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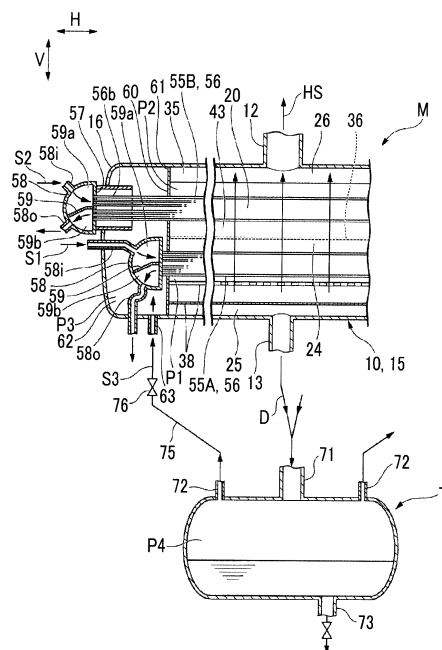
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(54) **MOISTURE SEPARATING AND HEATING DEVICE AND MOISTURE SEPARATING AND HEATING FACILITY WITH SAME**

(57) This moisture separating and heating device is provided with: an end partition plate (60) which divides the inside of a container (10) in the axial direction (H) into an end chamber (62) and a vapor chamber (20), the vapor chamber (20) allowing vapor to be heated to flow therein; and a heater (55) which penetrates through the end partition plate (60), has one part located in the end chamber and the other part located in the vapor chamber, and heats the vapor to be heated by means of heating vapor (S1), the vapor to be heated having flowed into the vapor chamber. The heater (55) is provided with a vapor drain pipe (58o) which discharges a drainage of the heating vapor having exchanged heat with the vapor to be heated, to the outside of the container (10) through the end chamber (62). The container (10) is provided with a nozzle (63) which is connected to a high-pressure fluid supply source (T) for supplying a high-pressure fluid (S3) having a pressure higher than pressure in the end chamber (62), penetrates through to the inside of the end chamber from below the end chamber (62), and jets the high-pressure fluid (S3) into the end chamber.

FIG. 7



Description

Technical Field

[0001] The present invention relates to a moisture separating and heating device which produces superheated vapor by separating moisture from vapor and heating the vapor, and a moisture separating and heating facility which is provided with the moisture separating and heating device. This application claims the right of priority based on Japanese Patent Application No. 2013-006110 filed with the Japan Patent Office on January 17, 2013, the contents of which are incorporated herein by reference.

Background Art

[0002] In a power-generating plant, there is a case where vapor used in a high-pressure steam turbine is used again in a low-pressure steam turbine. In this case, if moisture is present in the vapor, not only are turbine blades of the low-pressure steam turbine eroded, but also the thermal efficiency of the turbine is reduced. Therefore, in this case, a moisture separating and heating device which separates moisture from the vapor discharged from the high-pressure steam turbine and heats the vapor, thereby producing superheated vapor, is provided between the high-pressure steam turbine and the low-pressure steam turbine.

[0003] As such a moisture separating and heating device, there is, for example, a moisture separating and heating device disclosed in PTL 1 below.

[0004] The moisture separating and heating device is provided with a cylindrical container which extends in a horizontal axial direction and into which vapor to be heated flows, a partition plate which divides the inside of the container in the axial direction into an end chamber and a vapor chamber into which the vapor to be heated flows, and a heater which heats the vapor to be heated having flowed into the vapor chamber with heating vapor. The heater penetrates through the partition plate and has one portion located in the vapor chamber and the other portion located in the end chamber.

Citation List

Patent Literature

[0005] [PTL 1] Japanese Unexamined Utility Model Registration Application Publication 63-197903

Summary of Invention

Technical Problem

[0006] In the moisture separating and heating device disclosed in PTL 1 described above, usually, vapor does not flow into the end chamber. However, a slight amount

of vapor in the vapor chamber flows into the end chamber from a gap between the partition plate and the heater. The vapor having flowed into the end chamber is condensed and accumulated in the end chamber as drainage. If the amount of drainage in the end chamber increases, the heater located in the end chamber and the drainage come into contact with each other, whereby the heater is cooled, and therefore, the heating efficiency of the vapor to be heated is reduced. For this reason, it is not preferable that drainage is accumulated in the end chamber.

[0007] Therefore, a method of providing a separate drain tank having an internal pressure less than or equal to the pressure in an end chamber and discharging drainage accumulated in the end chamber into the drain tank is conceivable. However, in this method, it is necessary to provide a separate drain tank, and thus facility cost increases.

[0008] The present invention provides a moisture separating and heating device in which it is possible to reduce the amount of drainage which is accumulated in an end chamber of the moisture separating and heating device, while suppressing an increase in facility cost, and a moisture separating and heating facility provided with the moisture separating and heating device.

Solution to Problem

[0009] According to a first aspect of the present invention, there is provided a moisture separating and heating device including: a cylindrical container which extends in a horizontal axial direction and in which both ends in the axial direction are sealed and vapor to be heated flows into the inside; an end partition plate which divides the inside of the container in the axial direction into an end chamber and a vapor chamber into which the vapor to be heated flows; and a heater which penetrates through the end partition plate, has one portion located in the end chamber and the other portion located in the vapor chamber, and heats the vapor to be heated having flowed into the vapor chamber with heating vapor. The heater is provided with a vapor drain pipe which discharges the heating vapor having exchanged heat with the vapor to be heated and/or drainage of the heating vapor to the outside of the container through the end chamber. The container is provided with a nozzle which is connected to a high-pressure fluid supply source for supplying a high-pressure fluid having a pressure higher than pressure in the end chamber, penetrates into the end chamber from below the end chamber, and jets the high-pressure fluid into the end chamber.

[0010] In the moisture separating and heating device, even if drainage is accumulated on the bottom of the end chamber, the drainage is blown off by the high-pressure fluid which is jetted into the end chamber from below the end chamber. Some of the blown-off drainage comes into contact with the vapor drain pipe of the heater. In the vapor drain pipe of the heater, vapor for heating the vapor

to be heated which flows into the vapor chamber or drainage of the heating vapor flows. For this reason, the vapor drain pipe has a higher temperature than the drainage accumulated on the bottom of the end chamber. Therefore, the drainage being in contact with the vapor drain pipe is vaporized, thereby becoming vapor. Some of the vapor flows into the vapor chamber from, for example, a gap between the container and the end partition plate.

[0011] Therefore, in the moisture separating and heating device, even if drainage is accumulated on the bottom of the end chamber, it is possible to vaporize the drainage, thereby making the drainage flow out to the outside of the end chamber. Further, in a steam plant provided with a moisture separating and heating device, many devices or the like which retain a high-pressure fluid such as vapor having a pressure higher than the pressure in an end chamber of the moisture separating and heating device exist. For this reason, in the moisture separating and heating device, a device or the like in the steam plant can be easily utilized as a high-pressure fluid supply source. In addition, it is possible to suppress an increase in facility cost compared with separately providing a drain tank having an internal pressure less than or equal to the pressure in the end chamber in order to recover drainage in the end chamber.

[0012] According to a second aspect of the present invention, the moisture separating and heating device may further include a guide member which guides the high-pressure fluid such that the high-pressure fluid jetted from the nozzle into the end chamber is directed to the vapor drain pipe.

[0013] In the heater, the heating vapor having passed through a heat transfer tube and/or drainage of the heating vapor temporarily stays in a vapor recovery chamber and is then discharged from the vapor drain pipe to the outside. For this reason, in the vapor drain pipe of the heater, drainage or the like of the heating vapor flows at a flow velocity higher than the flow velocity of drainage or the like in the vapor recovery chamber. Therefore, in the heater, a heat exchange rate between fluids on the inside and the outside of the vapor drain pipe is higher than a heat exchange rate between fluids on the inside and the outside of an outer wall of a bonnet or the like which forms a vapor recovery chamber on the inside thereof.

[0014] In the moisture separating and heating device, the high-pressure fluid jetted from the nozzle into the end chamber is actively led to the vapor drain pipe of the heater by the guide member, whereby a contact ratio (the probability of contact) between the drainage accumulated on the bottom of the end chamber and the vapor drain pipe is increased. As a result, in the moisture separating and heating device, it is possible to efficiently vaporize the drainage accumulated on the bottom of the end chamber.

[0015] According to a third aspect of the present invention, the vapor drain pipe may meander in the end chamber.

[0016] In the moisture separating and heating device, the vapor drain pipe meanders in the end chamber, and thus a pipe length in the end chamber is long, and therefore, a contact ratio of blown-off drainage with respect to the vapor drain pipe increases.

[0017] According to a fourth aspect of the present invention, there is provided a moisture separating and heating facility including: the moisture separating and heating device according to any one of the above aspects; a drain tank as the high-pressure fluid supply source, which receives drainage accumulated at a lower portion in the vapor chamber of the moisture separating and heating device; and a high-pressure fluid line which connects an upper portion of the drain tank and the nozzle and supplies vapor in the drain tank to the nozzle as the high-pressure fluid.

