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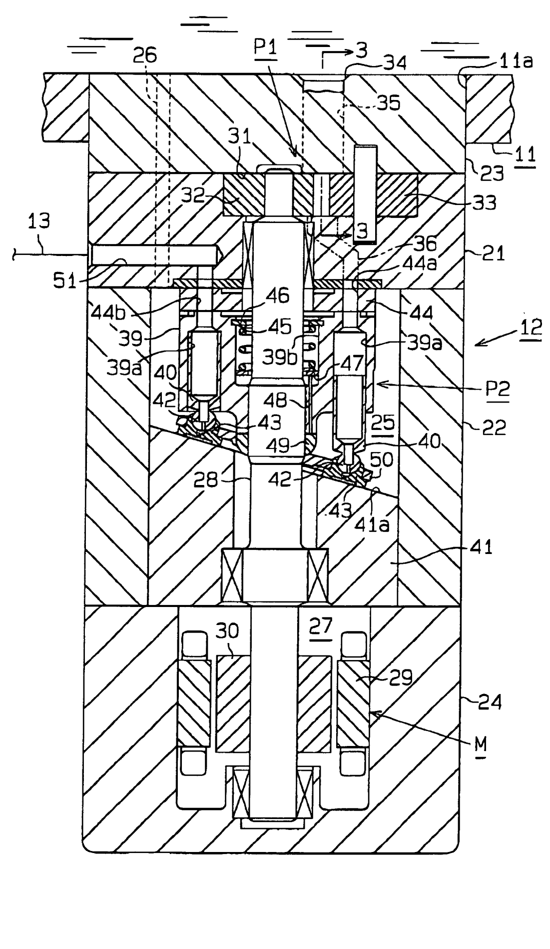
(54) Pump unit and fluid supplying system

(57) A fuel supplying system includes a tank (11) and a pump unit (12), which transfers fluid from the tank (11). The pump unit (12) includes a first pump (P1), a second pump (P2), and a drive source (M) . The first pump (P1) and the second pump (P2) are driven by the common drive source (M). The first pump (P1), the second pump (P2), and the drive source (M) are structured as one unit. This reduces the size and simplifies the structure of the fuel supplying system.

Fig.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a pump unit that is used in a fuel supplying system of an internal combustion engine that uses dimethyl ether as fuel, and to a fluid supplying system that, which has the pump unit.

[0002] A typical pump unit includes a piston pump, which functions as a main source for transferring fluid. To reliably feed dimethyl ether (hereinafter, referred to as DME) from a tank to an internal combustion engine (or fuel injection device) without vaporizing DME, that includes it has been proposed that a gear pump be provided at upstream of the piston pump has been proposed. The piston pump functions as a main source for transferring fluid. The pump unit reliably feeds dimethyl ether (hereinafter, referred to as DME) from the tank to an internal combustion engine (or fuel injection device) without vaporizing the DME. That is, the DME is compressed in advance with the gear pump, which has no expansion phase, to prevent the pressure of the DME from decreasing below the saturation pressure by the expansion (suction) phase of the piston pump.

[0003] However, the conventional fuel supplying system has the two separate pumps each having an electric motor as a drive source. Therefore, the size and the cost of the fuel supplying system are increased.

SUMMARY OF THE INVENTION

[0004] Accordingly, it is an objective of the present invention to provide a compact and low-cost pump unit and to provide a fluid supplying system that has the pump unit.

[0005] To achieve the forgoing and other objectives and in accordance with the purpose of the present invention, the invention includes a first pump, a second pump, and a single drive source. The first pump has no expansion phase and draws in and discharges fluid. The second pump has an expansion phase and draws in and discharges fluid that is discharged from the first pump. The second pump is connected to the first pump. The single drive source drives the first pump and the second pump.

[0006] The present invention also provides a fluid supplying system. The system includes the above described pump unit and a tank for reserving fluid. The pump unit transfers fluid from the tank.

[0007] The present invention further provides a fluid supplying system. The fluid supplying system includes the above described pump unit, a main tank for reserving fluid, and a sub-tank arranged separately from the main tank. The sub-tank receives fluid from the main tank. The pump unit is attached to the sub-tank to transfer fluid from the sub-tank.

[0008] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a cross-sectional view of a pump unit according to a first embodiment of the present invention;
Fig. 2 is a schematic view illustrating a fuel supplying system, which has the pump unit shown in Fig. 1;
Fig. 3 is a cross-sectional view taken along line 3-3 in Fig. 1;
Fig. 4 is a schematic view illustrating a fuel supplying system according to a second embodiment of the present invention;
Fig. 5 is a partial cross-sectional view illustrating the pump unit shown in Fig. 4;
Fig. 6 is a schematic view illustrating a fuel supplying system according to a third embodiment of the present invention; and
Fig. 7 is a schematic view illustrating a fuel supplying system according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] A fuel supplying system according to a first embodiment of the present invention will now be described with reference to Figs. 1 to 3.

[0011] Fig. 2 is a schematic view showing a fuel supplying system for supplying fuel, which is dimethyl ether (hereinafter, referred to as DME) in the first embodiment, to a fuel injection device 101, which includes, for example, in-line piston pumps. The fuel injection device 101 is located in a drive source of a vehicle, which is a diesel internal combustion engine (not shown). The fuel supplying system includes a tank 11 for reserving DME and a pump unit 12. The pump unit 12 is attached to the tank 11 and feeds the DME in the tank 11 to the fuel injection device 101 in a liquid state. The DME is a fluid that is-vaporized under the pressure that is less than or equal to the saturation pressure. In other words, the DME is vaporized at a normal temperature and under the atmospheric pressure.

