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2010-079265 30 March 2010 (30.03.2010) JP(71) Applicant (for all designated States except US): **Uni-Charm Corporation** [JP/JP]; 182, Shimobun, Kinsei-cho, Shikokuchuo-shi, Ehime, 7990111 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **NOMURA, Hiironori** [JP/JP]; c/o Technical Center, Uni-Charm Corporation, 1531-7, Wadahama, Toyohama-cho, Kanonji-shi, Kagawa, 7691602 (JP). **NANAUMI, Hisataka** [JP/JP]; c/o Technical Center, Uni-Charm Corporation, 1531-7, Wadahama, Toyohama-cho, Kanonji-shi, Kagawa, 7691602 (JP). **KAWAKAMI, Hikari** [JP/JP]; c/o Technical Center, Uni-Charm Corporation, 1531-7, Wadahama, Toyohama-cho, Kanonji-shi, Kagawa, 7691602 (JP).(74) Agents: **SHOBAYASHI, Masayuki** et al.; Sapia Tower, 1-7-12, Marunouchi, Chiyoda-ku, Tokyo, 1000005 (JP).

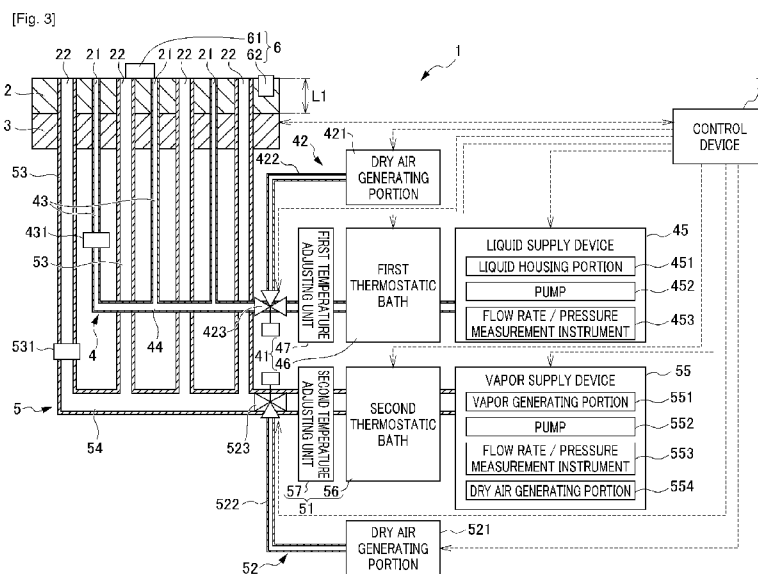
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(54) Title: ARTIFICIAL PERSPIRATION APPARATUS



(57) Abstract: An artificial perspiration apparatus is provided that can simulate the perspiration of a human body more accurately. The artificial perspiration apparatus (1) includes: a skin member (2); a plurality of liquid permeable holes (21) provided on the skin member (2); a plurality of vapor permeable holes (22) provided on the skin member (2); a liquid supply portion (4) that is disposed on an inner side of the skin member (2) and supplies liquid to the plurality of liquid permeable holes (21); a vapor supply portion (5) that is disposed on the inner side of the skin member (2) and supplies vapor to the plurality of vapor permeable holes (22); and a control portion (7) that controls supply of the liquid by the liquid supply portion (4) and supply of the vapor by the vapor supply portion (5).

Description

Title of Invention: ARTIFICIAL PERSPIRATION APPARATUS

Technical Field

[0001] The present invention relates to an artificial perspiration apparatus. More specifically, the present invention relates to an artificial perspiration apparatus used in performance assessment of absorbent articles such as disposable diapers, sanitary napkins and the like, to which the absorbent article can be attached.

Background Art

[0002] Conventionally, an artificial perspiration apparatus has been proposed that can simulate the perspiration of the human body. For example, a perspiration apparatus includes a simulated skin, a plurality of perspiration holes provided in the simulated skin, and an aqueous solution supply means that supplies an aqueous solution of the same temperature as the body temperature to the plurality of perspiration holes.

[0003] Sweat perspired from the human body includes liquid sweat and vaporous sweat (so-called insensible perspiration). The liquid sweat and the vaporous sweat have different perspiration behaviors. However, in the above-described perspiration apparatus, an aqueous solution of a predetermined temperature is supplied to all of the plurality of perspiration holes, thereby perspiring sweat in a liquid state from the plurality of perspiration holes. Although the liquid sweat perspired from each of the plurality of perspiration holes may be partially perspired as vaporous sweat, the vaporous sweat is merely a part of the liquid sweat being vaporized. Therefore, the above-described perspiration apparatus cannot accurately simulate perspiration of the human body.

Summary of Invention

[0004] Given this, the present invention aims at providing an artificial perspiration apparatus that can simulate perspiration of the human body more accurately.

[0005] The present invention relates to an artificial perspiration apparatus including: a skin member ; a plurality of liquid permeable holes provided in the skin member; a plurality of vapor permeable holes provided in the skin member; a liquid supply portion that is disposed on an inner side of the skin member and supplies liquid to the plurality of liquid permeable holes; a vapor supply portion that is disposed on the inner side of the skin member and supplies vapor to the plurality of vapor permeable holes; and a control portion that controls supply of the liquid by the liquid supply portion and supply of the vapor by the vapor supply portion.

Brief Description of Drawings

[0006] [fig.1]FIG. 1 is a perspective view showing an embodiment of the artificial per-

spiration apparatus of the present invention;

[fig.2]FIG. 2 is a partially enlarged plan view of the artificial perspiration apparatus shown in FIG. 1;

[fig.3]FIG. 3 is a cross-sectional view taken along the line A-A of FIG. 2 with a schematic illustration of components of the artificial perspiration apparatus;

[fig.4]FIG. 4 is a plan view showing an embodiment of a heating element;

[fig.5]FIG. 5 is a cross-sectional view of an artificial perspiration apparatus according to a second embodiment, corresponding to FIG. 3;

[fig.6]FIG. 6 is a cross-sectional view of an artificial perspiration apparatus according to a third embodiment, corresponding to FIG. 3;

[fig.7]FIG. 7 is a cross-sectional view of an artificial perspiration apparatus according to a fourth embodiment, corresponding to FIG. 3; and

[fig.8]FIG. 8 is a cross-sectional view of an artificial perspiration apparatus according to a fifth embodiment, corresponding to FIG. 3.