[0018] In a case where a moisture separating and heating device is installed, a drain tank which receives drainage from the moisture separating and heating device is also installed in conjunction with the installation. In the moisture separating and heating facility, the drain tank is utilized as a high-pressure fluid supply source, and therefore, it is possible to suppress an increase in facility cost.

[0019] Here, in the moisture separating and heating facility, the high-pressure fluid line may be provided with a flow rate regulating valve which regulates the flow rate of the vapor which is supplied from the drain tank to the end chamber through the nozzle.

[0020] In the moisture separating and heating facility, it is possible to regulate the flow rate of vapor which is supplied from the drain tank to the end chamber through the nozzle.

Advantageous Effects of Invention

[0021] According to the above aspects, it is possible to reduce the amount of drainage which is accumulated in the end chamber of the moisture separating and heating device, while suppressing an increase in facility cost.

Brief Description of Drawings

[0022]

Fig. 1 is a perspective view, with a main section cut away, of a moisture separating and heating device in an embodiment related to the present invention.

Fig. 2 is a vertical cross-sectional view of the moisture separating and heating device in the embodiment related to the present invention.

Fig. 3 is a cross-sectional view taken along line III-III in Fig. 2.

Fig. 4 is a cross-sectional view taken along line IV-IV in Fig. 3.

Fig. 5 is a cross-sectional view taken along line V-V in Fig. 2.

Fig. 6 is an enlarged perspective view, with a main section cut away, of the moisture separating and heating device in the embodiment related to the

present invention.

Fig. 7 is a vertical cross-sectional view of main sections of the moisture separating and heating device and a drain tank in the embodiment related to the present invention.

Fig. 8 is a system diagram of a steam plant in the embodiment related to the present invention.

Fig. 9 is a vertical cross-sectional view of main sections of a moisture separating and heating device and a drain tank in a modified example of the embodiment related to the present invention.

Description of Embodiments

[0023] Hereinafter, an embodiment and a modified example of a moisture separating and heating facility according to the present invention will be described in detail with reference to the drawings.

[Embodiment of Moisture Separating and Heating Facility]

[0024] First, an embodiment of a moisture separating and heating facility according to the present invention will be described by using Figs. 1 to 8.

[0025] The moisture separating and heating facility of this embodiment configures a portion of a steam plant, as shown in Fig. 8. The steam plant is provided with a BWR (Boiling Water Reactor) type reactor pressure vessel 1, a reactor containment vessel 2 covering the reactor pressure vessel 1, a high-pressure steam turbine 3 which is driven by steam generated in the reactor pressure vessel 1, a moisture separating and heating facility 4 which separates moisture from vapor exhausted from the high-pressure steam turbine 3 and heats the vapor, a low-pressure steam turbine 5 which is driven by the vapor from the moisture separating and heating facility 4, a power generator 6 which generates electric power with the driving of the high-pressure steam turbine 3 and the low-pressure steam turbine 5, a condenser 7 which returns the vapor exhausted from the low-pressure steam turbine 5 to water, and a water feed pump 8 which sends the water in the condenser 7 to the reactor pressure vessel 1.

[0026] The moisture separating and heating facility 4 is provided with a moisture separating and heating device M which separates moisture from the vapor exhausted from the high-pressure steam turbine 3 and heats the vapor, and a drain tank T which receives drainage accumulated in the moisture separating and heating device M.

[0027] The moisture separating and heating device M is provided with a cylindrical container 10 into which vapor to be heated S enters, and a heater 55 which heats the vapor to be heated S having entered into the container 10, as shown in Figs. 1 to 5. In addition, Fig. 3 is a cross-sectional view taken along line III-III in Fig. 2. Fig. 4 is a cross-sectional view taken along line IV-IV in Fig. 3. Fig. 5 is a cross-sectional view taken along line V-V in Fig. 2.

[0028] The container 10 has a cylindrical shell 15 which

extends in a horizontal axial direction H, and end plates 16 which block ends in the axial direction H of the shell 15. The inside of the container 10 is divided into an end chamber 62 and a vapor chamber 20 in the axial direction H by an end partition plate 60. In addition, in the following, a direction which is a horizontal direction and is perpendicular to the axial direction H is referred to as a transverse width direction W.

[0029] In the container 10, there are formed a vapor inlet 11 through which the vapor to be heated S is received into the vapor chamber 20, a plurality of vapor outlets 12 which send out superheated vapor HS subjected to moisture separation and heated in the vapor chamber 20, and a plurality of vapor drainage outlets 13 which discharge vapor drainage D from the vapor chamber 20. The vapor inlet 11 is formed at a lower portion of the container 10 and at a central portion of the container 10 in the axial direction H. Further, the plurality of vapor drainage outlets 13 are formed at the lower portion of the container 10 and on both sides in the axial direction H on the basis of the vapor inlet 11. The plurality of vapor outlets 12 are formed side by side in the axial direction H at an upper portion of the container 10. In addition, one vapor outlet 12 among the plurality of vapor outlets 12 is formed at the central portion of the container 10 in the axial direction H, similarly to the vapor inlet 11.

[0030] In the vapor chamber 20, there are formed a vapor receiving chamber 21 into which the vapor to be heated S flowing in from the vapor inlet 11 enters, a supply manifold chamber 22 (refer to Figs. 4 and 5) which communicates with the vapor receiving chamber 21 and is adjacent to both sides of the vapor receiving chamber 21 in the axial direction H, a moisture separation chamber 23 (refer to Figs. 4 and 5) which communicates with the supply manifold chamber 22 and is adjacent to the lower side of the supply manifold chamber 22, a heating chamber 24 which communicates with the moisture separation chamber 23 and in which the heater 55 is accommodated, a vapor drainage recovery chamber 25 (refer to Figs. 4 and 5) which communicates with the moisture separation chamber 23 and is adjacent to the lower sides of the moisture separation chamber 23 and the heating chamber 24, and a vapor recovery manifold chamber 26 which communicates with the heating chamber 24 and the vapor outlets 12 and is adjacent to the upper sides of the vapor receiving chamber 21, the supply manifold chamber 22, and the heating chamber 24.

[0031] The vapor recovery manifold chamber 26 is formed at an upper portion in the vapor chamber 20 over almost the whole of the vapor chamber 20 in the axial direction H, as shown in Figs. 1 and 2. On the other hand, the vapor receiving chamber 21 is formed adjacent to the lower side of the vapor recovery manifold chamber 26 at a central portion in the axial direction H of the vapor chamber 20. The vapor recovery manifold chamber 26 and the vapor receiving chamber 21 are separated from each other by a ceiling plate 30, as shown in Figs. 3 and 6.

[0032] All of the supply manifold chamber 22, the mois-

ture separation chamber 23, the heating chamber 24, and the vapor drainage recovery chamber 25 are adjacent to both sides of the vapor receiving chamber 21 in the axial direction H, as shown in Figs. 1, 2, and 4. As shown in Figs. 2 and 5, the heating chamber 24 is formed at the center in the transverse width direction W at a position deviated from the vapor receiving chamber 21 in the axial direction H. Further, the supply manifold chamber 22 is formed on both sides of the heating chamber 24 in the transverse width direction W, and the moisture separation chamber 23 is formed on both sides of the heating chamber 24 in the transverse width direction W and on the lower side of the supply manifold chamber 22. The vapor recovery manifold chamber 26 is formed on the upper sides of the vapor receiving chamber 21, the heating chamber 24, and the supply manifold chamber 22. Further, the vapor drainage recovery chamber 25 is formed on the lower sides of the heating chamber 24 and the moisture separation chamber 23 at a position deviated from the vapor receiving chamber 21 in the axial direction H.

[0033] The moisture separation chamber 23, the heating chamber 24, and the vapor drainage recovery chamber 25 among the supply manifold chamber 22, the moisture separation chamber 23, the heating chamber 24, and the vapor drainage recovery chamber 25 which are adjacent to the vapor receiving chamber 21 in the axial direction H are separated from the vapor receiving chamber 21 by a transverse partition plate 33, as shown in Figs. 1 to 3 and 6. In addition, the supply manifold chamber 22 is open without being separated from the vapor receiving chamber 21 by the transverse partition plate 33 in order to communicate with the vapor receiving chamber 21.

[0034] The supply manifold chamber 22 is separated from the vapor recovery manifold chamber 26 adjacent to the upper side of the supply manifold chamber 22 by inclined plates 35, as shown in Figs. 5 and 6. Each of the inclined plates 35 gradually slopes upward with increasing distance from the central portion of the container 10 in the transverse width direction W, and an end portion farthest from the central portion is joined to the inner surface of the container 10.