[0012] As shown in Fig. 1, the housing of the pump unit 12 includes an upper first center housing 21, a lower second center housing 22, a first end housing 23, which is secured to the upper end of the first center housing

21, and a second end housing 24, which is secured to the lower end of the second center housing 22. The first end housing 23 of the pump unit 12 is inserted into a hole 11a, which is formed through the lower part of the tank 11. The upper surface of the first end housing 23, or a small part of the pump unit 12, is exposed inside the tank 11.

[0013] The second center housing 22 defines a crank chamber 25.

[0014] A bleed passage 26 extends through the first end housing 23 to the first center housing 21. The crank chamber 25 is always communicated with the tank 11 via the bleed passage 26. The bleed passage 26 vertically extends from the tank 11 to the crank chamber 25.

[0015] The second end housing 24 defines a motor chamber 27. A drive shaft 28 is rotatably supported between the first center housing 21 and the second end housing 24. The drive shaft 28 extends through the crank chamber 25 and the motor chamber 27. A shaft sealing assembly 60 is arranged at the middle portion of the drive shaft 28 and separates the crank chamber 25 from the motor chamber 27.

[0016] A stator 29 is located inside the motor chamber 27 and is secured to the inner circumferential surface of the second end housing 24. A rotor 30 is located inside the motor chamber 27 and is secured to the outer circumferential surface of the drive shaft 28 facing the stator 29. Therefore, the above structure functions as an electric motor, which is a motor M in the first embodiment. When current is supplied to the stator 29 from the outside, the rotor 30 is rotated, which in turn rotates the drive shaft 28.

[0017] The pump unit 12 includes a gear pump, which is a first pump P1 in the first embodiment, and a piston pump, which is a second pump P2 in the first embodiment. The gear pump has less volume efficiency compared with the piston pump and differs from the piston pump in that the gear pump has no expansion (suction) phase. The piston pump has an expansion phase and higher volume efficiency compared with the gear pump. Therefore, the second pump P2 serves as a main pump for feeding the DME to the fuel injection device 101. The first pump P1 serves as a pressurization pump for preventing the DME from vaporizing during the expansion phase of the second pump P2.

[0018] The first and second pumps P1, P2 shares the motor M as a drive source. That is, the drive shaft 28 of the first pump P1 and the drive shaft 28 of the second pump P2 are coaxial and uniaxial. The first and second pumps P1, P2 and the motor M are surrounded with the housings 21, 22, 23, 24 as one unit. The discharge amount of the DME of the first pump P1 perduring one rotation of the drive shaft 28 is set to be equal to or greater than that of the second pump P2. That is, the discharge capacity of the first pump P1 is equal to or greater than the discharge capacity of the second pump P2.

[0019] As shown in Fig. 1, a pump chamber 31 is defined at the joint portion between the first center housing 21 and the first end housing 23. The upper end portion of the drive shaft 28 projects inside the pump chamber 31. A first gear 32 is secured to the projecting portion and is rotated integrally with the drive shaft 28. A second gear 33, which meshes with the first gear 32, is arranged inside the pump chamber 31. The second gear 33 is rotated on the same plane as the first gear 32.

[0020] An inlet 34 is formed on the upper surface of the first end housing 23 above the pump chamber 31. A suction passage 35 vertically extends through the first end housing 23. The suction passage 35 connects the inlet 34 and the low pressure side (left side in Fig. 3) of the pump chamber 31. A communication passage 36 extends downward from the high pressure side (right side in Fig. 3) of the pump chamber 31 through the first center housing 21. The communication passage 36 is connected to the suction side of the second pump P2.

[0021] When the drive shaft 28 is rotated, the first gear 32 is rotated, which in turn rotates the second gear 33. Therefore, the DME is drawn into the low pressure side of the pump chamber 31 from the tank 11 via the inlet 34 and the suction passage 35. The DME is then transferred to the high pressure side of the pump chamber 31 using the space between the teeth grooves of the gears 32, 33 and the inner surface of the pump chamber 31. The DME that is transferred to the high pressure side of the pump chamber 31 is discharged toward the communication passage 36.

[0022] As shown in Fig. 3, a pressure release passage 37 vertically extends through the first end housing 23. The pressure release passage 37 connects the high pressure side of the pump chamber 31 to the tank 11. A relief valve 38, which is formed of a ball valve 38a and a spring 38b, is arranged in the pressure release passage 37. The ball valve 38a is normally urged by the force of the spring 38b to close the pressure release passage 37. When the pressure in the high pressure side of the pump chamber 31, or the pressure in the communication passage 36, is excessive, the ball valve 38a moves against the force of the spring 38b to open the pressure release passage 37.

[0023] As shown in Fig. 1, the second pump P2 includes a cylinder block 39 located inside the crank chamber 25. The cylinder block 39 is fitted to the drive shaft 28 by splines such that the cylinder block 39 is rotated integrally with and relatively moves with respect to the drive shaft 28. Cylinder bores 39a are formed in the cylinder block 39 about the drive shaft 28. Each cylinder bore 39a accommodates a piston 40. A cam 41 is secured to the second center housing 22 below the crank chamber 25. An inclined surface 41a, which is inclined with respect to the axis of the drive shaft 28, is formed on the upper surface of the cam 41.

[0024] Each piston 40 is coupled to a shoe 43 via a spherical joint 42.

