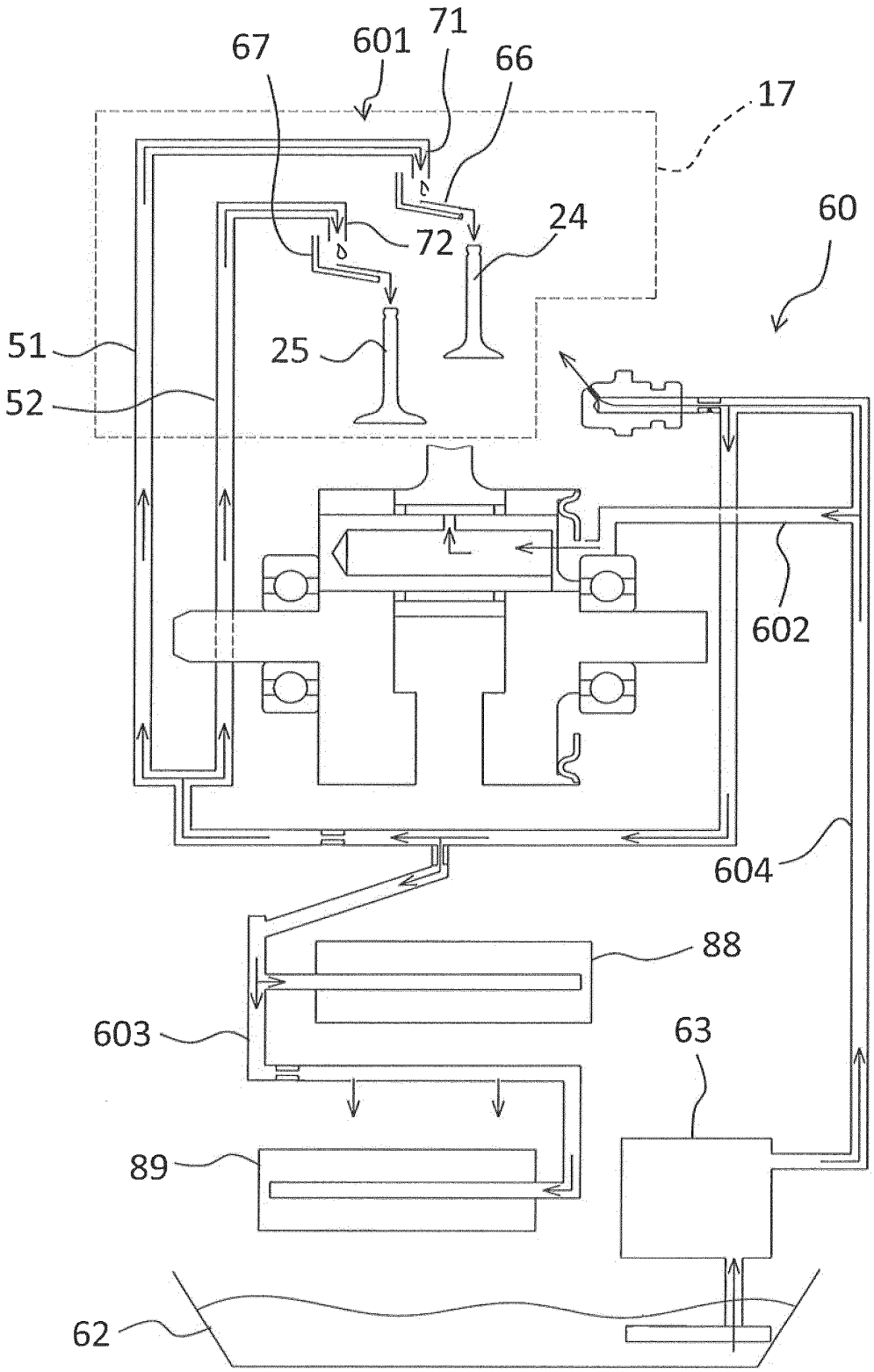

FIG. 11

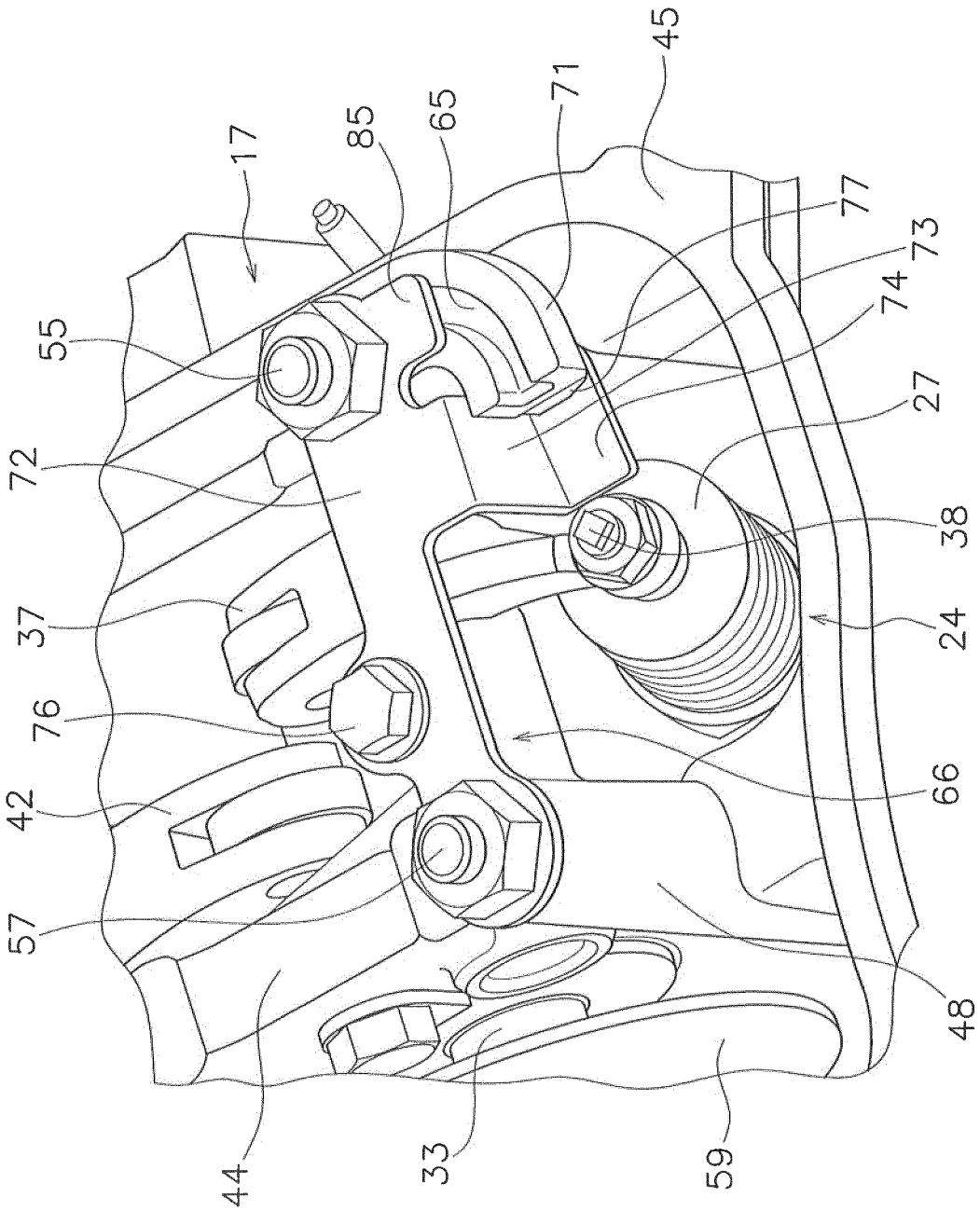

FIG. 12

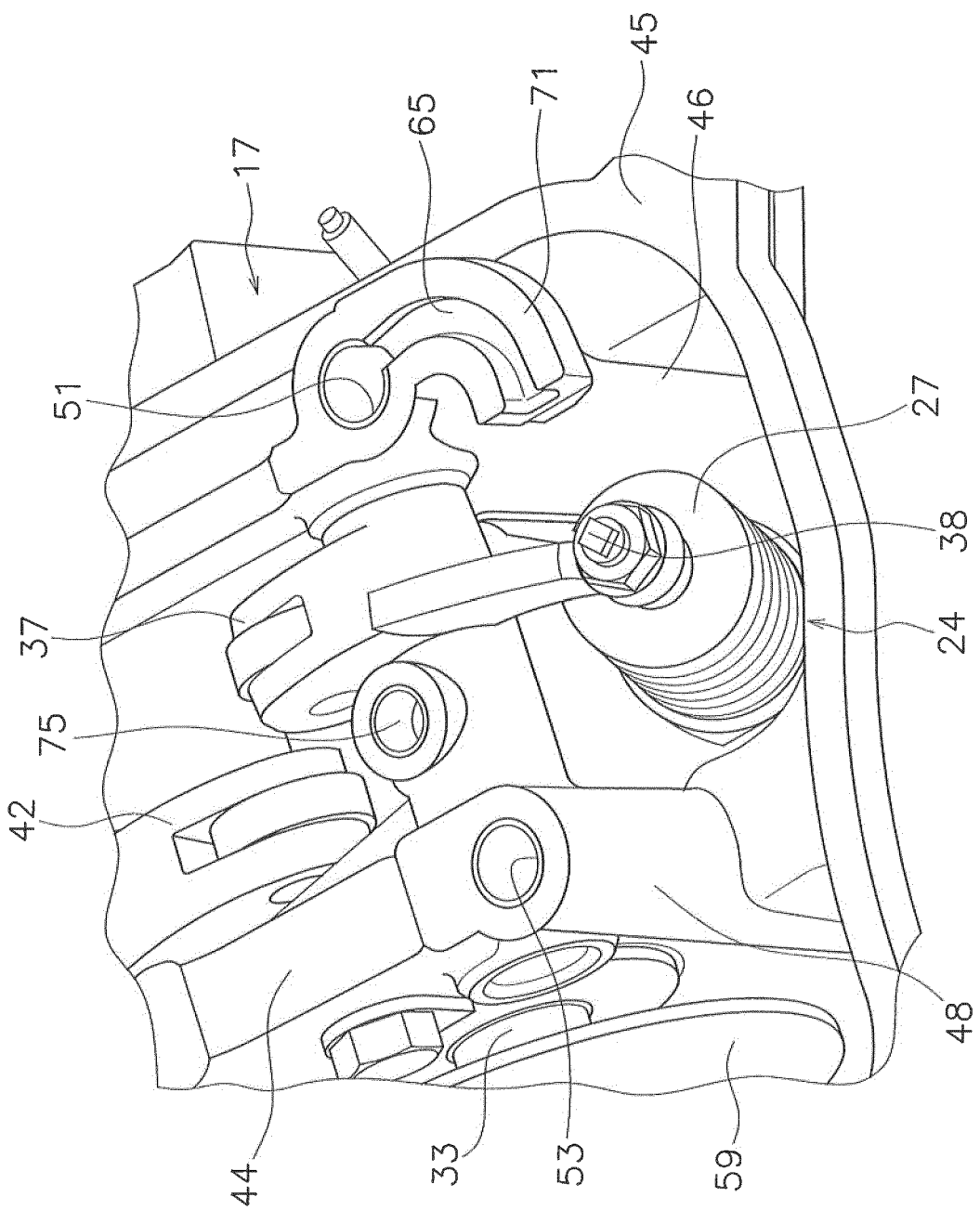

FIG. 13

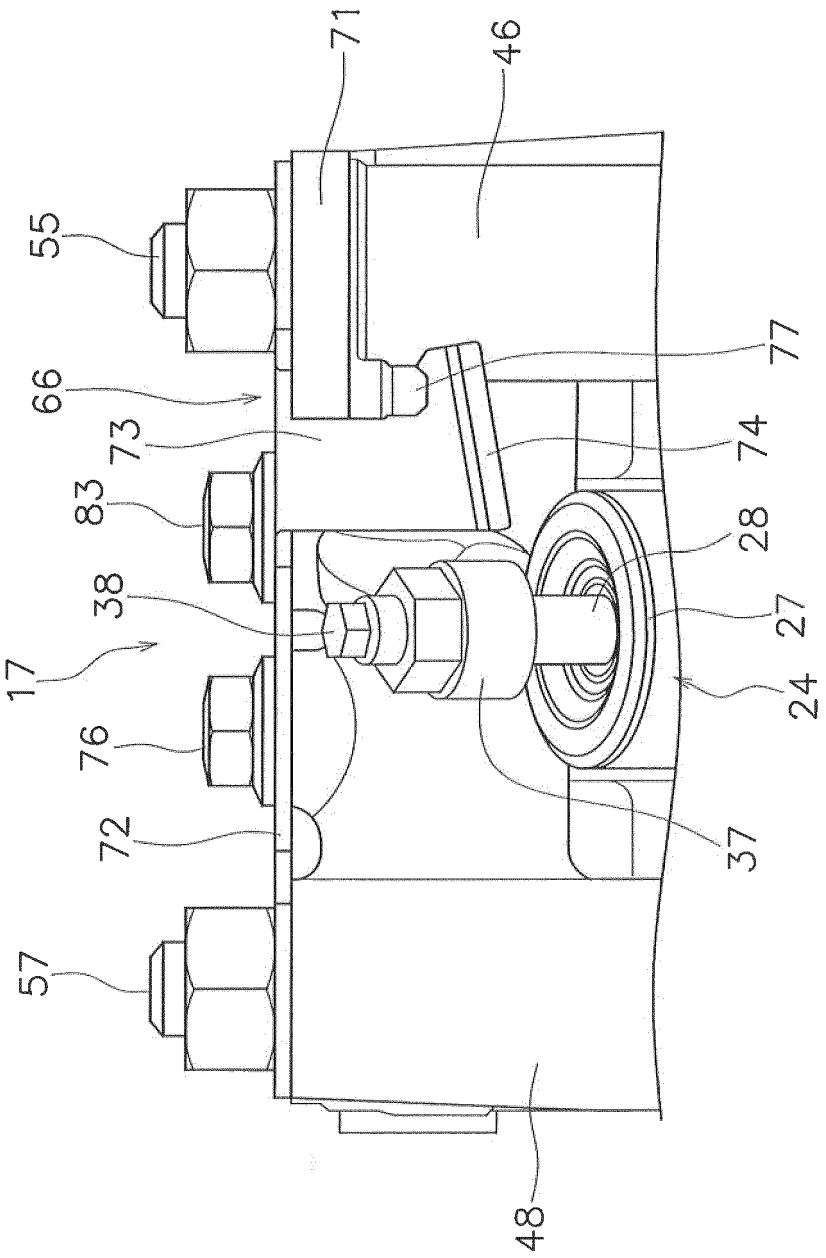

FIG. 14

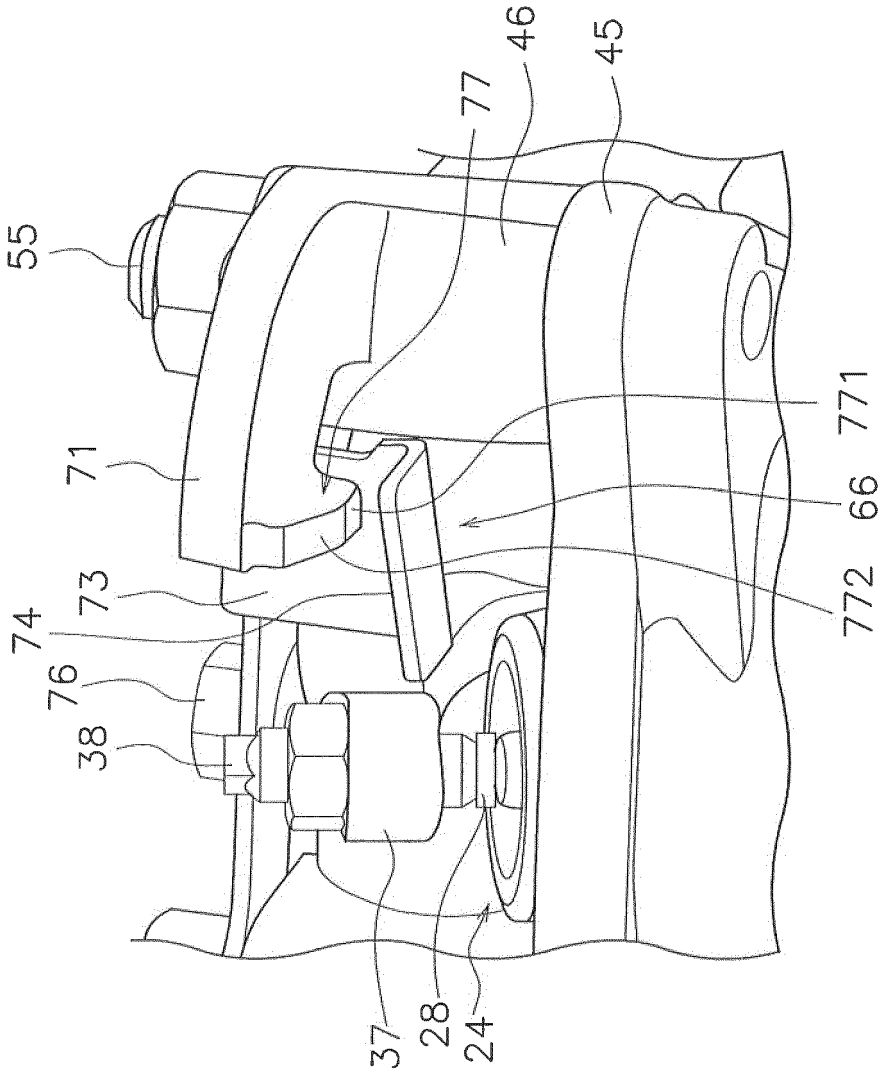

FIG. 15

