

Description

[0001] The present invention relates to a fuel feed apparatus having a suction filter.

[0002] According to JP-A-2001-132572, a fuel feed apparatus includes two-circuit inlet lines. A fuel pump and a fuel pipe are received in a fuel tank. The fuel pump discharges fuel drawn from the fuel tank through one inlet line of the two-circuit inlet lines. Fuel flows from the fuel pipe to the outside of the fuel tank through the other inlet line of the two-circuit inlet lines.

[0003] In the structure of JP-A-2001-132572, a fuel pump draws fuel, and foreign matters contained in the fuel are removed through the suction filter. However, the inlet of the fuel pipe is not provided with a suction filter. Accordingly, foreign matters may be contained in fuel introduced to the outside of the fuel tank through the fuel pipe.

[0004] In view of the foregoing problems, it is an object of the present invention to produce a fuel feed apparatus having a suction filter, the fuel feed apparatus being adapted to removing foreign matters contained in fuel drawn through inlet lines.

[0005] According to one aspect of the present invention, a fuel feed apparatus includes two-circuit inlet lines that connect a fuel tank with a pumping device. The pumping device is outside of the fuel tank. The fuel feed apparatus includes a fuel pump that is received in the fuel tank. The fuel pump constructs one inlet line of the two-circuit inlet lines for pumping fuel from the fuel tank. The fuel feed apparatus further includes a pump suction filter that is provided to an upstream end of the one inlet line. The pump suction filter connects with an inlet port of the fuel pump for removing foreign matters contained in fuel drawn into the fuel pump. The fuel feed apparatus further includes a fuel pipe that constructs an other inlet line of the two-circuit inlet lines for introducing fuel from the fuel tank toward the pumping device. The fuel feed apparatus further includes a pipe suction filter that is provided to an upstream end of the other inlet line. The pipe suction filter connecting with an inlet port of the fuel pipe for removing foreign matters contained in fuel drawn into the fuel pipe.

[0006] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a schematic view showing a fuel feed system in which a fuel pump supplies fuel into a jet pump;
FIG. 2 is a schematic view showing the fuel feed system in which the fuel pump supplies fuel into a high pressure pump;
FIG. 3 is a longitudinal view showing a fuel feed apparatus including the fuel pump;
FIG. 4 is a perspective view showing the fuel feed apparatus;

FIG. 5A is a view when being viewed from the arrow VA in FIG. 4, and FIG. 5B is a sectional view showing the jet pump; and

FIG. 6 is a view when being viewed from the arrow VI in FIG. 3.

(Example Embodiment)

[0007] As shown in FIGS. 1, 2, a fuel feed apparatus 20 is received in a fuel tank 2 that is in a substantially saddle shape. The fuel tank 2 includes two tank chambers 3, 5. The tank chamber 3 receives a sub-tank 4. The tank chamber 3 communicates with the sub-tank 4 through a communication hole that is provided in a bottom portion of the sidewall of the sub-tank 4. The fuel feed apparatus 20 is provided in the sub-tank 4. The fuel feed apparatus 20 has two-circuit inlet lines including an inlet line for a fuel pump 30 and an inlet line for a bellows pipe 70. In this embodiment, the fuel feed apparatus 20 supplies fuel to an engine 13 through the two-circuit inlet lines. Alternatively, the fuel feed apparatus 20 may supply fuel to both the engine 13 and a jet pump 60 through the two-circuit inlet lines. In this embodiment, the engine 13 is a diesel engine.

[0008] The fuel pump 30 discharges fuel, and the fuel is selectively supplied toward either a high pressure pump (pumping device) 12 or the jet pump 60 through a three-way solenoid valve 16. The three-way solenoid valve 16 serves as a switching valve. A suction filter 18 is provided to the bottom of the tank chamber 5. Fuel discharged from the fuel pump 30 is supplied to the jet pump 60, so that the jet pump 60 generates suction force. Thus, fuel in the tank chamber 5 of the fuel tank 2 is transferred into the sub-tank 4 in the tank chamber 3 through the suction filter 18 by the suction force generated by the jet pump 60. Fuel discharged from the fuel pump 30 is introduced toward the high pressure pump 12 through the three-way solenoid valve 16 when the engine 13 is applied with high load or when air is exhausted from a passage through which fuel is supplied to the high pressure pump 12, for example. In other cases, fuel discharged from the fuel pump 30 is supplied into the jet pump 60 through the three-way solenoid valve 16.

[0009] The high pressure pump 12 may be for supplying fuel into either intake air drawn into the engine 13 or a combustion chamber of the engine 13.