[0025] A valve plate 44 is fixed to the inner end surface of the crank chamber 25 in the first center housing 21. The valve plate 44 includes a suction port 44a and a discharge port 44b, each defining an arc about the axis of the drive shaft 28. The cylinder block 39 has a spring chamber 39b formed in the center. The spring chamber 39b accommodates a spring 45, which is arranged about the drive shaft 28. The force of the spring 45 acts on the cylinder block 39 via a spring seat 46. The force of the spring 45 also acts on a shoe retainer via another spring seat 47, a pin 48, and a pivot 49. Therefore, the shoes 43 on the shoe retainer 50 are pressed against the inclined surface 41a of the cam 41 and the cylinder block 39 is pressed against the valve plate 44. The force of the spring and the force of the cylinder block 39 that is generated by the pressure difference between the inside and outside of the cylinder bores 39a and acting toward the valve plate 44 improve the sealing effect between the cylinder block 39 and the valve plate 44.

[0026] The rotation of the cylinder block 39 with the drive shaft 28 is converted to the reciprocation of the pistons 40. The stroke of each piston 40 is determined by the inclination angle of the inclined surface 41a of the cam 41. Each cylinder bore 39a is alternately communicated with the suction port 44a and the discharge port 44b of the valve plate 44. Thus, the DME that is pressurized by the first pump P1 is drawn into each cylinder bore 39a via the communication passage 36 and the suction port 44a. The DME drawn into each cylinder bore 39a is discharged from the corresponding discharge port 44b by a pumping action. The DME discharged from the discharge port 44b is transferred to the fuel injection device 101 via a discharge passage 51, which is formed in the first center housing 21, and an external pipe 13.

[0027] The first embodiment provides the following advantages.

(1) The first pump P1 and the second pump P2 share the motor M as the drive source. Therefore, compared to a case where a drive source is provided for each of the first and second pumps P1 and P2, the size of the fuel supplying system is reduced and the structure is simplified, thereby reducing the manufacturing cost. Sharing the drive source between the first pump P1 and the second pump P2 is advantageous for integrating the first and second pumps P1, P2 and the motor M as a single pump unit 12.

(2) The electric motor M has a simpler structure compared to an internal combustion engine, or the like. Thus, the first and second pumps P1, P2 and the housings 21, 22, 23, and 24 can easily be integrated.

The electric motor M is also suitable for using as a drive source of the pump unit 12 of the fuel supplying system in that the electric motor M is safe.

(3) The drive shaft 28 of the first pump P1 and the drive shaft 28 of the second pump P2 and the output shaft 28 of the motor M are coaxial and uniaxial. Therefore, for example, a complex power transmission mechanism need not be arranged between the motor M and the second pump P2, and between the second pump P2 and the first pump P1. Thus, the structure of the pump unit 12 can be simplified, thereby reducing the size of the pump unit 12.

(4) The relief valve 38 is located in the communication passage 36, which connects the discharge side of the first pump P1 and the suction side of the second pump P2. The relief valve 38 releases excessive pressure in the communication passage 36 Lo the tank 11, or the upstream of the first pump P1. Therefore, the relief valve 38 prevents the pressure from increasing excessively in the communication passage 36. This prevents the increase of the power loss of the pump unit 12 due to the excessive pressure in the second pump P2.

(5) The crank chamber 25 of the second pump P2 is communicated with the tank 11, or the upstream of the first pump P1, via the bleed passage 26. Therefore, even when the DME that has leaked into the crank chamber 25 is vaporized by the heat generated by sliding parts (such as the cam 41 and the shoes 43) inside the crank chamber 25, the vaporized DME returns to the tank 11 through the bleed passage 26. Thus,

[0028] As shown in Figs. 4 and 5, the pump unit 12 according to a second embodiment is accommodated inside the tank 11 and is secured to the bottom of the tank 11. The pump unit 12 of the second embodiment differs from the pump unit 12 of the first embodiment in that the pump unit 12 is arranged laterally, that is, the drive shaft 28 is arranged horizontally. The discharge passage 51 of the pump unit 12 is communicated with an outlet 52, which is formed in the bottom of the tank 11. The discharge passage 51 is connected to the external pipe 13 via the outlet 52.

[0029] The bleed passage 26 vertically extends through the circumferential wall of the second center housing 22.

[0030] In the second embodiment, a centrifugal pump is used as the first pump P1. A bladed wheel 55, which forms the centrifugal pump, is secured to the drive shaft 28 inside the pump chamber 31 and rotates integrally with the drive shaft 28. Therefore, the bladed wheel 55 is rotated with the rotation of the drive shaft 28, thereby drawing the DME into the low pressure side (left side in Fig. 5) of the pump chamber 31 from the tank 11 through the inlet 34 and the suction passage 35. The DME that is drawn into the low pressure side of the pump chamber 31 is then transferred to the high pressure side (upper side in Fig. 5) of the pump chamber 31 by the space formed between the adjacent blades of the bladed wheel 55 and the inner surface of the pump chamber

31. The DME transferred to the high pressure side of the pump chamber 31 is discharged toward the communication passage 36 by the centrifugal force exerted by the rotation of the bladed wheel 55.

[0031] The second embodiment provides the same advantages as (1), (2), (3), (4), (5), and (7) of the first embodiment. The second embodiment further provides the following advantages.

(1) The pump unit 12 is entirely accommodated inside the tank 11. Therefore, the tank 11 has no projections outside. This further facilitates the installation of the tank 11 and the pump unit 12 in a vehicle. The bleed passage 26 is shorter than that of the first embodiment shown in Fig. 1. Therefore, the advantage described in (5) of the first embodiment is more efficiently provided. Furthermore, even when the suction passage 35 extends in the horizontal direction, the same advantage as described in (6) of the first embodiment is provided. This adds to the flexibility of the design of the suction passage 35.

(2) The centrifugal pump used as the first pump P1 has simpler structure compared to, for example, the gear pump. Therefore, the structure of the pump unit 12 can be simplified.

