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(54) Fuel pump unit and vehicle

(57) A fuel pump unit (20) includes a case (31), a partition portion (32), an inlet port (44) and a fuel pump (33). The case (31) includes a discharge port (37) from which a fuel is discharged and a return port (38) to which an excess fuel is returned. The partition portion (32) divides an inner space (35) of the case (31) into a return fuel chamber (39) and a main fuel chamber (40). The return port (38) is disposed in the return fuel chamber (39). The main fuel chamber (40) is communicated with the outside of the case (31). The inlet port (44) is disposed within the return fuel chamber (39). The fuel pump (33) is configured to inhale the fuel through the inlet port (44) and discharge the fuel through the discharge port (37).

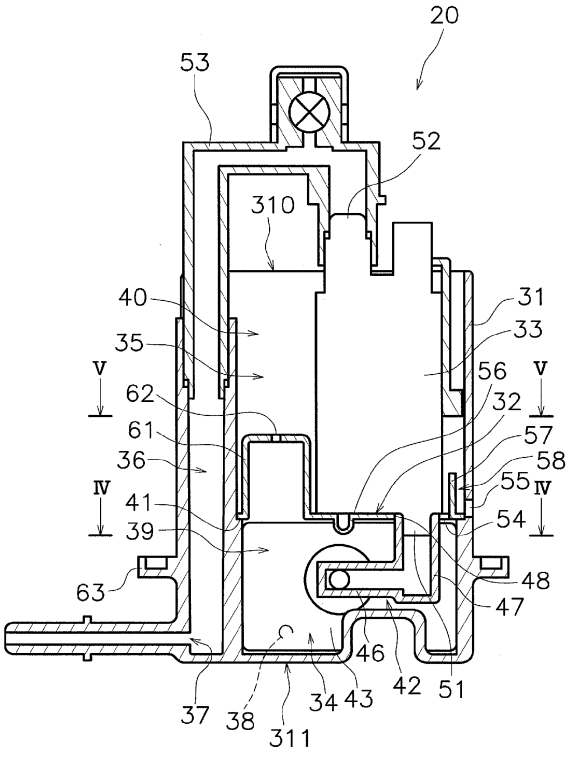

FIG. 3

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Description

Technical Field

[0001] The present invention relates to a fuel pump unit and a vehicle.

Background Art

[0002] In supplying a fuel to a vehicle embedded with an engine in which various fuels are usable, a fuel remaining therein is mixed with the supplied fuel. Thus, the fuel composition is changed. Therefore, it is preferable to control an air-fuel ratio of the engine in accordance with the fuel composition.

[0003] For example, Japan Laid-open Patent Application Publication No. JP-A-S63-5131 describes a technology that an air-fuel ratio is controlled in accordance with an alcohol content rate in an engine in which an alcohol-containing fuel is usable. Specifically, in the technology of the Publication No. JP-A-S63-5131, an oxygen sensor is configured to detect an oxygen concentration in an exhaust gas. Further, a computer is configured to compute an air-fuel ratio suitable for the oxygen concentration. When the alcohol content rate is changed, the oxygen concentration in the exhaust gas is changed. In this case, the computer is configured to compute an air-fuel ratio suitable for the changed oxygen concentration. Accordingly, even when the alcohol content rate is changed, the air-fuel ratio of the engine is controlled in accordance with the changed alcohol content rate.

[0004] However, it is not easy for the technology of the Publication No. JP-A-S63-5131 to execute a fuel injection control based on a new fuel composition in starting the engine. This is because the temperature of the oxygen sensor is low in starting the engine, and thereby, the oxygen concentration cannot be detected with a sufficient accuracy.

[0005] In view of the above, Japan Laid-open Patent Application Publication No. JP-A-2009-209909 proposes a fuel supply device for solving the aforementioned drawback. The fuel supply device includes a pipe connecting a fuel pump and a fuel injection device. Further, the pipe has a volume greater than or equal to the fuel consumption amount to be consumed until the temperature of the oxygen sensor goes up to a temperature high enough to measure the oxygen concentration after starting of the engine.

[0006] In the fuel supply device, the oxygen sensor is warmed by the exhaust gas until the fuel within the pipe is completely consumed after starting of the engine. The fuel, remaining within the pipe in starting the engine, is a fuel that the composition thereof has not been changed by the fuel supply. Therefore, immediately after starting of the engine, a fuel injection control can be executed based on the heretofore known fuel composition of a pre-fuel supply state.

SUMMARY OF INVENTION

[0007] It is an object of the present invention to provide a small-sized easily attachable fuel pump unit allowing to suppress the impact attributed to change in a fuel composition on a fuel injection control.
This object is achieved by the fuel pump unit according to claim 1.

[0008] In the fuel supply device of the Publication No. JP-A-2009-209909, the pipe connecting the fuel pump and the fuel injection device is required to reliably have a large volume. Therefore, a drawback is produced that the size of the fuel supply device is increased. Further, when the volume of the pipe is increased, this exerts impact on the layout of the devices disposed around the pipe. Consequently, it becomes difficult to attach the fuel supply device to the vehicle.

[0009] A fuel pump unit according to a first aspect includes a case, a partition portion, an inlet port and a fuel pump. The case includes: a discharge port from which a fuel is discharged; and a return port to which an excess fuel is retuned. The partition portion divides an inner space of the case into a return fuel chamber and a main fuel chamber. The return port is disposed in the return fuel chamber. The main fuel chamber is communicated with an outside of the case. The inlet port is disposed within the return fuel chamber. The fuel pump is configured to inhale the fuel through the inlet port and discharge the fuel through the discharge port.

[0010] A fuel pump unit according to a second aspect relates to the fuel pump unit according to the first aspect, and further includes a filter to be attached to the inlet port. The filter is disposed in opposition to the return port within the return fuel chamber.

[0011] A fuel pump unit according to a third aspect relates to the fuel pump unit according to the first or second aspect, and wherein the partition portion includes a first opening making the main fuel chamber and the return fuel chamber communicate with each other.

[0012] A fuel pump unit according to a fourth aspect relates to the fuel pump unit according to the third aspect, and wherein the fuel pump is positioned between the first opening and the inlet port.

[0013] A fuel pump unit according to a fifth aspect relates to the fuel pump unit according to the third or fourth aspect, and wherein a path length from the first opening to the inlet port is longer than a path length from the return port to the inlet port.

[0014] A fuel pump unit according to a sixth aspect relates to the fuel pump unit according to any of the third to fifth aspects, and further includes a vertical wall portion. The case includes a second opening in a lateral-side portion thereof. The second opening makes the main fuel chamber and the outside of the case communicate with each other. The vertical wall portion is disposed between the first opening and the second opening.

[0015] A fuel pump unit according to a seventh aspect relates to the fuel pump unit according to any of the first

to fifth aspects, and further includes a vertical wall portion. The case includes a second opening in a lateral-side portion thereof. The second opening makes the main fuel chamber and the outside of the case communicate with each other. The vertical wall portion is disposed in opposition to the second opening.