[0035] The moisture separation chamber 23 is separated from the supply manifold chamber 22 adjacent to the upper side of the moisture separation chamber 23 by distribution plates 36, as shown in Figs. 4 and 5. In the distribution plate 36, a plurality of slits 37 which penetrate in an up-down direction V and are long in the transverse width direction W are formed. The vapor drainage recovery chamber 25 is separated from the heating chamber 24 and the moisture separation chamber 23 adjacent to the upper side of the vapor drainage recovery chamber 25 by a bottom plate 38. The heating chamber 24 is separated from the supply manifold chamber 22 and the moisture separation chamber 23 adjacent to both sides of the heating chamber 24 in the transverse width direction W by longitudinal partition plates 43. An end edge in

the axial direction H of the ceiling plate 30 which separates the vapor recovery manifold chamber 26 and the vapor receiving chamber 21 from each other is joined to an upper end 43u of the longitudinal partition plate 43, as shown in Fig. 6. In addition, a center-side end portion of each of the inclined plates 35 which separate the supply manifold chamber 22 and the vapor recovery manifold chamber 26 from each other is joined to the upper end 43u of the longitudinal partition plate 43, as shown in Figs. 5 and 6. Further, a center-side end portion of each of the distribution plates 36 which separate the moisture separation chamber 23 and the supply manifold chamber 22 from each other is joined to a central portion in the up-down direction V of the longitudinal partition plate 43.

[0036] All of end portions on the side opposite to the vapor receiving chamber 21 in the axial direction H, in the vapor recovery manifold chamber 26, the supply manifold chamber 22, the moisture separation chamber 23, the heating chamber 24, and the vapor drainage recovery chamber 25 which are shown in Fig. 5, are blocked with the end partition plate 60, as shown in Figs. 1 and 2. For this reason, all of ends in the axial direction H of the inclined plate 35 which separates the supply manifold chamber 22 and the vapor recovery manifold chamber 26 from each other, the distribution plate 36 disposed between the moisture separation chamber 23 and the supply manifold chamber 22, the longitudinal partition plate 43 which separates the supply manifold chamber 22 and the moisture separation chamber 23 from the heating chamber 24, and the bottom plate 38 disposed between the heating chamber 24 and the moisture separation chamber 23, and the vapor drainage recovery chamber 25 are joined to the end partition plate 60. In addition, in an upper end of the end partition plate 60, as shown in Fig. 7, an air vent hole 61 making the vapor recovery manifold chamber 26 and the end chamber 62 communicate with each other, thereby extracting air in the vapor chamber 20, is formed.

[0037] In the vapor receiving chamber 21, as shown in Figs. 1 to 3 and 6, a baffle plate 50 in which a cross-sectional shape perpendicular to the axial direction H is a U-shape and a portion equivalent to a curved portion of the U-shape faces the lower side is disposed.

[0038] Mist separators 53 are disposed in the moisture separation chamber 23, as shown in Figs. 4 and 5. The mist separator 53 is made by disposing a plurality of corrugated plates (not shown) at equal intervals in the axial direction H and has a baffle (not shown) provided to face the flow of the vapor to be heated S at the top of each of the corrugated plates. All of the tops and the bottoms of the plurality of corrugated plates extend in the up-down direction V. In the bottom plate 38 separating the moisture separation chamber 23 and the vapor drainage recovery chamber 25 from each other, openings 39 penetrating in the up-down direction V at positions equivalent to lower portions of the plurality of corrugated plates configuring the mist separator 53 are formed.

[0039] The heater 55 includes a first heater 55A dis-

posed on the lower side in the container 10, and a second heater 55B disposed on the upper side in the container 10, as shown in Figs. 1 to 3.

[0040] Each of the first heater 55A and the second heater 55B has a heat transfer tube 56 formed with a U-shaped tube, a tube plate 57 to which an end portion of the heat transfer tube 56 is fixed, a bonnet 58 covering the side opposite to the side from which the heat transfer tube 56 extends, of the tube plate 57, and a partition plate 59 dividing a space which is formed by the tube plate 57 and the inner surface of the bonnet 58, into an upper space and a lower space. In the heat transfer tube 56 which is a U-shaped tube, an end portion 56a on the curved side faces the central portion side in the axial direction H of the container 10 and a tube end 56b of the heat transfer tube 56 faces the end portion side in the axial direction H of the container 10. In the space which is formed by the tube plate 57 and the inner surface of the bonnet 58, the space above the partition plate 59 forms a vapor receiving chamber 59a and the space below the partition plate 59 forms a vapor recovery chamber 59b. A vapor supply pipe 58i for supplying heating vapor to the vapor receiving chamber 59a and a vapor drain pipe 58o for discharging the heating vapor and/or drainage of the heating vapor in the vapor recovery chamber 59b to the outside are connected to the bonnet 58.

[0041] First heating vapor S1 is supplied from the outside to the heat transfer tube 56 of the first heater 55A through the vapor supply pipe 58i and the vapor receiving chamber 59a. Further, second heating vapor S2 is supplied to the heat transfer tube 56 of the second heater 55B through the vapor supply pipe 58i and the vapor receiving chamber 59a.

[0042] In addition, the first heating vapor S1 is vapor having a temperature higher than the temperature of the vapor to be heated S flowing from the high-pressure steam turbine 3 (refer to Fig. 8) into the vapor receiving chamber 21 of the moisture separating and heating device M. Further, the second heating vapor S2 is vapor having a temperature higher than the temperature of the first heating vapor S1.

[0043] The bonnet 58 of the first heater 55A is disposed in the end chamber 62, and the heat transfer tube 56 of the first heater 55A penetrates through the end partition plate 60 and is located in the heating chamber 24. Further, the bonnet 58 of the second heater 55B is disposed outside the container 10, and the heat transfer tube 56 of the second heater 55B penetrates through the end plate 16 of the container 10 and the end partition plate 60 and is located in the end chamber 62 and the heating chamber 24. As shown in Fig. 6, the end portion 56a on the curved side of the heat transfer tube 56 in each of the first heater 55A and the second heater 55B penetrates through the transverse partition plate 33 in the axial direction H, is located further toward the central portion side in the axial direction H of the container 10 than the end portions in the axial direction H of the transverse partition plate 33 and the ceiling plate 30, and is covered

with a shroud 44.

[0044] In the end plate 16 of the container 10, as shown in Figs. 1 and 7, a nozzle 63 penetrating from below the end plate 16 into the end chamber 62 and jetting spraying vapor S3 into the end chamber 62 is provided.

[0045] In an upper portion of the drain tank T, as shown in Fig. 7, a drainage receiving port 71 which receives the vapor drainage D accumulated in the vapor drainage recovery chamber 25 of the moisture separating and heating device M, and a vapor outlet 72 which discharges vapor in the drain tank T are formed. Further, in a lower portion of the drain tank T, a drainage outlet 73 which discharges the vapor drainage D in the drain tank T is formed.

[0046] The vapor outlet 72 of the drain tank T and the nozzle 63 of the moisture separating and heating device M are connected by a spraying vapor line (a high-pressure fluid line) 75 in order to supply vapor staying in an upper portion in the drain tank T into the end chamber 62 as the spraying vapor S3. In the spraying vapor line 75, a flow rate regulating valve 76 which regulates the flow rate of the spraying vapor S3 passing through the spraying vapor line 75 is provided.

[0047] Next, the flow of vapor and drainage in the moisture separating and heating facility 4 described above will be described.

[0048] As shown in Figs. 1 to 3 and 6, if the vapor to be heated S used in the high-pressure steam turbine 3 (refer to Fig. 8) flows from the vapor inlet 11 into the vapor receiving chamber 21, the vapor to be heated S is guided to the upper side and to both sides in the transverse width direction W while an impact at the time of inflow into the vapor receiving chamber 21 is alleviated at the baffle plate 50, thereby flowing into the supply manifold chamber 22.

[0049] The vapor to be heated S having flowed into the supply manifold chamber 22 flows into the moisture separation chamber 23 through the slits 37 of the distribution plates 36, as shown in Figs. 4 and 5. In the moisture separation chamber 23, the vapor to be heated S comes into contact with the plurality of corrugated plates, the baffles, and the like configuring the mist separator 53, whereby moisture in the vapor to be heated S is captured by the plurality of corrugated plates and the baffles, then flows down to the lower side, and flows from the openings 39 of the bottom plate 38 into the vapor drainage recovery chamber 25. The moisture, that is, the vapor drainage D, which has flowed into the vapor drainage recovery chamber 25, flows out from the vapor drainage outlet 13 along with some of the vapor to be heated S and flows into the drain tank T.

[0050] On the other hand, the vapor to be heated S having passed through the mist separators 53 flows into the heating chamber 24 and is heated by the first heater 55A and the second heater 55B in the process of flowing upward through the heating chamber 24, thereby becoming the superheated vapor HS. The superheated vapor HS flows from the heating chamber 24 into the vapor

recovery manifold chamber 26 and then flows out from the vapor outlet 12 to the outside. The superheated vapor HS having flowed out from the moisture separating and heating device M is sent to the low-pressure steam turbine 5 (refer to Fig. 8).

