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(57) [Claim(s)]

[Claim 1]

The discharge valve unit is mounted on a fluid device provided with an inlet, a housing provided with a 1 storage chamber of liquid flowing from the inlet, a 1 valve mechanism provided with a 1 discharge hole of liquid provided in the 1 storage chamber and a float stored in the 1 storage chamber for opening and closing the 1 discharge hole.

A valve case which is detachably attachable to the housing and is provided with a 1 storage chamber of liquid which is communicated with the 1 storage chamber via a communication hole, not the 2 discharge hole when the valve case is mounted on the housing ;

A 2 valve mechanism is provided in the 1 storage chamber and has a 2 discharge hole of a liquid having a larger hole diameter than the 2 discharge hole and a valve body housed in the 2 storage chamber and opening and closing the 2 discharge hole.

The 2 valve mechanism has a spring for urging the valve element in the valve opening direction, and when the pressure in the 2 storage chamber rises to a predetermined value, the valve element closes the 2 discharge hole against the urging force of the spring by the pressure.

The blowdown valve unit characterized by things.

[Claim 2]

The discharge valve unit of claim 1.

The valve case is mounted on a lower portion of the 1 storage chamber in the housing, while the communication hole is provided on an upper portion of the valve case.

The blowdown valve unit characterized by things.

[Claim 3]

The discharge valve unit of claim 2.

The 2 discharge hole opens in the vertical direction at the bottom of the 2 storage chamber.

The valve body is formed in a disk shape and is disposed above the 2 discharge hole.

The spring is provided below the valve body and urges the valve body upward.

The blowdown valve unit characterized by things.

[Claim 4]

The discharge valve unit of claim 3.

One end of the spring is connected to the lower surface of the valve body to support the valve body.

The 2 valve mechanism is provided above the valve element in the 2 storage chamber and has a baffle plate which prevents the liquid flowing down from the 1 storage chamber to the 2 storage chamber from the communication hole via the upper surface of the valve element.

The blowdown valve unit characterized by things.

[Claim 5]

The discharge valve unit of claim 4.

The valve element is pressed against the baffle plate by the biasing force of the spring.

The blowdown valve unit characterized by things.

[Claim 6]

The discharge valve unit of claim 5.

The baffle plate is provided so that its vertical position can be changed.

The blowdown valve unit characterized by things.

[Claim 7]

The discharge valve unit according to any one of claims 1 to 6.

The valve case includes an externally threaded portion threadably mounted to the housing.

The blowdown valve unit characterized by things.

[Claim 8]

A housing provided with an inlet, and a 1 storage chamber of liquid flowing from the inlet ;

A 1 valve mechanism having a 1 discharge hole of liquid provided in the 1 storage chamber and a float housed in the 1 storage chamber and opening and closing the 1 discharge hole ;

A discharge valve unit according to any one of claims 1 to 7, which is mounted on said housing.

Fluid equipment characterized by things.

[Claim 9]

The fluid device of claim 8.

A separation mechanism provided above the 1 storage chamber in the housing and separating a liquid contained in the gas flowing from the inflow port ;

The housing is provided with an outlet through which a gas separated from liquid by the separation mechanism flows out.

The liquid separated by the separation mechanism is stored in the 1 storage chamber.

Fluid equipment characterized by things.

[Claim 10]

The fluid device of claim 8.

A separation mechanism which is provided above the 1 storage chamber in the housing and separates the liquid contained in the gas flowing from the inflow port ;

A decompression mechanism is provided in the housing and is provided with a decompression mechanism for decompressing the gas separated from the liquid by the separation mechanism to maintain a constant pressure.

The housing is provided with an outlet through which the gas decompressed by the decompression mechanism flows out.

The liquid separated by the separation mechanism is stored in the 1 storage chamber.

Fluid equipment characterized by things.

[Detailed description of the invention]

[Technical field]

[0001]

This application relates to an exhaust valve unit for discharging a liquid and a fluid device to which the exhaust valve unit is mounted.

[Background of the Invention]

[0002]

As a fluid device, a drain trap for a steam system is known, and a drain trap for discharging drain is known. In order to prevent a water hammer which may be generated by mixing the steam with the low-temperature drain remaining in the system at the start of the operation of the steam system, it is necessary to quickly discharge a large amount of drain by the drain trap.

[0003]

For example, in the drain trap disclosed in Patent Document 1 2 discharge holes having different sizes and 2 floats for opening and closing each discharge hole are provided in a storage chamber. In this drain trap, drain is discharged from a lower discharge hole having a large hole diameter at the start of operation. When the pressure rises into a normal operating state, the lower discharge opening is closed by the float. Even if the drain is accumulated, the lower drain remains closed without

floating. This is because the size of the lower discharge hole is set so that the valve closing force of the float caused by the pressure difference upstream and downstream of the exhaust hole becomes larger than the opening force of the float caused by the buoyancy. On the other hand, the upper discharge hole is opened and closed by floating and lowering the float according to the storage position of the drain.

[Prior art reference]

[Patent document]

[0004]

[Patent document 1]JP 2007-218332A

[Summary of the invention]

[Problem to be solved by the invention]

[0005]

However, in the lower discharge hole having the larger hole diameter, even if the operation is finished and the pressure decreases, there is a possibility that the float adheres to the discharge hole and the discharge hole remains closed. In this case, there is a possibility that drain cannot be discharged from the lower discharge hole at the start of the next operation.

[0006]

In view of this, it is an object of the present invention to provide a discharge valve unit having a liquid discharge hole which can be opened and closed at the start of operation and closed at the time of operation.