Description of Embodiments

[0007] Preferred embodiments of an artificial perspiration apparatus according to the present invention are explained hereinafter with reference to the drawings. An artificial perspiration apparatus 1 according to the present invention is used in performance assessment and the like of absorbent articles such as disposable diapers, sanitary napkins and the like. As shown in FIG. 1, the artificial perspiration apparatus 1 is configured in a doll-shape provided with a torso portion 11, two leg portions 12 that are formed on a first side of the torso portion 11, and an excretion portion that is formed in the vicinity of the base of the torso portion 11. The artificial perspiration apparatus 1 has a motor that is not shown in Figures, and moves driven by the motor. The artificial perspiration apparatus 1 can behave and/or assume a posture approximating a human body. More specifically, the artificial perspiration apparatus 1 is configured such that the two leg portions 12 can be driven rotatably in a back and forth direction and a side to side (horizontal) direction, the torso portion 11 can be driven to incline in a vertical direction and driven rotatably in a waistline direction, thereby realizing behavior and/or posture approximating the actual behavior and/or posture of a human body.

[0008] First, the artificial perspiration apparatus 1 of a first embodiment is explained hereinafter with reference to FIGS. 2 to 4. FIG. 2 is a partially enlarged plan view of the artificial perspiration apparatus 1 according to the first embodiment. FIG. 3 is a cross-sectional view taken along the line A-A of FIG. 2. As shown in FIGS. 2 and 3, the artificial perspiration apparatus 1 according to the first embodiment includes: a skin member 2; a heating element 3 as a heating portion disposed on an inner side of the skin member 2; a plurality of liquid permeable holes 21 and a plurality of vapor

permeable holes 22 provided on the skin member 2; a liquid supply portion 4 that supplies liquid to the plurality of liquid permeable holes 21; a vapor supply portion 5 that supplies vapor to the plurality of vapor permeable holes 22; a first warming portion 41 that warms the liquid supply portion 4; a second warming portion 51 that warms the vapor supply portion 5; a first air supply portion 42 that supplies dry air to the liquid supply portion 4; a second air supply portion 52 that supplies dry air to the vapor supply portion 5; a plurality of sensors 6 disposed on a surface side of the skin member 2; and a control device 7 as a control portion for controlling these.

[0009] The skin member 2 is disposed to spread in a planar shape or a curved shape and configures the surface of the artificial perspiration apparatus 1. The skin member 2 is preferably configured from a member having elasticity such as urethane or silicon and the like. As a material configuring the skin member 2, urethane foam, silicon foam, rubber and the like can be exemplified. A thickness L1 of the skin member 2 is preferably 1.5 mm to 5 mm, and more preferably 2.5 mm to 3.5 mm. If the thickness L1 of the skin member 2 is less than 1.5 mm, adhesion between the skin member 2 and a first liquid supply tube 43 (described later) and between the skin member 2 and a first vapor supply tube 53 will weaken, which may lead to the generation of a gap between the skin member 2 and the first liquid supply tube 43 and between the skin member 2 and the first vapor supply tube 53. On the other hand, if the thickness L1 of the skin member 2 exceeds 5 mm, it may be difficult to form holes extending in the thickness direction of the skin member 2 (the liquid permeable holes 21 and the vapor permeable hole 22).

[0010] As shown in FIG. 3, the heating element 3 is disposed on an inner side of the skin member 2 so as to contact the skin member 2. The heating element 3 heats the skin member 2 up to a human skin temperature (approximately 30 degrees centigrade to 37 degrees centigrade). The heating element 3 is configured from, for example, a heater including a heating member of a net-like shape or a stick shape. In addition, as shown in FIG. 4, the heating element 3 can be configured to include a thin plate member 31 such as a copper plate excelling in heat conductivity and a warming member 32 such as a hot water circulation tube that is disposed to contact a first face of the thin plate member. In this case, the skin member 2 can be warmed by closely attaching a second face of the thin plate member 31 to the skin member 2 and warming the thin plate member 31 by the warming member 32.

[0011] As shown in FIG. 3, the plurality of liquid permeable holes 21 are provided to penetrate the skin member 2 in the thickness direction thereof. A liquid is supplied to the liquid permeable holes 21 from the inner side of the skin member 2 by the liquid supply portion 4. The liquid discharged from the liquid permeable holes 21 to the surface (an outer side) of the skin member 2 is regarded as liquid sweat. A diameter D1

of the liquid permeable holes 21 (see FIG. 2) is preferably 0.01 mm to 2 mm, and more preferably 0.03 mm to 1 mm. In addition, a distance L2 between center points of each of adjacent liquid permeable holes 21 is preferably 2 mm to 10 mm. If the distance L2 between adjacent liquid permeable holes 21 exceeds 10 mm, the artificial perspiration apparatus 1 may not be able to accurately simulate perspiration. On the other hand, if the distance L2 between adjacent liquid permeable holes 21 is less than 2 mm, the plumbing structure of the liquid supply portion 4 (described later) may become complex.

[0012] As shown in FIG. 3, the plurality of vapor permeable holes 22 is provided to penetrate the skin member 2 in the thickness direction thereof. Vapor is supplied to the vapor permeable holes 22 from the inner side of the skin member 2 by the vapor supply portion 4. The vapor discharged from the vapor permeable holes 22 to the surface (an outer side) of the skin member 2 is regarded as vaporous sweat. A diameter D2 (see FIG. 2) of the vapor permeable holes 22 is configured to be larger than the diameter D1 of the liquid permeable holes 21. More specifically, the diameter D2 of the vapor permeable holes 22 is preferably 1 mm to 10 mm, and more preferably 5 mm to 7 mm. In addition, a distance L3 between center points of each of adjacent vapor permeable holes 22 is preferably 2 mm to 10 mm. If the distance L3 between adjacent vapor permeable holes 22 exceeds 10 mm, the artificial perspiration apparatus 1 may not be able to accurately simulate perspiration (for example, a state in which vaporous sweat is perspired substantially uniformly from cuticle). On the other hand, if the distance L3 between adjacent vapor permeable holes 21 is less than 2 mm, the plumbing structure of the vapor supply portion 5 (described later) may become complex.