[0010] Air is exhausted from the passage through which fuel is supplied to the high pressure pump 12 by operating the fuel pump 30 in one of the following five conditions:

when the fuel feed apparatus 20 is assembled;
when the fuel filter 40 of the fuel feed apparatus 20 is replaced;
when the fuel tank 2 becomes empty;
when water is exhausted from a water separator 10; and
when the engine 13 is restarted after the engine 13

is stopped for a long period.

[0011] The fuel pump 30 may be regularly operated to supply fuel into the jet pump 60. Alternatively, the fuel pump 30 may be intermittently started to refill fuel, as the engine 13 consumes.

[0012] The bellows pipe 70 serves as a fuel pipe of the fuel feed apparatus 20. Fuel flows from the fuel tank 2 to the outside of the fuel tank 2 through the bellows pipe 70, and the fuel is drawn into the high pressure pump 12.

[0013] The fuel pump 30 discharges fuel into the high pressure pump 12 through the bellows pipe 70. The water separator 10 removes moisture from the fuel discharged from the fuel pump 30, and thereafter, the filter 11 removes foreign matters from the fuel after passing through the water separator 10. Thus, the high pressure pump 12 pumps the fuel after passing through the water separator 10 into the engine 13. A pump device such as a gear pump or a vane pump is provided in the high pressure pump 12 or in an inlet of the high pressure pump 12. The high pressure pump 12 draws fuel thereinto using the gear pump or the pump device. The engine 13 discharges surplus fuel, which returns into the sub-tank 4 through a pipe 86 or the like.

[0014] Next, the fuel feed apparatus 20 is described in reference to FIGS. 3 to 6. The fuel feed apparatus 20 has a lid member 22 that is in a substantially circular shape. The lid member 22 plugs an opening defined in an upper wall of the fuel tank 2. Components of the fuel feed apparatus 20 excluding the lid member 22 are received in the sub-tank 4 accommodated in the fuel tank 2. The fuel tank 2 may be formed of either resin or metal.

[0015] As referred to FIG. 4, the lid member 22 is assembled with an electric connector 24, a fuel pump outlet 25, a pipe outlet 26, a jet pump inlet 27, and a return inlet 28. The fuel pump 30 is supplied with electricity via a lead wire provided to the electric connector 24. A level meter 80 outputs a detection signal to the outside of the fuel tank 2 via the electric connector 24. The fuel pump 30 discharges fuel into the three-way solenoid valve 16 through the fuel pump outlet 25. Fuel passes through the bellows pipe 70, and the fuel flows toward the high pressure pump 12, which is outside of the fuel tank 2, through the pipe outlet 26. Fuel flows from the fuel pump outlet 25 to the outside of the fuel tank 2, and the fuel is supplied from the outside of the fuel tank 2 into the jet pump 60 through the three-way solenoid valve 16 and the jet pump inlet 27. The engine 13 discharges surplus fuel, and the surplus fuel returns into the sub-tank 4 through the return inlet 28.

[0016] The outer circumferential periphery of the fuel pump 30 is surrounded by a fuel filter in the form of a segment of a substantially circle. The fuel pump 30 is attached to a filter case 42 of the fuel filter 40 via a bracket 50. The fuel pump 30 accommodates an unillustrated motor. The fuel pump 30 further accommodates an unillustrated rotor member such as an impeller that rotates together with the motor. The fuel pump 30 pumps fuel

using the rotor member through a suction filter 32. The suction filter 32 serves as a pump suction filter. The suction filter 32 connects with an inlet of the fuel pump 30. In this structure, the suction filter 32 is provided to the upstream end of the inlet line of the fuel pump 30. The fuel pump 30 has an outlet that connects with the fuel filter 40 through an unillustrated check valve, which restricts fuel from causing reverse flow from the fuel filter 40 into the fuel pump 30.

[0017] As referred to FIG. 5A, the fuel filter 40 has the filter case 42 accommodating a filter element 44. The pressure regulator 46 is attached to the lateral side of the filter case 42 for controlling pressure of fuel, which is discharged from the fuel pump 30 and removed of foreign matters through the fuel filter 40. The fuel, which is controlled in pressure through the pressure regulator 46, is supplied into the three-way solenoid valve 16 through the fuel pump outlet 25.

[0018] Fuel is discharged from the fuel pump 30, and the fuel passes through the three-way solenoid valve 16, the jet pump inlet 27, and a rubber pipe 54, so that the fuel is supplied into the jet pump 60 after passing through the rubber pipe 54. The inlet 62 (FIG. 5B) of the jet pump 60 connects with the suction filter 18 in the tank chamber 5 through a rubber pipe or the like. Fuel is jetted through a nozzle 64 of the jet pump 60, thereby generating suction force around the nozzle 64. Fuel in the tank chamber 5 is drawn into the sub-tank 4 through the inlet 62 by the suction force. When pressure in the nozzle 64 of the jet pump 60 increases and becomes equal to or greater than predetermined pressure, the relief valve 66 communicates therein so that the relief valve 66 releases pressure, thereby protecting the jet pump 60 from overpressure.