[Means for solving the problem]

[0007]

The technology disclosed in the present application is a discharge valve unit mounted on a fluid device including a housing provided with an inlet, a 1 storage chamber of liquid flowing in from the inlet, and a 1 valve mechanism including a 1 discharge hole of liquid provided in the 1 storage chamber and a float stored in the 1 storage chamber and opening and closing the 1 discharge hole.

[0008]

The discharge valve unit includes a valve case and a 2 valve mechanism. The valve case is detachably attachable to the housing, and a 1 storage chamber of liquid which is communicated with the 2 storage chamber when the housing is mounted is provided. The 2 valve mechanism is provided

in the 2 storage chamber and has a 1 discharge hole of a liquid having a larger hole diameter than the 2 discharge hole, and a valve element housed in the 2 storage chamber and opening and closing the 2 discharge hole. The 2 valve mechanism has a spring for urging the valve element in the valve opening direction, and has a pressure in the 2 storage chamber increased to a predetermined value.

This pressure causes the valve body to close the 2 discharge hole against the urging force of the spring.

[0009]

Another technique disclosed in this application is a fluid device comprising a housing, a 1 valve mechanism, and an exhaust valve unit as described above. The housing is provided with an inlet port, and a 1 reservoir chamber. The 1 valve mechanism has a 1 discharge hole of liquid provided in the 1 storage chamber, and a float housed in the 1 storage chamber for opening and closing the 1 discharge hole. The discharge valve unit is mounted on the housing.

[Effect of the Invention]

[0010]

According to the technology disclosed in this application, it is possible to provide a discharge valve unit and a fluid device with a discharge hole for liquid which can be reliably opened at the start of operation and closed at the time of subsequent operation.

[Brief Description of the Drawings]

[0011]

[Fig. 1]FIG. 1 is a cross-sectional view showing a schematic configuration of a pressure reducing valve according to Embodiment 1.

[Fig. 2]FIG. 2 is an enlarged cross-sectional view of an essential portion of the pressure reducing valve according to the 1 embodiment.

[Fig. 3]FIG. 3 is a cross-sectional view showing a schematic configuration of a discharge valve unit according to Embodiment 1.

[Fig. 4]FIG. 4 is a view corresponding to FIG. 3 showing a discharge valve unit according to Embodiment 1 ;.

[Fig. 5]FIG. 5 is a cross-sectional view showing a schematic configuration of a gas-liquid separator according to Embodiment 2.

[Mode for carrying out the invention]

[0012]

Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. It should be noted that the following embodiments are intended to be illustrative in nature and are not intended to limit the scope of the disclosure, its application, or its scope of application.

[0013]

(Embodiment 1)

Embodiment 1 of the present application will be described with reference to FIGS. 1 to 4. The pressure reducing valve 100 of the present embodiment is provided in a steam system or the like, and reduces the pressure of the steam flowing into the steam to a constant pressure and supplies the steam to the downstream side. The pressure reducing valve 100 is an example of a fluid device.

[0014]

Further, the pressure reducing valve 100 includes a separation mechanism 10 for separating the drain contained in the flowing steam and a drain mechanism 40 for discharging the separated drain. In other words, the pressure reducing valve 100 is a pressure reducing valve having a gas-liquid separating function and a drain trap function. The pressure reducing valve 100 is provided with a discharge valve unit 50 which constitutes a part of the drain mechanism 40. Drain and steam are examples of liquid and gas, respectively.

[0015]

As shown in FIG. 1, the pressure reducing valve 100 includes a housing 1 in which a fluid flow path is formed, a separation mechanism 10, a pressure reducing mechanism 20, and a drain mechanism 40 which are respectively incorporated in the housing 1.

[0016]

The housing 1 has a body 2 and an upper lid 3 and a bottom lid 4 mounted on top and bottom of the body 2. Further, the body 2 includes an upper portion 2 a, a middle portion 2 b, and a lower portion 2 c which are vertically connected. The housing 1 is provided with an inlet 6 and an outlet 7 for steam. More specifically, the inlet 6 and the outlet 7 are part of the above-described channel and are provided in the middle portion 2 b. The inlet 6 and the outlet 7 are formed on the same shaft extending horizontally.

[0017]

In the housing 1, a decompression mechanism 20, a separation mechanism 10, and a drainage mechanism 40 are disposed in this order from the top. The separation mechanism 10 is provided generally at the middle portion 2 b and communicates with the inlet 6. The pressure reducing mechanism 20 is provided across the upper lid 3, the upper part 2 a, and the middle part 2 b, and communicates with the outlet 7.

The drain mechanism 40 is provided across the lower portion 2 c and the bottom lid 4 and communicates with the inlet 6 via the separation mechanism 10.

[0018]

In other words, in the housing 1, there are formed a flow path in which steam flowing in from the inlet port 6 flows through the separation mechanism 10 and the decompression mechanism 20 to the outlet port 7 in this order, and a flow path in which the drain flowing from the inlet port 6 together with the steam flows into the drain mechanism 40 via the separation mechanism 10.

[0019]

The separation mechanism 10 is a so-called cyclone type separator, and separates the drain contained in the steam flowing from the inlet 6, as described above. The separation mechanism 10 includes an inner cylinder 11, an outer cylinder 12, and a swirl blade 14.

[0020]

The inner cylinder 11 and the outer cylinder 12 are formed in a cylindrical shape extending vertically. The outer cylinder 12 has a larger diameter than the inner cylinder 11 and a shorter length than the inner cylinder 11. The outer cylinder 12 is provided at an interval on the outer peripheral side of the inner cylinder 11 and is provided coaxially with the inner cylinder 11. The outer cylinder 12 is provided at a position corresponding to a substantially lower half of the inner cylinder 11. Note that the upper end and the lower end of the inner cylinder 11 expand like a trumpet.