[0013] The liquid permeable holes 21 and the vapor permeable holes 22 are preferably provided in a density of no less than 1 hole/cm², from a viewpoint of accurately simulating the perspiration of a human body.

[0014] As shown in FIG. 3, the liquid supply portion 4 includes a plurality of first liquid supply tubes 43, a second liquid supply tube 44, and a liquid supply device 45. The plurality of first liquid supply tubes 43 is disposed to extend substantially perpendicular to a direction in which a surface of the skin member 2 extends. A tip side of the plurality of first liquid supply tubes 43 is respectively inserted and connected to the plurality of liquid permeable holes 21 on the skin member 2, from the inner side of the skin member 2. A base end side of the plurality of first liquid supply tubes 43 is respectively connected to the second liquid supply tube 44. In a predetermined first liquid supply tube 43 among the plurality of first liquid supply tubes 43, a flow rate / pressure measurement instrument 431 is provided that measures the flow rate or pressure of the liquid running in the first liquid supply tube 43. The diameter (inside

diameter) of the first liquid supply tube 43 is preferably 0.01 mm to 2 mm, and more preferably 0.03 mm to 1 mm.

- [0015] The second liquid supply tube 44 is disposed to extend in a direction intersecting with the plurality of first liquid supply tubes 43. To the second liquid supply tube 44, the base end side of the plurality of first liquid supply tubes 43 is connected at predetermined intervals in a longitudinal direction. Here, all of the plurality of first liquid supply tubes 43 can be connected to the single second liquid supply tube 44; alternatively, by providing a plurality of second liquid supply tubes 44, a predetermined number of the first liquid supply tubes 43 can be connected to each of the plurality of second liquid supply tubes 44. The diameter (inside diameter) of the second liquid supply tube 44 is configured to be larger than the diameter (inside diameter) of the first liquid supply tube 43. The diameter (inside diameter) of the second liquid supply tube 44 is preferably 0.05 mm to 7 mm, and more preferably 1 mm to 4 mm.
- [0016] The first liquid supply tubes 43 and the second liquid supply tube 44 are configured from hard tubes made of metallic members or flexible tubes made of silicon tubes and the like.
- [0017] The liquid supply device 45 is disposed on a base end side of the second liquid supply tube 44. The liquid supply device 45 is configured to include: a liquid housing portion 451 that houses the liquid; a pump 452 that pushes the liquid housed in the liquid housing portion 451 toward the second liquid supply tube 44; and a flow rate / pressure measurement instrument 453 that measures the flow rate or pushing pressure of the liquid that is pushed from the liquid housing portion 451 to the second liquid supply tube 44.
- [0018] In the above-described liquid supply portion 4, the liquid housed in the liquid housing portion 451 is pushed by the pump 452 in the liquid supply device 45, then the liquid thus pushed passes through the second liquid supply tube 44 and the plurality of first liquid supply tubes 43, and is discharged from the plurality of liquid permeable holes 21. In addition, the flow rate / pressure measurement instrument 453 measures the flow rate or pressure of the liquid that is pushed from the liquid supply device 45. Furthermore, in the above-described liquid supply portion 4, the liquid can be continuously discharged and the amount of the liquid discharged from the liquid permeable holes 21 can be changed by adjusting the pushing pressure of the pump 452.
- [0019] The amount of the liquid supplied by the liquid supply portion 4 and discharged from the plurality of liquid permeable holes 21 is preferably in the range of 0 to 1000 g/m² / h. The amount of the liquid discharged from the liquid permeable holes 21 is measured by the flow rate / pressure measurement instrument 431 provided in the first liquid supply tube 43.
- [0020] As shown in FIG. 3, the vapor supply portion 5 includes a plurality of first vapor

supply tubes 53, a second vapor supply tube 54, and a vapor supply device 55. The plurality of first vapor supply tubes 53 is disposed to extend substantially perpendicular to a direction in which a surface of the skin member 2 extends. A tip side of the plurality of first vapor supply tubes 53 is respectively inserted and connected to the plurality of vapor permeable holes 22 on the skin member 2, from the inner side of the skin member 2. A base end side of the plurality of first vapor supply tubes 53 is respectively connected to the second vapor supply tube 54. In a predetermined first vapor supply tube among the plurality of first vapor supply tubes 53, a flow rate / pressure measurement instrument 531 is provided that measures the flow rate or pressure of the vapor running in the first vapor supply tube 53. The diameter (inside diameter) of the first vapor supply tube 53 is preferably 1 mm to 10 mm, and more preferably 5 mm to 7 mm.

[0021] The second vapor supply tube 54 is disposed to extend in a direction intersecting with the plurality of first vapor supply tubes 53. To the second vapor supply tube 54, the base end side of the plurality of first vapor supply tubes 53 is connected at predetermined intervals in a longitudinal direction. Here, all of the plurality of first vapor supply tubes 53 can be connected to the single second vapor supply tube 54; alternatively, by providing a plurality of second vapor supply tubes 54, a predetermined number of the first vapor supply tubes 53 can be connected to each of the plurality of second vapor supply tubes 54. The diameter (inside diameter) of the second vapor supply tube 54 is configured to be larger than the diameter (inside diameter) of the first vapor supply tube 53. The diameter (inside diameter) of the second vapor supply tube 54 is preferably 2 mm to 15 mm, and more preferably 6 mm to 8 mm.

[0022] The first vapor supply tubes 53 and the second vapor supply tube 54 are configured from hard tubes made of metallic members or flexible tubes made of silicon tubes and the like.