[0051] The vapor drainage D and some of the vapor to be heated S having flowed into the drain tank T are divided into a gas phase and a liquid phase and temporarily accumulated in the drain tank T, as shown in Fig. 7. Pressure P4 in the drain tank T is almost the same as pressures P1 and P2 in the drainage recovery chamber and the heating chamber of the moisture separating and heating device M. On the other hand, pressure P3 in the end chamber 62 of the moisture separating and heating device M is lower than the pressures P1 and P2 in the vapor drainage recovery chamber 25 and the heating chamber 24, and therefore, the pressure is also lower than the pressure P4 in the drain tank T. For this reason, a gas phase fluid (a high-pressure fluid), that is, the spraying vapor S3, staying at the upper portion in the drain tank T is jetted into the end chamber 62 of the moisture separating and heating device M from below the end chamber 62 through the vapor outlet 72 formed at the upper portion of the drain tank T, the spraying vapor line (the high-pressure fluid line) 75, and the nozzle 63 of the moisture separating and heating device M.

[0052] Incidentally, in a case where the nozzle 63 is not provided, the end chamber 62 does not form a portion of a pathway through which vapor flows, and therefore, usually, vapor does not flow into the end chamber 62. However, as described above, the pressures P1 and P2 in the heating chamber 24 are higher than the pressure P3 in the end chamber 62, and therefore, the vapor to be heated S in the heating chamber 24 flows in from gaps between the end partition plate 60 and the heat transfer tubes 56 of the first and second heaters 55A and 55B. In particular, the vapor to be heated S in the heating chamber 24 flows in from the gap between the end partition plate 60 and the heat transfer tube 56 of the first heater 55A. This is because the pressure P1 of the vapor to be heated S around the heat transfer tube 56 of the first heater 55A is slightly higher than the pressure P2 of the vapor to be heated around the heat transfer tube 56 of the second heater 55B because the first heater 55A is located further toward the upstream side than the second heater 55B for the vapor to be heated S.

[0053] The vapor having flowed from the heating chamber 24 into the end chamber 62 is condensed and accumulated in the end chamber 62 as drainage. If the amount of drainage in the end chamber 62 increases and thus a drainage level in the end chamber 62 becomes higher, the upper portion or the vapor supply pipe 58i of the bonnet 58 of the first heater 55A located in the end chamber 62 comes into contact with the drainage. As a result, the first heating vapor S1 flowing through the vapor supply pipe 58i or the vapor receiving chamber 59a of the first heater 55A is cooled, and thus the heating efficiency of the vapor to be heated S is reduced.

[0054] For this reason, it is not preferable that drainage is accumulated in the end chamber 62.

[0055] In this embodiment, if the flow rate regulating valve 76 in the spraying vapor line 75 is opened, the vapor in the drain tank T is jetted into the end chamber 62 as the spraying vapor S3, and therefore, the pressure in the end chamber 62 is increased, and thus the amount of the vapor to be heated S in the heating chamber 24 which flows into the end chamber 62 from the gaps between the end partition plate 60 and the heat transfer tubes 56 of the first and second heaters 55A and 55B is reduced.

[0056] Further, even if drainage is accumulated on the bottom of the end chamber 62, the drainage is blown off by the spraying vapor S3 which is jetted into the end chamber 62 from below the end chamber 62, and some of the blown-off drainage comes into contact with the lower surface or the vapor drain pipe 58o of the bonnet 58 of the first heater 55A. Furthermore, the vapor drain pipe 58o meanders in the end chamber 62, as shown in Figs. 1 and 7, and thus the pipe length in the end chamber 62 is long, and therefore, the contact ratio of the blown-off drainage with respect to the vapor drain pipe 58o is increased. In the bonnet 58 or the vapor drain pipe 58o of the first heater 55A, the high-temperature first heating vapor S1 supplied to the heat transfer tube 56 of the first heater 55A or drainage of the first heating vapor flows, and therefore, the lower surface or the vapor drain pipe 58o of the bonnet 58 of the first heater 55A has a higher temperature than the drainage accumulated on the bottom of the end chamber 62. For this reason, the drainage which is in contact with the lower surface or the vapor drain pipe 58o of the bonnet 58 of the first heater 55A is vaporized, thereby becoming vapor. Some of the vapor flows from, for example, the gap between the end partition plate 60 and the heat transfer tube 56 of the second heater 55B into the heating chamber 24 and some other vapor flows from the air vent hole 61 of the end partition plate 60 into the vapor recovery manifold chamber 26 having even lower pressure than the heating chamber 24.

[0057] Therefore, in this embodiment, even if drainage is accumulated on the bottom of the end chamber 62, it is possible to vaporize the drainage, thereby causing the drainage to flow out to the outside of the end chamber 62.

[0058] Accordingly, in this embodiment, it is possible to reduce the amount of drainage which is accumulated in the end chamber 62 of the moisture separating and heating device M. Furthermore, in a case where the moisture separating and heating device M is installed, the drain tank T which is installed in conjunction with the installation is used as a supply source of a high-pressure fluid for blowing off the drainage accumulated in the end chamber 62, and therefore, it is possible to suppress an increase in facility cost.

[0059] In addition, the flow rate regulating valve 76 in the spraying vapor line 75 may be opened at all times, but may be made so as to be periodically and temporarily opened.

[Modified Example of Moisture Separating and Heating Device]

[0060] Next, a modified example of the moisture separating and heating device described above will be described by using Fig. 9.

[0061] The moisture separating and heating device M of this modified example is provided with a guide member 65 for actively leading the spraying vapor S3 jetted from the nozzle 63 into the end chamber 62 to the vapor drain pipe 58o of the first heater 55A.

[0062] In a case where the guide member 65 is not provided, as described above, the drainage accumulated on the bottom of the end chamber 62 comes into contact with the lower surface or the vapor drain pipe 58o of the bonnet 58 of the first heater 55A due to the spraying vapor S3 jetted from the nozzle 63 into the end chamber 62. The first heating vapor S1 supplied to the heat transfer tube 56 of the first heater 55A and/or drainage of the first heating vapor temporarily stays in the vapor recovery chamber 59b in the bonnet 58 of the first heater 55A. On the other hand, in the vapor drain pipe 58o of the first heater 55A, the first heating vapor S1 and/or drainage of the first heating vapor flows at a higher flow velocity than the flow velocity of drainage in the vapor recovery chamber 59b. Therefore, a heat exchange rate between fluids on the inside and the outside of the vapor drain pipe 58o is higher than a heat exchange rate between fluids on the inside and the outside of the bonnet 58.

[0063] Therefore, in this modified example, the spraying vapor S3 jetted from the nozzle 63 into the end chamber 62 is actively led to the vapor drain pipe 58o of the first heater 55A by the guide member 65, whereby a contact ratio between the drainage accumulated on the bottom of the end chamber 62 and the vapor drain pipe 58o is increased. As a result, in this modified example, it is possible to efficiently vaporize the drainage accumulated on the bottom of the end chamber 62.

[0064] In addition, in the embodiment and the modified example described above, the drain tank T of the moisture separating and heating device M is used as a high-pressure fluid supply source and the spraying vapor S3 in the drain tank T is jetted to the end chamber 62 of the moisture separating and heating device M as a high-pressure fluid. However, vapor from another high-pressure fluid supply source in the steam plant may be jetted to the end chamber 62 of the moisture separating and heating device M as a high-pressure fluid. Even with such a configuration, since many devices or the like which retain vapor having a pressure higher than the pressure in the end chamber 62 of the moisture separating and heating device M exist in the steam plant, it is possible to suppress an increase in facility cost compared with separately providing a drain tank having an internal pressure less than or equal to the pressure in the end chamber 62.

Industrial Applicability

[0065] According to the moisture separating and heating device and the moisture separating and heating facility, it is possible to reduce the amount of drainage which is accumulated in the end chamber of the moisture separating and heating device, while suppressing an increase in facility cost.