[0021]

The swirl blade 14 is provided in an annular space 13 between the outer cylinder 12 and the inner cylinder 11. The swirl blade 14 is integrally formed with the outer cylinder 12 and the inner cylinder 11. In the separation mechanism 10, an upper portion of the annular space 13 communicates with the inflow port 6. In other words, the steam flowing from the inlet 6 flows from above into the annular

space 13. The separating mechanism 10 is provided with a conical screen 8 on top of the annular space 13. The screen 8 prevents foreign matter from entering into the annular space 13 from the inlet 6.

[0022]

In the separation mechanism 10, steam flowing from the inflow port 6 passes through the screen 8 and flows into the annular space 13 and swirls. As the steam swirls, the drain (water droplets) contained in the steam is separated to the outer peripheral side. Steam from which the drain has been separated flows into the inner cylinder 11 from the lower end side and flows into the pressure reducing mechanism 20. The separated drain flows down along the inner wall surface of the lower portion 2 c and flows into the drain mechanism 40.

[0023]

The decompression mechanism 20 reduces the pressure of steam separated from the drain by the separation mechanism 10 to maintain a constant pressure. The decompression mechanism 20 includes a main valve element 21, a valve seat 22, a piston 27, a pilot valve chamber 29, a pilot valve element 30, a diaphragm 33, a spring 34, and an adjustment screw 35.

[0024]

The valve seat 22 is provided at an upper end portion of the inner cylinder 11 and has a valve hole 23 which opens in the vertical direction. The valve hole 23 communicates with the outlet 7. The main valve element 21 is provided below the valve seat 22 (upstream side) and opens and closes the valve hole 23 by being seated on the valve seat 22. The main valve element 21 is biased upward (valve-closing direction) by a spring 24.

[0025]

A cylindrical cylinder 26 extending up and down is provided above the main valve body 21, and a piston 27 slidable up and down is provided in the cylinder 26. The piston 27 has a shaft portion 27 a projecting downward from the lower end of the cylinder 26. A lower end of the shaft portion 27 a is inserted into the valve hole 23 and contacts an upper surface of the main valve element 21. A piston chamber 28 is formed in the cylinder 26 on the side of the piston 27 opposite to the main valve body 21.

[0026]

A pilot valve chamber 29 is provided above the cylinder 26 and the piston 27. The pilot valve

chamber 29 communicates with the inflow port 6 via the communication passage 31 and communicates with the piston chamber 28 via the communication passage 32. The pilot valve body 30 is a rod-like member extending up and down, and is provided so as to penetrate the pilot valve chamber 29 in the vertical direction. The pilot valve body 30 is a top.

By displacing downward, the communication passage 31 and the communication passage 32 are switched between a state in which they communicate with each other and a state in which they are shut off.

[0027]

The diaphragm 33 is formed in a disk shape extending horizontally and is provided above the pilot valve element 30. The upper end of the pilot valve element 30 is in contact with the lower surface of the diaphragm 33. A lower surface chamber 36 is formed on the lower surface side of the diaphragm 33. The lower surface chamber 36 communicates with an outflow port 7 via a communication passage 37.

[0028]

A spring 34 is provided on an upper surface side of the diaphragm 33. The spring 34 urges the diaphragm 33 downward (toward the lower chamber 36). An adjusting screw 35 for adjusting the urging force of the spring 34 is provided at an upper end portion of the spring 34. In other words, when the adjustment screw 35 is displaced downward, the urging force of the spring 34 increases, and when the adjustment screw 35 is displaced upward, the urging force of the spring 34 decreases.

[0029]

In the decompression mechanism 20, when the pressure of the outflow port 7 (I. e., the downstream side of the valve hole 23) falls below a predetermined value, the pressure in the lower chamber 36 decreases, and thus the diaphragm 33 is displaced downward by the urging force of the spring 34. When the diaphragm 33 is displaced downward, the pilot valve body 30 is pushed downward and displaced. As a result, the communication passage 31 communicates with the communication passage 32, and the high pressure in the inflow port 6 (I. e., upstream of the valve hole 23) acts on the piston chamber 28.

[0030]

Then, the piston 27 is displaced downward by the high pressure of the piston chamber 28. By this

displacement of the piston 27, the main valve element 21 is separated from the valve seat 22, and the valve hole 23 is opened. As a result, high pressure steam passing through the inside of the inner cylinder 11 flows through the valve hole 23 to the outflow port 7, so that the pressure of the outflow port 7 rises to a predetermined value.

[0031]

When the pressure of the outflow port 7 rises to a predetermined value, the pressure in the lower surface chamber 36 also increases, and the pushing up force of the diaphragm 33 due to the pressure of the lower surface chamber 36 balances with the urging force of the spring 34, so that the pilot valve element 30 is displaced upward. Thus, the communication passage 31 and the communication passage 32 are shut off, and the high-pressure fluid in the piston chamber 28 flows out from the escape hole (not shown) into the outflow port 7. Therefore, since the pressure in the piston chamber 28 decreases, as the piston 27 is displaced upward, the main valve element 21 is displaced upward by the urging force of the spring 24 and seated on the valve seat 22. Thus, the valve hole 23 is closed. In this way, the pressure of the outlet 7 is maintained at a constant value by the decompression mechanism 20.

[0032]

The drain mechanism 40 discharges drain separated from the steam by the separation mechanism 10 to the outside of the housing 1. In other words, the drain mechanism 40 discharges only the drain of the steam and the drain flowing from the inlet 6.

[0033]

As shown in FIG. 2, the drainage mechanism 40 includes a 1 storage chamber 41, a 1 valve mechanism 42, a discharge passage 46, and a discharge valve unit 50.