[0016] A fuel pump unit according to an eighth aspect relates to the fuel pump unit according to the sixth or seventh aspect, and wherein the vertical wall portion is integrally provided with the partition portion.

[0017] A fuel pump unit according to a ninth aspect relates to the fuel pump unit according to any of the first to eighth aspects, and the partition portion divides an inside of the case up and down. The return fuel chamber is positioned below the partition portion.

[0018] A fuel pump unit according to a tenth aspect relates to the fuel pump unit according to the ninth aspect, and wherein the partition portion includes a convex portion protruded upwards. The convex portion includes an aperture penetrating through the partition portion.

[0019] A fuel pump unit according to an eleventh aspect relates to the fuel pump unit according to the tenth aspect, and wherein at least a portion of the convex portion is disposed between the return port and the inlet port.

[0020] A vehicle according to a twelfth aspect includes a fuel tank and the fuel pump unit according to any of the first to eleventh aspects. The fuel pump unit is attached to the fuel tank.

[0021] A vehicle according to a thirteenth aspect relates to the vehicle according to the twelfth aspect, and further includes a controller. The controller is configured to control the fuel pump by means of a PWM (Pulse Width Modulation) control. The controller is configured to reduce a discharge amount of the fuel pump in starting an engine.

Advantageous Effects of Invention

[0022] In the fuel pump unit according to the first aspect, the inlet port is disposed in the return fuel chamber. Therefore, in starting the engine, the fuel contained within the return fuel chamber is more preferentially supplied to the engine than that contained within the main fuel chamber. In starting the engine, the fuel contained within the return fuel chamber is the one that the composition thereof has not been changed by fuel supply. On the other hand, the fuel contained within the main fuel chamber is the one that the composition thereof has been changed by fuel supply. The return fuel chamber and the main fuel chamber are divided by the partition portion. Accordingly, the fuel contained within the return fuel chamber and that contained within the main fuel chamber are less easily mixed. Therefore, immediately after starting the engine, a fuel injection control can be executed based on the heretofore known fuel composition of a pre-fuel supply state. Further, it is not required to increase the volume of the pipe to be connected to the fuel pump. Therefore, the fuel pump unit can be compactly provided, while being easily attachable to the vehicle.

[0023] In the fuel pump unit according to the second aspect, the fuel returning through the return port can be further preferentially supplied to the engine.

[0024] In the fuel pump unit according to the third aspect, the fuel flows from the main fuel chamber to the return fuel chamber through the first opening. Further, the fuel is inhaled through the inlet port provided within the return fuel chamber and is then discharged through the discharge port. Thus, the fuel is supplied to the engine.

[0025] In the fuel pump unit according to the fourth aspect, the first opening is disposed farther away from the inlet port. Therefore, the fuel contained within the main fuel chamber is less easily mixed with that contained within the return fuel chamber. Accordingly, change of the fuel composition can be further suppressed low.

[0026] In the fuel pump unit according to the fifth aspect, with difference in length between paths, the fuel contained within the main fuel chamber is less easily mixed with that contained within the return fuel chamber. Accordingly, change of the fuel composition can be further suppressed low.

[0027] In the fuel pump unit according to the sixth aspect, the fuel contained outside the case, i.e., the fuel contained inside a fuel tank to which the fuel pump unit is attached, is supplied to the main fuel chamber through the second opening. The vertical wall portion interferes with the fuel flow from the second opening to the first opening. Therefore, the fuel contained within the main fuel chamber is less easily mixed with that contained within the return fuel chamber. Accordingly, change of the fuel composition can be further suppressed low.

[0028] In the fuel pump unit according to the seventh aspect, the fuel contained outside the case, i.e., the fuel contained inside a fuel tank to which the fuel pump unit is attached, is supplied to the main fuel chamber through the second opening. The vertical wall portion interferes with the fuel flow from the second opening to the main fuel chamber. Therefore, the fuel contained within the main fuel chamber is less easily mixed with that contained within the return fuel chamber. Accordingly, change of the fuel composition can be further suppressed low.

[0029] In the fuel pump unit according to the eighth aspect, the vertical wall portion and the partition portion can be easily provided.

[0030] In the fuel pump unit according to the ninth aspect, the fuel can be supplied to the engine from the return fuel chamber even when a small amount of fuel is only left in the fuel tank.

[0031] In the fuel pump unit according to the tenth aspect, it is possible to collect air bubbles, contained in the fuel contained within the return fuel chamber, in a space produced within the convex portion and release the air bubbles to the main fuel chamber through the aperture.

[0032] In the fuel pump unit according to the eleventh aspect, it is possible to efficiently release air bubbles, contained in the fuel returning through the return port, to

the main fuel chamber through the aperture.

[0033] In the vehicle according to the twelfth aspect, immediately after starting the engine, a fuel injection control can be executed based on the heretofore known fuel composition of a pre-fuel supply state. Further, the fuel pump unit is easily attachable to the fuel tank.

[0034] In the vehicle according to the thirteenth aspect, the discharge amount of the fuel pump is reduced in starting the engine. In other words, the amount of fuel returning to the return fuel chamber is reduced. Accordingly, the fuel can be inhibited from being agitated in the return fuel chamber. Therefore, the fuel contained within the main fuel chamber is less easily mixed with that contained within the return fuel chamber. Accordingly, change of the fuel composition can be further suppressed low.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] FIG. 1 is a side view of a vehicle according to an exemplary embodiment;

[0036] FIG. 2 is a schematic diagram representing a fuel supply system embedded in the vehicle;

[0037] FIG. 3 is a cross-sectional side view of a fuel pump unit according to the exemplary embodiment;

[0038] FIG. 4 is a cross-sectional view of the fuel pump unit taken along a line IV-IV in FIG. 3;

[0039] FIG. 5 is a cross-sectional view of the fuel pump unit taken along a line V-V in FIG. 3; and

[0040] FIG. 6 is a cross-sectional side view of the fuel pump unit according to a modification.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0041] FIG. 1 illustrates a vehicle 1 according to an exemplary embodiment. FIG. 1 is a side view of the vehicle 1. The vehicle 1 is a motorcycle. It should be noted that in the following explanation, the terms "front", "rear", "left" and "right" mean corresponding directions seen from a rider riding on the vehicle 1 unless especially explained. The vehicle 1 includes a vehicle body frame 2, an engine 3, a seat 4, a fuel tank 5, a front wheel 6 and a rear wheel 7.

[0042] The vehicle body frame 2 includes a head pipe 11, a front frame 16 and a rear frame 17. A front fork 14 is supported by the head pipe 11. A handle 15 is fixed to the upper end of the front fork 14. Further, a head light unit 13 is disposed forwards of the head pipe 11. The front wheel 6 is rotatably supported by the lower portion of the front fork 14. A front fender 8 is disposed above the front wheel 6.

[0043] The front frame 16 is provided by pipe-shaped members bent at a plurality of positions. A swing arm 12 is coupled to the rear end of the front frame 16, while being pivotable up and down. The rear wheel 7 is rotatably supported by the rear end of the swing arm 12.