10 Reference Signs List

[0066]

- | | |
|------|--|
| 3: | high-pressure steam turbine |
| 4: | moisture separating and heating facility |
| 5: | low-pressure steam turbine |
| 10: | container |
| 11: | vapor inlet |
| 12: | vapor outlet |
| 15: | shell |
| 16: | end plate |
| 20: | vapor chamber |
| 21: | vapor receiving chamber |
| 22: | supply manifold chamber |
| 23: | moisture separation chamber |
| 24: | heating chamber |
| 25: | vapor drainage recovery chamber |
| 26: | vapor recovery manifold chamber |
| 30: | ceiling plate |
| 33: | transverse partition plate |
| 35: | inclined plate |
| 36: | distribution plate |
| 38: | bottom plate |
| 43: | longitudinal partition plate |
| 44: | shroud |
| 50: | baffle plate |
| 53: | mist separator |
| 55: | heater |
| 55A: | first heater |
| 55B: | second heater |
| 56: | heat transfer tube |
| 58: | bonnet |
| 58i: | vapor supply pipe |
| 58o: | vapor drain pipe |
| 59: | partition plate |
| 59a: | vapor receiving chamber |
| 59b: | vapor recovery chamber |
| 60: | end partition plate (or partition plate) |
| 61: | air vent hole |
| 62: | end chamber |
| 63: | nozzle |
| 65: | guide member |
| 75: | spraying vapor line (high-pressure fluid line) |
| 76: | flow rate regulating valve |
| M: | moisture separating and heating device |
| T: | drain tank (high-pressure fluid supply source) |
| S: | vapor to be heated |
| HS: | superheated vapor |

S1: first heating vapor
 S2: second heating vapor
 S3: spraying vapor (high-pressure fluid)

moisture separating and heating device; and
 a high-pressure fluid line which connects an upper portion of the drain tank and the nozzle and supplies vapor in the drain tank to the nozzle as the high-pressure fluid.

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Claims

1. A moisture separating and heating device comprising:

a cylindrical container which extends in a horizontal axial direction and in which both ends in the axial direction are sealed and vapor to be heated flows into the inside;

an end partition plate which divides the inside of the container in the axial direction into an end chamber and a vapor chamber into which the vapor to be heated flows; and

a heater which penetrates through the end partition plate, has one portion located in the end chamber and the other portion located in the vapor chamber, and heats the vapor to be heated having flowed into the vapor chamber with heating vapor,

wherein the heater is provided with a vapor drain pipe which discharges the heating vapor having exchanged heat with the vapor to be heated and/or drainage of the heating vapor to the outside of the container through the end chamber, and

the container is provided with a nozzle which is connected to a high-pressure fluid supply source for supplying a high-pressure fluid having a pressure higher than pressure in the end chamber, penetrates into the end chamber from below the end chamber, and jets the high-pressure fluid into the end chamber.

2. The moisture separating and heating device according to Claim 1, further comprising:

a guide member which guides the high-pressure fluid such that the high-pressure fluid jetted from the nozzle into the end chamber is directed to the vapor drain pipe.

3. The moisture separating and heating device according to Claim 1 or 2, wherein the vapor drain pipe meanders in the end chamber.

4. A moisture separating and heating facility comprising:

the moisture separating and heating device according to any one of Claims 1 to 3;

a drain tank as the high-pressure fluid supply source, which receives drainage accumulated at a lower portion in the vapor chamber of the

5. The moisture separating and heating facility according to Claim 4, wherein the high-pressure fluid line is provided with a flow rate regulating valve which regulates the flow rate of the vapor which is supplied from the drain tank to the end chamber through the nozzle.

