{DESCRIPTION}

{Title of Invention}

LIQUID SUCTION DEVICE

{Technical Field}

{0001}

The present invention relates to a liquid suction device suitably used in a ship for transporting a liquid, in particular, an LNG carrier for transporting a liquefied natural gas (hereinafter referred to as "LNG").

{Background Art}

{0002}

Generally, ships for transporting liquid have a tank that stores the liquid as cargo, and equipped with pumps, pipes, or necessary parts for loading and unloading the cargo.

An opening end of a pipe for unloading of the liquid, which is placed in a tank, is generally provided near a bottom surface of the tank in order to prevent undesirable air sucking (for example, see PTL 1).

{Citation List}

{Patent Literature}

{PTL 1}

Japanese Unexamined Patent Application, Publication No. 2006-123592

{Summary of Invention}

{0003}

Also in a LNG carrier for transporting LNG as a cargo, pumps or pipes for unloading of the LNG are placed near a bottom surface of a tank.

However, for LNG carriers, in particular, a LNG carrier having a flat bottom surface (such as a membrane type tank or a square tank), the pump described above cannot be continuously operated in some cases. Specifically, if a hull of the LNG carrier rolls and/or pitches at a time when a small amount of LNG is loaded in the tank and the liquid level is low, the LNG in the tank flows in accordance with rolling and/or pitching of the hull, and a suction port of the pump is sometimes exposed above the liquid surface of the LNG. If the suction port is exposed above the liquid surface, the pump stops due to lack of liquid, thereby preventing continuous operation.

{0004}

The present invention is made to improve the above described situation, and has an object to provide a liquid suction device that can prevent occurrence of lack of liquid even in rolling and/or pitching of a hull, and allow continuous operation of a pump.

{Solution to Problem}

{0005}

In order to achieve the above described object, the present invention adopts the following solutions.

The present invention provides a liquid suction device that delivers a liquid as a cargo from an inside of a tank storing the liquid to an outside of the tank, comprising a pump located in an internal space formed between a partition wall standing upward from a bottom surface of the tank and a side wall forming a part of the tank, or an internal space formed inside a container placed on or near the bottom surface of the tank, for sucking the liquid in the internal space and delivering the liquid to the outside of the tank via a pipe for the delivering, wherein the partition wall or the container includes an opening portion through which the liquid passes, and a check valve that allows a flow from an inside of the internal space through the opening portion, and restricts a flow out to the internal space through the opening portion.

{0006}

According to the liquid suction device of the present invention, even when a hull, a floating storage facility, or the like including the tank rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank, the liquid is stored in the internal space, and a suction portion of the pump is not exposed above the liquid surface.

In other words, even when a fluid in the tank flows in accordance with rolling and/or pitching of the hull, the floating storage facility, or the like, and there is little

liquid around the internal space, since flowing of the liquid from the inside to the outside of the internal space is restricted, the liquid is stored in the internal space. Thus, the suction portion of the pump is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull, the floating storage facility, or the like, occurrence of lack of liquid can be prevented to allow continuous operation of the pump.

{0007}

In the above described liquid suction device, it is more preferable that at least two check valves are provided along a height direction of the partition wall or the container.

{0008}

According to the liquid suction device, more liquid is taken into the internal space, occurrence of lack of liquid is prevented even in rolling and/or pitching of the hull or the like, and an amount of liquid that allows continuous operation of the pump is ensured in the internal space.

This can more reliably prevent occurrence of lack of liquid in rolling and/or pitching of the hull or the like, and allow continuous operation of the pump.

{0009}

In the above described liquid suction device, it is more preferable that a bottom portion of a pipe tower that

vertically extends at a center of the tank and houses the pipe for the delivering and the pump is utilized as the container.

{0010}

According to the liquid suction device, the bottom portion of the pipe tower is utilized to form an internal space.

This can eliminate the need to separately prepare a partition wall and a container, and reduce construction cost.

{0011}

In the above described liquid suction device, it is more preferable that an inflow pipe is provided and the inflow pipe communicates with the opening portion, the inflow pipe has a proximal end connected to the opening portion and a distal end extending obliquely upward, and the check valve is provided on a distal end of the inflow pipe.

{0012}

According to the liquid suction device, for example, if the check valve has a simple configuration including a valve body that opens/closes a channel, and a hinge that is provided at an upper portion of the valve body and rotatably supports the valve body, the valve body is made to normally open, that is, usually open.