[0019] A suction filter 72 connects with an inlet of the bellows pipe 70. The suction filter 72 serves as a pipe suction filter. In this structure, the suction filter 72 is provided to the upstream end of the inlet line of the bellows pipe 70. Both inlets of the fuel pump 30 and the bellows pipe 70 are respectively provided with the suction filters 32, 72, so that foreign matters can be removed from fuel drawn through the two-circuit inlet lines of the fuel feed apparatus 20.

[0020] An arm 52 extends from the bracket 50. The bellows pipe 70 connects with the suction filter 72 via a connecting portion that is snap-fitted to the arm 52, so that the suction filter 72 can be restricted from swinging. The inlet of the bellows pipe 70 is provided with a check valve 74 (FIGS. 1, 2, 4). The check valve 74 restricts fuel from causing reverse flow from the high pressure pump 12 into the suction filter 72.

[0021] The level meter 80 connects with a float 84 via an arm 82. The engine 13 discharges surplus fuel, and the surplus fuel returns into the sub-tank 4 through the return inlet 28 and the pipe 86.

[0022] Next, the suction filters 32, 72 are described in detail.

[0023] As referred to FIG. 3, the suction filter 32 and the suction filter 72 are axially arranged in a staggered

configuration. Specifically, the suction filter 32 is axially staggered relative to the suction filter 72. The axial position of the suction filter 32 is distant from the axial position of the suction filter 72 by the distance L. The suction filter 72 is arranged downward with respect to the suction filter 32 in FIG. 3. In this structure, the suction filters 32, 72, which are located in the bottom of the sub-tank 4, can be restricted from causing interference with each other. Thus, the filtration area of the suction filters 32, 72 can be secured, while reducing the total occupied area including the suction filters 32, 72 with respect to an extending direction, along which the suction filters 32, 72 extend. Furthermore, the fuel feed apparatus 20 can be inserted into the fuel tank 2 through the opening defined in the fuel tank 2, even the opening has a limited area.

[0024] In addition, as referred to FIG. 6, the suction filter 32 has an outer periphery (first outer periphery) 33. The suction filter 72 has an outer periphery (second outer periphery) 73. The suction filter 32 opposes to the suction filter 72 respectively via the outer peripheries 33, 73, which are arranged in a staggered configuration. That is, the outer periphery 33 is staggered relative to the outer periphery 73 in the plane of FIG. 6. The suction filter 32 extends into the suction filter 72 via the outer periphery 33 thereof. The suction filter 72 extends into the suction filter 32 via the outer periphery 73 thereof. The suction filters 32, 72, which are opposed to each other with respect to an opposed direction, have the total width d0. The suction filter 32 has the width d1 with respect to the opposed direction. The suction filter 72 has the width d2 with respect to the opposed direction. In this structure, the total width d0, the width d1, and the width d2 satisfy the following relationship: $d0 < d1 + d2$. Thus, the suction filters 32, 72 can be restricted from causing interference with each other. Furthermore, the width of each of the suction filters 32, 72 can be reduced with respect to the opposed direction, while the total occupied area of the suction filters 32, 72 is possibly reduced with respect to the extending direction. Therefore, even when fuel in the sub-tank 4 is inclined due to cornering of the vehicle or due to driving on a sloping road, the suction filters 32, 72 are apt to be submerged into fuel, regardless of the inclining direction of fuel. Therefore, fuel can be drawn through the suction filters 32, 72, regardless of the inclining direction of fuel. Furthermore, the total occupied area of the suction filters 32, 72 is possibly reduced with respect to the extending direction, so that the fuel feed apparatus 20 can be inserted into the fuel tank 2 through the opening defined in the fuel tank 2, even the opening has a limited area.

(Other Embodiment)

[0025] In the above structure, fuel discharged from the fuel pump 30 is supplied selectively into the high pressure pump 12 or the jet pump 60 through the three-way solenoid valve 16. Alternatively, fuel discharged from the fuel pump 30 may be supplied into either one of the high pres-

sure pump 12 and the jet pump 60.

[0026] The fuel feed apparatus may be provided to a fuel tank having one tank chamber. In this construction, fuel may be supplied into the high pressure pump 12 through both the inlet lines of the bellows pipe 70 and the fuel pump 30. In this structure, the fuel pump is preferably intermittently started as appropriate.

[0027] The location of the three-way solenoid valve 16 is not limited to the lateral side of the fuel tank 2. The three-way solenoid valve 16 may be provided to the lid member 22, or may be provided in the fuel tank 2, as one component of the fuel feed apparatus.