[0044] The rear frame 17 is provided by a pair of right and left pipe-shaped members. It should be noted that FIG. 1 illustrates only the left-positioned one of the right and left pipe-shaped members. The rear frame 17 is connected to the front frame 16, while being extended rearwards from the front frame 16.

[0045] The seat 4 and the fuel tank 5 are attached to the upper portion of the vehicle body frame 2. The fuel tank 5 is disposed forwards of the seat 4. The fuel tank 5 is disposed above the front frame 16. The seat 4 is disposed above the rear frame 17.

[0046] The engine 3 is configured to transmit a driving force to the rear wheel 7 through a chain (not illustrated in the figures). The engine 3 is disposed below the fuel tank 5, while being supported by the front frame 16.

[0047] FIG. 2 is a schematic diagram of a fuel supply system embedded in the vehicle 1. The fuel supply system includes a fuel pump unit 20, a fuel filter 21, a fuel pressure regulator 22, a fuel injection device 23, an oxygen sensor 24 and a controller 25. The fuel pump unit 20 is attached to the fuel tank 5. The fuel pump unit 20 and the fuel filter 21 are connected through a first fuel pipe 26. The fuel pump unit 20 is configured to discharge the fuel contained within the fuel tank 5 to the first fuel pipe 26. The fuel filter 21 is configured to filter the fuel. The fuel filter 21 and the fuel pressure regulator 22 are connected through a second fuel pipe 27. The fuel pressure regulator 22 is configured to maintain the fuel within a third fuel pipe 28 at a predetermined pressure. The fuel pressure regulator 22 and the fuel injection device 23 are connected through the third fuel pipe 28. The fuel injection device 23 is configured to inject the fuel into the air existing within an induction pipe of the engine 3. Further, the fuel pressure regulator 22 and the fuel pump unit 20 are connected through a return fuel pipe 29. An excess fuel, having not been supplied to the fuel injection device 23, returns to the fuel pump unit 20 through the return fuel pipe 29.

[0048] The oxygen sensor 24 is disposed within the exhaust pipe of the engine 3. The oxygen sensor 24 is a sensor using, for instance, zirconia. The oxygen sensor 24 is configured to detect the oxygen concentration in the exhaust gas. The oxygen sensor 24 can detect the oxygen concentration with an effective accuracy when the temperature of the oxygen sensor 24 reaches a predetermined activation temperature or greater. The oxygen sensor 24 is configured to transmit a signal corresponding to the detected oxygen concentration to the controller 25.

[0049] The controller 25 is an electronic control device including a processing device such as a CPU and a recording device such as a memory. The controller 25 is configured to control the amount of the fuel to be discharged from the fuel pump unit 20. The controller 25 is configured to control the amount of the fuel to be injected from the fuel injection device 23. The controller 25 is configured to compute an air-fuel ratio that is suitable for the oxygen concentration detected by the oxygen sensor 24. For example, when the rate of alcohol contained in the fuel is changed, the oxygen concentration in the exhaust gas is changed. In this case, the controller 25 is config-

ured to compute an air-fuel ratio that is suitable for the changed oxygen concentration. Further, the controller 25 is configured to control the fuel injection device 23 based on the computation result. For example, the controller 25 is configured to estimate the present alcohol content rate based on the output value of the oxygen sensor and calculate the injection amount based on the estimated alcohol content rate.

[0050] The controller 25 is configured to store the computed air-fuel ratio or the alcohol content rate. The controller 25 is configured to control the fuel injection device 23 based on the stored air-fuel ratio or the stored alcohol content rate in the cold start of the engine 3. The cold start means that the engine 3 is started while the temperature thereof is the same as the outdoor temperature. In the cold start, the temperature of the oxygen sensor 24 is lower than the activation temperature.

[0051] Next, the fuel pump unit 20 will be explained. FIG. 3 is a cross-sectional side view of the fuel pump unit 20. As illustrated in FIG. 3, the fuel pump unit 20 includes a case 31, a partition portion 32, a fuel pump 33 and a filter unit 34.

[0052] The case 31 includes a cylindrical contour. One end of the case 31 is opened, while the other end of the case 31 is closed. It should be noted that in the explanation of the fuel pump unit 20, a direction from the closed end to the opened end of the case 31 is defined as "an upward direction" and its opposite direction is defined as "a downward direction". Therefore, the case 31 includes an opening 310 in the upper portion thereof, while the lower portion of the case 31 is closed with a bottom surface 311. In the explanation of the fuel pump unit 20, a horizontal direction means a direction arranged perpendicular to the up-and-down direction. Further, in the explanation of the fuel pump unit 20, a plan view means a view seen in the up-and-down direction.

[0053] The case 31 includes an inner space 35 and a discharge path 36. The discharge path 36 is extended in the up-and-down direction. The case 31 includes a discharge port 37 and a return port 38. The discharge port 37 is disposed in the lower portion of the discharge path 36. The return port 38 is disposed in the lower portion of the inner space 35.

[0054] The partition portion 32 divides the inner space 35 of the case 31 into a return fuel chamber 39 and a main fuel chamber 40. The partition portion 32 divides the inner space 35 of the case 31 up and down. The return fuel chamber 39 is positioned below the partition portion 32. The main fuel chamber 40 is positioned above the partition portion 32. Therefore, the return fuel chamber 39 is disposed below the main fuel chamber 40. The aforementioned return port 38 is disposed in the return fuel chamber 39. The main fuel chamber 40 is communicated with the outside of the case 31 through the opening 310 provided in the upper portion of the case 31. The partition portion 32 is a member provided separately from the case 31. The case 31 includes a stepped portion 41 on the inner surface of the lateral-side portion thereof. The partition portion 32 is supported by the stepped portion 41.

[0055] The filter unit 34 is disposed in the return fuel chamber 39. FIG. 4 is a cross-sectional view of FIG. 3 taken along a line IV-IV. As illustrated in FIGS. 3 and 4, the filter unit 34 includes a first connection pipe 42 and a filter 43. The first connection pipe 42 connects the filter 43 and the fuel pump 33. The first connection pipe 42 includes an inlet port 44. The inlet port 44 is disposed in the return fuel chamber 39. The filter 43 is attached to the inlet port 44. The filter 43 is disposed in opposition to the return port 38 within the return fuel chamber 39. The filter 43 is disposed for dividing the return fuel chamber 39 into a space for disposing therein the return port 38 and a space for disposing therein the first connection pipe 42.

[0056] The first connection pipe 42 includes a first pipe portion 45, a second pipe portion 46 and a third pipe portion 47. The first pipe portion 45 is connected to the inlet port 44. The first pipe portion 45 is extended in the horizontal direction. The second pipe portion 46 is connected to the first pipe portion 45. The second pipe portion 46 is extended in both of the horizontal direction and a direction intersecting with the first pipe portion 45. The third pipe portion 47 is connected to the second pipe portion 46. The third pipe portion 47 is extended in the up-and-down direction. As illustrated in FIG. 3, the partition portion 32 includes an attachment opening 48. The upper portion of the third pipe portion 47 is connected to the attachment opening 48.