[0034]

The 1 storage chamber 41 is provided below the inlet 6 and the separation mechanism 10, and is formed across the lower portion 2 C and the bottom lid 4. The 1 storage chamber 41 communicates with the inlet 6 through an annular space 13 of the separation mechanism 10. The 1 storage chamber 41 is separated by the separation mechanism 10 to store the drain flowing down on the inner wall surface of the lower portion 2 c. In other words, the drain that has flowed in from the inflow port 6 is stored in the 1 storage chamber 41.

[0035]

The 1 valve mechanism 42 is a valve mechanism that allows drain to flow out from the 1 storage chamber 41 into the discharge passage 46, while preventing outflow of steam from the 1 storage chamber 41 into the discharge passage 46. A discharge passage 46 is formed in the bottom lid 4. An upstream end of the exhaust passage 46 is connected to a lower portion of the 1 storage chamber 41, and a downstream end of the exhaust passage 5 is opened to an outside of the housing 1 (atmosphere).

[0036]

The 1 valve mechanism 42 is provided in the 1 storage chamber 41 and has a 1 valve element 43 and a 1 valve seat 44.

[0037]

The 1 valve element 43 is a hollow spherical float and is accommodated in the 1 storage chamber 41 in a free state. The 1 valve seat 44 is provided at a connecting portion of the discharge passage 46 in the 1 storage chamber 41. In the 1 valve seat 44, a 1 discharge hole 45 a is formed. In other words, the 1 discharge hole 45 is provided in the 1 storage chamber 41 and communicates the 1 storage chamber 41 with the discharge passage 46. An upstream end of the 1 discharge hole 45 constitutes an orifice.

[0038]

In the 1 valve mechanism 42, the 1 valve element 43 floats and lowers in accordance with the storage position (drain water level) of the drain in the 1 storage chamber 41 and opens and closes the 1 discharge hole 45. Specifically, when the drain of the 1 storage chamber 41 increases, the 1 valve element 43 floats and separates from the 1 valve seat 44, and the 1 discharge hole 45 is opened. On the other hand, when the drain of the 1 storage chamber 41 decreases, the 1 valve element 43 descends and seats on the 1 valve seat 44, and the 1 discharge hole 45 is closed.

[0039]

More specifically, during operation of the steam system, the pressure upstream of the 1 discharge hole 45 rises to a predetermined value (hereinafter, also referred to as a pressure  $P_a$  during operation). In other words, a pressure difference (a difference between the pressure in the upstream 1 storage chamber 41 and the pressure in the downstream exhaust passage 46 (I. e., the atmospheric pressure)) is generated upstream and downstream of the 1 exhaust hole 45. On the other hand, in the

time of a start up (at the time of operation starting), since the pressure of the upstream of the 1st discharge hole 45 does not immediately rise, the pressure of the upstream of the 1st discharge hole 45 turns into the pressure  $P_b$  (henceforth the pressure  $P_b$  at the time of a start up) lower than pressure  $P_a$  at the time of operation. In other words, the pressure difference at the 1 discharge hole 45 at the start of operation becomes smaller than that at the time of operation.

[0040]

Here, the pressure upstream of the 1 discharge hole 45 (or the 2 discharge hole 56 to be described later) is referred to as the pressure of the inflow port 6 and the 1 storage chamber 41 (or the 2 storage chamber 52 described later), and the pressure of the drain in the 1 storage chamber 41 and the 2 storage chamber 52 is also referred to as the pressure of the drain.

[0041]

A force in the valve-closing direction (hereinafter, also referred to as a valve-closing force) is applied to the 1 valve element 43 by the pressure  $P_a$  and the pressure  $P_b$  at the start of the operation. In other words, due to the occurrence of a pressure difference in the 1 discharge hole 45, a valve-closing force acts on the 1 valve body 43. In the 1 valve mechanism 42, the drain water level of the 1 storage chamber 41 is set such that the floating force of the 1 valve element 43 at a predetermined position becomes larger than the valve-closing force of the 1 valve element 43 due to the pressure  $P_a$  during operation. Therefore, in the 1 valve mechanism 42, when the drain water level of the 1 storage chamber 41 reaches a predetermined position regardless of either the operation or the start of the operation, the 1 valve element 43 is floated and opened.

[0042]

It is to be noted that, of course, the valve closing force of the 1 valve element 43 due to the pressure  $P_a$  at the time of operation is larger than the valve closing force at the time of starting the operation. Further, the floating force of the 1 valve element 43 is obtained by subtracting its own weight from the buoyancy acting on the 1 valve element 43.

[0043]

In addition, a cap-like valve cover 47 is provided in the 1 storage chamber 41. The valve cover 47 is provided above the 1 valve seat 44 and regulates the floating region of the 1 valve element 43. In other words, the valve cover 47 prevents the 1 valve element 43 from floating above a predetermined height by causing the 1 valve element 43 to float and contact the valve cover 47. Note that the valve

cover 47 is provided with a vent hole 47 a that allows gas existing in the valve cover 47 to flow out when the drain is accumulated in the 1 storage chamber 41.

[0044]

The discharge valve unit 50 is detachably mounted on the bottom lid 4. Specifically, a through hole 48 is formed in the bottom lid 4 so as to communicate with the bottom of the 1 storage chamber 41 and the outside of the housing 1. The through hole 48 extends up and down. The discharge valve unit 50 penetrates from the outside of the housing 1.

It is inserted into the through hole 48 and is mounted.

[0045]

As shown in FIG. 3, the discharge valve unit 50 includes a valve case 51 and a 2 valve mechanism 53.

[0046]

The valve case 51 is formed in a cylindrical shape extending up and down, and has one end (upper end) closed. The valve case 51 is detachably attachable to the through hole 48 of the bottom lid 4, and a 2 storage chamber 52 of the drain which communicates with the 1 storage chamber 41 when the valve case is inserted into the through hole 48 is provided.