This can reduce flow resistance in the check valve, and allow more liquid to be taken into the internal space, thereby more reliably preventing occurrence of lack of liquid in

rolling and/or pitching of the hull, and allowing continuous operation of the pump.

{0013}

In the above described liquid suction device, it is further preferable that a gap adjustment member that adjusts a gap between the partition wall or the container and a valve body that constitutes a part of the check valve is provided along a peripheral edge of the opening portion.

{0014}

According to the liquid suction device, liquid leak from the inside to the outside of the internal space when the valve body is closed can be significantly reduced to surely store more liquid in the internal space.

{0015}

In the above described liquid suction device, it is further preferable that a mass that adds a force to a valve body in an opening direction thereof is mounted via an arm on an upper part of a valve body that constitutes a part of the check valve.

{0016}

According to the liquid suction device, a weight of the mass makes the valve body normally open, that is, usually open.

This can reduce flow resistance in the check valve, and allow more liquid to be taken into the internal space, thereby

more reliably preventing occurrence of lack of liquid in rolling and/or pitching of the hull, and allowing continuous operation of the pump.

{0017}

In the above described liquid suction device, it is further preferable that the partition wall, or a peripheral wall that forms a part of the container stands obliquely upward so that an upper end thereof is closer to the pump than a bottom end thereof.

{0018}

According to the liquid suction device, for example, if the check valve has a simple configuration including a valve body that opens/closes a channel, and a hinge that is provided at an upper end portion of the valve body and rotatably supports the valve body, the valve body is made normally to open, that is, usually open.

This can reduce flow resistance in the check valve, and allow more liquid to be taken into the internal space, thereby more reliably preventing occurrence of lack of liquid in rolling and/or pitching of the hull, and allowing continuous operation of the pump.

{0019}

In the above described liquid suction device, it is further preferable that a pushing member that adds a force to a valve body in an opening direction thereof is mounted on an

upper part of the valve body that constitutes a part of the check valve.

{0020}

According to the liquid suction device, the force of the pushing member makes the valve body normally open, that is, usually open.

This can reduce flow resistance in the check valve, and allow more liquid to be taken into the internal space, thereby more reliably preventing occurrence of lack of liquid in rolling and/or pitching of the hull, and allowing continuous operation of the pump.

{0021}

The present invention provides a liquefied natural gas carrier having the liquid suction device according to any of the above.

{0022}

The liquefied natural gas carrier of the present invention includes a liquid suction device that can prevent occurrence of lack of liquid even in rolling and/or pitching of a hull, and allow continuous operation of a pump, and thus allows reliable and efficient discharge of a cargo irrespective of weather.

{0023}

The present invention provides a floating storage facility having the liquid suction device according to any of

the above.

{0024}

The floating storage facility of the present invention includes a liquid suction device that can prevent occurrence of lack of liquid even in rolling and/or pitching of a floating body, and allow continuous operation of a pump, and thus allows reliable and efficient discharge of a cargo irrespective of weather.

{0025}

The liquid suction device of the present invention can prevent occurrence of lack of liquid even in rolling and/or pitching of a hull, and allow continuous operation of a pump.

{Brief Description of Drawings}

{0026}

{Fig. 1}

Fig. 1 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to a first embodiment of the present invention is placed in a membrane type tank.

{Fig. 2}

Fig. 2 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to a second embodiment of the present invention is placed in a membrane type tank.

{Fig. 3}

Fig. 3 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to a third embodiment of the present invention is placed in a membrane type tank.

{Fig. 4}

Fig. 4 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to a fourth embodiment of the present invention is placed in a moss type tank.

{Fig. 5}

Fig. 5 is a schematic configuration diagram of a liquid suction device according to a fifth embodiment of the present invention, showing a centerline of a hull being located on a vertical line.

{Fig. 6}

Fig. 6 is a sectional view showing details of a valve device shown in Fig. 5.

{Fig. 7}

Fig. 7 is a schematic configuration diagram of the liquid suction device according to the fifth embodiment of the present invention, showing the centerline of the hull being tilted with respect to the vertical line.

{Fig. 8}

Fig. 8 is a sectional view showing details of a valve device shown in Fig. 7.

{Fig. 9}

Fig. 9 is an enlarged view of essential parts of a liquid suction device according to a sixth embodiment of the present invention.

{Fig. 10}

Fig. 10 is an enlarged view of essential parts of a liquid suction device according to a seventh embodiment of the present invention, (a) shows a state where LNG in an internal space presses a valve body, and the valve body closes an opening portion, and (b) shows a state where a mass mounted to the valve body biases the valve body in an opening direction, and the opening portion is open.