[0057] The fuel pump 33 is configured to inhale the fuel through the inlet port 44 and discharge the fuel through the discharge port 37. The fuel pump 33 is disposed above the partition portion 32. The fuel pump 33 includes an inlet portion 51 and a discharge portion 52. The fuel pump 33 is configured to inhale the fuel through the inlet portion 51 and discharge the fuel through the discharge portion 52. The inlet portion 51 is disposed on the bottom surface of the fuel pump 33. The inlet portion 51 is connected to the first connection pipe 42. Specifically, the inlet portion 51 is connected to the upper portion of the third pipe portion 47. The discharge portion 52 is disposed on the top surface of the fuel pump 33. The discharge portion 52 is connected to a second connection pipe 53. The second connection pipe 53 connects the discharge portion 52 and the discharge path 36.

[0058] The partition portion 32 includes a first opening 54. The first opening 54 makes the main fuel chamber 40 and the return fuel chamber 39 communicate with each other. FIG. 5 is a cross-sectional view of FIG. 3 taken along a line V-V. It should be noted that FIG. 5 omits illustration of the fuel pump 33 but illustrates only the position of the fuel pump 33 with a dashed two-dotted line. As illustrated in FIG. 5, the first opening 54 is disposed as far away from the inlet port 44 as possible. Specifically, the fuel pump 33 is positioned between the first opening 54 and the inlet port 44 in a plan view. Further, the path length from the first opening 54 to the inlet

port 44 is longer than that from the return port 38 to the inlet port 44.

[0059] As illustrated in FIGS. 3 and 5, the case 31 includes a second opening 55 in the lateral surface thereof. The second opening 55 makes the main fuel chamber 40 and the outside of the case 31 communicate with each other. The partition portion 32 includes a flat portion 56 and a vertical wall portion 57. The fuel pump 33 is put on the flat portion 56. The flat portion 56 is provided with the aforementioned attachment opening 48 and first opening 54. The vertical wall portion 57 is upwardly protruded from the flat portion 56. The vertical wall portion 57 is integrally provided with the partition portion 32. The vertical wall portion 57 is disposed between the first opening 54 and the second opening 55. In other words, the vertical wall portion 57 is disposed for interfering with the flow of the fuel directed from the second opening 55 to the first opening 54. The vertical wall portion 57 includes a shape curved along the inner surface of the lateral-side portion of the case 31. The vertical wall portion 57 is disposed away from the inner surface of the lateral-side portion of the case 31, while being opposed to the second opening 55. The upper end of the vertical wall portion 57 is positioned above the second opening 55. As illustrated in FIG. 5, a space 58 is opened upwards, which is produced between the vertical wall portion 57 and the inner surface of the lateral-side portion of the case 31. As illustrated in FIG. 5, the space 58 is closed at an end 58a, which is an end closer to the second opening 55 in the horizontal direction. The space 58 is opened at an end 58b, which is the other end away from the second opening 55 in the horizontal direction.

[0060] The partition portion 32 includes a convex portion 61 protruded upwards. The convex portion 61 is upwardly protruded from the flat portion 56. The convex portion 61 includes an aperture 62 penetrating through the partition portion 32. The aperture 62 is provided in the upper surface of the convex portion 61. In a plan view, at least a portion of the convex portion 61 is disposed between the return port 38 and the inlet port 44. In a plan view, at least a portion of the convex portion 61 is overlapped with the space produced between the return port 38 and the filter 43. In other words, at least a portion of the convex portion 61 is positioned above the space produced between the return port 38 and the filter 43. The convex portion 61 is disposed laterally to the fuel pump 33. A lateral surface 61a, which is one lateral surface of the convex portion 61, includes a shape curved along the lateral surface of the fuel pump 33. A lateral surface 61b, which is the other lateral surface of the convex portion 61, includes a shape curved along the inner surface of the lateral-side portion of the case 31.

[0061] A flange portion 63 is disposed on the outer surface of the lateral-side portion of the case 31. The flange portion 63 is attached to the bottom surface of the fuel tank 5. The fuel pump unit 20 is thereby attached to the fuel tank 5. A portion of the fuel pump unit 20, positioned above the flange portion 63, is disposed inside the fuel tank 5. A portion of the fuel pump unit 20, positioned below the flange portion 63, is disposed outside the fuel tank 5.

[0062] Explanation will be hereinafter made for the fuel flow in the fuel pump unit 20. The fuel contained within the fuel tank 5 flows to the main fuel chamber 40 through the opening 310 provided in the upper portion of the case 31. Further, the fuel contained within the fuel tank 5 flows to the main fuel chamber 40 through the second opening 55. The fuel flows from the main fuel chamber 40 to the return fuel chamber 39 through the first opening 54. On the other hand, the aforementioned excess fuel, returned through the return fuel pipe 29, flows to the return fuel chamber 39 through the return port 38. The fuel pump 33 inhales the fuel in the return fuel chamber 39 through the inlet port 44, and discharges the fuel through the discharge port 37. The fuel, discharged through the discharge port 37, is supplied to the aforementioned fuel injection device 23.

[0063] In the fuel pump unit 20 according to the present exemplary embodiment, the inlet port 44 is disposed within the return fuel chamber 39. Therefore, in starting the engine 3, the fuel contained within the return fuel chamber 39 is more preferentially supplied to the engine 3 than the fuel contained within the main fuel chamber 40. In starting the engine 3, the fuel contained within the return fuel chamber 39 is the one that the composition thereof has not been changed by fuel supply. On the other hand, the fuel contained within the main fuel chamber 40 is the one that the composition thereof has been changed by fuel supply. The return fuel chamber 39 and the main fuel chamber 40 are divided by the partition portion 32. Therefore, the fuel contained within the return fuel chamber 39 and that contained within the main fuel chamber 40 are less easily mixed with each other. Therefore, immediately after starting the engine 3, a fuel injection control can be executed based on the heretofore known fuel composition of a pre-fuel supply state. Further, it is not required to increase the volume of the pipe to be connected to the fuel pump 33. Therefore, the fuel pump unit 20 can be compactly provided while being easily attachable to the vehicle.

[0064] As illustrated in FIG. 4, the filter 43 is disposed in opposition to the return port 38 within the return fuel chamber 39. Therefore, the fuel returning thereto from the return port 38 can be further preferentially supplied to the engine 3.

[0065] The fuel contained within the main fuel chamber 40 flows to the return fuel chamber 39 through the first opening 54. As illustrated in a plan view of FIG. 5, the fuel pump 33 is positioned between the first opening 54 and the inlet port 44. In other words, the first opening 54 is disposed farther away from the inlet port 44. Therefore, the fuel contained within the main fuel chamber 40 is less easily mixed with that contained within the return fuel chamber 39. Accordingly, change of the fuel composition can be further suppressed low.

[0066] The path length from the first opening 54 to the

inlet port 44 is longer than that from the return port 38 to the inlet port 44. Therefore, the fuel contained within the main fuel chamber 40 is less easily mixed with that contained within the return fuel chamber 39. Accordingly, change of the fuel composition can be further suppressed low.