[0023] The vapor supply device 55 is disposed on a base end side of the second vapor supply tube 54. The vapor supply device 55 is configured to include: a vapor generating portion 551 that generates water-saturated vapor; a pump 552 that supplies water to the vapor generating portion 551; a dry air generating portion 554 that generates and supplies dry air to the vapor generating portion 551; and a flow rate / pressure measurement instrument 553 that measures a flow rate or pushing pressure of the vapor that is pushed from the vapor generation portion 551 to the second vapor supply tube 54.

[0024] According to the above-described vapor supply portion 5, in the vapor supply device 55, the water supplied from the pump 552 to the vapor generating portion 551 is heated and vaporized in the vapor generating portion 551. In addition, dry air is supplied from the dry air generating portion 554 to the vapor generating portion 551. The vapor thus

generated in the vapor generating portion 551 is pushed toward the second vapor supply tube 54 along with the dry air supplied from the dry air generating portion 554. The vapor thus pushed toward the second vapor supply tube 54 passes through the second vapor supply tube 54 and the plurality of first vapor supply tubes 53, and is discharged from the plurality of vapor permeable holes 22. In addition, the flow rate / pressure measurement instrument 553 measures the flow rate or pressure of the vapor that is pushed from the vapor supply device 55. Furthermore, in the above-described vapor supply portion 5, the vapor can be continuously discharged and the amount of the vapor discharged from the vapor permeable holes 22 can be changed by adjusting the amount of the water supplied to the vapor generating portion 551 by the pump 552 and the amount of the dry air supplied to the vapor generating portion 551 by the dry air generating portion 554.

- [0025] The amount of the vapor supplied by the vapor supply portion 5 and discharged from the plurality of vapor permeable holes 22 is preferably in the range of 0 to 500 g/m²/h. The amount of the vapor discharged from the vapor permeable holes 22 is measured by the flow rate / pressure measurement instrument 531 provided in the first vapor supply tube 53.
- [0026] The first warming portion 41 includes a first thermostatic bath 46 and a first temperature adjusting unit 47, which is disposed on a downstream side of the first thermostatic bath 46. Warm water of approximately 30 degrees centigrade to 40 degrees centigrade is retained in the first thermostatic bath 46, and at least portions of the first liquid supply tubes 43 and the second liquid supply tube 44 are immersed in the first thermostatic bath 46. A decline in temperature of the liquid passing through the first liquid supply tubes 43 and the second liquid supply tube 44 can thus be prevented. The entirety of the second liquid supply tube 44 and the plurality of first liquid supply tubes 43 except for portions inserted into the skin member 2 and the heating element 3 are preferably immersed in the first thermostatic bath 46.
- [0027] The first temperature adjusting unit 47 adjusts (warms) the temperature of the liquid passing through the liquid supply portion 4 (the second liquid supply tube 44) to a predetermined temperature on a downstream side of the first thermostatic bath 46. The temperature of the liquid discharged from the liquid permeable holes 21 can thus be adjusted to the same temperature as the skin member 2.
- [0028] The second warming portion 51 includes a second thermostatic bath 56 and a second temperature adjusting unit 57 disposed on a downstream side of the second thermostatic bath 56. Warm water of approximately 30 degrees centigrade to 40 degrees centigrade is retained in the second thermostatic bath 56, and at least portions of the first vapor supply tubes 53 and the second vapor supply tube 54 are immersed in the second thermostatic bath 56. A decline in the temperature of the vapor passing through

the first vapor supply tubes 53 and the second vapor supply tube 54 can thus be prevented. The entirety of the second vapor supply tube 54 and the plurality of first vapor supply tubes 53 except for portions inserted into the skin member 2 and the heating element 3 are preferably immersed in the second thermostatic bath 56.

[0029] The second temperature adjusting unit 57 adjusts (warms) the temperature of the vapor passing through the vapor supply portion 5 (the second vapor supply tube 54) to a predetermined temperature on a downstream side of the second thermostatic bath 56. Condensation inside of the first vapor supply tubes 53, inside of the second vapor supply tube 54, and on the surface of the skin member 2 can thus be prevented.

[0030] The first air supply portion 42 includes a dry air generating portion 421 that generates dry air and a dry air supply tube 422 that connects the dry air generating portion 421 to the second liquid supply tube 44. The dry air supply tube 422 supplies the dry air generated by the dry air generating portion 421 to the liquid supply portion 4 (the second liquid supply tube 44). In a connection portion between the dry air supply tube 422 and the second liquid supply tube 44, a three-way valve 423 is disposed.

[0031] The abovementioned first air supply portion 42 can supply dry air to the second liquid supply tube 44 and the plurality of first liquid supply tubes 43, by driving the dry air generating portion 421 to generate dry air in a state in which a flow path from the dry air supply tube 422 to the second liquid supply tube 44 is opened by switching the three-way valve 423.

[0032] The second air supply portion 52 includes a dry air generating portion 521 that generates dry air and a dry air supply tube 522 that connects the dry air generating portion 521 to the second vapor supply tube 54. The dry air supply tube 522 supplies the dry air generated by the dry air generating portion 521 to the vapor supply portion 5 (the second vapor supply tube 54). In a connection portion between the dry air supply tube 522 and the second vapor supply tube 54, a three-way valve 523 is disposed.

[0033] The abovementioned second air supply portion 52 can supply dry air to the second vapor supply tube 54 and the plurality of first vapor supply tubes 53, by driving the dry air generating portion 521 to generate dry air in a state in which a flow path from the dry air supply tube 522 to the second vapor supply tube 54 is opened by switching the three-way valve 523.

[0034] The plurality of sensors 6 includes a first sensor 61 that measures a state of the surface side of the skin member 2 and a second sensor 62 that measures an operating state of the artificial perspiration apparatus 1. Here, the "state of the surface side of the skin member 2" indicates a state of a surface (inner surface) of an absorbent article and a state of a space formed between the skin member 2 and the inner surface of the absorbent article, in a case in which the absorbent article is attached to the artificial

perspiration apparatus 1 for performance assessment. A plurality of first sensors 61 is disposed at predetermined positions on the surface of the skin member 2. In the first embodiment, a temperature sensor as a temperature measuring portion, a humidity sensor as a humidity measuring portion, a flow rate sensor as a flow rate measuring portion, and a wettability sensor as a wettability measuring portion are disposed as the first sensors 61.