{Fig. 11}

Fig. 11 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to an eighth embodiment of the present invention is placed in a membrane type tank.

{Fig. 12}

Fig. 12 is a sectional view of a liquefied natural gas carrier in which a liquid suction device according to a ninth embodiment of the present invention is placed in a membrane type tank.

{Fig. 13}

Fig. 13 shows shapes of a valve body and an opening portion on front view according to an embodiment of the

present invention.

{Fig. 14}

Fig. 14 shows shapes of a valve body and an opening portion on front view according to another embodiment of the present invention.

{Reference Signs List}

{0027}

1 LNG carrier (liquefied natural gas carrier)

3 tank

3a tank

4 bottom surface

10 liquid suction device

11 partition wall

12 pump

22 opening portion

23 check valve

24 valve body

29 LNG carrier (liquefied natural gas carrier)

30 liquid suction device

31 container

33 side portion (peripheral wall)

34 opening portion

39 LNG carrier (liquefied natural gas carrier)

40 liquid suction device

41 container

43 side portion (peripheral wall)

44 opening portion

49 LNG carrier (liquefied natural gas carrier)

50 liquid suction device

51 pipe tower

52 pipe for unloading

53 bottom

55 peripheral wall

56 opening portion

60 liquid suction device

61 container

63 side portion (peripheral wall)

64 opening portion

65 inflow pipe

67 check valve

73 valve body

75 liquid suction device

76 gap adjustment member

80 liquid suction device

81 mass

82 arm

89 LNG carrier (liquefied natural gas carrier)

90 liquid suction device

91 container

93 side portion (peripheral wall)

94 opening portion

99 LNG carrier (liquefied natural gas carrier)

100 liquid suction device

101 spring (biasing member)

S1 internal space

S2 internal space

S3 internal space

S4 internal space

S5 internal space

S8 internal space

{Description of Embodiments}

{0028}

{First embodiment}

With reference to Fig. 1, a liquid suction device according to a first embodiment of the present invention will be described below.

Fig. 1 is a sectional view of a liquefied natural gas carrier (hereinafter referred to as "LNG carrier") 1 in which a liquid suction device 10 according to this embodiment is placed in a membrane type tank 3.

{0029}

The LNG carrier 1 is a ship for transporting LNG, in which a plurality of tanks (membrane type tanks in this embodiment) 3 filled with LNG are provided in a hull 2.

The plurality of tanks 3 are arranged side by side in a

longitudinal direction of the hull 2 (perpendicularly to the sheet of Fig. 1). Each tank 3 is a cryogenically insulated container filled with cryogenic LNG, has a shape which fits a rectangular hold space, and has a bottom surface (planar portion) 4 with a predetermined area at a lowest portion.

{0030}

A liquid suction device (LNG suction device) 10 is provided in the tank 3.

The liquid suction device 10 delivers the LNG from the inside to the outside of the tank 3. The liquid suction device 10 is placed near the bottom surface 4 of the tank 3, and near a side of the tank (port side in this embodiment) 5 of the hull 2.

{0031}

The liquid suction device 10 includes a partition wall 11 and a (cargo) pump 12.

The partition wall 11 stores the LNG in an internal space S1 formed by the partition wall 11 and side walls of the tank 3, and thus prevents a suction portion 21 of the pump 12 provided at the lowest portion of the pump 12 from being exposed above the liquid surface of the LNG. The partition wall 11 stands vertically upward from the bottom surface 4 of the tank 3 near the side of the tank 5 of the hull 2 so that the side of the pump 12 is surrounded, and is secured to the tank 3 via a securing bracket (not shown) or the like. An

opening portion (aperture) 22 is provided in the partition wall 11 at a center (or a lower portion) in a height direction of the partition wall 11. On an inner side at the opening portion 22 (on a side of an inner surface of the partition wall 11), a check valve 23 is provided and the check valve allows a flow to the inside of the internal space S1 and restricts a flow to the outside of the internal space S1.

{0032}

The check valve 23 includes a valve body (lid) 24 that opens/closes the opening portion 22, and a hinge 25 that is mounted on a position located above an upper end of the opening portion 22, and that rotatably supports the valve body 24.

{0033}

According to the liquid suction device 10 of this embodiment, even when the hull 2 having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is stored in the internal space S1, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space S1, since flowing of the liquid from the inside to the outside of the internal space S1 is restricted, the liquid is stored in the internal

space S1. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0034}

{Second embodiment}

With reference to Fig. 2, a liquid suction device according to a second embodiment of the present invention will be described below.