[0067] As illustrated in FIGS. 3 and 5, the vertical wall portion 57 is disposed between the first opening 54 and the second opening 55. Therefore, the vertical wall portion 57 interferes with the fuel flow from the second opening 55 to the first opening 54. The fuel contained within the main fuel chamber 40 is thereby less easily mixed with that contained within the return fuel chamber 39. Accordingly, change of the fuel composition can be further suppressed low.

[0068] The vertical wall portion 57 is disposed in opposition to the second opening 55. Therefore, the vertical wall portion 57 interferes with the fuel flow from the second opening 55 to the main fuel chamber 40. The fuel contained within the main fuel chamber 40 is thereby less easily mixed with that contained within the return fuel chamber 39. Accordingly, change of the fuel composition can be further suppressed low.

[0069] The vertical wall portion 57 is integrally provided with the partition portion 32. Therefore, the vertical wall portion 57 and the partition portion 32 can be easily provided.

[0070] The return fuel chamber 39 is positioned below the main fuel chamber 40. Therefore, the fuel can be supplied to the engine 3 from the return fuel chamber 39 even when a small amount of fuel is only left in the fuel tank 5.

[0071] The aperture 62 is provided in the convex portion 61 of the partition portion 32. Therefore, it is possible to collect air bubbles, contained in the fuel contained within the return fuel chamber 39, in the space produced within the convex portion 61 and to release the air bubbles to the main fuel chamber 40 through the aperture 62.

[0072] At least a portion of the convex portion 61 is disposed between the return port 38 and the inlet port 44. Therefore, it is possible to efficiently release air bubbles, contained in the fuel returning from the return port 38, to the main fuel chamber 40 through the aperture 62.

[0073] An exemplary embodiment 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.

[0074] The controller 25 may be configured to control the fuel pump 33 by means of a PWM (Pulse Width Modulation) control. In this case, the controller 25 preferably executes a control of reducing the discharge amount of the fuel pump 33 in starting the engine 3. Specifically, the controller 25 reduces the duty cycle of a command signal to be transmitted to the fuel pump 33. Accordingly, the amount of fuel to be returned to the return fuel chamber 39 is reduced, and therefore, the fuel can be inhibited from being agitated in the return fuel chamber 39. As a result, the fuel contained within the main fuel chamber 40 is less easily mixed with that contained within the return fuel chamber 39. Thus, change of the fuel composition can be further suppressed low. Further, the discharge amount of the fuel pump 33 can be controlled to be constant by means of the PWM control for the fuel pump 33. Accordingly, the fuel supply to the fuel injection device 23 can be stabilized.

[0075] A type of vehicle to which the present invention is applied is not limited to a motorcycle. For example, the present invention may be applied to a vehicle such as a snowmobile, an ATV (All Terrain Vehicle) or a PWC (Personal Water Vehicle).

[0076] The structure of the fuel supply system is not limited to that described above. For example, the filter 21 may be integrated with the fuel pump unit 20. The fuel pressure regulator 22 may be integrated with the fuel pump unit 20. In these cases, one or more of the fuel pipes 26 to 29 may not be provided. Alternatively, the fuel filter 21 may not be provided.

[0077] The oxygen sensor 24 may be disposed in an exhaust path portion provided within a cylinder head of the engine 3. Alternatively, the oxygen sensor 24 may be disposed in an exhaust pipe connected to the cylinder head. The oxygen sensor 24 may be either a sensor with a heater or a sensor without a heater.

[0078] The structure of the partition portion is not limited to that described above. For example, the partition portion may divide the inner space of the case in the horizontal direction. The position of the first opening is not limited to that described above. It should be noted that the first opening is preferably disposed as far away from the inlet port as possible in order to suppress change of the fuel composition low in starting the engine.

[0079] The structures of the case and the partition portion are not limited to those described above. For example, FIG. 6 is a schematic cross-sectional side view of a fuel pump unit according to a modification. As illustrated in FIG. 6, the case 31 includes a first case portion 31a and a second case portion 31b. The first case portion 31a and the second case portion 31b are members provided separately from each other. The second case portion 31b is attached to the first case portion 31a while being disposed below the first case portion 31a. The partition portion 32 is a bottom surface of the first case portion 31a.

[0080] The position of the vertical wall portion is not limited to that described above. It should be noted that the vertical wall portion is preferably positioned between the first opening and the second opening when the second opening is disposed closer to the first opening.

Claims

1. A fuel pump unit (20), comprising:

a case (31) including:

a discharge port (37) configured to discharge a fuel; and
a return port (38) configured to receive an excess fuel returned;

a partition portion (32) dividing an inner space (35) of the case (31) into a return fuel chamber (39) in which the return port (38) is disposed and a main fuel chamber (40) communicated with an outside of the case (31);
an inlet port (44) disposed within the return fuel chamber (39); and
a fuel pump (33) configured to inhale the fuel through the inlet port (44) and discharge the fuel through the discharge port (37).

2. The fuel pump unit (20) according to claim 1, further comprising:

a filter (43) attached to the inlet port (44),
wherein the filter (43) is disposed in opposition to the return port (38) within the return fuel chamber (39).

3. The fuel pump unit (20) according to claim 1 or 2, wherein the partition portion (32) includes a first opening (54) making the main fuel chamber (40) and the return fuel chamber (39) communicate with each other.

4. The fuel pump unit (20) according to claim 3, wherein the fuel pump (33) is positioned between the first opening (54) and the inlet port (44).

5. The fuel pump unit (20) according to claim 3 or 4, wherein a path length from the first opening (54) to the inlet port (44) is longer than a path length from the return port (38) to the inlet port (44).

6. The fuel pump unit (20) according to any of claims 3 to 5, further comprising:

a vertical wall portion (57),
wherein the case (31) includes a second opening (55) in a lateral-side portion thereof, the second opening (55) making the main fuel chamber (40) and the outside of the case (31) communicate with each other, and
the vertical wall portion (57) is disposed between the first opening (54) and the second opening (55).

7. The fuel pump unit (20) according to any of claims 1 to 5, further comprising:

a vertical wall portion (57),
wherein the case (31) includes a second opening (55) in a lateral-side portion thereof, the second opening (55) making the main fuel chamber (40) and the outside of the case (31) communicate with each other, and
the vertical wall portion (57) is disposed in opposition to the second opening (55).

8. The fuel pump unit (20) according to claim 6 or 7, wherein the vertical wall portion (57) is integrally provided with the partition portion (32).

9. The fuel pump unit (20) according to any of claims 1 to 8,
wherein the partition portion (32) divides an inside of the case (31) up and down, and
the return fuel chamber (39) is positioned below the partition portion (32).

10. The fuel pump unit (20) according to claim 9,
wherein the partition portion (32) includes a convex portion (61) protruded upwards, and
the convex portion (61) includes an aperture (62) penetrating through the partition portion (32).

11. The fuel pump unit (20) according to claim 10, wherein at least a portion of the convex portion (61) is disposed between the return port (38) and the inlet port (44).

12. A vehicle, comprising:

a fuel tank (5); and
the fuel pump unit (20) according to any of claims 1 to 11 to be attached to the fuel tank (5).