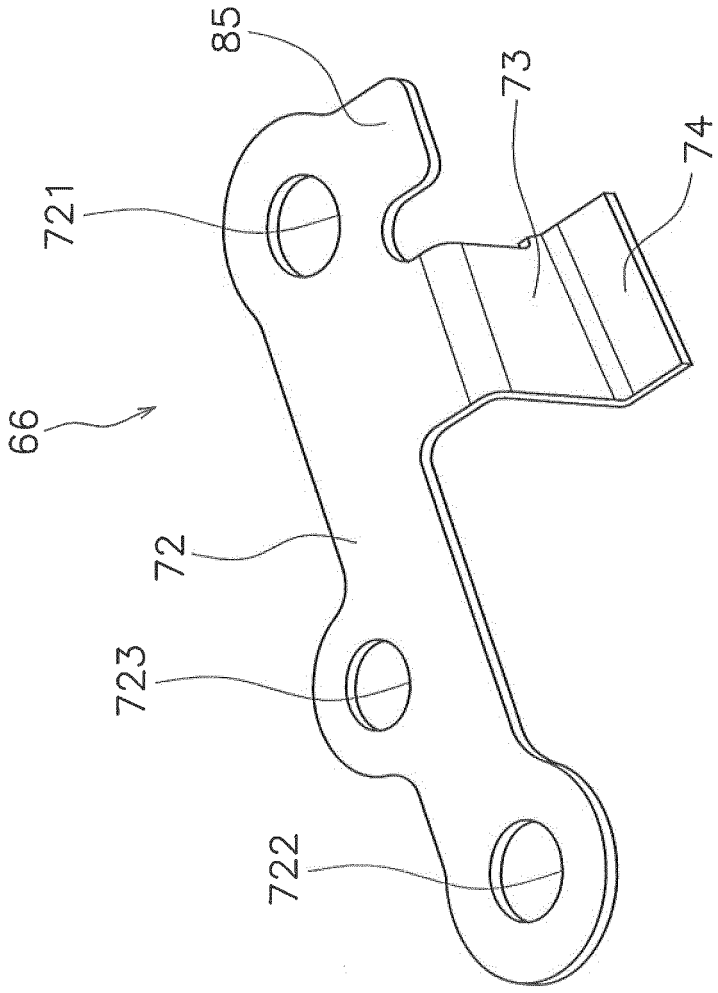

FIG. 16

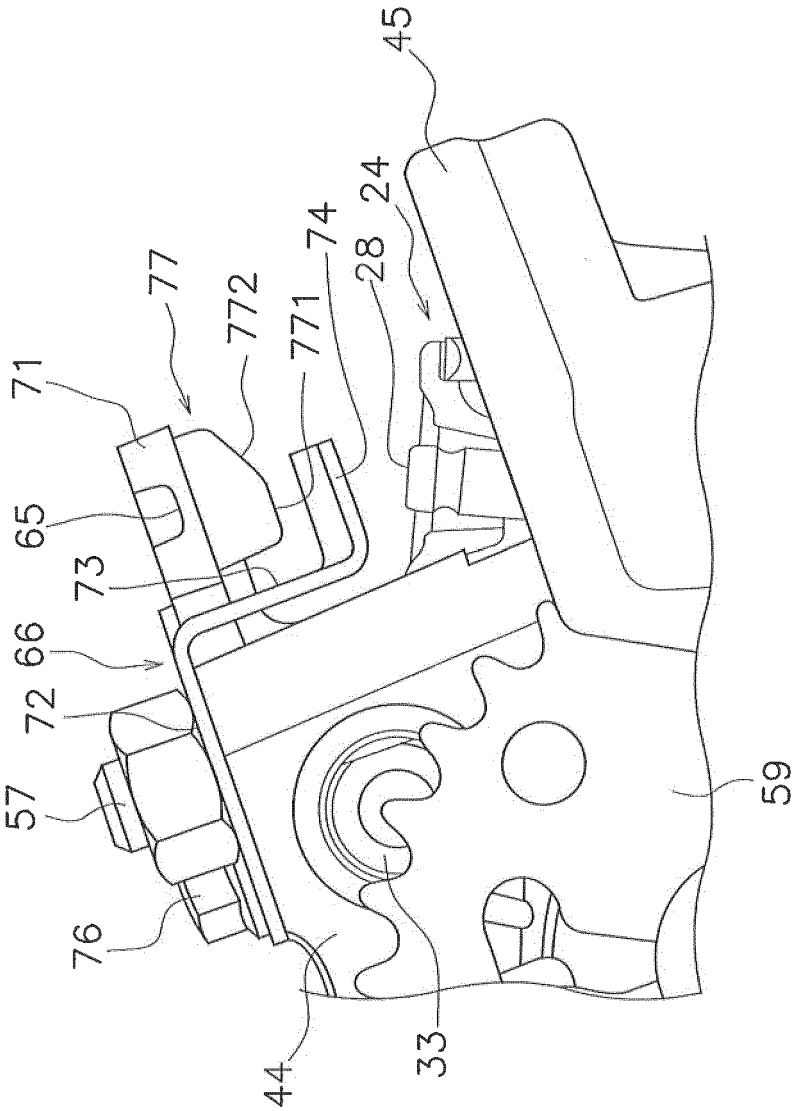

FIG. 17

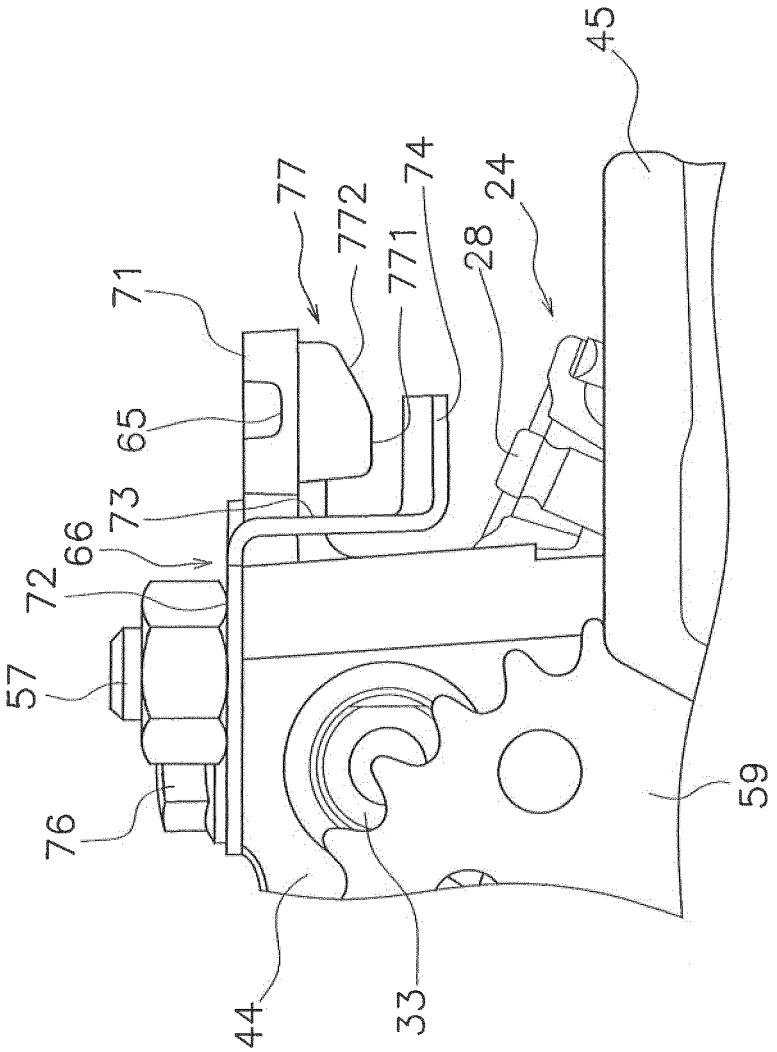

FIG. 18

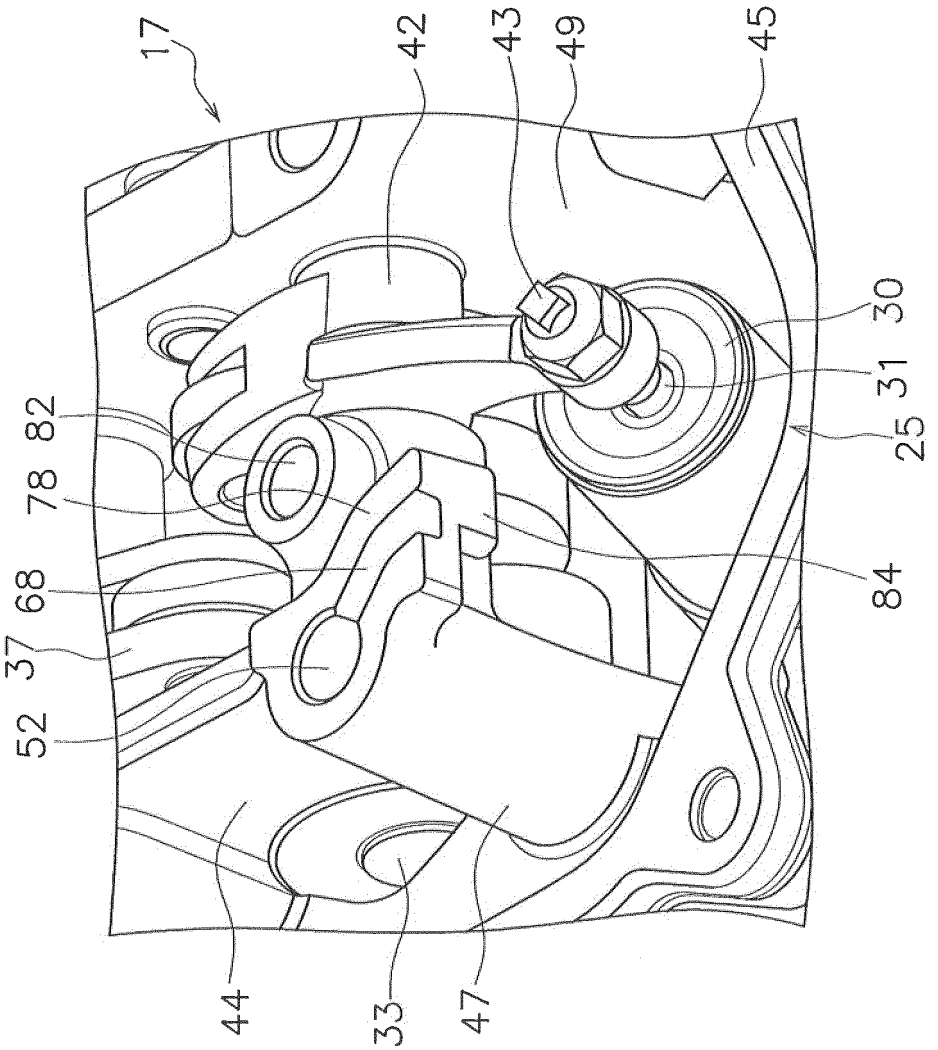

FIG. 19

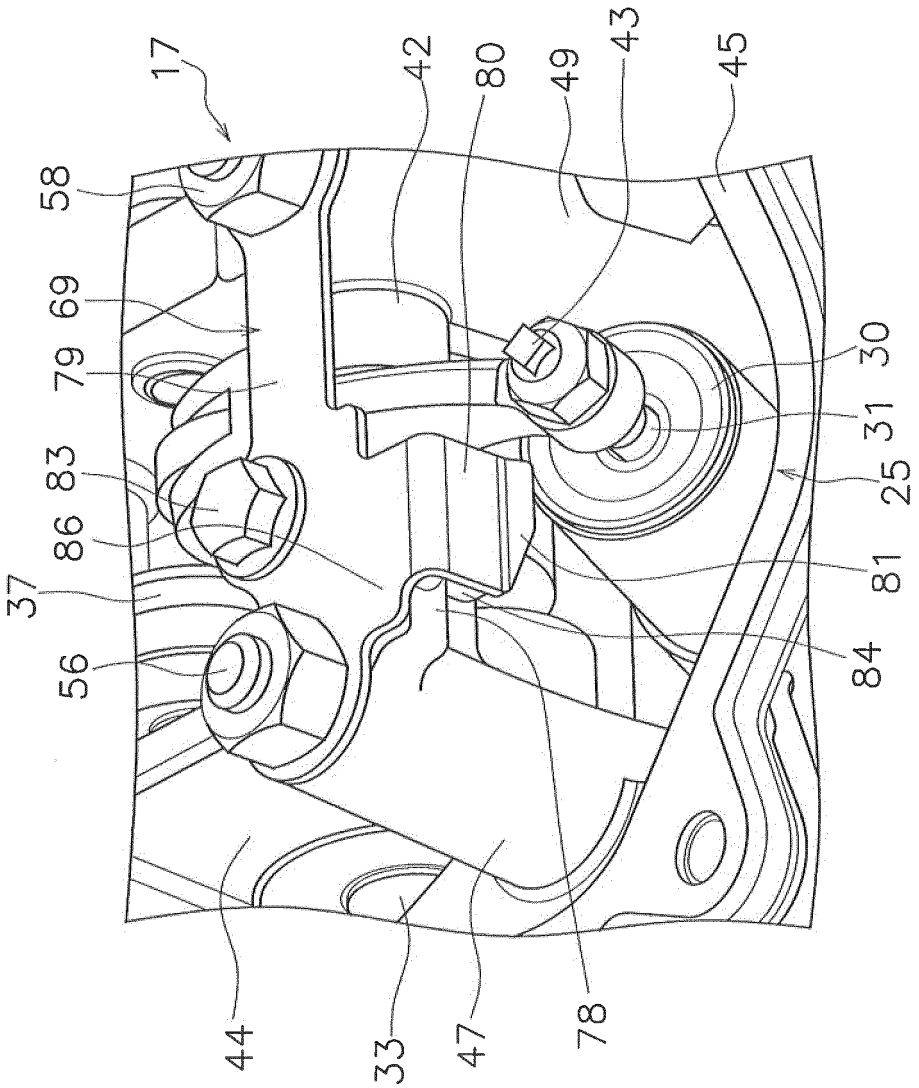

FIG. 20