Fig. 2 is a sectional view of an LNG carrier 29 in which a liquid suction device 30 of this embodiment is placed in a membrane type tank 3.

{0035}

The liquid suction device 30 of this embodiment is different from that of the first embodiment described above in that the liquid suction device 30 is placed on a centerline L of a hull 2, and the partition wall 11 is replaced by a container 31. Other components are the same as those in the first embodiment described above, and descriptions thereof will be omitted.

The same reference numerals as in the first embodiment described above are used for the same components.

{0036}

The liquid suction device 30 includes a container 31 and

a (cargo) pump 12.

The container 31 stores LNG in an internal space S2 formed therein, and thus prevents a suction portion 21 of a pump 12 provided at the lowest portion of the pump 12 from being exposed above a liquid surface of the LNG. The container 31 includes a bottom portion (bottom plate) 32 placed to surround a lower portion of the pump 12, and a side portion (side plate: peripheral wall) 33 standing vertically upward from a peripheral edge of the bottom portion 32 and placed to surround a side of the pump 12. The container 31 is placed on the centerline L of the hull 2, and secured to the tank 3 via an unshown securing bracket or tank support, or the like. Also, an opening portion (aperture) 34 is provided on the side portion 33 at a center (or a lower portion) in a height direction of the side portion 33. On an inner side at the opening portion 34 (on an inner peripheral surface side of the side portion 33), a check valve 23 is provided and the check valve allows a flow to the inside of the internal space S2 and restricts a flow to the outside of the internal space S2.

{0037}

According to the liquid suction device 30 of this embodiment, even when the hull 2 having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is

stored in the internal space S2, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space S2, since flowing of the liquid from the inside to the outside of the internal space S2 is restricted, the liquid is stored in the internal space S2. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0038}

{Third embodiment}

With reference to Fig. 3, a liquid suction device according to a third embodiment of the present invention will be described below.

Fig. 3 is a sectional view of an LNG carrier 39 in which a liquid suction device 40 of this embodiment is placed in a membrane type tank 3.

{0039}

The liquid suction device 40 of this embodiment is different from that of the second embodiment described above in that the container 31 is replaced by a container 41. Other components are the same as those in the embodiments described

above, and descriptions thereof will be omitted.

The same reference numerals as in the embodiments described above are used for the same components.

{0040}

The liquid suction device 40 includes a container 41 and a (cargo) pump 12.

The container 41 stores LNG in an internal space S3 formed therein, and thus prevents a suction portion 21 of a pump 12 provided at the lowest portion of the pump 12 from being exposed above a liquid surface of the LNG. The container 41 includes a bottom portion (bottom plate) 42 placed to surround a lower portion of the pump 12, and a side portion (side plate: peripheral wall) 43 standing vertically upward from a peripheral edge of the bottom portion 42 and placed to surround a side of the pump 12. The container 41 is placed on the centerline L of the hull 2, and secured to the tank 3 via an unshown securing bracket or tank support, or the like. Also, opening portions (apertures) 44 are provided on the side portion 43 at upper and lower portions in a height direction of the side portion 43. On an inner side at the opening portion 44 (on an inner peripheral surface side of the side portion 43), a check valve 23 is provided and the check valve allows a flow to the inside of the internal space S3 and restricts a flow to the outside of the internal space S3.

The side portion 43 has an upper end located above the

upper end of the pump 12.

{0041}

According to the liquid suction device 40 of this embodiment, even when the hull 2 having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is stored in the internal space S3, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space S3, since flowing of the liquid from the inside to the outside of the internal space S3 is restricted, the liquid is stored in the internal space S3. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0042}

Also, according to the liquid suction device 40 of this embodiment, two check valves 23 are arranged along the height direction of the container 41. Thus, more liquid can be taken into the internal space S3, and therefore occurrence of lack of liquid is prevented even in rolling and/or pitching of the hull 2, and an amount of liquid that allows continuous

operation of the pump 12 can be ensured in the internal space S3.

This can more reliably prevent occurrence of lack of liquid in rolling and/or pitching of the hull 2, and allows continuous operation of the pump 12.

{0043}

{Fourth embodiment}

With reference to Fig. 4, a liquid suction device according to a fourth embodiment of the present invention will be described below.

Fig. 4 is a sectional view of an LNG carrier 49 in which a liquid suction device 50 of this embodiment is placed in a moss type tank 3A.