[0028] The fuel feed apparatus may be provided for a gasoline engine.

[0029] The fluid lines connecting the fuel tank 2 with the high pressure pump (pumping device) 12 is not limited to two lines. The fluid lines connecting the fuel tank 2 with the high pressure pump 12 may include at least three lines. In this case, the at least three lines include the two-circuit inlet lines described above.

[0030] Various modifications and alternations may be diversely made to the above embodiments without departing from the spirit of the present invention.

[0031] A fuel feed apparatus (20) includes two-circuit inlet lines that connect a fuel tank (2) with a pumping device (12). The pumping device (12) is outside of the fuel tank (2). The fuel feed apparatus (20) includes a fuel pump (30) that is received in the fuel tank (2). The fuel pump (30) constructs one inlet line of the two-circuit inlet lines for pumping fuel from the fuel tank (2). A pump suction filter (32) is provided to an upstream end of the one inlet line. The pump suction filter (32) connects with an inlet of the fuel pump (30) for removing foreign matters contained in fuel drawn into the fuel pump (30). A fuel pipe (70) constructs an other inlet line of the two-circuit inlet lines for introducing fuel from the fuel tank (2) toward the pumping device (12). A pipe suction filter (72) is provided to an upstream end of the other inlet line. The pipe suction filter (72) connects with an inlet of the fuel pipe (70) for removing foreign matters contained in fuel drawn into the fuel pipe (70).

Claims

1. A fuel feed apparatus (20) including two-circuit inlet lines that connect a fuel tank (2) with a pumping device (12), the pumping device (12) being outside of the fuel tank (2), the fuel feed apparatus (20) comprising:

a fuel pump (30) that is received in the fuel tank (2), the fuel pump (30) constructing one inlet line of the two-circuit inlet lines for pumping fuel from the fuel tank (2);

a pump suction filter (32) that is provided to an upstream end of the one inlet line, the pump suction filter (32) connecting with an inlet port of the

- fuel pump (30) for removing foreign matters contained in fuel drawn into the fuel pump (30);
 a fuel pipe (70) that constructs an other inlet line of the two-circuit inlet lines for introducing fuel from the fuel tank (2) toward the pumping device (12); and
 a pipe suction filter (72) that is provided to an upstream end of the other inlet line, the pipe suction filter (72) connecting with an inlet port of the fuel pipe (70) for removing foreign matters contained in fuel drawn into the fuel pipe (70).
2. The fuel feed apparatus (20) according to claim 1, wherein the pump suction filter (32) and the pipe suction filter (72) are axially staggered with each other, and one of the pump suction filter (32) and the pipe suction filter (72) is located downward with respect to an other of the pump suction filter (32) and the pipe suction filter (72).
3. The fuel feed apparatus (20) according to claim 1 or 2, wherein the pump suction filter (32) and the pipe suction filter (72) are opposed to each other, the pump suction filter (32) has a first outer periphery (33) on a side of the pipe suction filter (72), the pipe suction filter (72) has a second outer periphery (73) on a side of the pump suction filter (32), the first outer periphery (33) and the second outer periphery (73) are staggered relative to each other, and the first outer periphery (33) and the second outer periphery (73) extend into each other.
4. The fuel feed apparatus (20) according to any one of claims 1 to 3, wherein the one inlet line of the fuel pump (30) connects with the pumping device (12).
5. The fuel feed apparatus (20) according to any one of claims 1 to 3, wherein the fuel tank (2) has a plurality of tank chambers (3, 5) that includes one tank chamber (3) receiving the fuel pump (30) and the fuel pipe (70), the fuel feed apparatus (20) further comprising:
 a jet pump (60) that generates suction force by jetting fuel therethrough for transferring fuel from an other tank chamber (5) of the plurality of tank chambers into the one tank chamber (3),
 wherein the one inlet line of the fuel pump (30) connects with the jet pump (60).
6. The fuel feed apparatus (20) according to any one of claims 1 to 3, wherein the fuel tank (2) has a plurality of tank chambers (3, 5) that includes one tank chamber (3) receiving the fuel pump (30) and the fuel pipe (70), the fuel feed apparatus (20) further comprising:
 a jet pump (60) that generates suction force by jetting fuel therethrough for transferring fuel from an other tank chamber (5) of the plurality of tank chambers into the one tank chamber (3),
 wherein the one inlet line of the fuel pump (30) selectively connects with one of the pumping device (12) and the jet pump (60).
7. The fuel feed apparatus (20) according to claim 6, further comprising:
 a switching valve (16) that selectively connects the one inlet line of the fuel pump (30) with one of the pumping device (12) and the jet pump (60).
8. The fuel feed apparatus (20) according to any one of claims 1 to 7, wherein the pumping device (12) is a high-pressure pump for supplying fuel into one of intake air drawn into an internal combustion engine (13) and a combustion chamber of the internal combustion engine (13).