[0032] A third embodiment will now be described with reference to Fig. 6. The differences from the first embodiment of Figs. 1 to 3 will mainly be discussed below with reference to Fig. 6, and like or the same reference numerals are given to those components that are like or the same as the corresponding components of the first embodiment.

[0033] In the first and second embodiments, the pump unit 12 is directly attached Lo the tank 11. However, in the third embodiment, a sub-tank 61 is provided separately from the tank (main tank) 11, which reserves fuel, as shown in Fig. 6. The pump unit 12 is arranged in the sub-tank 61.

[0034] The pump unit 12 that is the same as the one that is described in the first and second embodiments is used in the third embodiment. The pump unit 12 is secured to the inner bottom surface of the sub-tank 61. More specifically, the first end housing 23 is secured to the inner bottom surface of the sub-tank 61. The first center housing 21, which incorporates the first pump P1, is secured on top of the first end housing 23 and the second center housing 22, which incorporates the second pump P2, is secured on top of the first center housing 21. The second end housing 24, which incorporates the motor M, is secured on top of the second center housing 22. The bleed passage 26, the suction passage 35, and the discharge passage 51 are formed as shown in Fig. 6 to be suitable for arranging in the pump unit 12. The discharge passage 51 is connected to the fuel injection device 101 by the external pipe 13.

[0035] The position of the sub-tank 61 with respect to the main tank 11 is determined such that the first pump P1 is arranged lower than the inner bottom surface of the main tank 11. In other words, the inlet 34, which introduces the DME in the sub-tank 61 into the first pump P1 is located lower than the inner bottom surface of the main tank 11.

[0036] The sub tank 61 is connected to the main tank 11 by a connecting pipe 62. The inlet of the connecting pipe 62 is connected to the bottom wall of the main tank 11 and the outlet of the connecting pipe 62 is connected to the lower portion of the side wall of the sub-tank 61. The DME in the main tank 11 is introduced into the sub-tank 61 through the connecting pipe 62 by its own weight. A return pipe 63 connects the upper wall of the sub-tank 61 (or preferably the uppermost portion of the sub-tank 61) to the upper portion of the side wall of the main tank 11. Gas is retained in the upper portion of the main tank 11 and the liquid DME does not reach the gaseous space. The return pipe 63 is communicated with the gaseous space. The vaporized DME generated in the sub-tank 61 returns to the main tank 11 through the return pipe 63.

[0037] The fuel injection device 101 is connected to the upper portion of the side wall of the main tank 11 by a feedback pipe 64. The feedback pipe 64 is communicated with the gaseous space in the main tank 11. The remaining DME that was not injected by the fuel injection device 101 returns to the main tank 11 through the feedback pipe 64.

[0038] The third embodiment provides the following advantages.

(1) When the tank 11 is empty, the tank 11 may be filled with DME without being removed, or the empty tank 11 may be exchanged with another tank 11 filled with DME. Since the pump unit 12 is directly attached to the tank 11 in the first and second embodiments, the pump unit 12 is also replaced when exchanging the tank 11. In this case, the same number of pump units 12 as the tanks 11 must be provided, which increases the cost. In the first and second embodiments, the pump unit 12 may be detached from the tank 11 when exchanging the tank 11. However, such process is very troublesome.

In contrast, the pump unit 12 according to the third embodiment is arranged inside the sub-tank 61 separately from the main tank 11. Therefore, when the main tank 11 is empty, only the main tank 11 is easily removed from the fuel supplying system and replaced with another main tank 11 filled with DME. Thus, the pump unit 12 is not wasted by exchanging the pump unit 12 with the main tank 11 and it is not necessary to detach the pump unit 12 from the main tank 11.

(2) The first pump P1 of the pump unit 12 is arranged lower than the inner bottom surface of the main tank 11. The DME in the main tank 11 flows

into the sub-tank 61 through the connecting pipe 62, which is connected to the bottom wall of the main tank 11, by its own weight. The vaporized DME retained at the upper portion of the sub-tank 61 returns to the main tank 11 via the return pipe 63. Therefore, even when the level of liquid surface of the DME in the main tank 11 is close to Lhe inner bottom surface of the main tank 11, the DME is reliably sent to the sub-tank 61 from the main tank 11 and the first pump P1 reliably draws the DME while being immersed in the DME inside the sub-tank 61. That is, the first pump P1 is able to draw in the DME even when the remaining DME in the main tank 11 is only a small amount. As a result, the DME in the main tank 11 can almost be used up. This is particularly effective with the structure that permits the main tank 11 to be exchanged.

(3) Excessive DME in the fuel injection device 101 returns to the main tank 11 through the feedback pipe 64. The excessive DME is heated while flowing through the fuel injection device 101, but the heat is released in the relatively large main tank 11. This suppresses the temperature increase of the DME and decreases the amount of DME that is vaporized.

[0039] In the fourth embodiment, the differences from the third embodiment of Fig. 6 will mainly be discussed below with reference to Fig. 7. In the fourth embodiment, the pump unit 12 is arranged inside the sub-tank 61, which is separate from the main tank 11, in the same manner as in the third embodiment.

[0040] As shown in Fig. 7, the pump unit 12 is laterally secured to the inner side surface of the sub-tank 61. That is, the pump unit 12 is arranged such that the drive shaft 28 becomes horizontal. The feedback pipe 64, which extends from the fuel injection device 101, is connected to the upper portion of the sub-tank 61 instead of the main tank 11. The feedback pipe 64 is communicated with the upper portion, or the gaseous space, of the sub-tank 61.

[0041] The fourth embodiment provides the following advantages in addition to the advantages of the third embodiment.