The same reference numerals as in the embodiments described above are used for the same components, and descriptions thereof will be omitted.

{0044}

The liquid suction device 50 includes a pipe tower 51 and a (cargo) pump 12.

The pipe tower 51 stores LNG in an internal space S4 formed therein (in the bottom portion), and thus prevents a suction portion 21 of a pump 12 provided at the lowest portion of the pump 12 from being exposed above the liquid surface of the LNG. The pipe tower 51 is a cylindrical member that vertically extends at a center in a radial direction of the

tank 3A, and houses a pipe 52 for loading and unloading and the pump 12. The bottom portion (the lowest portion) 53 of the pipe tower 51 is formed so as to have inner and outer diameters larger than inner and outer diameters of the body 54 (portion above the bottom portion 53) of the pipe tower 51. Also, an opening portion (opening) 56 is provided on the peripheral wall 55 at a center (or a lower portion) in a height direction of the peripheral wall (side plate) 55 which is a part of the bottom 53. On an inner side at the opening portion 56 (on an inner peripheral surface side of the peripheral wall 55), a check valve 23 is provided that allows a flow to the inside of the internal space S4 and restricts a flow to the outside of the internal space S4.

{0045}

According to the liquid suction device 50 of this embodiment, even when the hull having the tank 3A rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3A, the liquid is stored in the internal space S4, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3A flows in accordance with rolling and/or pitching of the hull, and there is no liquid around the internal space S4, since flowing of the liquid from the inside to the outside of the internal space S4 is restricted, the liquid is stored in the internal

space S4. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0046}

Also, according to the liquid suction device 50 of this embodiment, the containers 31, 41 described above are replaced by the bottom portion 53 of the pipe tower 51 that vertically extends at the center of the tank 3A, and houses therein the pipe 52 for unloading and the pump 12, and the bottom portion 53 is utilized to form the internal space S4.

This can eliminate the need to separately prepare the containers 31, 41, and reduce construction cost.

{0047}

{Fifth embodiment}

With reference to Figs. 5 to 8, a liquid suction device according to a fifth embodiment of the present invention will be described.

Fig. 5 is a schematic configuration diagram of the liquid suction device of this embodiment, showing a state where a centerline L of a hull 2 (see Fig. 2) is located on the vertical line, Fig. 6 is a sectional view showing a detail of the valve device shown in Fig. 5, Fig. 7 is a schematic configuration diagram of the liquid suction device of this

embodiment, showing a state where the centerline L of the hull 2 is tilted with respect to the vertical line, and Fig. 8 is a sectional view of a detail of the valve device shown in Fig. 7.

{0048}

The liquid suction device 60 of this embodiment is different from that of the second embodiment described above in that the container 31 is replaced by a container 61. Other components are the same as those in the second embodiment described above, and descriptions thereof will be omitted.

The same reference numerals as in the second embodiment described above are used for the same components.

{0049}

The liquid suction device 60 includes a container 61 and a (cargo) pump 12.

The container 61 stores LNG in an internal space S5 formed therein, and thus prevents a suction portion 21 of a pump 12 provided at the lowest portion of the pump 12 from being exposed above the liquid surface of the LNG. The container 61 includes a bottom portion (bottom plate) 62 placed to surround a lower portion of the pump 12, and a side portion (side plate: peripheral wall) 63 standing vertically upward from a peripheral edge of the bottom portion 62 and placed to surround a side of the pump 12. The container 61 is placed on the centerline L of the hull 2, and secured to the

tank 3 via an unshown securing bracket or tank support, or the like. Also, at a lower portion (or a center) in a height direction of the side portion 63, an opening portion (aperture) 64 and an inflow pipe (inflow portion) 65 communicating with the opening portion 64 are provided. On a flange 66 provided at the distal end of the inflow pipe 65, a check valve (valve device) 67 is mounted and the check valve allows a flow to the inside of the internal space S5 and restricts a flow to the outside of the internal space S5.

{0050}

The inflow pipe 65 is a pipe extending outward from the proximal end connected to the opening portion 64, extends horizontally from the proximal end connected to the opening portion 64 to a center in a length direction of the inflow pipe 65, and extends obliquely upward from the center in the length direction of the inflow pipe 65 to the distal end. At the distal end of the inflow pipe 65, the flange 66 is provided and the flange 66 is coupled to a flange 69 provided at one end of a casing 68 (see Fig. 6 or 8) that is a part of the check valve 67.