[0047]

More specifically, the inside of the valve case 51 is partitioned into upper and lower (axial direction), and the space on the upper side (closed end side) constitutes the 2 storage chamber 52. A communication hole 51 a for communicating the 2 storage chamber 52 with the 1 storage chamber 41 is provided at an upper wall (closed end) of the valve case 51. In other words, the valve case 51 is inserted (inserted) into the through hole 48 of the bottom lid 4 which is the lower portion of the 1 storage chamber 41, so that the 2 storage chamber 52 communicates with the 1 storage chamber 41 via the communication hole 51 a. Thus, the 2 storage chamber 52 is provided below the 1 storage chamber 41.

[0048]

Further, the valve case 51 has a male screw portion 51 c which is screwed into the through hole 48 of the bottom lid 4. The male screw portion 51 c is formed in an outer peripheral surface of the valve case 51 in the vertical direction (axial direction). The valve case 51 is mounted in the through hole

48 by the male screw portion 51 c being threadedly engaged with a female screw portion (not shown) formed on an inner peripheral surface of the through hole 48.

[0049]

The 2 valve mechanism 53 is a valve mechanism that allows drain to flow out of the housing 1 (atmosphere) directly from the 2 storage chamber 52, while preventing outflow of steam from the 2 storage chamber 52 to the outside of the housing 1. The 2 valve mechanism 53 is provided in the 2 storage chamber 52 and includes a 2 valve body 54, a 2 valve seat 55, a spring 57, and a baffle plate 58.

[0050]

The 2 valve element 54 corresponds to a valve element according to the claims of the present application, and is formed in a disk shape (disk shape). The 2 valve element 54 is housed in the 2 storage chamber 52 in a state in which the axial center extends in the vertical direction. The 2 valve element 54 is provided so as to be vertically movable. The 2 valve element 54 is disposed above the 2 discharge hole 56, which will be described later, and opens and closes the 2 discharge hole 56 by moving up and down.

[0051]

On an inner peripheral surface of the valve case 51, a guide portion 51 b protruding radially inward from the inner peripheral surface and extending in the vertical direction is provided. A plurality of guide portions 51 b are provided in the circumferential direction of the valve case 51. The 2 valve body 54 is provided inside the plurality of guide portions 51 b and moves up and down along the guide portion 51 b.

[0052]

The 2 valve seat 55 is provided on a bottom portion of the 2 storage chamber 52, i. e., a wall which partitions the inside of the valve case 51 up and down. In the 2 valve seat 55, a 2 discharge hole 56 is formed. In other words, the 2 discharge hole 56 is provided at the bottom of the 2 storage chamber 52 and opens in the vertical direction. The 2 discharge hole 56 communicates the 2 storage chamber 52 with the outside of the housing 1 (atmosphere).

[0053]

An upstream end of the 2 discharge hole 56 constitutes an orifice. The 2 discharge hole 56 has a larger hole diameter than the 1 discharge hole 45. Here, in the drainage mechanism 40, the pore

diameter means the diameter of the upstream end of each of the discharge holes 45,56 (I. e., the diameter of the orifice).

[0054]

The spring 57 biases the 2 valve element 54 in the valve-opening direction, and is constituted by a coil spring. A spring 57 is provided below the 2 valve element 54 in the 2 storage chamber 52 and urges the 2 valve element 54 upward. One end of the spring 57 is connected to the lower surface of the 2 valve element 54 to support the 2 valve element 54. More specifically, one end of the spring 57 is fitted and connected to an annular recess 2 a formed in the lower surface of the 54 valve element 54. The other end of the spring 57 is a 2 valve seat 5.

It is fitted and connected to an annular recess 55 a formed around the 2 discharge hole 56 at an upstream end face of 5.

[0055]

The baffle plate 58 prevents the drain flowing down from the 1 storage chamber 41 through the communication hole 51 a from the 2 storage chamber 52 to the upper surface of the 2 valve element 54. The baffle plate 58 is provided above the 2 valve element 54 in the 2 storage chamber 52.

[0056]

The baffle plate 58 is formed in a substantially disk shape, and is provided with an axial center extending vertically. The baffle plate 58 has a diameter substantially equal to that of the 2 valve element 54 and is provided coaxially with the 2 valve element 54. In other words, the baffle plate 58 is provided so as to cover the upper surface of the 2 valve element 54. When the valve is opened, the 2 valve element 54 is pressed against the baffle plate 58 by the urging force of the spring 57.

[0057]

The baffle plate 58 is provided so that its position in the vertical direction can be changed. Specifically, the baffle plate 58 is fixed to an upper wall of the valve case 51 by a screw 59. By changing the screwing length of the screw 59 to the upper wall, the vertical position of the baffle plate 58 is changed. In other words, the baffle plate 58 also functions as a restriction member for regulating an upper limit position of the 2 valve element 54 when the valve is opened.

[0058]

The 2 valve mechanism 53 is configured so that the 2 valve element 54 is displaced (raised and

lowered) in accordance with the pressure of the 2 storage chamber 52 to open and close the 2 discharge hole 56.

[0059]

Specifically, in the 2 valve mechanism 53, when the pressure in the 2 storage chamber 52 decreases to a predetermined value (the pressure  $P_b$  at the start of the operation), the 2 valve element 54 is raised by the urging force of the spring 57 and separated from the 2 valve seat 55, and the 2 discharge hole 56 is opened. In addition, in the 2 valve mechanism 53, when the pressure in the 2 storage chamber 52 rises to a predetermined value (a pressure  $P_a$  during operation), the 2 valve element 54 descends against the urging force of the spring 57 and seats on the 2 valve seat 55. Thus, the 2 discharge hole 56 is closed.