FIG. 1

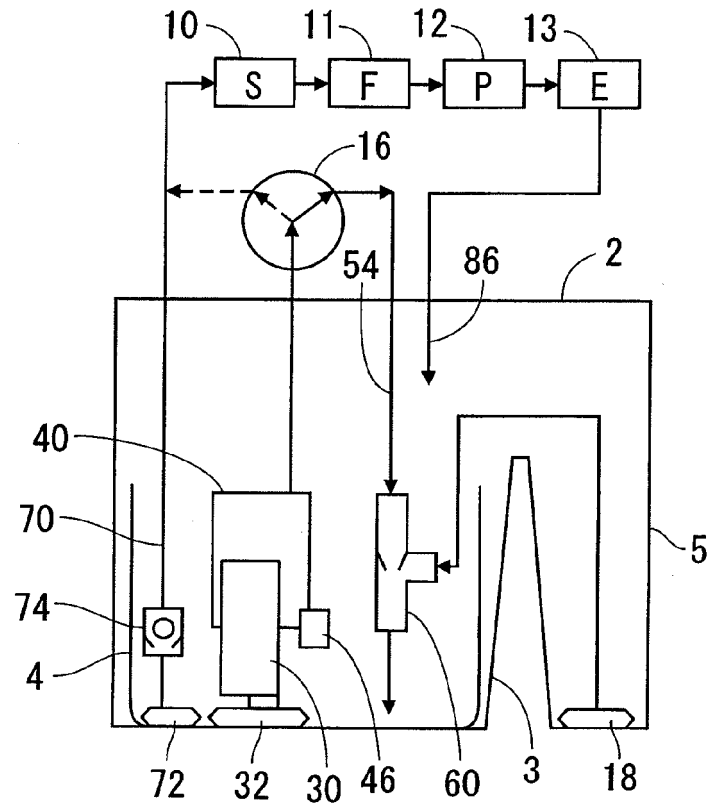


FIG. 2

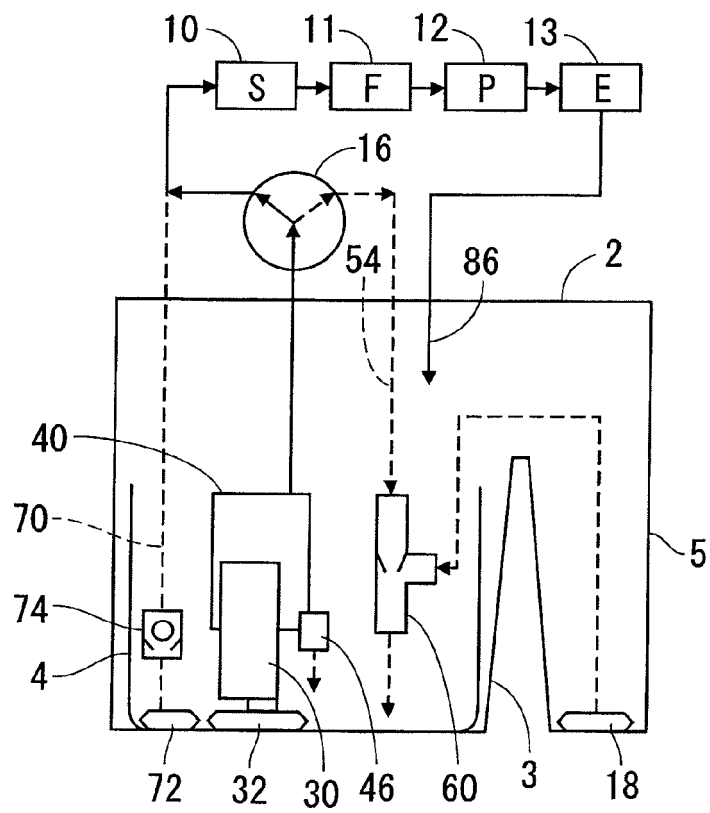


FIG. 3

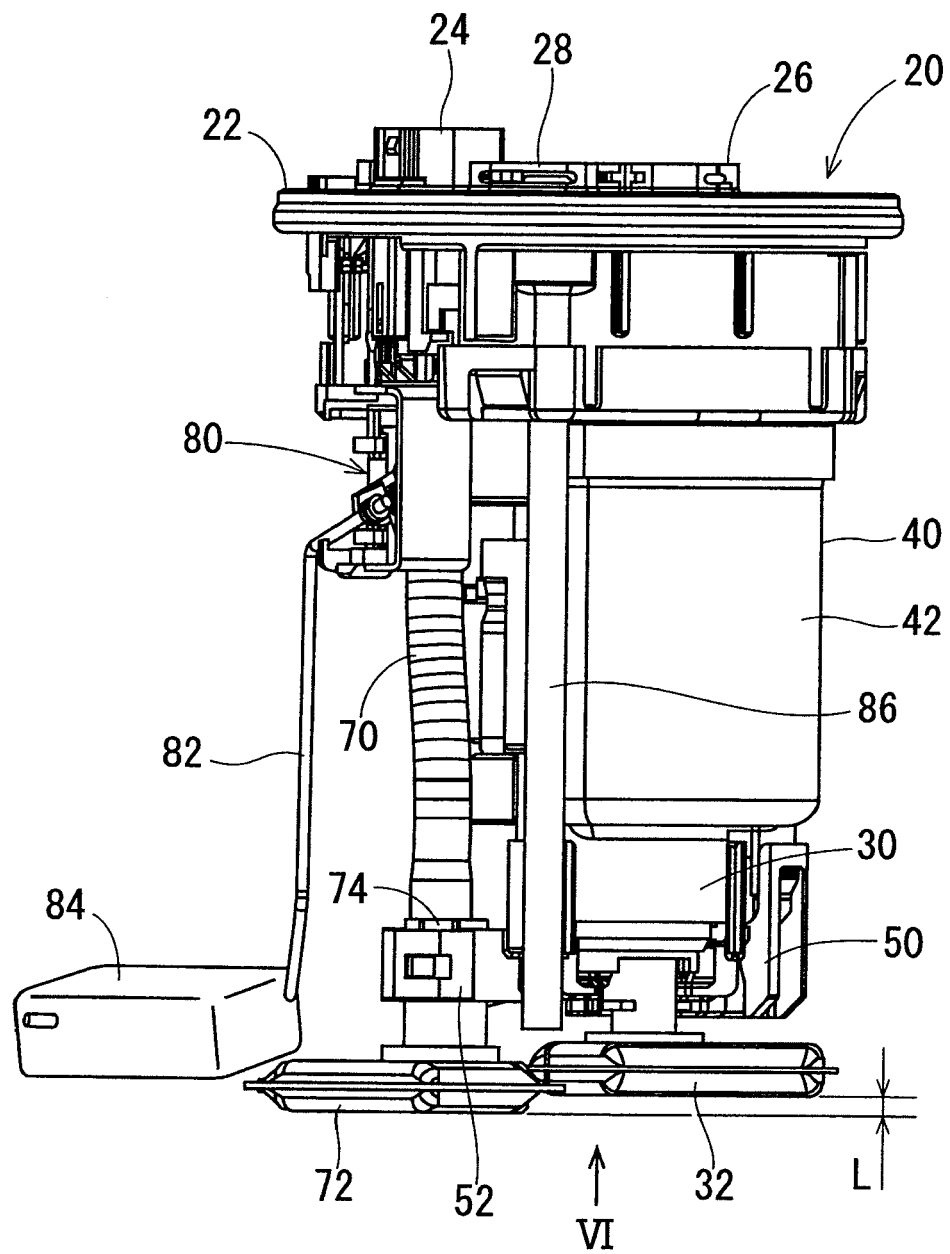


FIG. 4