[0035] The temperature sensor measures the temperature of the surface side of the skin member 2 (the temperature of the inner side of the absorbent article). The humidity sensor measures humidity of the surface side of the skin member 2 (humidity of the space formed between the skin member 2 and the inner side of the absorbent article). The flow rate sensor measures the air flow of the surface side of the skin member 2 (flow direction and flow rate of air in the space formed between the skin member 2 and the inner side of the absorbent article). The wettability sensor measures the wettability of the surface side of the skin member 2 (wettability of the inner side of the absorbent article). The wettability sensor measures the wettability of the surface side of the skin member 2 by measuring the capacitance between two poles.

[0036] The second sensor 62 is embedded on the surface side of the skin member 2 for checking of a constant temperature of the skin member 2. The second sensor 62 measures the temperature of the skin member 2. Temperature data measured by the second sensor 62 is transmitted to the control device 7.

[0037] The locations of the first sensors 61 are not limited to the surface of the skin member 2. In other words, in a case in which the artificial perspiration apparatus 1 is configured to be flat, all of the first sensors 61 are disposed on the surface of the skin member 2. Alternatively, in a case in which the artificial perspiration apparatus 1 is configured to be in a doll shape, in a position such that a space is formed between the surface of the skin member 2 and the inner surface of the absorbent article (for example, the buttocks) in a state in which the absorbent article is attached to the artificial perspiration apparatus 1, the first sensors 61 can be disposed on the inner surface of an absorbent article or in a space formed between the skin member 2 and the inner surface of the absorbent article.

[0038] The control device 7 controls the driving of the artificial perspiration apparatus 1. More specifically, the control device 7 controls the discharge rate and discharge pressure of the liquid discharged from the liquid permeable holes 21 by controlling the driving of the liquid supply device 45 (the pump 452). In addition, the control device 7 controls the discharge rate and discharge pressure of the vapor discharged from the vapor permeable holes 22 by controlling the driving of the vapor supply device 55 (the pump 552). It is noted that the control device 7 controls the liquid supply device 45 and the vapor supply device 55 individually.

- [0039] In addition, the control device 7 controls the temperature of the liquid discharged from the plurality of liquid permeable holes 21 by controlling the first warming portion 41 (the first thermostatic bath 46 and the first temperature adjusting unit 47). Moreover, the control device 7 controls the temperature of the vapor discharged from the plurality of vapor permeable holes 22 by controlling the second warming portion (the second thermostatic bath 56 and the second temperature adjusting unit 57).
- [0040] Furthermore, the control device 7 controls the supply of dry air from the first air supply portion 42 to the liquid supply portion 4 by controlling the driving of the dry air generating portion 421 and opening and closing of the three-way valve 423. Additionally, the control device 7 controls the supply of dry air from the second air supply portion 52 to the vapor supply portion 5 by controlling the driving of the dry air generating portion 521 and opening and closing of the three-way valve 523. Moreover, the control device 7 controls a heating state of the skin member 2 by the heating element 3.
- [0041] An example of a usage of the abovementioned artificial perspiration apparatus 1 is described hereinafter. The artificial perspiration apparatus 1 according to the present embodiment is used in performance assessment of absorbent articles such as disposable diapers and the like, for example. In the performance assessment of a disposable diaper using the artificial perspiration apparatus 1, first, the disposable diaper is attached to the artificial perspiration apparatus 1.
- [0042] Next, the liquid (liquid sweat) is discharged (perspired) from the plurality of liquid permeable holes 21 and the vapor (vaporous sweat) is discharged (perspired) from the plurality of vapor permeable holes 22. Here, the amount of the liquid sweat and the amount of the vaporous sweat to be perspired are determined based on conditions such as the age of targeted users of the disposable diaper, a supposed season of usage of the disposable diaper and the like, and are controlled by the control device 7. Perspiration of a human body is thereby accurately simulated.
- [0043] Subsequently, the environment inside the disposable diaper during perspiration is measured. More specifically, the temperature and humidity inside the disposable diaper during perspiration in a predetermined state are measured by the temperature sensor and the humidity sensor. In addition, the flow direction and flow rate of air (including vaporous sweat) inside the disposable diaper is measured by the flow rate sensor. Furthermore, the wettability of the surface (inner surface) of the disposable diaper is measured by the wettability sensor. The artificial perspiration apparatus 1 of the present embodiment can simulate perspiration of human body more accurately in this way, thereby allowing for more accurate determination of the performance of the disposable diaper.
- [0044] The artificial perspiration apparatus 1 according to the first embodiment produces the

following effects.

- [0045] (1) The liquid is supplied to the plurality of liquid permeable holes 21 by the liquid supply portion 4 and the vapor is supplied to the plurality of vapor permeable holes 22 by the vapor supply portion 5. In addition, the control device 7 controls the liquid supply portion 4 and the vapor supply portion 5 independently. As a result, liquid sweat can be perspired from the plurality of liquid permeable holes 21 and vaporous sweat can be perspired from the plurality of vapor permeable holes 22. Since the artificial perspiration apparatus 1 can thereby adjust the amount of the liquid sweat and the amount of the vaporous sweat independently according to the age of targeted users and an external environment, perspiration of a human body can be simulated more accurately.
- [0046] (2) The artificial perspiration apparatus 1 is configured to include the heating element 3, the first warming portion 41, and the second warming portion 51. As a result, the skin member 2 can be maintained at the same temperature as a human skin temperature. In addition, a decline in the temperature of the liquid passing through the first liquid supply tubes 43 and the second liquid supply tube 44 can thus be prevented and the temperature of the liquid sweat discharged from the liquid permeable holes 21 can be adjusted to the same temperature as the skin member 2. Furthermore, a decline in the temperature of the vapor passing through the first vapor supply tubes 53 and the second vapor supply tube 54 can thus be prevented and condensation inside of the first vapor supply tubes 53, inside of the second vapor supply tube 54, and on the surface of the skin member 2 can thus be prevented.
- [0047] (3) The liquid supply portion 4 is configured to include the plurality of first liquid supply tubes 43, the second liquid supply tube 44 connected to the plurality of first liquid supply tubes 43, and the liquid supply device 45 that supplies the liquid to the second liquid supply tube 44. As a result, by supplying the liquid to the second liquid supply tube 44, the liquid sweat can be perspired from the plurality of liquid permeable holes 21 via the plurality of first liquid supply tubes 43 connected to the second liquid supply tube 44. The number of the pumps 452 pushing the liquid toward the second liquid supply tube 44 can thus be reduced, thereby realizing space savings in the structure of the artificial perspiration apparatus 1.
- [0048] (4) The vapor supply portion 5 is configured to include the plurality of first vapor supply tubes 53, the second vapor supply tube 54 connected to the plurality of first vapor supply tubes 53, and the vapor supply device 55 that supplies the vapor to the second vapor supply tube 54. As a result, by supplying the vapor to the second vapor supply tube 54, the vaporous sweat can be perspired from the plurality of vapor permeable holes 22 via the plurality of first vapor supply tubes 53 connected to the second vapor supply tube 54. The number of the pumps 552 pushing the vapor toward