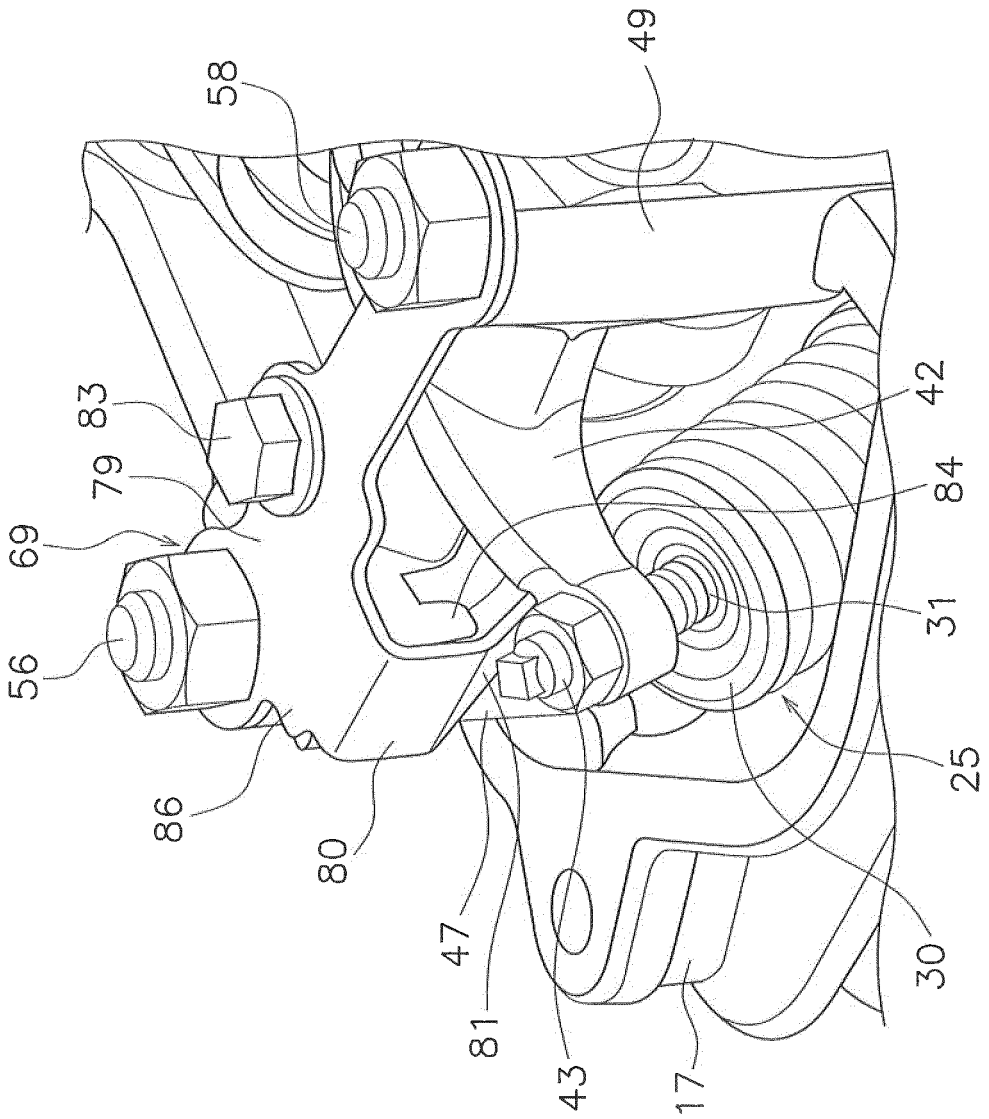

FIG. 21

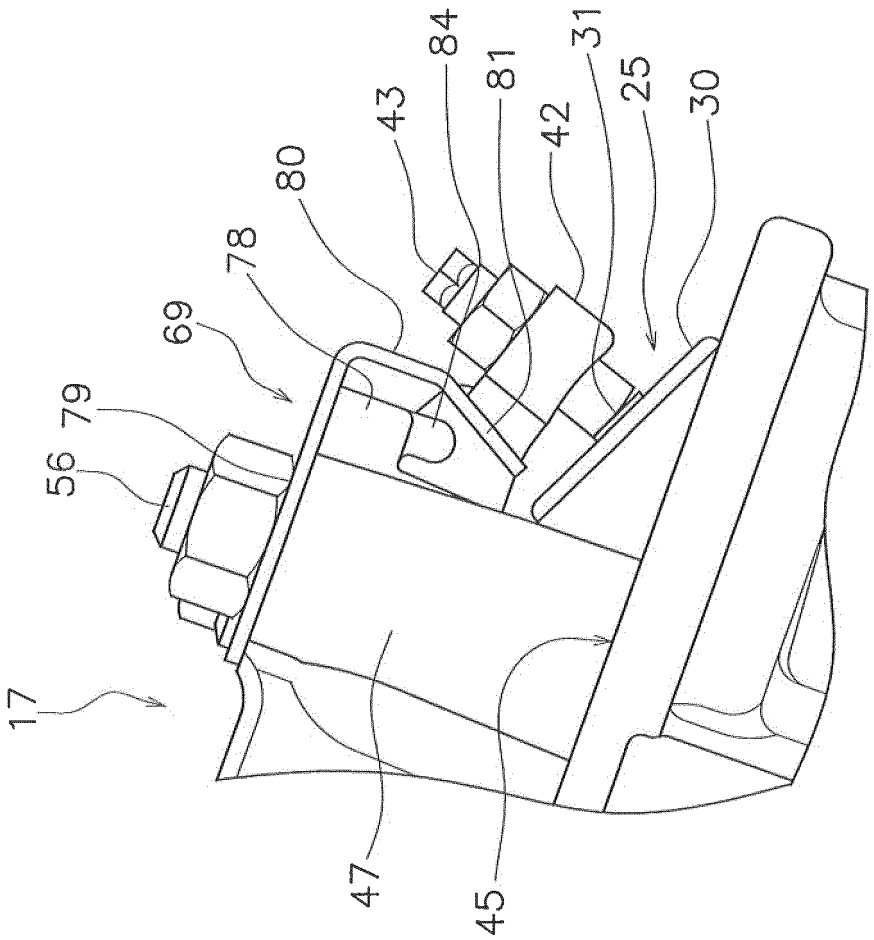

FIG. 22

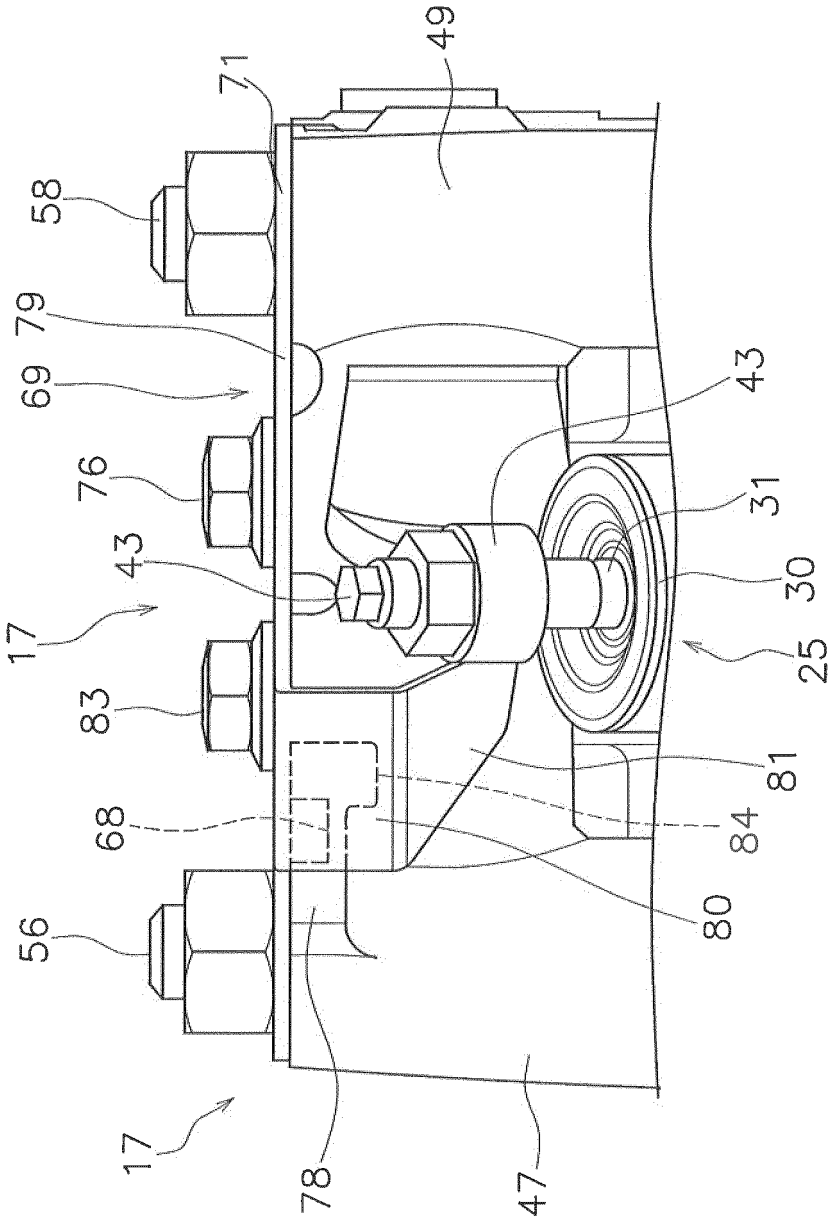

FIG. 23

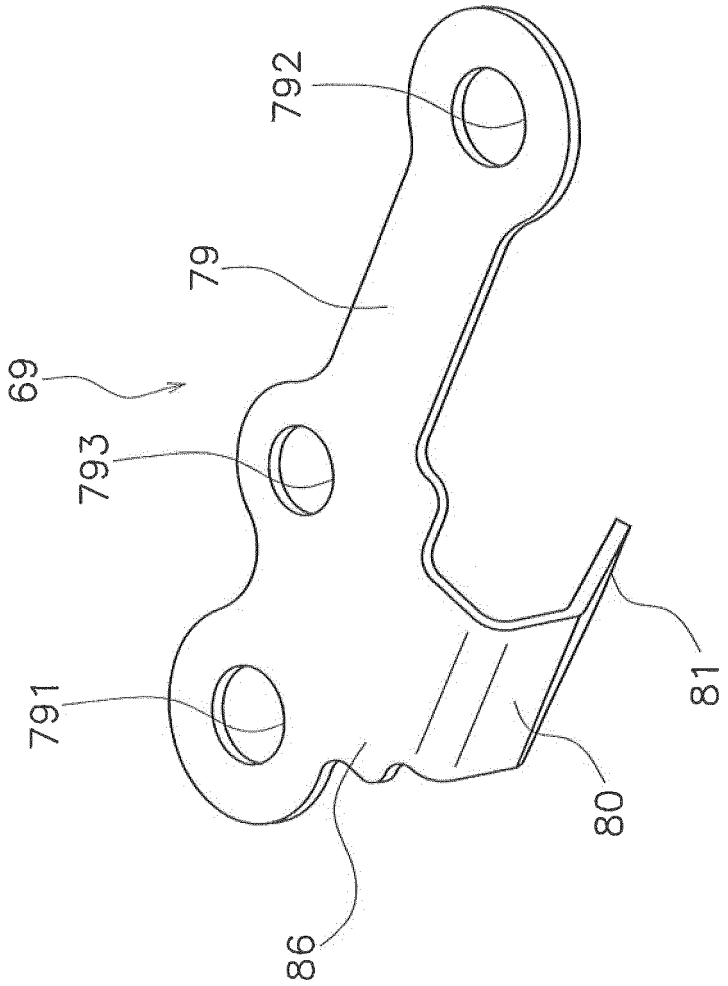

FIG. 24

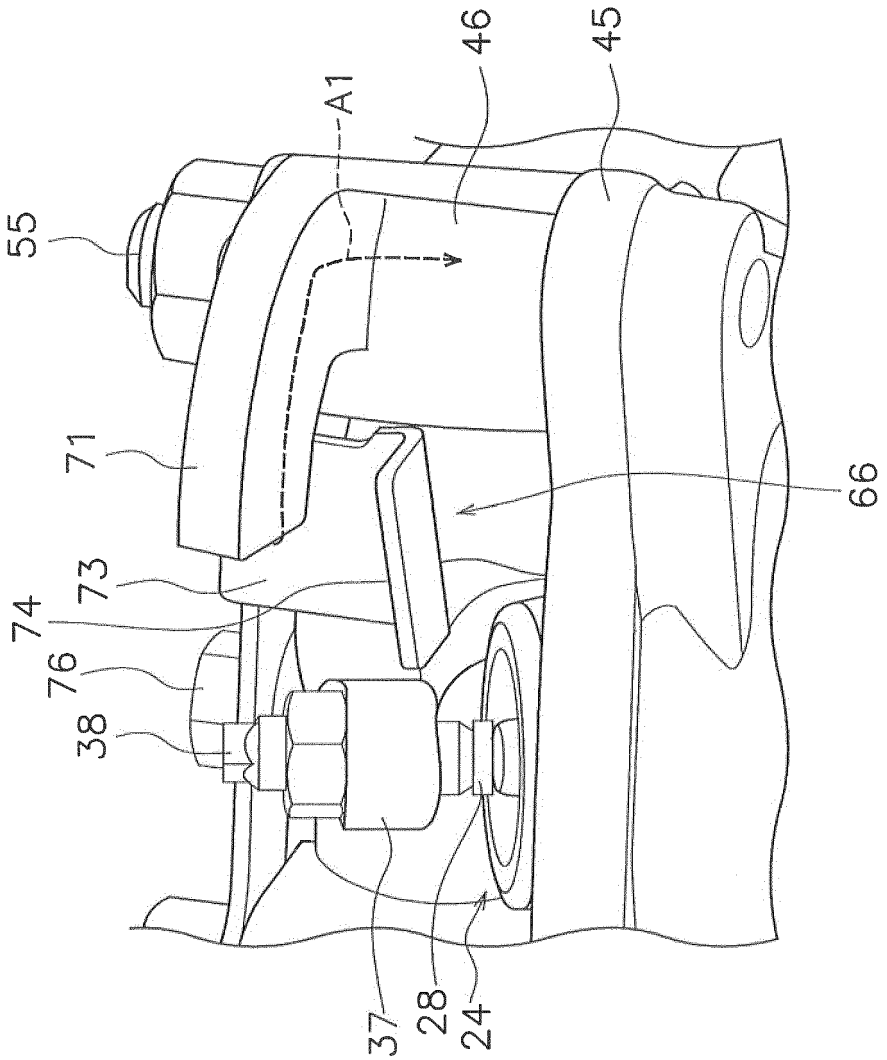

FIG. 25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/062539

A. CLASSIFICATION OF SUBJECT MATTER
F01M9/10(2006.01)i, *F01M1/06*(2006.01)i, *F01M9/08*(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)
F01L3/18, F01M1/00-9/12, F01P3/14

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.
A	JP 2008-82311 A (Honda Motor Co., Ltd.), 10 April 2008 (10.04.2008), paragraphs [0040] to [0043]; fig. 3 (Family: none)	1-15
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 124327/1982(Laid-open No. 28615/1984) (Honda Motor Co., Ltd.), 22 February 1984 (22.02.1984), page 8, line 6 to page 9, line 13; fig. 3 to 10 (Family: none)	1-15

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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2016 (20.06.16)	28 June 2016 (28.06.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/062539

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-215939 A (Fuji Heavy Industries Ltd.), 24 September 2009 (24.09.2009), page 8, lines 2 to 3; fig. 3 (Family: none)	1-15
A	US 2010/0326393 A1 (REINHART, Paul T.), 30 December 2010 (30.12.2010), abstract; fig. 1 to 2 & DE 102010024270 A	1-15

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

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Patent documents cited in the description

- JP 2012246839 A **[0007]**
- JP 2008082311 A **[0007]**