[0060]

More specifically, during operation of the steam system, similar to the 1 discharge hole 45, the pressure upstream of the 2 discharge hole 56 also rises to the pressure  $P_a$  during operation. In other words, a pressure difference (a difference between the pressure of the upstream 2 storage chamber 52 and the atmospheric pressure of the downstream side of the housing 1) is generated in the upstream and downstream of the 2 discharge hole 56. On the other hand, at the time of a start up (at the time of operation starting), the pressure of the upstream of the 2nd discharge hole 56 turns into the pressure  $P_b$  at the time of a start up lower than pressure  $P_a$  at the time of operation like the 1st discharge hole 45. In other words, the pressure difference at the 2 discharge hole 56 at the start of operation becomes smaller than that at the time of operation.

[0061]

As in the case of the 1 valve element 43, a valve-closing force is applied to the 2 valve element 54 by the pressure  $P_a$  during operation and the pressure  $P_b$  at the start of operation. In other words, a valve closing force is exerted on the 2 valve element 54 due to a pressure difference occurring in the 2 exhaust hole 56. Note that, of course, the valve closing force of the 2 valve element 54 due to the pressure  $P_a$  at the time of operation is larger than the valve closing force at the time of start of operation due to the pressure  $P_b$ .

[0062]

The urging force of the spring 57 is set larger than the valve-closing force of the 2 valve body 54 due to the pressure  $P_b$  at the start of the operation. Further, the urging force of the spring 57 is set to be

smaller than the valve-closing force of the 2 valve body 54 due to the pressure  $P_a$  during operation. Therefore, at the start of operation, the 2 valve mechanism 53 opens because the pressure in the 2 storage chamber 52 decreases to the pressure  $P_b$  at the start of operation, and in subsequent operation, the pressure in the 2 storage chamber 52 rises to the pressure  $P_a$  during operation and closes.

[0063]

#### Operation OF THE DRAIN MECHANISM

The operation of the above-described drain mechanism 40 at the start of operation of the steam system (at the start of operation) will be described. At the start of the operation, the pressure and the temperature on the upstream side of the 1 discharge hole 45 and the 2 discharge hole 56 are low, and low temperature and low pressure drain remains in the piping and the like of the steam system. That is, the pressure of the 1st reservoir room 41 and the 2nd reservoir room 52 is pressure  $P_b$  \* at the time of a start up.

Came out and it is deteriorated.

[0064]

In the 1 valve mechanism 42, when there is no drain in the 1 storage chamber 41 or when the drain water level is lower than a predetermined level, the 1 valve element 43 is seated on the 1 valve seat 44 and the 1 discharge hole 45 is closed (see FIG. 2). In the 2 valve mechanism 53, since the urging force of the spring 57 is larger than the valve-closing force of the 2 valve element 54 due to the pressure  $P_b$  at the start of the operation, the 2 valve element 54 is separated from the 2 valve seat 55 and the 2 discharge hole 56 is opened (see FIG. 2,3). In other words, the 1 valve mechanism 42 is closed and the 2 valve mechanism 53 is opened.

[0065]

Thus, at the start of the operation, the 2 valve mechanism 53 is opened, and residual drain of the steam system flows into the pressure reducing valve 100. In the pressure reducing valve 100, the drain flowing from the inlet 6 flows into the 1 storage chamber 41 through the annular space 13 of the separation mechanism 10. Then, the drain flows from the 1 storage chamber 41 through the communication hole 51 a into the 2 storage chamber 52 and flows out of the housing 1 through the 2 discharge hole 56 (discharged). Since the 2 discharge hole 56 has a larger hole diameter than the 1

discharge hole 45, a large amount of drain is quickly discharged.

[0066]

In this way, the drain mechanism 40 of the pressure reducing valve 100 quickly discharges the low-temperature drain remaining in the steam system at the start of the operation.

[0067]

Further, when the drain flows down from the 1 storage chamber 41 into the 2 storage chamber 52, it is possible to prevent the drain from coming into contact with the upper surface of the 2 valve element 54 by the baffle plate 58. Therefore, it is possible to prevent the 2 valve element 54 from swinging, which can be generated when the drain abuts on the upper surface of the 2 valve element 54. Further, as shown in FIG. 3, since the 2 valve element 54 is pressed against the baffle plate 58 by the urging force of the spring 57, it is also possible to prevent the 2 valve element 54 from swinging due to the contact of the drain.

[0068]

Next, the operation of the above-described drainage mechanism 40 during operation of the steam system will be described. In operation, the pressure and the temperature of the upstream side of the 1 discharge hole 45 and the 2 discharge hole 56 become high, and the high-temperature and high-pressure steam (including drain) flows into the pressure reducing valve 100. In other words, the pressure of the 1 storage chamber 41 and the 2 storage chamber 52 increases to the pressure  $P_a$  during operation. The steam flowing into the pressure reducing valve 100 is separated from the drain in the separation mechanism 10.

[0069]

In the 2 valve mechanism 53, since the urging force of the spring 57 is smaller than the valve-closing force of the 2 valve element 54 due to the pressure  $P_a$  during operation, the 2 valve element 54 is seated on the 2 valve seat 55 and the 2 discharge hole 56 is closed by the pressure  $P_a$  during operation (see FIG. 4). In other words, the 2 valve mechanism 53 is closed. Therefore, the drain separated by the separation mechanism 10 flows from the 1 storage chamber 41 into the 2 storage chamber 52 and is stored therein.

[0070]

When the drain of the 2 storage chamber 52 becomes full, drain begins to accumulate in the 1 storage chamber 41. In the 1 valve mechanism 42, when the drain water level of the 1 storage

chamber 41 rises to a predetermined position, the 1 valve element 43 floats and separates from the 1 valve seat 44, and the 1 discharge hole 45 is opened. In other words, the 1 valve mechanism 42 opens. Then, the drain of the 1 storage chamber 41 flows into the exhaust passage 46 via the 1 valve mechanism 42 and is discharged outside the housing 1 (atmosphere).