the second vapor supply tube 54 can thus be reduced, thereby realizing space savings in the structure of the artificial perspiration apparatus 1.

- [0049] (5) The artificial perspiration apparatus 1 is configured to include the first air supply portion 42 and the second air supply portion 52. As a result, by supplying dry air from the first air supply portion 42 to the liquid supply portion 4 after using the artificial perspiration apparatus 1, the liquid supply portion 4 (the second liquid supply tube 44 and the plurality of first liquid supply tubes 43) can be dried. In addition, by supplying dry air from the second air supply portion 52 to the vapor supply portion 5, the vapor supply portion 5 (the second vapor supply tube 54 and the plurality of first vapor supply tubes 53) can be dried. As a result, the accuracy of the assessments by repeated use of the artificial perspiration apparatus 1 can be improved. In addition, foreign objects accumulated inside the tubes configuring the liquid supply portion 4 and the vapor supply portion 5 can be removed. Furthermore, the growth of mold inside the tubes can be prevented.
- [0050] (6) The liquid permeable holes 21 and the vapor permeable holes 22 are provided respectively in a density of no less than 1 hole/cm². The perspiration of a human body can thus be simulated more accurately.
- [0051] (7) The artificial perspiration apparatus 1 is configured to include the first sensor 61 (temperature sensor, flow rate sensor, and wettability sensor) that measures a state of the surface side of the skin member 2 (a surface state of the absorbent article attached to the artificial perspiration apparatus 1). As a result, the state of the surface side of the skin member 2 can be determined more accurately.
- [0052] (8) The liquid supply device 45 and the vapor supply device 55 are configured to include the flow rate / pressure measurement instruments 453, 553 respectively, and the flow rate / pressure measurement instruments 431, 531 are disposed in the first liquid supply tube 43 and the first vapor supply tube 53 respectively. As a result, the flow rate / pressure measurement instruments 453, 553 can determine the flow rate and pressure of the liquid supplied to the second liquid supply tube 44 and the flow rate and pressure of the vapor supplied to the second vapor supply tube 54, and the flow rate / pressure measurement instruments 431, 531 can determine the flow rate and pressure of the liquid passing through the first liquid supply tube 43 and the flow rate and pressure of the vapor passing through the first vapor supply tube 53. The amount of the liquid sweat and the amount of the vaporous sweat can thus be controlled more accurately.
- [0053] (9) The heating element 3 is configured from a heater including a heating member of a net-like shape or a stick shape. This allows for easy arrangement of the heating element 3 to follow the shape of the skin member 2.
- [0054] A second embodiment of the artificial perspiration apparatus according to the present

invention is explained hereinafter with reference to FIG. 5. FIG. 5 is a cross-sectional view of an artificial perspiration apparatus 1A according to a second embodiment. In the following description of the second embodiment, the same components are denoted by the same reference numerals, and descriptions thereof will be omitted or simplified.

[0055] The artificial perspiration apparatus 1A of the second embodiment is different from the first embodiment in the configuration of a liquid supply portion 4A. More specifically, in the second embodiment, the inside diameter of the plurality of first liquid supply tubes 43A varies in a range from 0.01 mm to 2.0 mm according to the distances thereof from the liquid supply device 45, as shown in FIG. 5. The inside diameter of the plurality of first liquid supply tubes 43A gradually increases as the distance between the liquid supply device 45 and the base end portion of each of the plurality of first liquid supply tubes 43A increases.

[0056] The artificial perspiration apparatus 1A according to the second embodiment produces the following effect, in addition to the abovementioned effects (1) to (9).

[0057] (10) In a case in which the plurality of first liquid supply tubes 43 is connected to the second liquid supply tube 44, if the inside diameter of the plurality of first liquid supply tubes 43A is configured to be identical, the amount of the liquid passing through the first liquid supply tube 43 connected to a position near the liquid supply device 45 becomes greater than that of the liquid passing through the first liquid supply tube 43 connected at a position far from the liquid supply device 45. Given this, the inside diameters of each of the plurality of first liquid supply tubes 43A is configured to gradually increase as the distance between the liquid supply device 45 and the base end portion of each of the plurality of first liquid supply tubes 43A increases. As a result, the amount of the liquid passing through each of the plurality of first liquid supply tubes 43A can be made substantially uniform and the amount of the liquid sweat perspired from each of the plurality of liquid permeable holes 21 can be made substantially uniform.

[0058] A third embodiment of the artificial perspiration apparatus 1 according to the present invention is explained hereinafter with reference to FIG. 6. FIG. 6 is a cross-sectional view of an artificial perspiration apparatus 1B according to the third embodiment. The artificial perspiration apparatus 1B of the third embodiment is different from the first embodiment in the configuration of a skin member 2B and a vapor supply portion 5B. More specifically, in the third embodiment, the skin member 2B is configured from a sheet member including a plurality of fine pores (30 micrometer to 70 micrometer in diameter) allowing gas to permeate, but not allowing liquid to permeate. In other words, in the third embodiment, the plurality of fine pores formed in the sheet member functions as vapor permeable holes. In addition, the same plurality of liquid permeable holes 21 as in the first embodiment is provided in the sheet member.