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FIG. 1

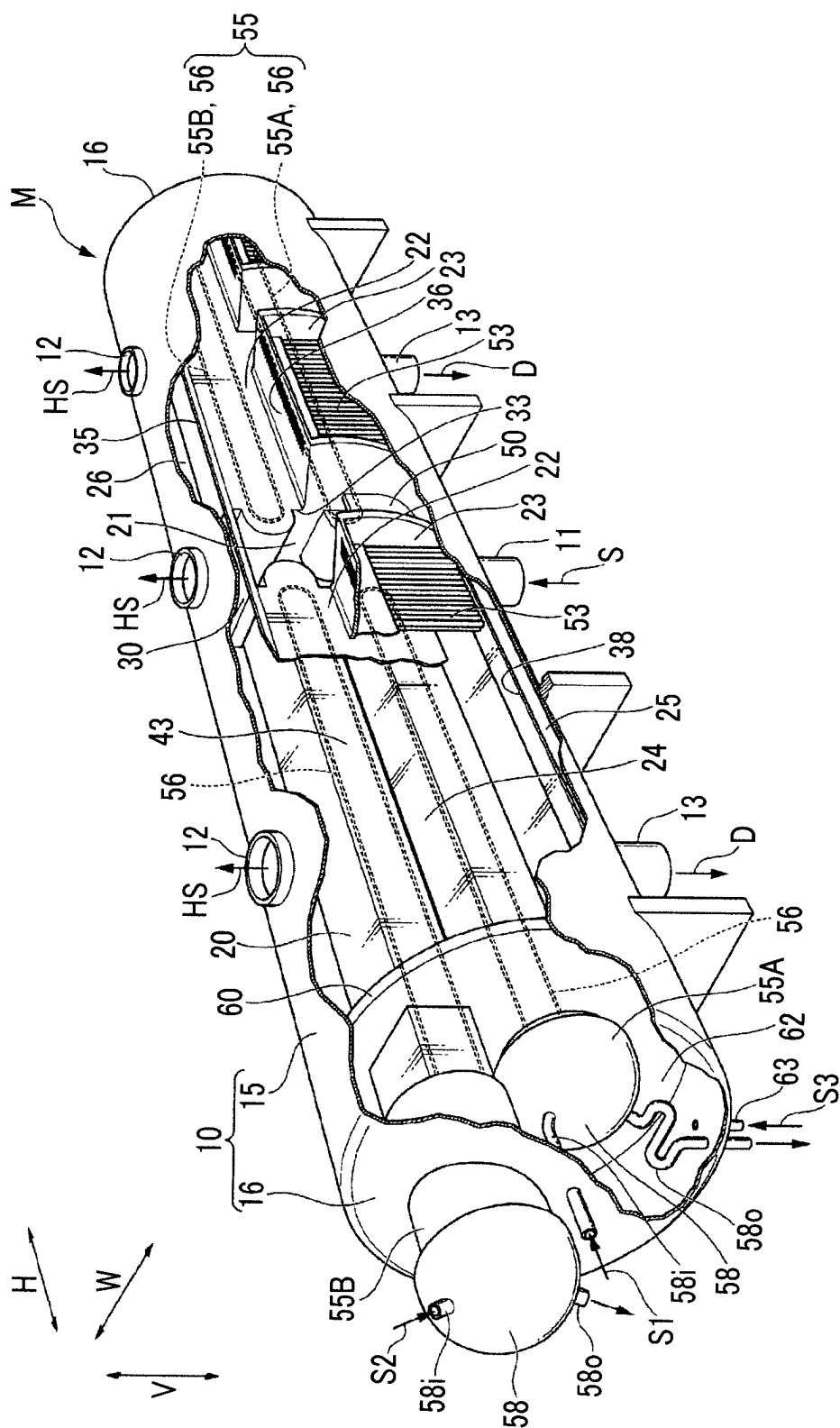


FIG. 2

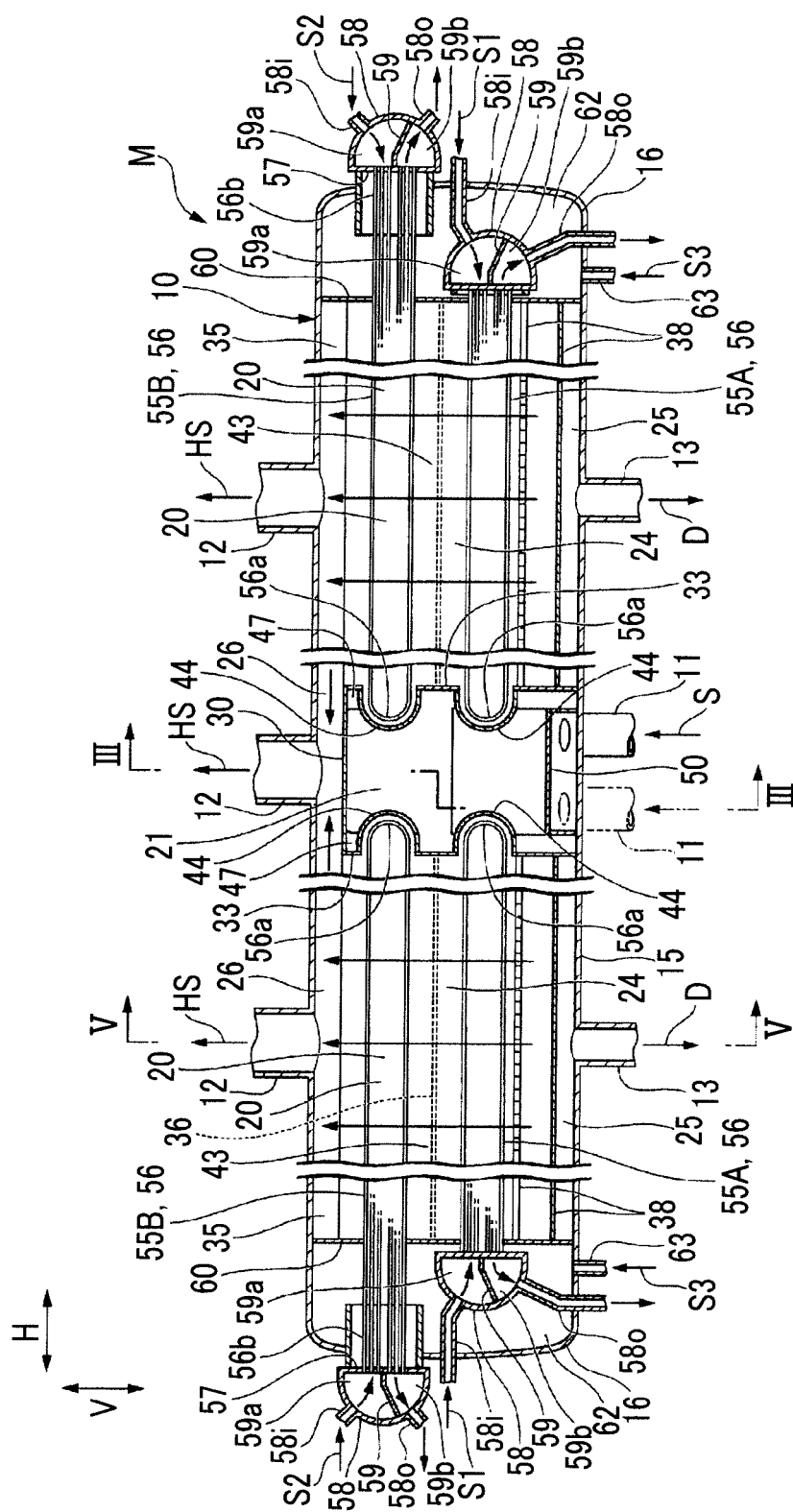


FIG. 3

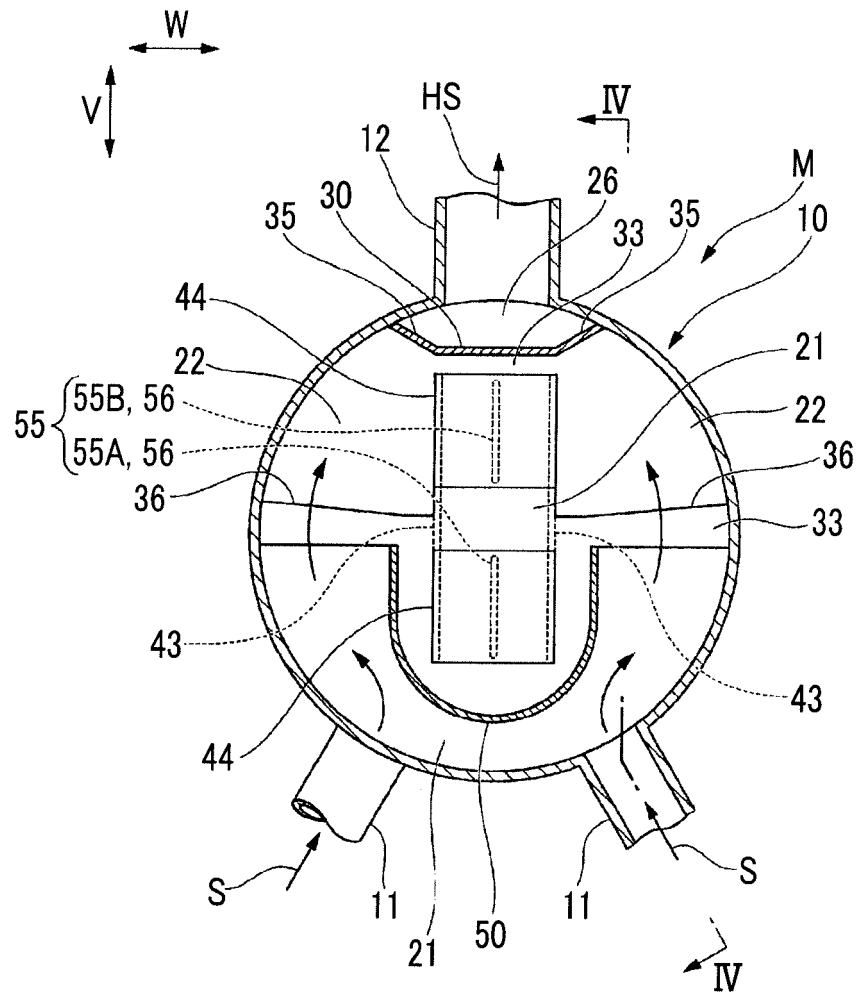


FIG. 4

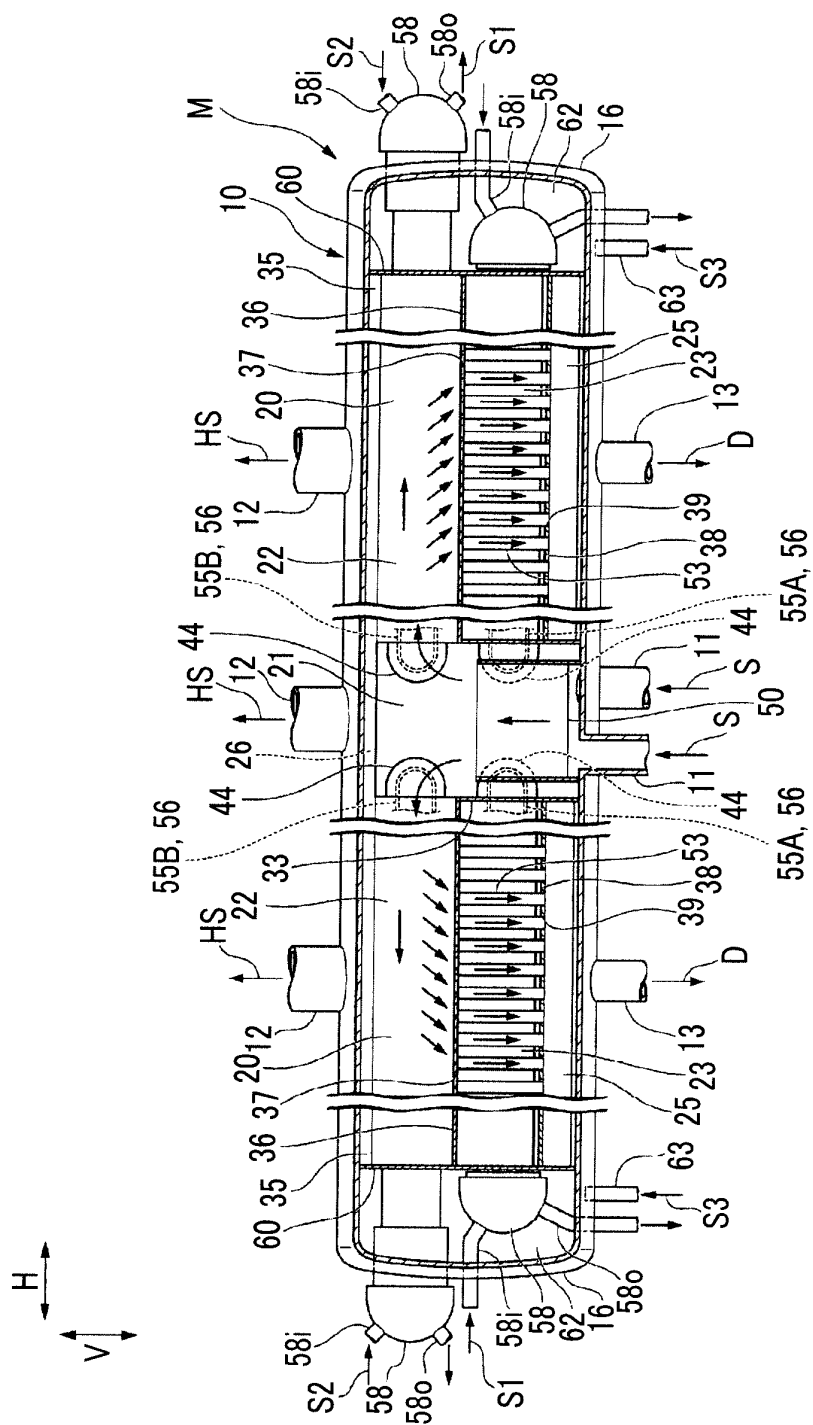


FIG. 5

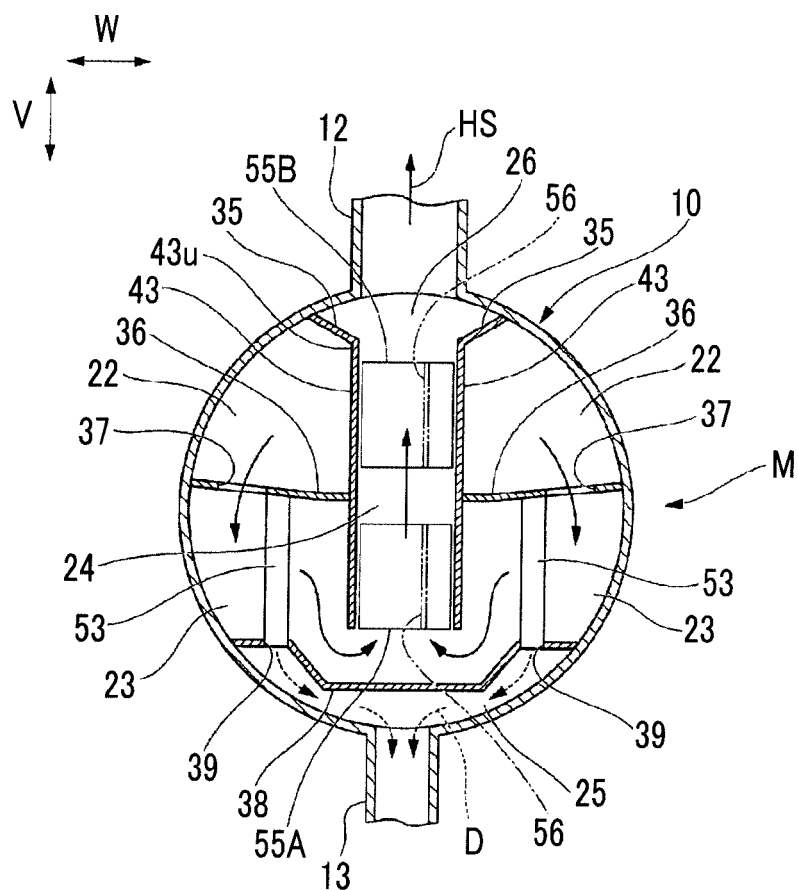


FIG. 6

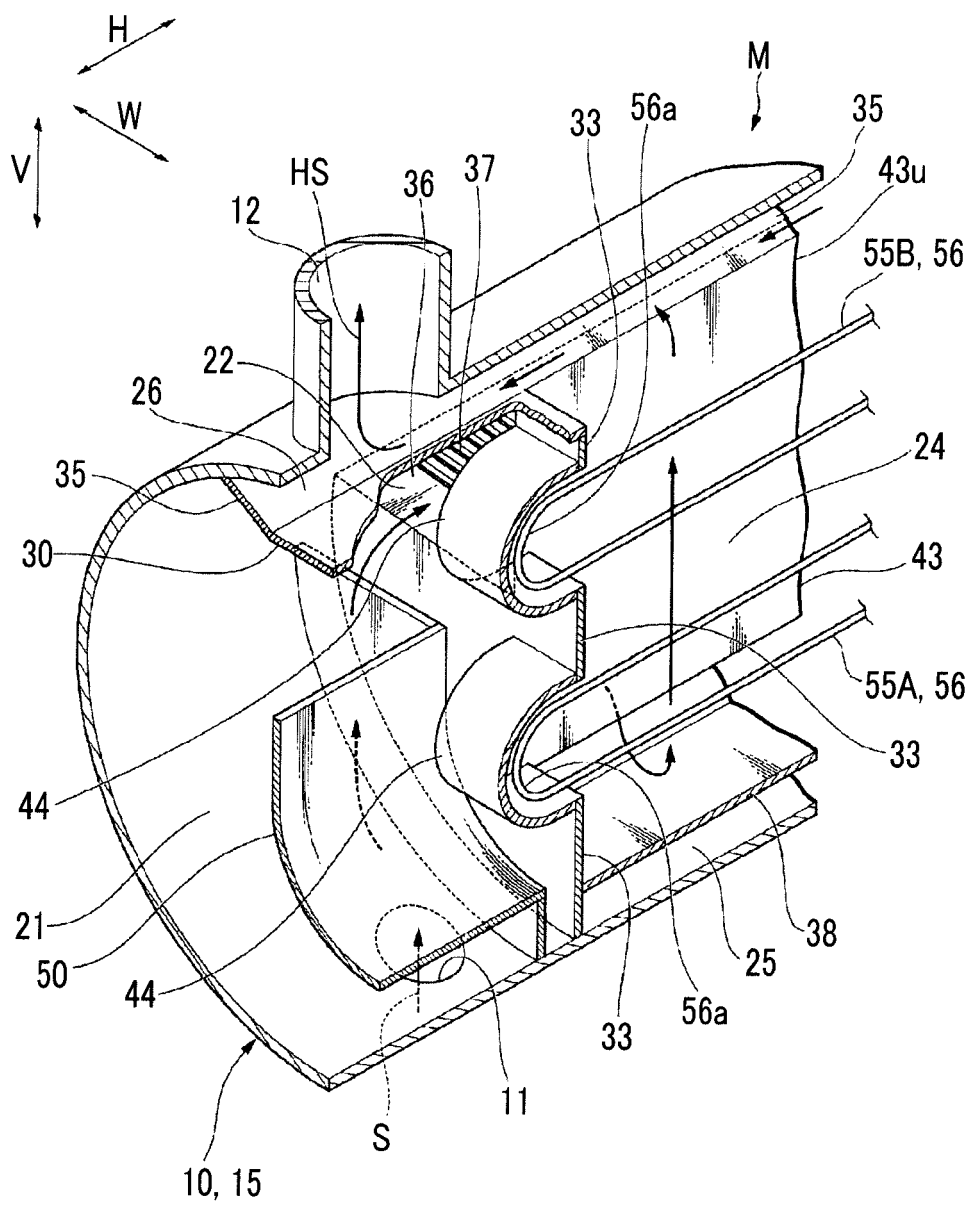


FIG. 7

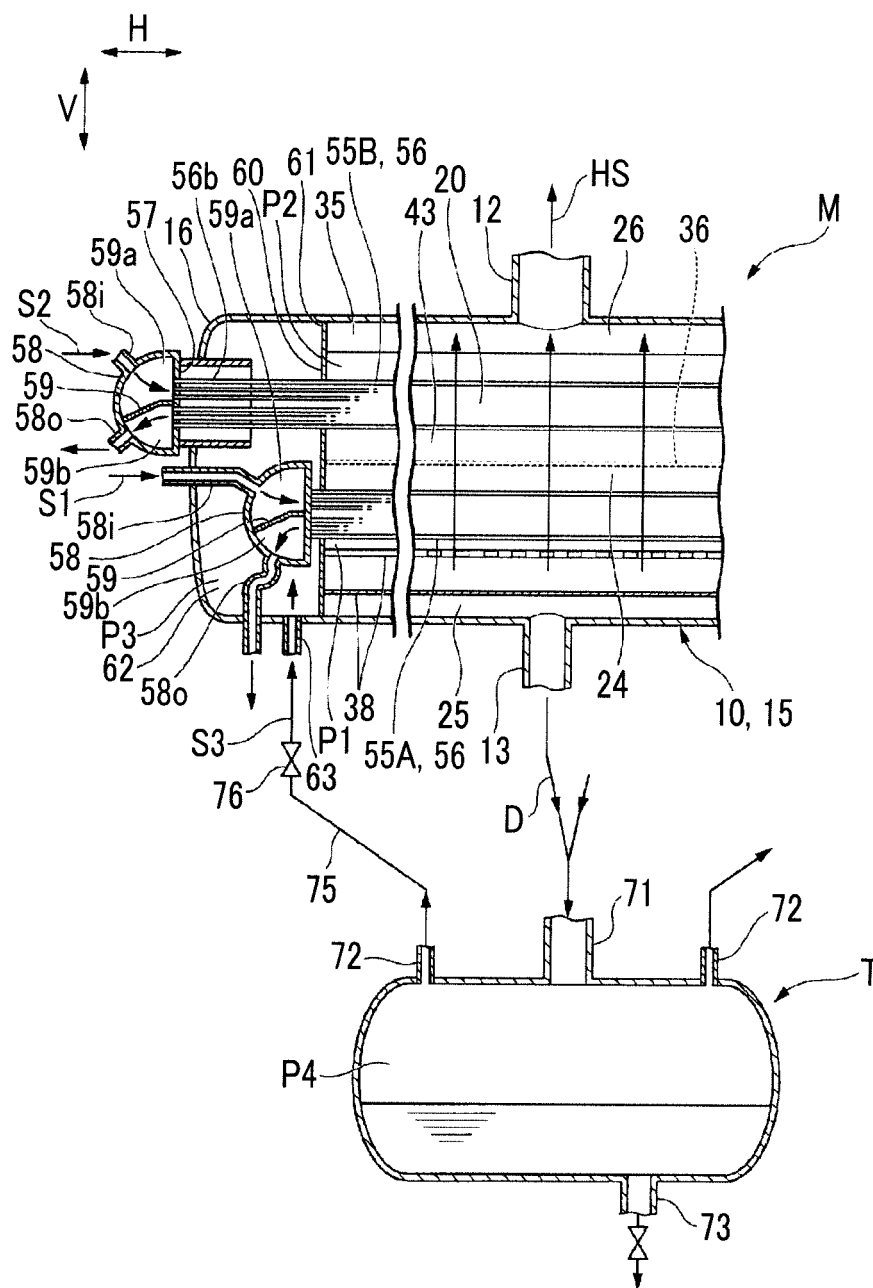


FIG. 8

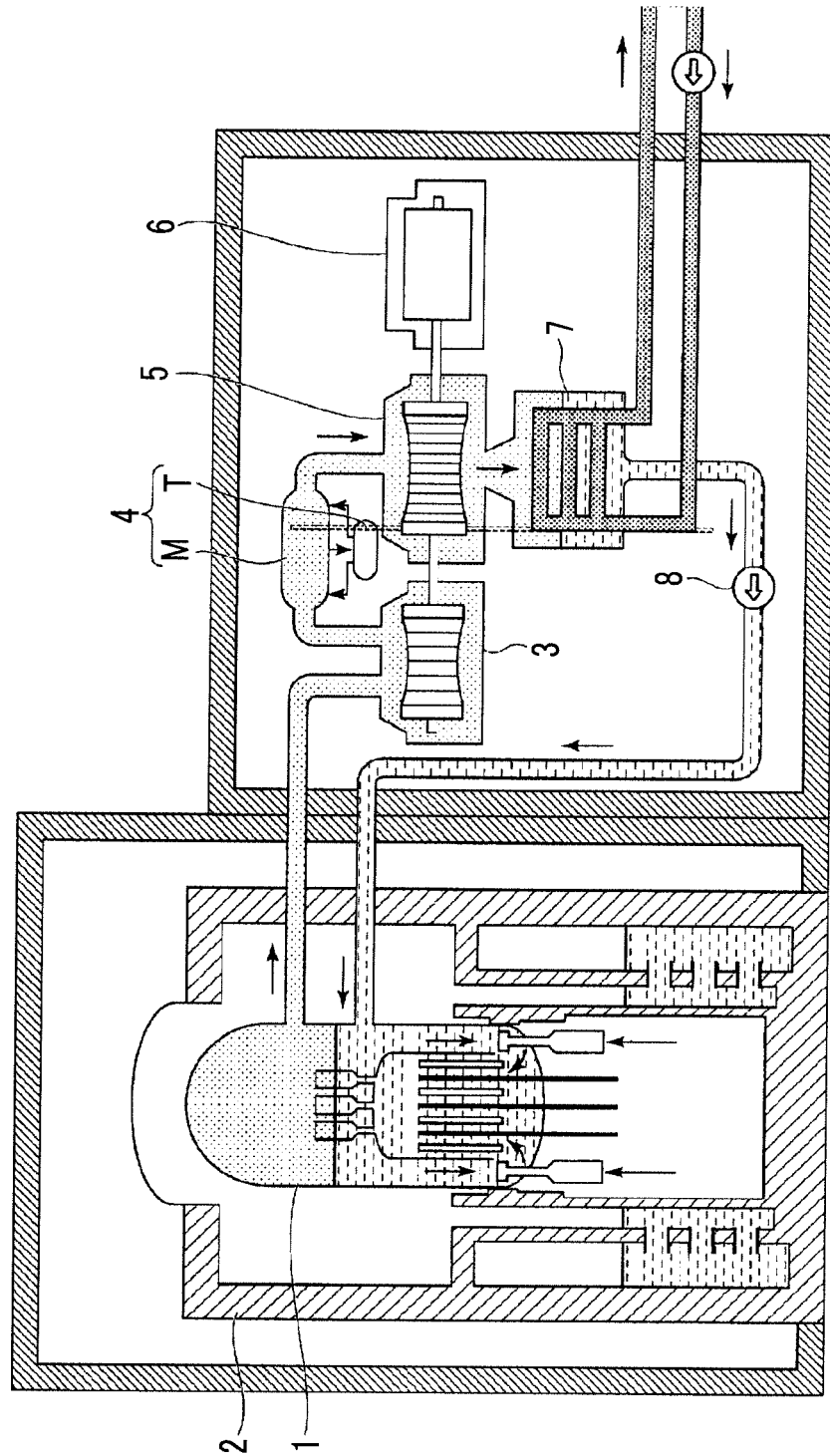