{0051}

The check valve 67 includes a casing 68 having an inflow portion 70 at one end (outer end) and an outflow portion 71 at the other end (inner end), a valve body (lid) 73 that is provided in the casing 68 and opens/closes an outlet 72 of the

inflow portion 70, and a hinge 74 that is mounted on a position located above an upper end of the outlet 72, and rotatably supports the valve body 73. At the distal end of the outflow portion 71, the flange 69 is provided and the flange 69 is coupled to the flange 66 provided at the distal end of the inflow pipe 65.

{0052}

According to the liquid suction device 60 of this embodiment, even when the hull having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is stored in the internal space S5, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull, and there is no liquid around the internal space S5, since flowing of the liquid from the inside to the outside of the internal space S5 is restricted, the liquid is stored in the internal space S5. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0053}

Also, according to the liquid suction device 60 of this

embodiment, the inflow pipe 65 is provided and the inflow pipe 65 communicates with the opening portion 64, and has the proximal end connected to the opening portion 64 and the distal end extending obliquely upward, and the check valve 67 is provided at the distal end of the inflow pipe 65. Thus, the valve body 73 is normally open, that is, usually open.

This can reduce flow resistance in the check valve 67, and allow more liquid to be taken into the internal space S5, thereby more reliably preventing occurrence of lack of liquid in rolling and/or pitching of the hull, and allowing continuous operation of the pump 12.

{0054}

{Sixth embodiment}

With reference to Fig. 9, a liquid suction device according to a sixth embodiment of the present invention will be described below.

Fig. 9 is an enlarged view of essential parts of a liquid suction device according to this embodiment.

{0055}

The liquid suction device 70 of this embodiment is different from that of the first embodiment described above in that a gap adjustment member 77 is provided along the peripheral edge of an opening portion 22 on an inner surface of a partition wall 11, different from those of the second and third embodiments described above in that the gap adjustment

member 77 is provided along the peripheral edge of opening portions 34, 44 on inner peripheral surfaces of side portions 33, 43, and different from that of the fourth embodiment in that the gap adjustment member 77 is provided along the peripheral edge of an opening 56 on an inner peripheral surface of a peripheral wall 55. Other components are the same as those in the first to fourth embodiments described above, and descriptions thereof will be omitted.

The same reference numericals as in the first to fourth embodiments described above are used for the same components.

{0056}

The gap adjustment member 71 is a plate-like member having an opening 72 communicating with the opening portions 22, 34, 44, 56 at a radially inner side, and having a predetermined (a certain) width along a circumferential direction, and is formed so that a surface facing inner surfaces of the partition wall 11, the side portions 33, 43, the peripheral wall 55 are in (tight) contact with the inner surfaces of the partition wall 11, the side portions 33, 43, and the peripheral wall 55, and an opposite surface (a surface opposite to the surface facing the inner surfaces of the partition wall 11, the side portions 33, 43, and the peripheral wall 55) are configured to come in (tight) contact with a surface of a valve body 24.

{0057}

According to the liquid suction device 70 of this embodiment, even when the hull 2 having the tanks 3, 3A rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tanks 3, 3A, the liquid is stored in the internal space, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tanks 3, 3A flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space, since flowing of the liquid from the inside to the outside of the internal space is restricted, the liquid is stored in the internal space. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0058}

Also, according to the liquid suction device 70 of this embodiment, the gap adjustment member 71 is provided along the peripheral edges of the opening portions 22, 34, 44, 56. Thus, liquid leak from the inside to the outside of the internal space when the valve body 24 is closed can be significantly reduced to surely store more liquid in the internal space.

{0059}

{Seventh embodiment}

With reference to Fig. 10, a liquid suction device according to a seventh embodiment of the present invention will be described below.

Fig. 10 is an enlarged view of essential parts of a liquid suction device according to this embodiment, (a) shows a state where LNG in the internal space presses a valve body, and the valve body closes the opening portion, and (b) shows a state where a mass mounted to the valve body add a force to the valve body in an opening direction, and the opening portion is open.

{0060}

The liquid suction device 80 of this embodiment is different from those of the first to fourth embodiments described above in that a mass 81 that adds a force to a valve body 24 in an opening direction is mounted via an arm 82 on an upper end portion of the valve body 24. Other components are the same as those in the first to fourth embodiments described above, and descriptions thereof will be omitted.

The same reference numerals as in the first to fourth embodiments described above are used for the same components. As shown in Fig. 10(b), the valve body 24 is normally open, that is, usually open.