- [0059] In addition, the vapor supply portion 5B is configured from a vapor supply device 55B disposed on the inner side of the skin member 2B with a predetermined space therefrom. The vapor supply device 55B supplies vapor toward a space on the inner side of the skin member 2B. As a result, the vapor supplied to the space on the inner side of the skin member 2B is discharged (perspired) to the surface (outer surface) of the skin member 2B through the fine pores formed on the sheet member. In addition, in the third embodiment, a second warming portion 51B is configured from a temperature adjusting unit 57B disposed in a space on the inner side of the skin member 2B, without having a thermostatic bath. Alternatively, the second warming portion 51B can be configured to include a thermostatic bath.
- [0060] Furthermore, in the third embodiment, a liquid supply portion 4B includes a plurality of first liquid supply tubes 43B, a plurality of second liquid supply tubes 44B connected to a plurality of first liquid supply tubes 43B respectively, and a liquid supply device 45B that is disposed on the base end side of the second liquid supply tube 44B.
- [0061] The artificial perspiration apparatus 1B according to the third embodiment produces the following effects, in addition to the abovementioned effects (1), (2) and (6) to (9).
- [0062] (11) The skin member 2B is configured from a sheet member having a plurality of fine pores, and the vapor supply device 55B is disposed on the inner side of the skin member 2B with a predetermined space therefrom. As a result, the fine pores in the sheet member can function as vapor permeable holes, without providing the vapor permeable holes 22 separately. Therefore, the vapor supplied from the vapor supply device 55B can be discharged (perspired) from the fine pores in the sheet member to the surface side of the skin member 2B, without passing through tubes, whereby space savings in the structure of the artificial perspiration apparatus 1B can be realized.
- [0063] (12) The liquid supply portion 4B is configured to include the plurality of first liquid supply tubes 43B, the plurality of second liquid supply tubes 44B respectively connected to the plurality of first liquid supply tubes 43B, and the liquid supply device 45B that is disposed on the base end side of the second liquid supply tube 44B. As a result, by controlling the amount of the liquid supplied to each of the plurality of second liquid supply tubes 44B, the amount of the liquid sweat perspired from each of the plurality of liquid permeable holes 21 can be adjusted. Therefore, the liquid sweat can be perspired in different amounts according to the location on the skin member 2B.
- [0064] A fourth embodiment of the artificial perspiration apparatus 1 according to the present invention is explained hereinafter with reference to FIG. 7. FIG. 7 is a cross-sectional view of an artificial perspiration apparatus according to the fourth embodiment. The artificial perspiration apparatus 1C of the fourth embodiment is different from the first embodiment in the configuration of a liquid supply portion 4C

and a vapor supply portion 5C.

[0065] In the fourth embodiment, the liquid supply portion 4C includes a plurality of first liquid supply tubes 43C, a plurality of second liquid supply tubes 44C respectively connected to the plurality of first liquid supply tubes 43C, and a liquid supply device 45C that is disposed on the base end side of the plurality of second liquid supply tubes 44C. In addition, the vapor supply portion 5C includes a plurality of first vapor supply tubes 53C, a plurality of second vapor supply tubes 54C respectively connected to the plurality of first vapor supply tubes 53C, and a vapor supply device 55C that is disposed on the base end side of the plurality of second vapor supply tubes 54C.

[0066] The artificial perspiration apparatus 1C according to the fourth embodiment produces the following effects, in addition to the abovementioned effects (1), (2), (5) to (9) and (12).

[0067] (13) The vapor supply portion 5C is configured to include the plurality of first vapor supply tubes 53C, the plurality of second vapor supply tubes 54C respectively connected to the plurality of first vapor supply tubes 53C, and the vapor supply device 55C that is disposed on the base end side of the plurality of second vapor supply tubes 54C. As a result, by controlling the amount of the vapor supplied to each of the plurality of second vapor supply tubes 54C, the amount of the vaporous sweat perspired from each of the plurality of vapor permeable holes 22 can be adjusted. Therefore, the vaporous sweat can be perspired in different amounts according to the location on the skin member 2.

[0068] A fifth embodiment of the artificial perspiration apparatus 1 according to the present invention is explained hereinafter with reference to FIG. 8. FIG. 8 is a cross-sectional view of an artificial perspiration apparatus 1D according to the fifth embodiment. The artificial perspiration apparatus 1D of the fifth embodiment is different from the first embodiment in the configuration of a vapor supply portion 5D.

[0069] In the fifth embodiment, a plurality of first vapor supply tubes 53D configuring the vapor supply portion 5D is not inserted into a plurality of vapor permeable holes 22D provided in the skin member 2, and the tip side of the plurality of first vapor supply tubes 53D contacts the inner surface of the skin member 2. According to the fifth embodiment, the vapor discharged from the tip side of the plurality of first vapor supply tubes 53B passes through the vapor permeable holes 22D and is discharged to the surface (outer surface) of the skin member 2, without leaking to the inner side of the skin member 2 through a contacting portion between the first vapor supply tubes 53D and the skin member 2. It is noted that, in a case in which the tip side of the plurality of first liquid supply tubes 43 contacts the inner surface of the skin member 2, the liquid may leak to the inner side of the skin member 2 through a contacting portion between the first liquid supply tube 43 and the skin member 2.

[0070] The artificial perspiration apparatus 1D according to the fifth embodiment produces the following effect, in addition to the abovementioned effects (1) to (10).

[0071] (14) The tip side of the plurality of first vapor supply tubes 53D contacts the inner surface of the skin member 2. As a result, vaporous sweat can be perspired from the plurality of vapor permeable holes 22 without inserting the plurality of first vapor supply tubes 53D into the plurality of vapor permeable holes 22 provided on the skin member 2. Therefore, without a need of inserting the plurality of first vapor supply tubes 53D into the plurality of vapor permeable holes 22 provided on the skin member 2, the manufacturing process of the artificial perspiration device 1D can be simplified. In addition, the damage occurring to the plurality of first vapor supply tubes 53D in a case of the skin member 2 being pressed or the like can be alleviated.