(1) The feedback pipe 64 is connected to the sub-tank 61 instead of the main tank 11. Therefore, the number of pipes connected to the main tank 11 is reduced as compared to the third embodiment shown in Fig. 6. This facilitates detaching and connecting procedures when exchanging the main tank 11.

[0042] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or scope of the invention. Particularly, it should be understood that the invention may be embodied in the following forms.

[0043] Instead of DME, cChlorofluorocarbon or propane may be used instead of DME asfor fluid that turns into gaseous state under the pressure that is less than or equal to the saturation pressure. That is, the present invention may be embodied in a pump unit that transfers chlorofluorocarbon or propane.

[0044] A pump that has no expansion phase includes screw pump and roots pump in addition to the gear pump and the centrifugal pump. That is, the screw pump or roots pump may be used as the first pump.

[0045] In the above embodiments, the pressure release passage 37 and the relief valve 38 may be omitted. In this case, the discharge amount of DME of the first and second pumps P1 and P2 per one rotation of the drive shaft 28 is set to be equal.

[0046] In the above embodiments, the shaft sealing assembly 60 is provided between the second pump P2 (the crank chamber 25) and the motor M (the motor chamber 27). However, the shaft sealing assembly 60 may be omitted and the motor chamber 27 may be exposed to the DME.

[0047] In the above embodiments, the motor M may be separated from the pump unit 12. In this case, the motor M is connected to and driven by the drive shaft 28 of the pump unit 12 via the power transmission mechanism, which includes a belt and a pulley.

[0048] The feedback pipe 64 according to the third embodiment of Fig. 6 may be applied to the system according to the first embodiment shown in Figs. 1 to 3 or the second embodiment shown in Figs. 4 and 5.

[0049] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein, but may be modified within the scope and equivalence of the appended claims.

[0050] A fuel supplying system includes a tank (11) and a pump unit (12), which transfers fluid from the tank (11). The pump unit (12) includes a first pump (P1), a second pump (P2), and a drive source (M). The first pump (P1) and the second pump (P2) are driven by the common drive source (M). The first pump (P1), the second pump (P2), and the drive source (M) are structured as one unit. This reduces the size and simplifies the structure of the fuel supplying system.

Claims

1. A pump unit comprising:

a first pump (P1), which has no expansion phase, wherein the first pump (P1) draws in and discharges fluid;

a second pump (P2), which has an expansion phase, for drawing in and discharging fluid that is discharged from the first pump (P1), the pump unit being **characterized in that** the second pump (P2) is connected to the first pump (P1) and a single drive source (M) drives the first pump (P1) and the second pump (P2).

2. The pump unit according to claim 1, **characterized in that** the discharge capacity of the first pump (P1) is equal to or greater than the discharge capacity of the second pump (P2).

3. The pump unit according to claim 1 or 2, **characterized in that** the first pump (P1), the second pump (P2), and the drive source (M) are coupled with one another to form a single unit (12).

4. The pump unit according to claim 3, **characterized in that** the drive source (M) is an electric motor, and wherein a housing of the electric motor (24), a housing of the first pump (21), and a housing of the second pump (22) are coupled to one another.

5. The pump unit according to any one of claims 1 to 4, **characterized in that** the first pump (P1) and the second pump (P2) are driven by a common single drive shaft (28).

6. The pump unit according to claim 5, **characterized in that** the drive shaft (28) extends to the drive source (M) to serve also as an output shaft of the drive source (M).

7. The pump unit according to any one of claims 1 to 6, **characterized by**:

a communication passage (36) for introducing fluid that is discharged from the first pump (P1) into the second pump (P2); and
a relief valve (38) for releasing excessive pressure from the communication passage (36).

8. The pump unit according to claim 7, **characterized in that** the relief valve (38) releases excessive pressure from the communication passage (36) toward a section where the fluid is stored before being introduced into the first pump (P1).

9. The pump unit according to any one of claims 1 to 3, **characterized in that** the second pump (P2) is a piston pump, the piston pump comprising:

a drive shaft (28);
a piston (40);
a housing (22), which defines a crank chamber (25);
a cam (41) arranged in the crank chamber (25), wherein the cam (41) converts the rotation of the drive shaft (28) into the reciprocation of the piston (40); and
a bleed passage (26), which communicates the crank chamber (25) with the outside of the housing.

10. The pump unit according to claim 9, **characterized in that** the bleed passage (26) communicates the crank chamber (25) with the section where the fluid is stored before being introduced into the first pump (P1).

11. The pump unit according to claim 9 or 10, **characterized in that** the bleed passage (26) extends upward from the crank chamber (25).

12. The pump unit according to any one of claims 1 to 11, **characterized in that** the first pump (P1) is a gear pump or a centrifugal pump.

13. The pump unit according to any one of claim 1 to 12, **characterized by** a suction passage (35) for introducing fluid into the first pump (P1), wherein the suction passage (35) is structured such that gas that is generated in the suction passage (35) can ascend toward the upstream of the suction passage (35).

14. A fluid supplying system comprising the pump unit according to any one of claims 1 to 13, and a tank (11) for reserving fluid, wherein the pump unit transfers fluid from the tank (11).

15. The fluid supplying system according to claim 14, **characterized in that** the pump unit is attached to the tank (11) such that substantially almost the entire pump unit is exposed outside the tank (11).

16. The fluid supplying system according to claim 14, **characterized in that** the pump unit is accommodated in the tank (11).

17. A fluid supplying system comprising the pump unit according to any one of claims 1 to 13, a main tank (11) for reserving fluid, and a sub-tank (61) arranged separately from the main tank (11), wherein the sub-tank (61) receives fluid from the main tank (11), and wherein the pump unit is attached to the sub-tank (61) to transfer fluid from the sub-tank (61).