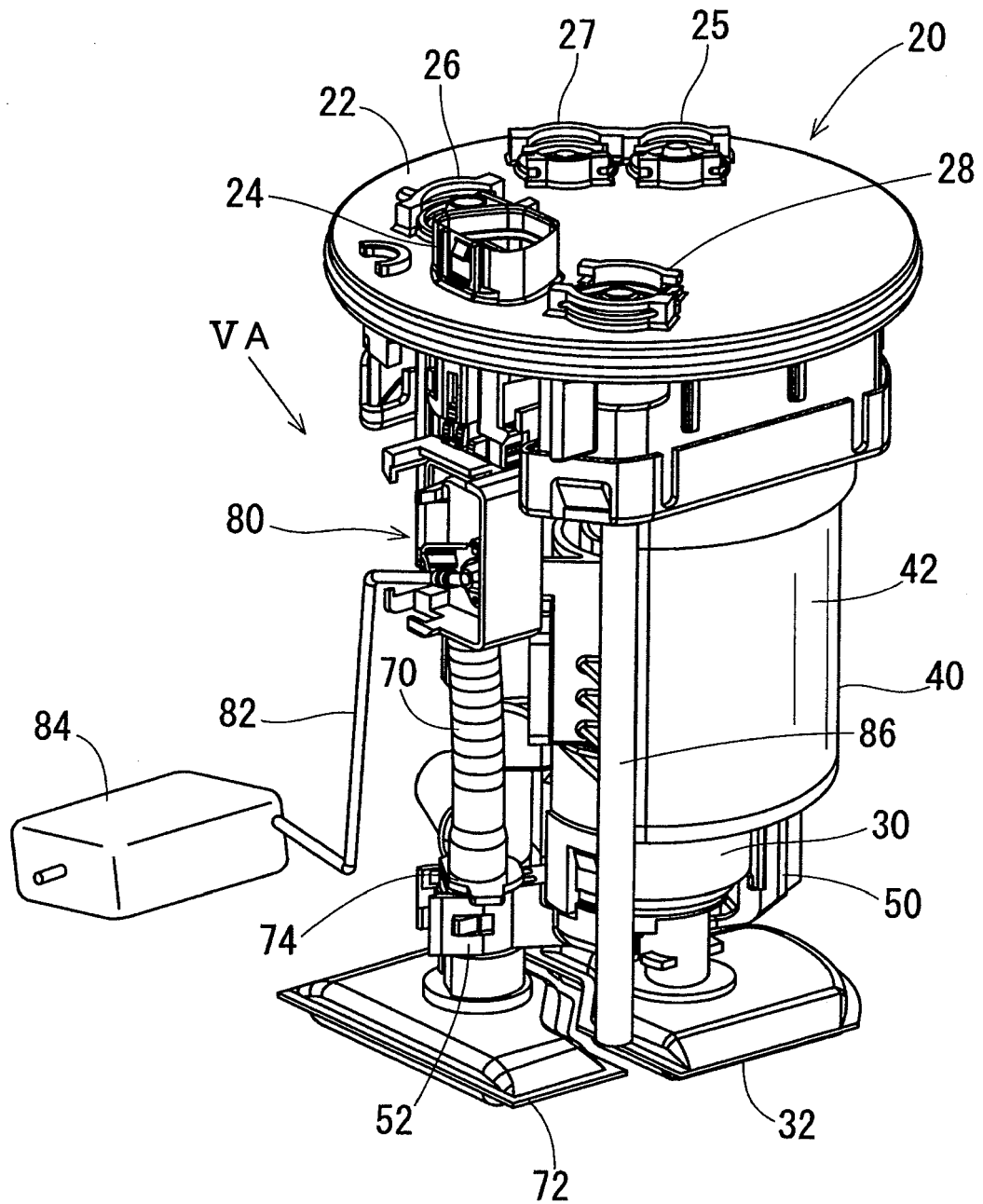


FIG. 5A

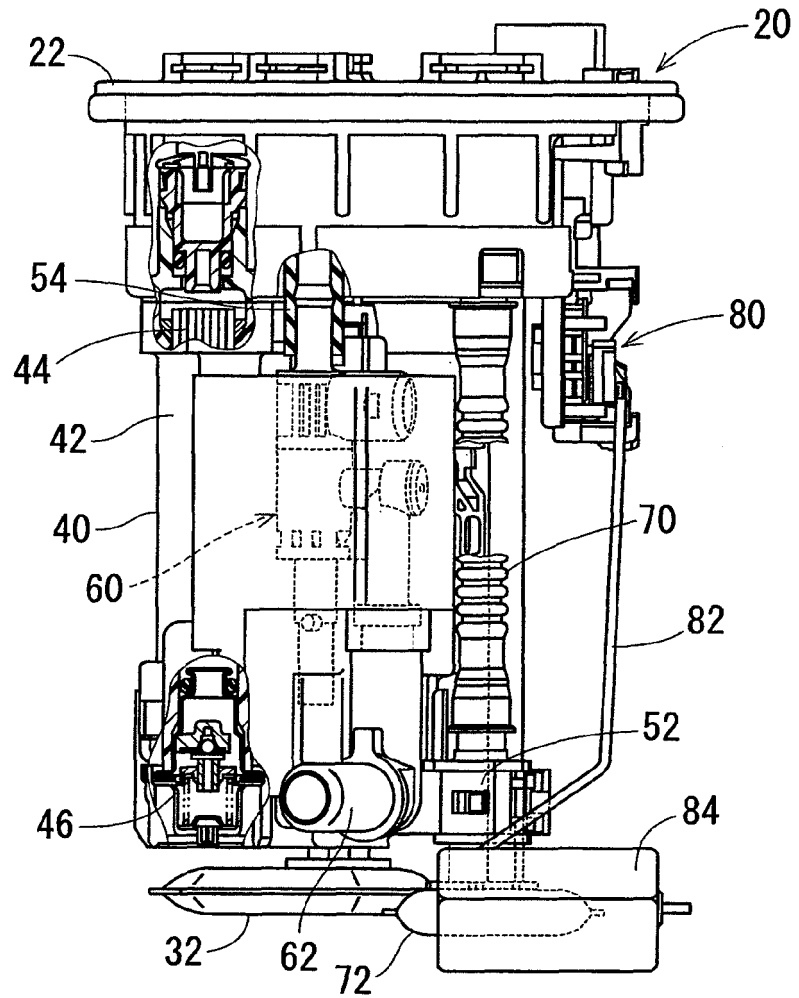


FIG. 5B

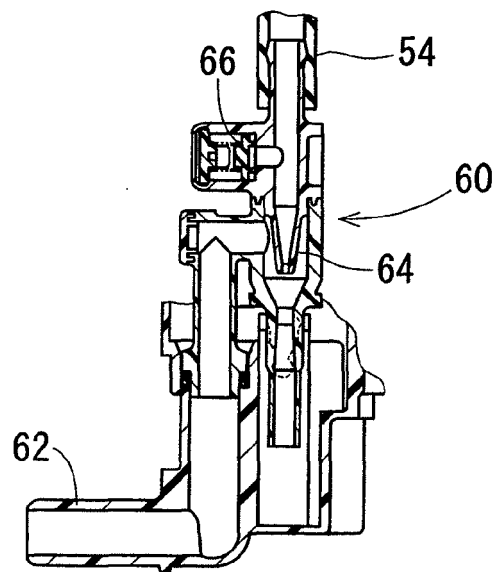
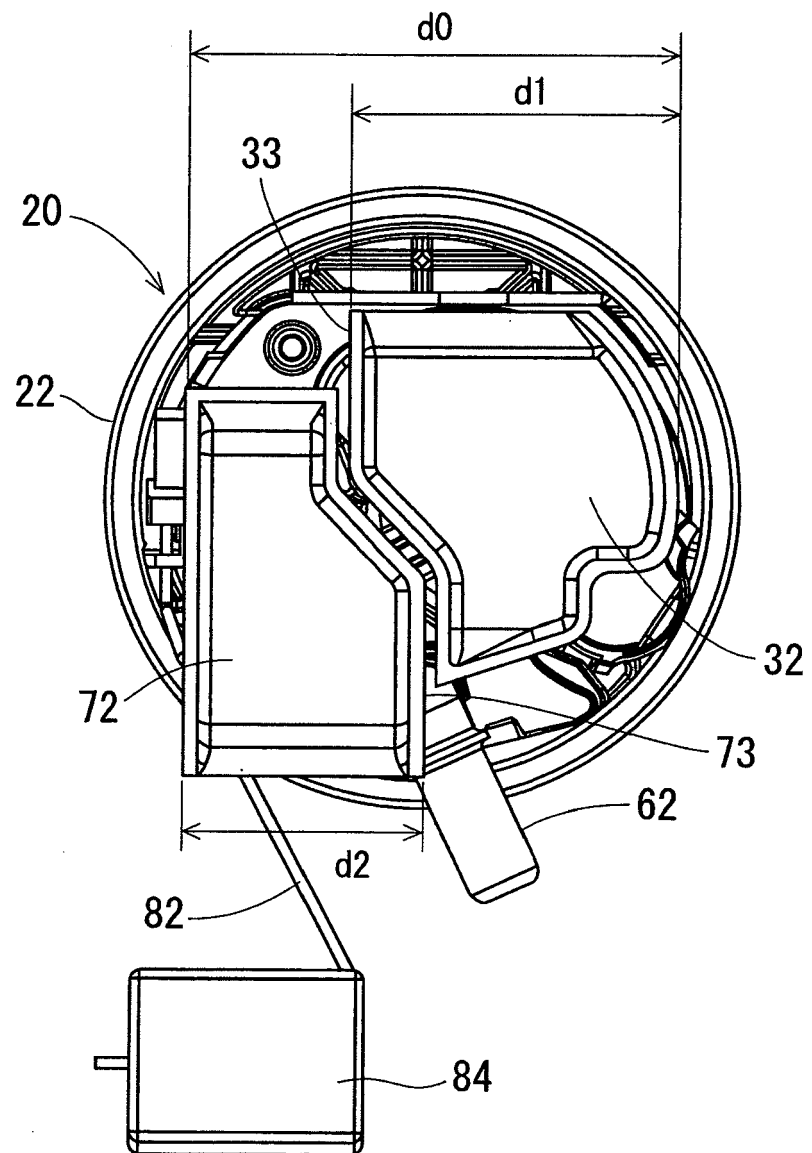


FIG. 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 12 5398

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 April 2007	Examiner Dorfstätter, Markus
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 06 12 5398

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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