[0071]

On the other hand, when a portion of the steam separated from the drain by the separation mechanism 10 flows into the 1 storage chamber 41, the drain of the 1 storage chamber 41 flows out of the 1 valve mechanism 42 and decreases, and eventually, the 1 valve element 43 is seated on the 1 valve seat 44. Thus, since the 1 valve mechanism 42 is closed, outflow of steam from the 1 discharge hole 45 is prevented.

[0072]

In this way, the drain mechanism 40 of the pressure reducing valve 100 is separated by the separation mechanism 10 during operation.

Drain is discharged out of housing 1, while preventing outflow of steam out of housing 1. Further, during operation, the 2 valve mechanism 53 is maintained in the closed state, and the drain remains in the 2 storage chamber 52. On the other hand, the steam separated from the drain by the separation mechanism 10 is reduced to a constant pressure by the decompression mechanism 20, and is supplied from the outflow port 7 to the downstream use point.

[0073]

When the operation of the vapor system is stopped, the pressure and the temperature of the upstream side of the 1 exhaust hole 45 and the 2 exhaust hole 56 gradually decrease. Then, when the pressure in the 2 storage chamber 52 decreases to the pressure  $P_b$  at the start of the operation, the 2 valve element 54 rises by the urging force of the spring 57 and separates from the 2 valve seat 55. Thus, when the 2 valve mechanism 53 is opened, drain accumulated in the 2 storage chamber 52 is discharged from the 2 discharge hole 56 to the outside of the housing 1. The 2 valve mechanism 53 is maintained in an open state until the next operation start.

[0074]

As described above, the discharge valve unit 50 of the above embodiment is provided with the housing 1 provided with the inflow port 6 and the 1 storage chamber 41 of the drain flowing from

the inflow port 6. The fluid device is mounted on a fluid device provided with a 1 discharge hole 45 of a drain provided in the 1 storage chamber 41 and a 1 valve mechanism 42 which is housed in the 1 storage chamber 41 and has a 1 valve element 43 (float) for opening and closing the discharge hole 45. 1.

[0075]

The discharge valve unit 50 includes a valve case 51 and a 2 valve mechanism 53. The valve case 51 is detachably mountable on the housing 1, and a 2 storage chamber 52 of a drain which communicates with the 1 storage chamber 41 when the housing 1 is mounted is provided. The 2 valve mechanism 53 is provided in the 2 storage chamber 52, and has a 2 discharge hole 56 of drain having a larger hole diameter than the 1 discharge hole 45, and a 2 valve body 54 (valve body) accommodated in the 2 storage chamber 52 and opening and closing the 2 discharge hole 56. The 2 valve mechanism 53 has a spring 57 for urging the 2 valve element 54 in the valve opening direction, and when the pressure in the 2 storage chamber 52 rises to a predetermined value, the 2 valve element 54 closes the 2 discharge hole 56 against the urging force of the spring 57.

[0076]

According to the above configuration, it is possible to reliably open the 2 discharge hole 56 of the drain at the start of operation and to close it at the time of subsequent operation, and thus it is possible to provide the discharge valve unit 50 and the pressure reduction valve 100 (fluid device) having the 2 discharge hole 56. Therefore, at the start of the operation, a large amount of low-temperature drain remaining in the steam system can be discharged quickly. Therefore, it is possible to prevent water hammer which can be generated by mixing steam with the low-temperature drain.

[0077]

Further, in the discharge valve unit 50 according to the embodiment, the valve case 51 is mounted on the lower portion of the 1 storage chamber 41 of the housing 1, and a communication hole 51 a is provided on the upper portion of the valve case for communicating the 1 storage chamber 41 with the 2 storage chamber 52.

[0078]

According to the above configuration, since the 2 storage chamber 52 is provided below the 1 storage chamber 41, a drain head of the 2 storage chamber 52 is added to the drain of the 1 storage chamber 41. Therefore, the drain capacity of the drain by the 2 valve mechanism 53 increases at the

start of the operation.

[0079]

In addition, in the discharge valve unit 50 of the above embodiment, the 2 discharge hole 56 opens in the vertical direction at the bottom of the 2 storage chamber 52. The 2 valve element 54 is formed in a disk shape and is disposed above the 2 discharge hole 56. A spring 57 is provided below the 2 valve element 54 and urges the 2 valve element 54 upward.

[0080]

According to the above configuration, since the 2 discharge hole 56 is provided at the bottom of the 2 storage chamber 52, it is possible to increase the drain head of the 2 storage chamber 52 as much as possible, and to further enhance the drain capacity of the drain by the 2 valve mechanism 53. In addition, the 2 valve element 54 is a disk-shaped valve element formed in a disk shape, and therefore, as compared with a spherical float, for example, the 2 valve element 53 is installed in an installation space.

It is reducible.

[0081]

In addition, in the discharge valve unit 50 of the embodiment, the spring 57 has one end connected to the lower surface of the 2 valve body 54 to support the 2 valve body 54. The 2 valve mechanism 53 has a baffle plate 58 which is provided above the 2 valve element 54 in the 2 storage chamber 52 and prevents the drain flowing down from the 2 storage chamber 41 through the communication hole 54 a into the 1 storage chamber 52 against the upper surface of the 2 valve element 51.