18. The fluid supplying system according to claim 17, **characterized in that** the first pump (P1) is located below an inner bottom surface of the main tank (11).

19. The fluid supplying system according to claim 17 or 18, **characterized by** a return pipe (63) for returning vaporized fluid in the sub-tank (61) into the main tank (11).

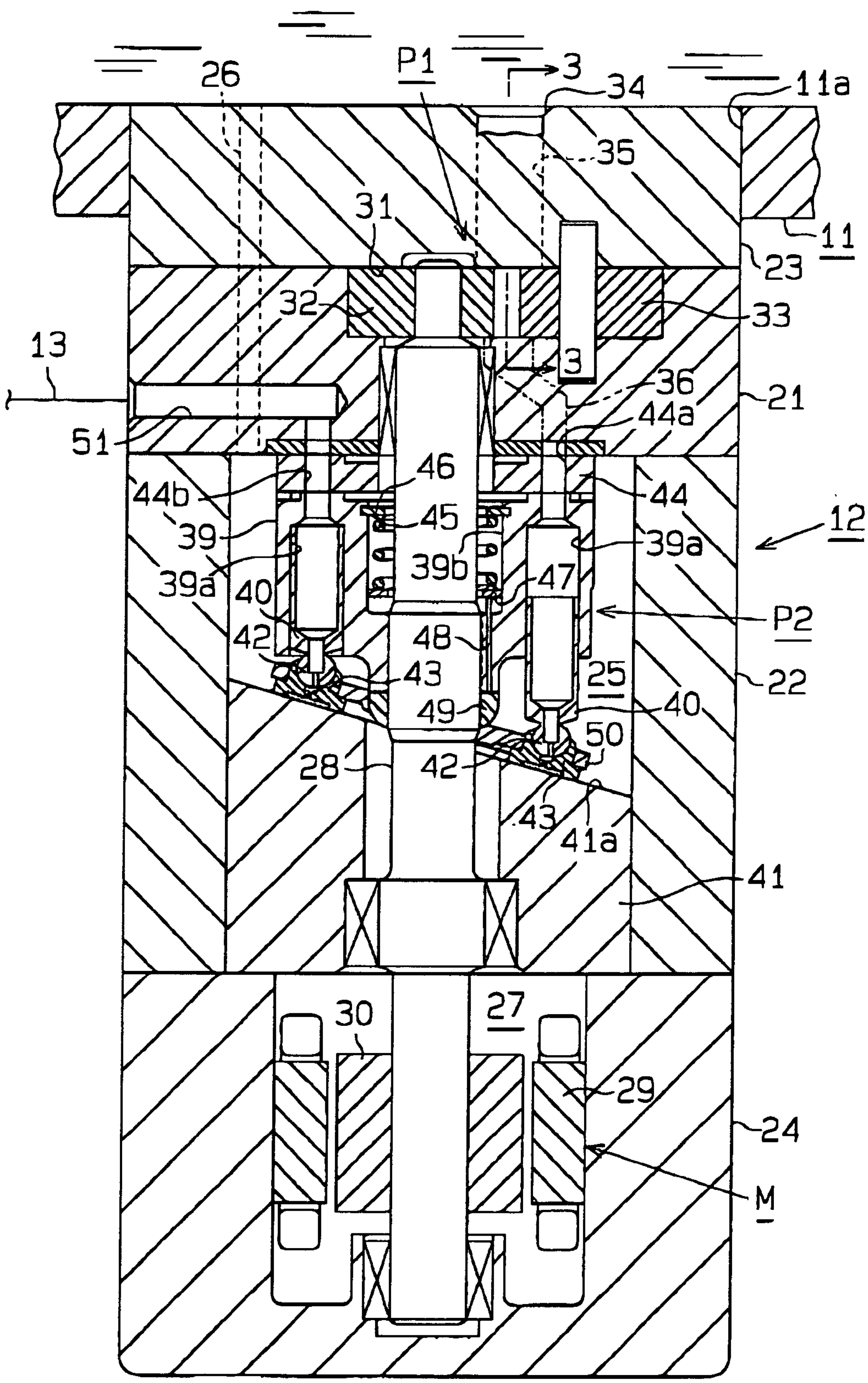
20. The fluid supplying system according to any one of claims 17 to 19, **characterized in that** the fluid is fuel for an internal combustion engine, the system further comprising:

a fuel injection device (101) for injecting the fuel into the internal combustion engine; and
a feedback pipe (64), which connects the fuel injection device (101) to the main tank (11), wherein the feedback pipe (64) returns excessive fuel that is generated in the fuel injection device (101) to the main tank (11).

21. The fluid supplying system according to any one of claims 17 to 19, **characterized in that** the fluid is fuel for an internal combustion engine, the system further comprising:

a fuel injection device (101) for injecting fuel into the internal combustion engine; and
a feedback pipe (64), which connects the fuel injection device (101) to the sub-tank (61), wherein the feedback pipe (64) returns the excessive fuel generated in the fuel injection device (101) to the sub-tank (61).