13. The vehicle according to claim 12, further comprising:

a controller (25) configured to control the fuel pump (33) by means of a PWM control and reduce a discharge amount of the fuel pump (33) in starting an engine (3).

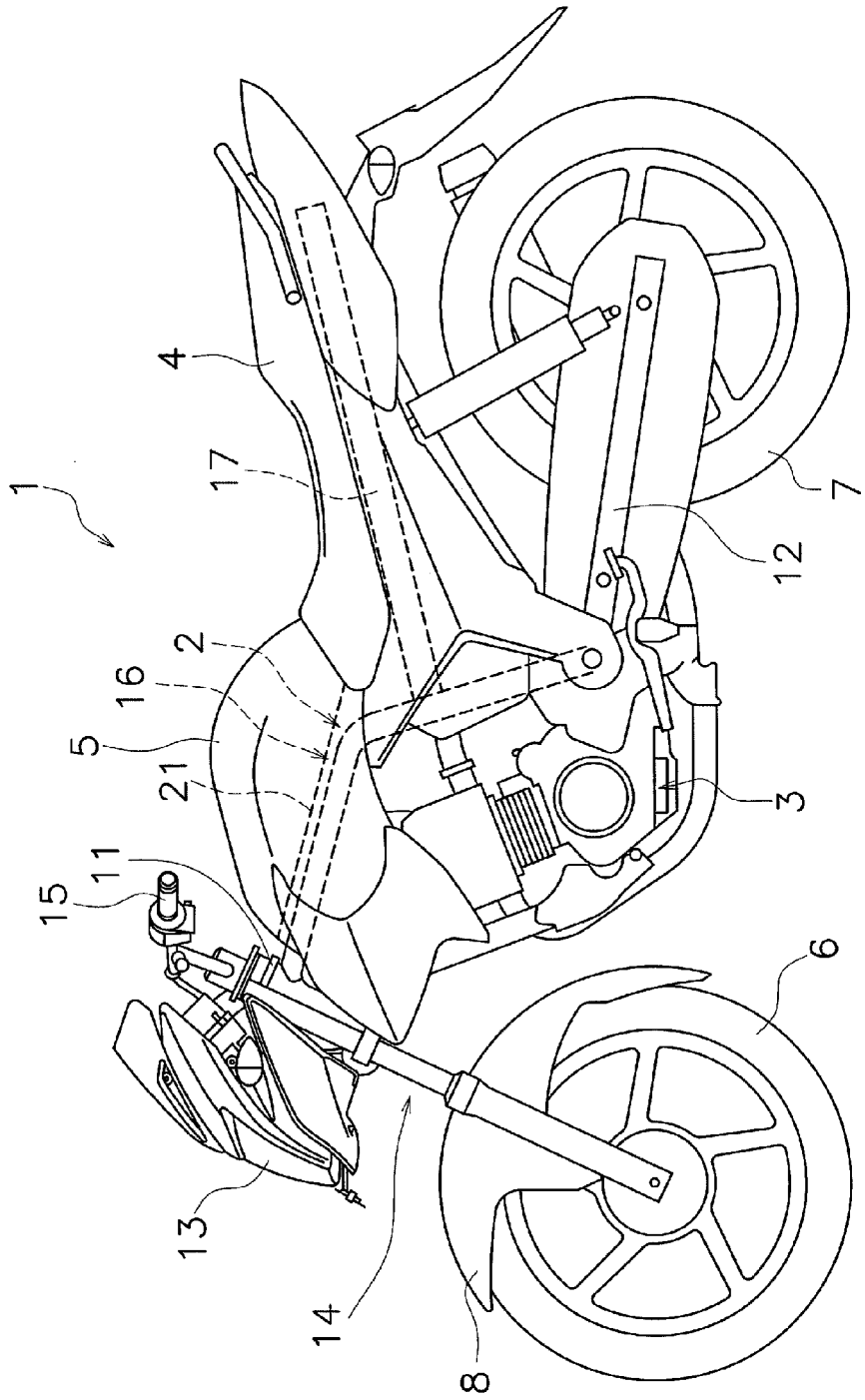


FIG. 1

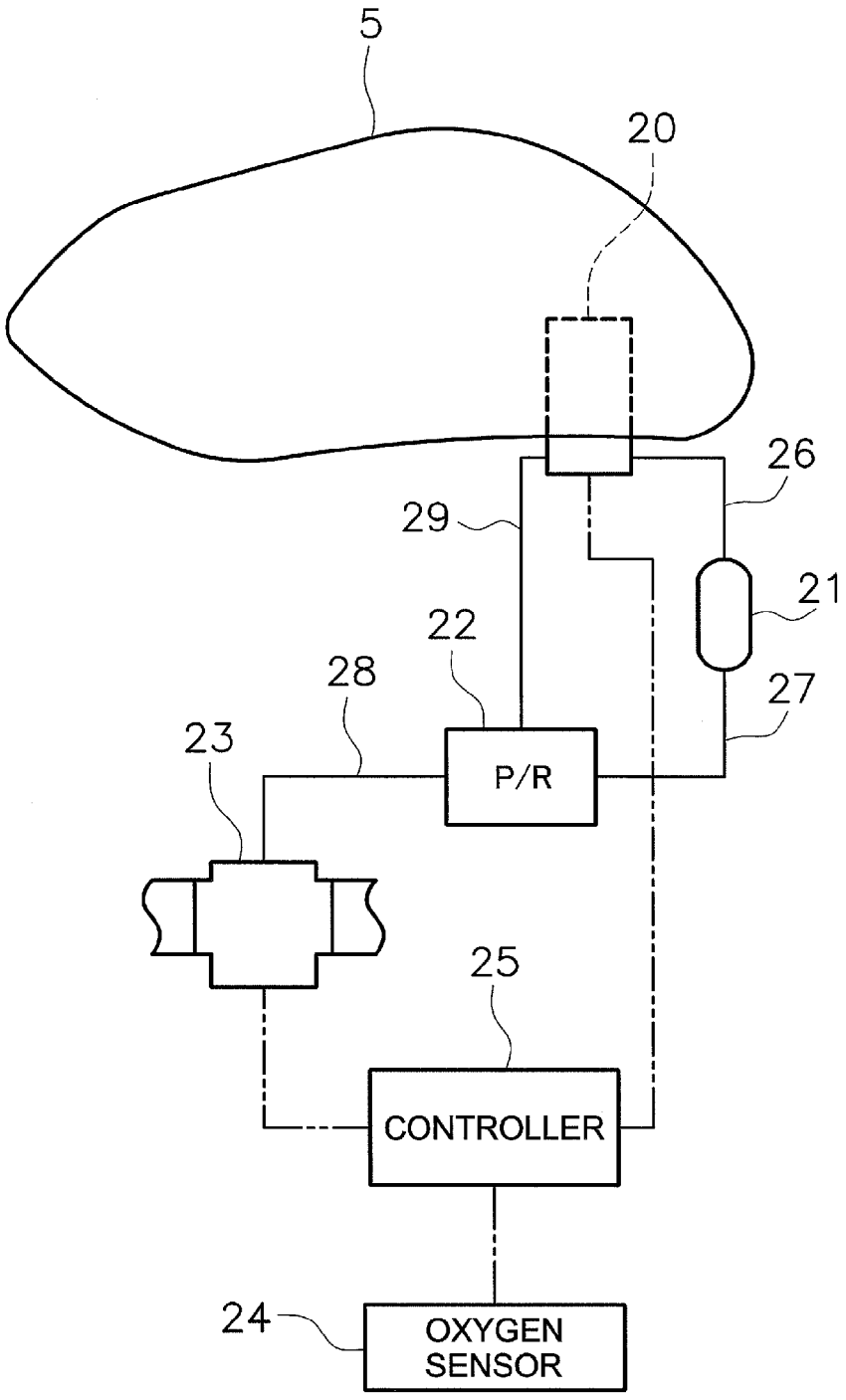
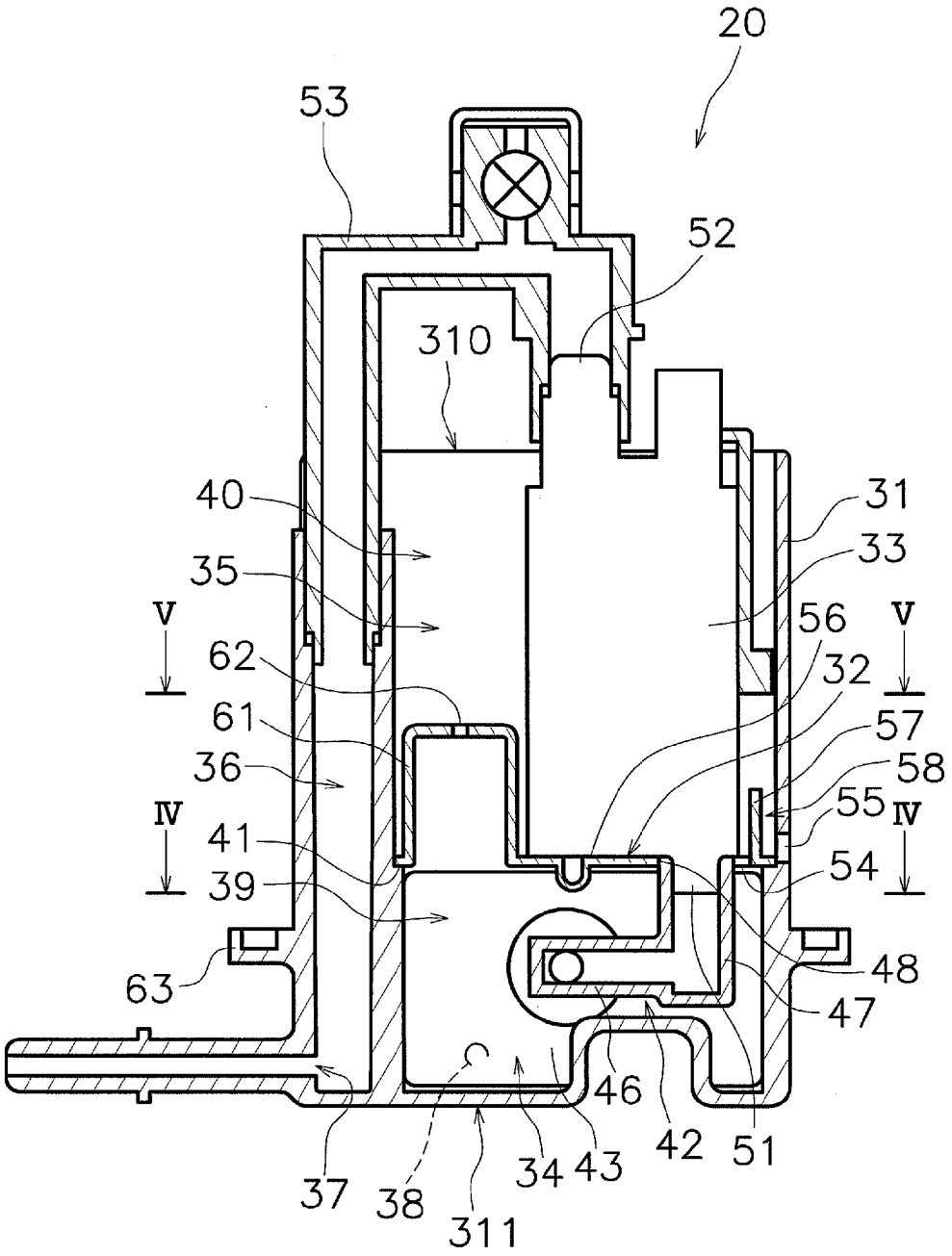