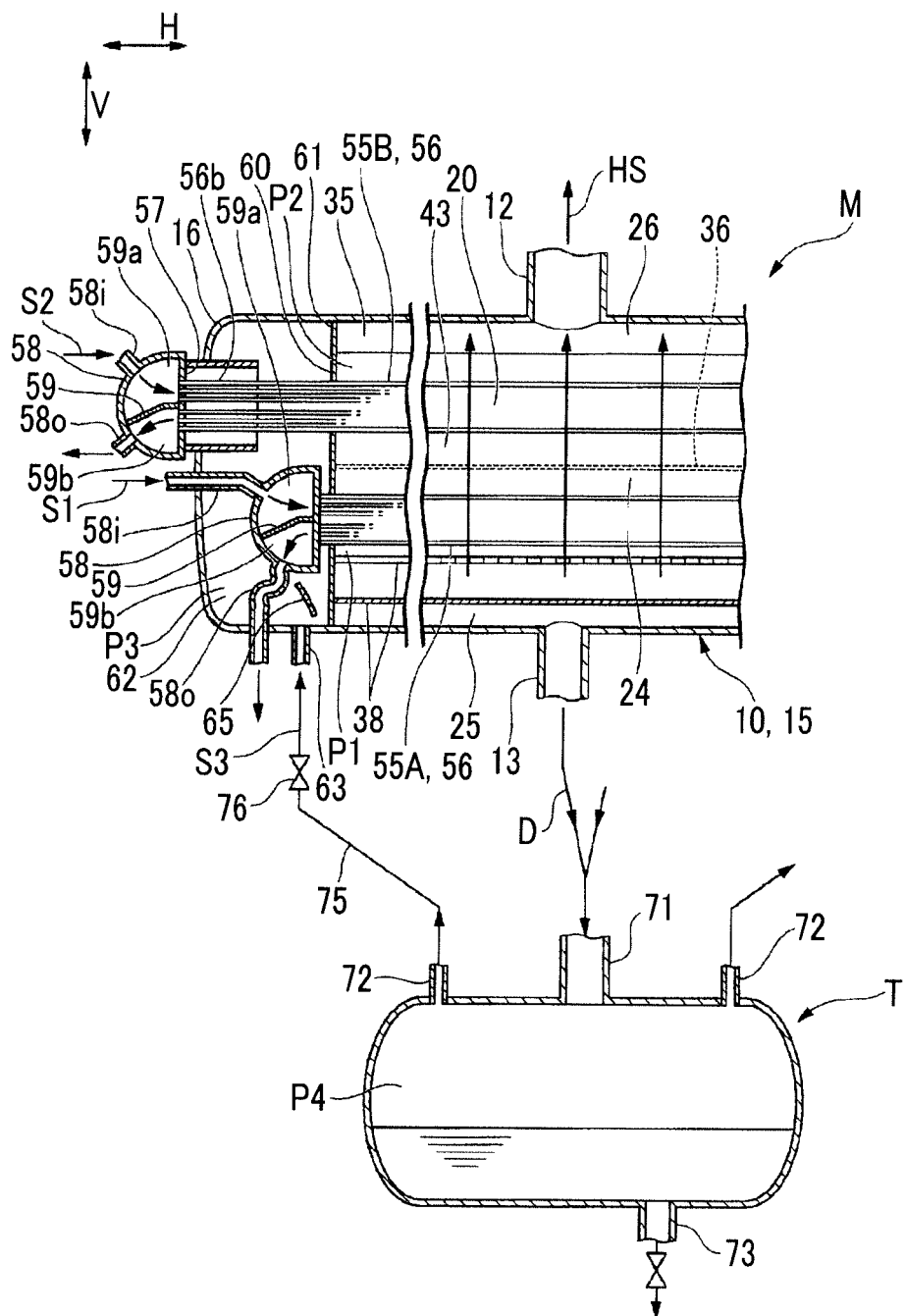


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/050089

A. CLASSIFICATION OF SUBJECT MATTER

F22G3/00(2006.01)i, F01K7/22(2006.01)i, G21D1/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F22G3/00, F01K7/22, G21D1/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-62902 A (Mitsubishi Heavy Industries, Ltd.), 26 March 2009 (26.03.2009), entire text; all drawings & US 2011/0005471 A1 & WO 2009/031553 A1 & CN 101779005 A	1-5
A	US 4206802 A (General Electric Co.), 10 June 1980 (10.06.1980), entire text; all drawings & DE 2912113 A	1-5

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
04 March, 2014 (04.03.14)Date of mailing of the international search report
11 March, 2014 (11.03.14)Name and mailing address of the ISA/
Japanese Patent Office

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REFERENCES CITED IN THE DESCRIPTION

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- JP 63197903 A [0005]