[0082]

According to the above configuration, when the 2 valve mechanism 53 is in the open state, it is possible to prevent the 2 valve element 54 from swinging, which can be generated when the drain flowing down from the 1 storage chamber 41 hits the upper surface of the 2 valve element 54. When the 2 valve element 54 swings irregularly, the flow of drain toward the 2 discharge hole 56 can be disturbed and thereby the drain efficiency of drain can be impaired, but in this embodiment, it can be prevented. In particular, since the 2 valve element 54 is supported by the spring 57 connected to the lower surface, there is a possibility that the occurrence of wobbling becomes remarkable, and it is possible to effectively prevent the occurrence of the wobbling.

[0083]

Further, in the discharge valve unit 50 of the above embodiment, since the 2 valve element 54 is pressed against the baffle plate 58 by the urging force of the spring 57, it is also possible to prevent the 2 valve element 54 from swinging due to the contact of the drain.

[0084]

Further, in the discharge valve unit 50 according to the embodiment, the baffle plate 58 is provided so as to be capable of changing its vertical position. According to this configuration, it is possible to adjust the urging force of the spring 57 in accordance with the change in the operating condition of the steam system.

[0085]

In other words, when the pressure  $P_a$  during operation and the pressure  $P_b$  at the start of operation are changed, the urging force of the spring 57 can be adjusted so that the 2 valve mechanism 53 appropriately opens and closes under the changed pressures  $P_a$  and  $P_b$ . For example, when the urging force of the spring 57 is reduced, the position of the baffle plate 58 is shifted upward, and when the urging force of the spring 57 is increased, the position of the baffle plate 58 is shifted downward.

[0086]

In addition, in the discharge valve unit 50 of the embodiment, the valve case 51 has a male screw portion 51 c which is screwed into the housing 1. According to this configuration, the discharge valve unit 50 can be easily attached and detached to and from the housing 1 of the pressure reducing valve 100 (fluid device).

[0087]

In addition, in the case where the function of the discharge valve unit 50 is not required in the pressure reducing valve 100 (fluid device), the pressure reducing valve 100 can be continuously used by screwing a plug instead of the discharge valve unit 50.

[0088]

(Embodiment 2)

Embodiment 2 of the present application will be described with reference to FIG. 5. This embodiment is a gas-liquid separator 110 (fluid device) to which the discharge valve unit 50 of Embodiment 1 is mounted. The gas-liquid separator 110 of the present embodiment has substantially

the same configuration as that of the pressure reducing valve 100 of Embodiment 1 except that the depressurizing mechanism 20 is omitted. Here, differences from Embodiment 1 will be described.

[0089]

The gas-liquid separator 110 is provided in a steam system or the like, separates the drain contained in the steam that has flowed into, and supplies the separated steam to the downstream side. The gas-liquid separator 110 has a drain mechanism 40 for discharging the separated drain. In other words, the gas-liquid separator 110 is a gas-liquid separator with a drain trap function. In addition, a discharge valve unit 50 which constitutes a part of the drain mechanism 40 is mounted on the gas-liquid separator 110.

[0090]

The gas-liquid separator 110 includes a housing 70 in which a fluid flow path is formed, and a separation mechanism 10 and a drain mechanism 40 respectively incorporated in the housing 70. The configuration and the function of the separation mechanism 10 and the drainage mechanism 40 are similar to those of Embodiment 1.

[0091]

Housing 70 includes a body 71 and a bottom lid 72 mounted below body 71. In addition, the main body 2 includes an upper portion 71 a and a lower portion 71 b connected in the vertical direction. As in Embodiment 1, the housing 70 is provided with an inlet 6 and an outlet 7 for steam. The inflow port 6 and the outflow port 7 are part of the above-described channel and are provided in the upper portion 71 a.

[0092]

In the housing 70, as in Embodiment 1, a separation mechanism 10 and a drainage mechanism 40 are arranged in this order from the top. The separation mechanism 10 is generally provided at the upper portion 71 a and communicates with the inlet 6. The drain mechanism 40 is provided across the lower portion 71 b and the bottom lid 72 and communicates with the inlet 6 via the separation mechanism 10.

[0093]

In other words, in the housing 70, there is formed a flow passage through which the steam flowing from the inlet port 6 flows into the outlet port 7 through the separation mechanism 10 and a flow

passage through which the drain gas flowing from the inlet port 6 along with the steam flow flows through the separation device 10 through the separation mechanism 40.

[0094]

In the gas-liquid separator 110 of the present embodiment configured as described above, the same effect as in Embodiment 1 is obtained.

[0095]

Note that, in the technology disclosed in the present application, the above-described embodiment may be configured as follows.

[0096]

For example, in the discharge valve unit 50 of the above embodiment, the spring 57 is provided below the 2 valve element 54, but may be provided above the 2 valve element. In this case, the spring is configured as a tension spring which urges the 2 valve body in the valve-opening direction (upward).

[0097]

In addition, in the discharge valve unit 50 of the above embodiment, a spherical float may be used as the 2 valve element 54.

[0098]

In addition, in the discharge valve unit 50 of the embodiment, the baffle plate 58 may be omitted, or the valve case may be fixed to the housing by a screw.

[0099]

Further, although the pressure reducing valve 100 and the gas-liquid separator 110 have been described as examples of the fluid device, the present invention is applicable to other fluid devices as long as the fluid device is provided.

[Industrial applicability]

[0100]

The techniques disclosed herein are useful for an exhaust valve unit and a fluid device to which it is mounted.

[Explanation of letters or numerals]

[0101]

1,70 housing

6 Input

7 Tap Hole

10 Separation Mechanism

20 Reduced Pressure Control

41 1 storage chamber

42 1 valve mechanism

43 1 valve element (float)

45 1 discharge hole

50 discharge valve unit

51 Valve Case

51 a communication hole

51 c male threaded portion

52 2 storage chamber

53 2 valve mechanism

54 2 valve element

56 2 discharge hole

57 spring

58 Baffle