{0061}

According to the liquid suction device 80 of this

embodiment, even when the hull 2 having the tanks 3, 3A rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tanks 3, 3A, the liquid is stored in the internal space, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tanks 3, 3A flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space, since flowing of the liquid from the inside to the outside of the internal space is restricted, the liquid is stored in the internal space S5. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0062}

Also, according to the liquid suction device 80 of this embodiment, the mass 81 that adds a force to the valve body 24 in the opening direction is mounted via the arm 82 on the upper end portion of the valve body 24. Thus, a weight of the mass 81 makes the valve body 24 normally open, that is, usually open.

This can reduce flow resistance in the check valve 23, and allow more liquid to be taken into the internal space, thereby more reliably preventing occurrence of lack of liquid

in rolling and/or pitching of the hull 2, and allowing continuous operation of the pump 12.

{0063}

{Eighth embodiment}

With reference to Fig. 11, a liquid suction device according to an eighth embodiment of the present invention will be described below.

Fig. 11 is a sectional view of an LNG carrier 89 in which a liquid suction device 90 of this embodiment is placed in a membrane type tank 3.

{0064}

The liquid suction device 90 of this embodiment is different from that of the second embodiment described above in that the container 31 is replaced by a container 91. Other components are the same as those in the second embodiment described above, and descriptions thereof will be omitted.

The same reference numerals as in the second embodiment described above are used for the same components.

{0065}

The liquid suction device 90 includes a container 91 and a (cargo) pump 12.

The container 91 stores LNG in an internal space S8 formed therein, and thus prevents a suction portion 21 of a pump 12 provided at the lowest portion of the pump 12 from being exposed above a liquid surface of the LNG. The

container 91 includes a bottom portion (bottom plate) 92 placed to surround a lower portion of the pump 12, and a side portion (side plate: peripheral wall) 93 standing obliquely upward from a peripheral edge of the bottom portion 92 so that an upper end thereof is closer to the pump 12 than a bottom end thereof, and placed to surround a side of the pump 12. The container 91 is placed on the centerline L of the hull 2, and secured to the tank 3 via an unshown securing bracket or tank support, or the like. Also, an opening portion (aperture) 94 is provided on the side portion 93 at a center (or a lower portion) in a height direction of the side portion 93. On an inner side at the opening portion 94 (on an inner peripheral surface side of the side portion 93), a check valve 23 is provided and the check valve allows a flow to the inside of the internal space S8 and restricts a flow to the outside of the internal space S8.

In this embodiment, the side portion 93 is tilted (formed obliquely) so that the upper end thereof is closer to the pump 12 than the bottom end thereof, and therefore a valve body 24 is normally open, that is, usually open as shown in Fig. 11.

{0066}

According to the liquid suction device 90 of this embodiment, even when the hull 2 having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is

stored in the internal space S8, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space S8, since flowing of the liquid from the inside to the outside of the internal space S8 is restricted, the liquid is stored in the internal space S8. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0067}

Also, according to the liquid suction device 90 of this embodiment, the side portion (peripheral wall) 93 stands obliquely upward so that the upper end thereof is closer to the pump 12 then the bottom end thereof. Thus, the valve body 24 is normally open, that is, usually open.

This can reduce flow resistance in the check valve 23, and allow more liquid to be taken into the internal space S8, thereby more reliably preventing occurrence of lack of liquid in rolling and/or pitching of the hull 2, and allowing continuous operation of the pump 12.

{0068}

{Ninth embodiment}

With reference to Fig. 12, a liquid suction device according to a ninth embodiment of the present invention will be described below.

Fig. 12 is a sectional view of an LNG carrier 99 in which a liquid suction device 100 of this embodiment is placed in a membrane type tank 3.

{0069}

The liquid suction device 100 of this embodiment is different from that of the first embodiment described above in that a spring (pushing member) 101 that adds a force to a valve body 24 in an opening direction thereof is mounted on an upper end portion of the valve body 24. Other components are the same as those in the first embodiment described above, and descriptions thereof will be omitted.

The same reference numerals as in the first embodiment described above are used for the same components.

{0070}

One end of the spring 100 is connected to an upper end portion of the valve body 24, and the other end of the spring 100 is connected to an inner surface of a partition wall 11 at a portion located above an opening portion 22. As shown in Fig. 12, the valve body 24 is normally open, that is, usually open.