Fig.1


26
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39
39b
39a
39a
40
47
P2
42
48
43
25
22
49
40
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42
43
41a
41
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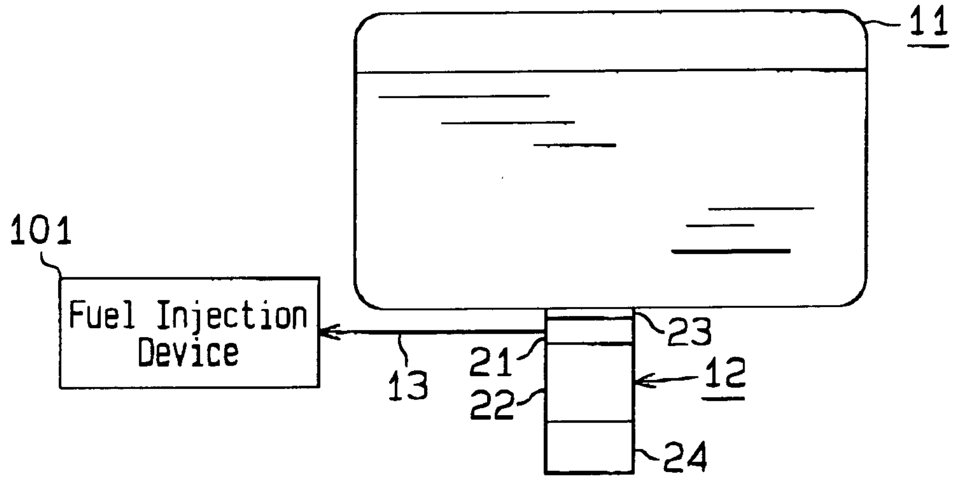
29
24
M

Fig.2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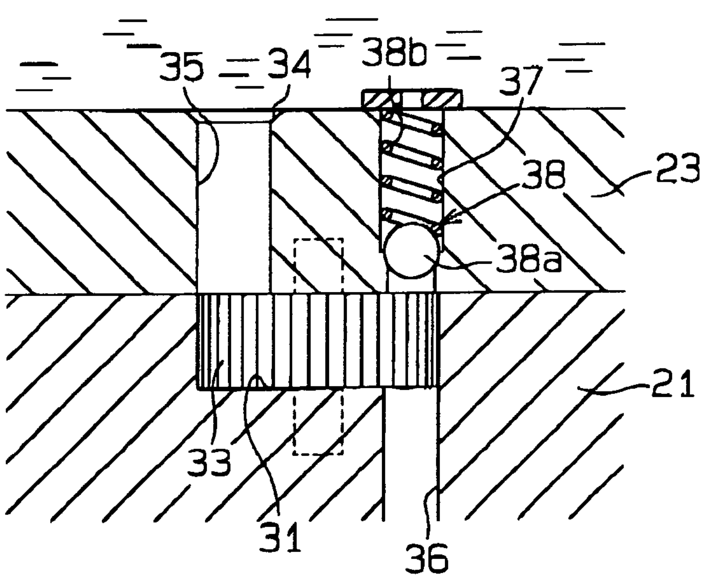
101
Fuel Injection
Device
23
21
13
12
22
24

Fig.3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38
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38a
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Fig.4

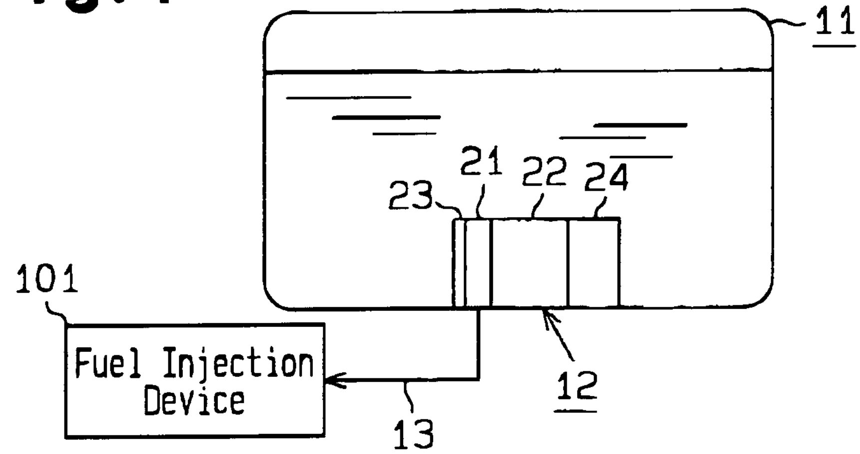
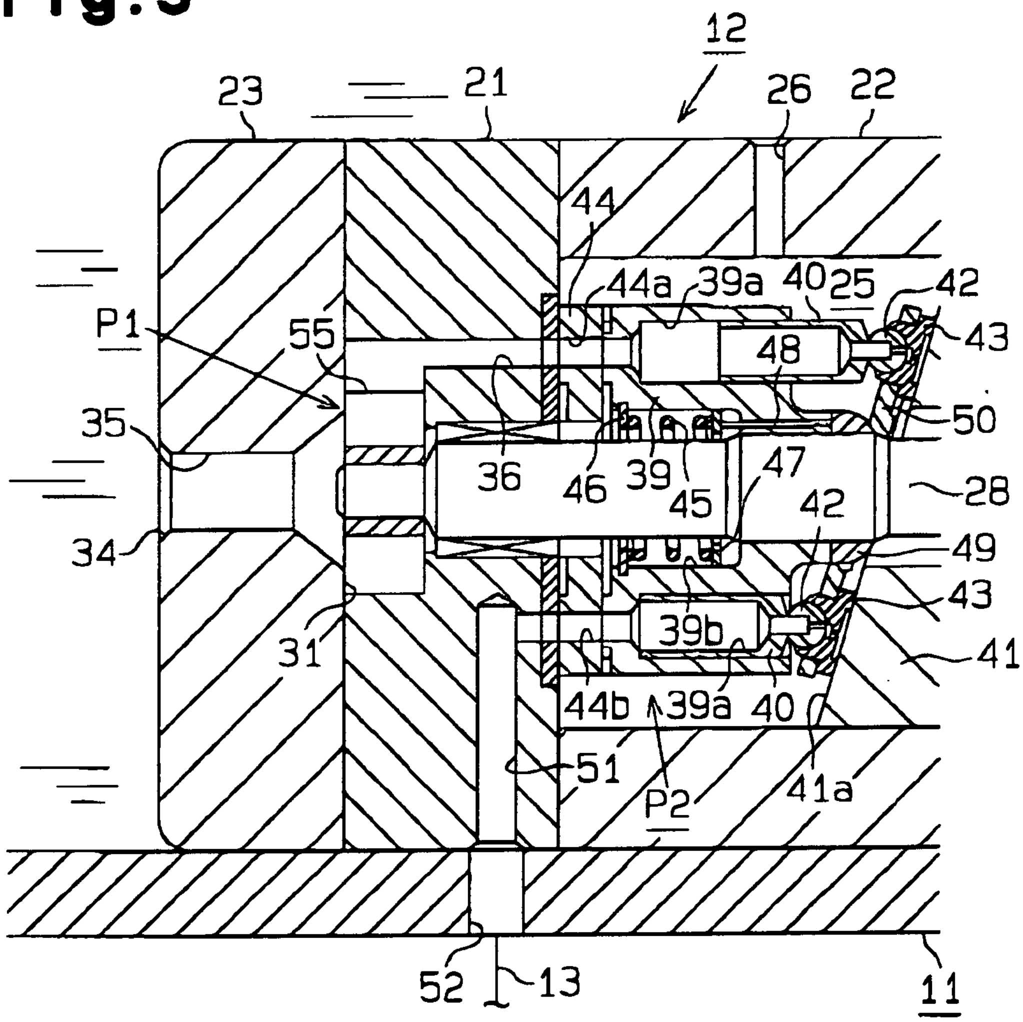