FIG. 2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311

FIG. 3

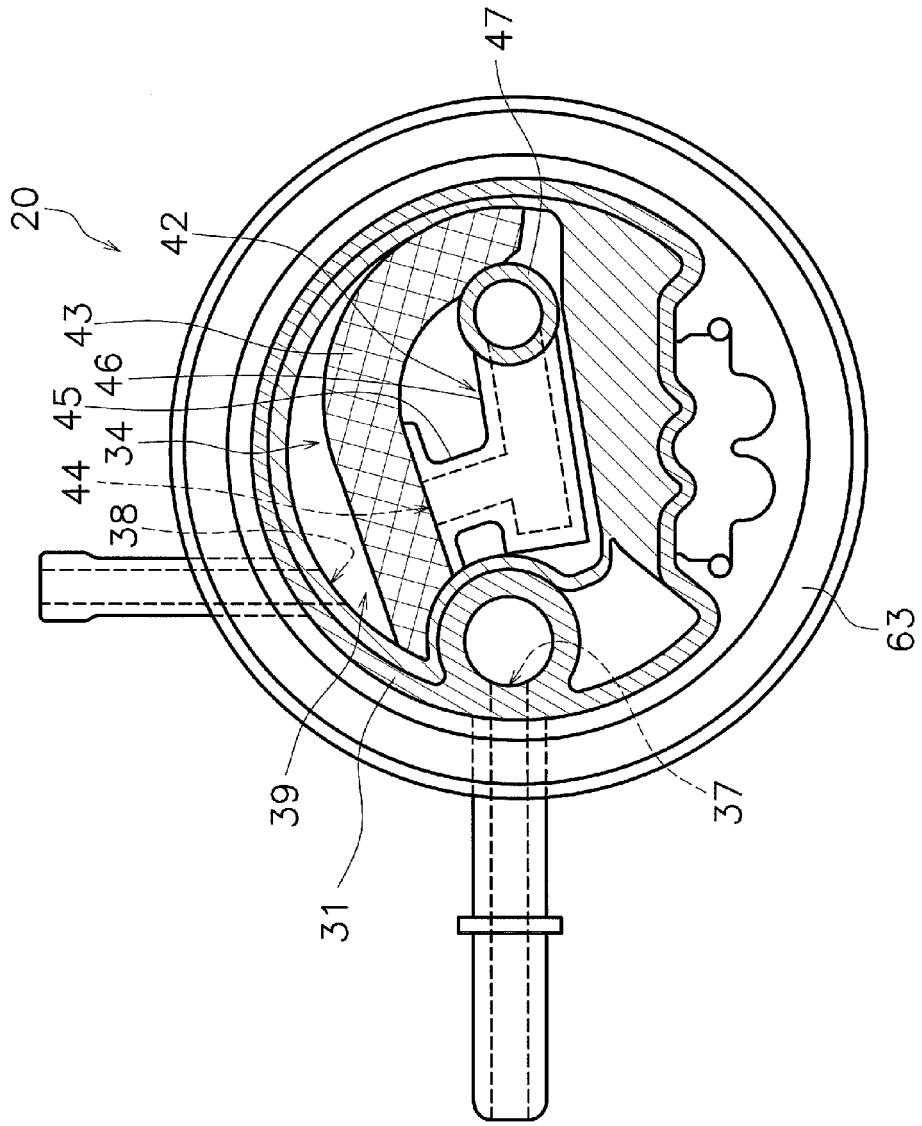

FIG. 4

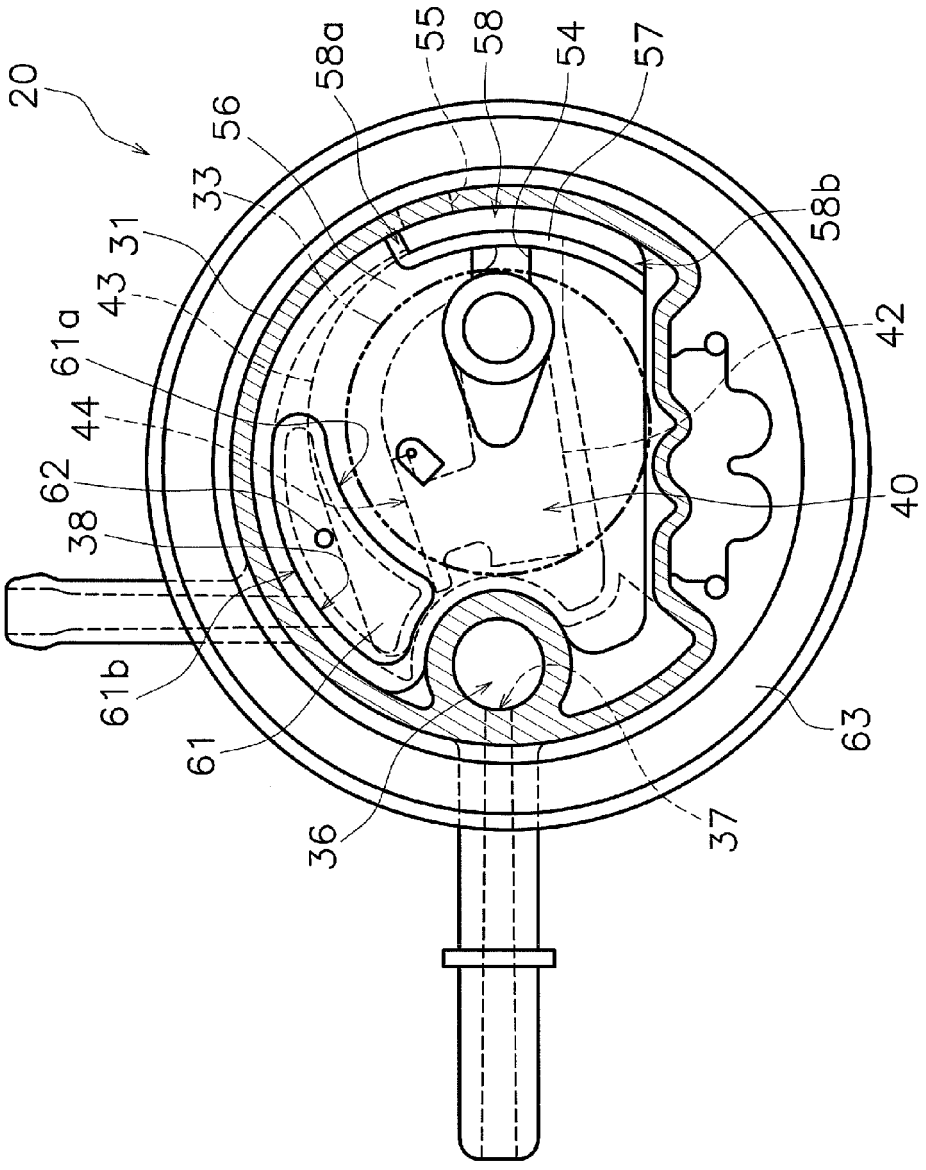

FIG. 5

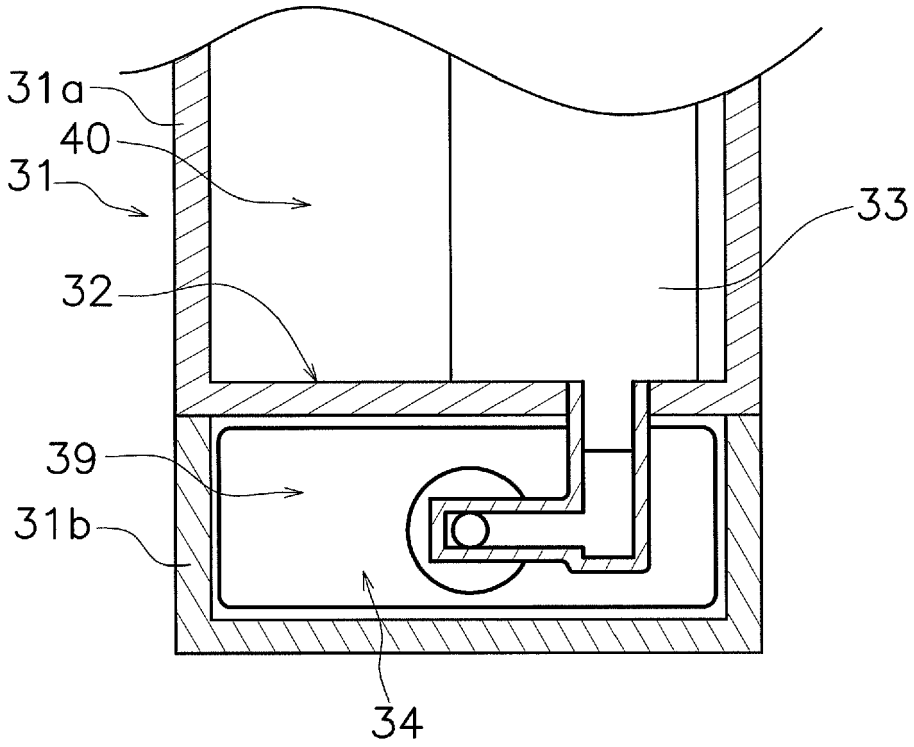

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP S635131 A **[0003] [0004]**
- JP 2009209909 A **[0005] [0008]**