{0071}

According to the liquid suction device 100 of this

embodiment, even when the hull 2 having the tank 3 rolls and/or pitches at a time when the liquid level is low because of a small amount of liquid in the tank 3, the liquid is stored in the internal space S1, and the suction portion 21 of the pump 12 is not exposed above the liquid surface.

In other words, even when a fluid in the tank 3 flows in accordance with rolling and/or pitching of the hull 2, and there is no liquid around the internal space S1, since flowing of the liquid from the inside to the outside of the internal space S1 is restricted, the liquid is stored in the internal space S1. Thus, the suction portion 21 of the pump 12 is not exposed above the liquid surface.

Thus, even in rolling and/or pitching of the hull 2, occurrence of lack of liquid can be prevented to allow continuous operation of the pump 12.

{0072}

Also, according to the liquid suction device 100 of this embodiment, the spring (pushing member) 101 that adds a force to the valve body 24 in the opening direction thereof is mounted on the upper end portion of the valve body 24. Thus, the force of the spring 101 allows the valve body 24 to be normally open, that is, usually open.

This can reduce flow resistance in the check valve 23, and allow more liquid to be taken into the internal space S1, thereby more reliably preventing occurrence of lack of liquid

in rolling and/or pitching of the hull 2, and allowing continuous operation of the pump 12.

{0073}

In the above described embodiments, it is most preferable that the valve body 24 and the opening portions 22, 34, 44, 56, 94 have a rectangular shape as shown in Fig. 13 or a circular shape as shown in Fig. 14 in a front view (in a plan view). However, the valve body 24 and the opening portions 22, 34, 44, 56, 94 in the present invention may have any shape in the front view (in a plan view) such as a polygonal shape including a triangular or pentagonal shape or an oval shape, not limited to the rectangular shape or the circular shape.

{0074}

The present invention is not limited to the above described embodiments, but may be modified and changed as required.

Also, the above described embodiments may be combined and implemented.

{0075}

Further, in the above described embodiments, the liquid suction device of the present invention applied to the LNG carrier has been described as a specific example, but the liquid suction device of the present invention may be applied to, besides the LNG carrier, floating storage facilities such as a floating production storage and offloading system (FPSO),

or a floating storage and re-gasification unit (FSRU).

{CLAIMS}

{Claim 1}

A liquid suction device that delivers a liquid as a cargo from an inside of a tank storing the liquid to an outside of the tank, comprising

a pump located in an internal space formed between a partition wall standing upward from a bottom surface of the tank and a side wall forming a part of the tank, or an internal space formed inside a container placed on or near the bottom surface of the tank, for sucking the liquid in the internal space and delivering the liquid to the outside of the tank via a pipe for the delivering,

wherein the partition wall or the container includes an opening portion through which the liquid passes, and a check valve that allows a flow from an inside of the internal space through the opening portion, and restricts a flow out to the internal space through the opening portion.

{Claim 2}

The liquid suction device according to claim 1, wherein at least two check valves are provided along a height direction of the partition wall or the container.

{Claim 3}

The liquid suction device according to claim 1 or 2, wherein a bottom portion of a pipe tower that vertically extends at a center of the tank and houses the pipe for the

delivering and the pump is utilized as the container.

{Claim 4}

The liquid suction device according to any one of claims 1 to 3,

wherein an inflow pipe is provided and the inflow pipe communicates with the opening portion,

wherein the inflow pipe has a proximal end connected to the opening portion and a distal end extending obliquely upward, and

wherein the check valve is provided on a distal end of the inflow pipe.

{Claim 5}

The liquid suction device according to any one of claims 1 to 4, wherein a gap adjustment member that adjusts a gap between the partition wall or the container and a valve body that constitutes a part of the check valve is provided along a peripheral edge of the opening portion.

{Claim 6}

The liquid suction device according to any one of claims 1 to 5, wherein a mass that adds a force to a valve body in an opening direction thereof is mounted via an arm on an upper end of a valve body that constitutes a part of the check valve.

{Claim 7}

The liquid suction device according to any one of claims

1 to 5, wherein the partition wall, or a peripheral wall that forms a part of the container stands obliquely upward so that an upper end thereof is closer to the pump than a bottom end thereof.

{Claim 8}

The liquid suction device according to any one of claims 1 to 5, wherein a pushing member that adds a force to a valve body in an opening direction thereof is mounted on an upper end of the valve body that constitutes a part of the check valve.

{Claim 9}

A liquefied natural gas carrier comprising a liquid suction device according to any one of claims 1 to 8.

{Claim 10}

A floating storage facility comprising a liquid suction device according to any one of claims 1 to 8.