11
21
22
24
23
101
Fuel Injection Device
12
13

Fig.5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22
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44a
39a
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25
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P1
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43
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35
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36
46
39
45
47
28
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49
34
43
31
39b
41
44b
39a
40
51
P2
41a
52
13
11

Fig. 6

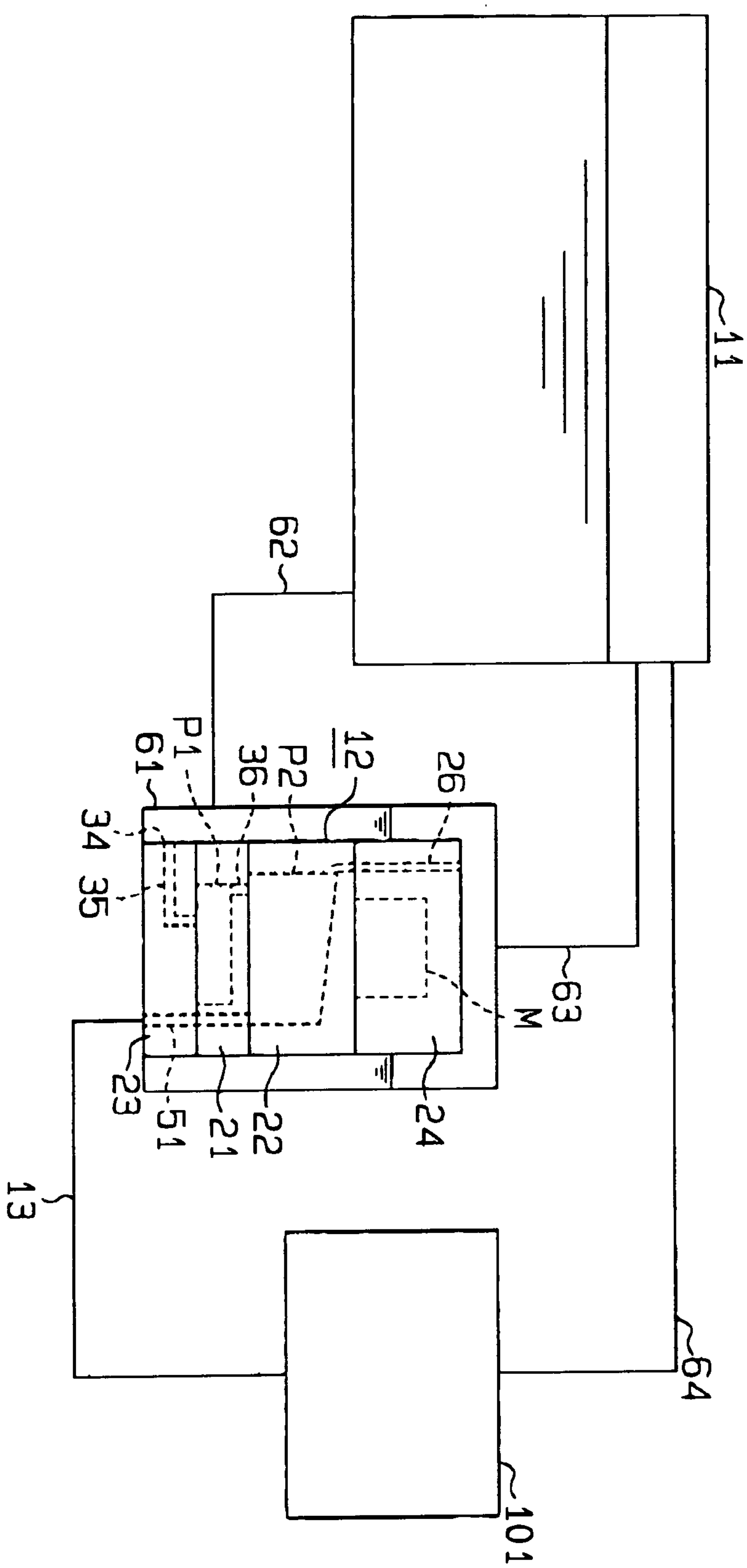

Fig.7