[0072] Although preferred embodiments of the present invention have been described above, the present invention is not limited thereto and can be embodied in various modes. For example, in the first to fifth embodiments, the present invention is applied to the artificial perspiration apparatus 1 including the skin member 2 spreading in a curved shape; however, the present invention is not limited thereto. In other words, the present invention can be applied to an artificial perspiration apparatus including a skin member spreading in a planar shape.

Claims

- [Claim 1] An artificial perspiration apparatus comprising:
a skin member;
a plurality of liquid permeable holes provided in the skin member;
a plurality of vapor permeable holes provided in the skin member;
a liquid supply portion that is disposed on an inner side of the skin member and supplies liquid to the plurality of liquid permeable holes;
a vapor supply portion that is disposed on the inner side of the skin member and supplies vapor to the plurality of vapor permeable holes;
and
a control portion that controls supply of the liquid by the liquid supply portion and supply of the vapor by the vapor supply portion.
- [Claim 2] The artificial perspiration apparatus according to claim 1, further comprising:
a heating portion that is disposed on the inner side of the skin member and can heat the skin member;
a first warming portion that warms the liquid supply portion; and
a second warming portion that warms the vapor supply portion.
- [Claim 3] The artificial perspiration apparatus according to claim 1 or 2, wherein the liquid supply portion includes:
a plurality of first liquid supply tubes having a tip side thereof connected to the plurality of liquid permeable holes, respectively;
a second liquid supply tube that is connected to a base end side of each of the plurality of first liquid supply tubes; and
a liquid supply device that is connected to a base end side of the second liquid supply tube.
- [Claim 4] The artificial perspiration apparatus according to claim 3, wherein an inside diameter of the plurality of first liquid supply tubes gradually increases in a range from 0.01 mm to 2.0 mm as a distance between the liquid supply device and a base end portion of each of the plurality of first liquid supply tubes increases.
- [Claim 5] The artificial perspiration apparatus according to any one of claims 1 to 4, wherein the vapor supply portion includes:
a plurality of first vapor supply tubes having a tip side thereof connected to the plurality of vapor permeable holes, respectively;
a second vapor supply tube that is connected to a base end side of each of the plurality of first vapor supply tubes; and

a vapor supply device that is connected to a base end side of the second vapor supply tube.

[Claim 6] The artificial perspiration apparatus according to any one of claims 1 to 5, further comprising:

a first air supply portion that is connected to the liquid supply portion and supplies dry air to the liquid supply portion; and

a second air supply portion that is connected to the vapor supply portion and supplies dry air to the vapor supply portion.

[Claim 7] The artificial perspiration apparatus according to any one of claims 1 to 6, wherein the liquid permeable holes and the vapor permeable holes are provided respectively in a density of no less than one hole/cm².

[Claim 8] The artificial perspiration apparatus according to claim 7, wherein the liquid permeable hole has a diameter of 0.01 to 2 mm, and a distance between center points of each of adjacent liquid permeable holes is 2 to 10 mm, and

the vapor permeable hole has a diameter of 1 to 10 mm, and a distance between center points of each of adjacent vapor permeable holes is 2 to 10 mm.

[Claim 9] The artificial perspiration apparatus according to any one of claims 1 to 8, further comprising at least any one of: a temperature measuring portion that can measure a temperature of a surface side of the skin member;

a humidity measuring portion that can measure humidity of the surface side of the skin member;

a pressure measuring portion that can measure a pressure applied to the surface of the skin member;

a flow rate measuring portion that can measure a flow rate of gas on the surface side of the skin member; and

a wettability measuring portion that can measure wettability on the surface side of the skin member.

[Claim 10] The artificial perspiration apparatus according to any one of claims 1 to 9 comprising:

a torso portion;

two leg portions that are formed on a first side of the torso portion; and

at least one excretion portion that is formed in a vicinity of a base of the torso portion,

the artificial perspiration apparatus being formed in a doll-shape to which an absorbent article can be attached so as to cover the excretion

portion,

wherein the skin member configures a surface of the torso portion, a surface of the leg portions, and a surface of the excretion portion.

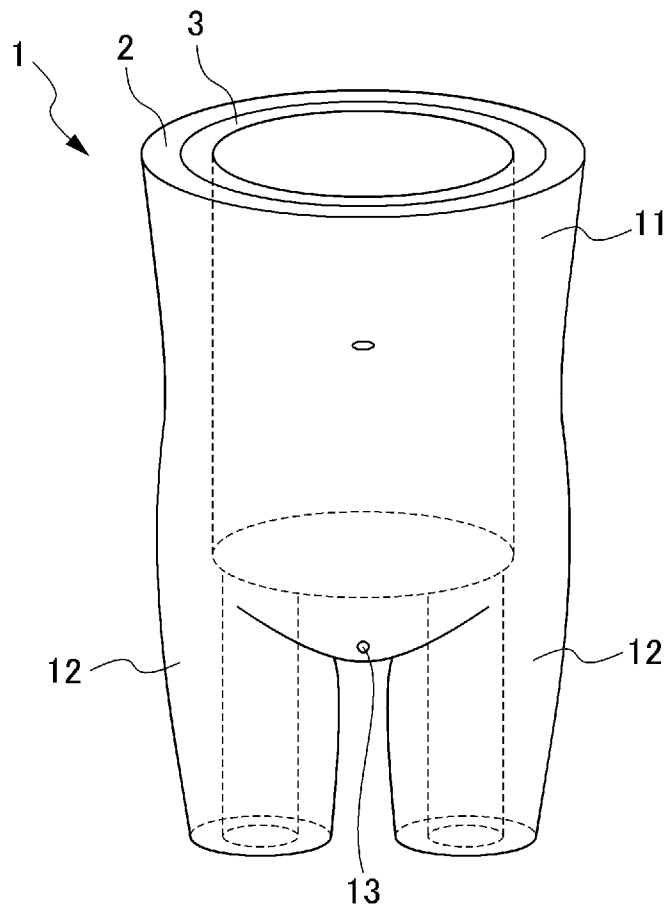
[Claim 11]

The artificial perspiration apparatus according to claim 10,

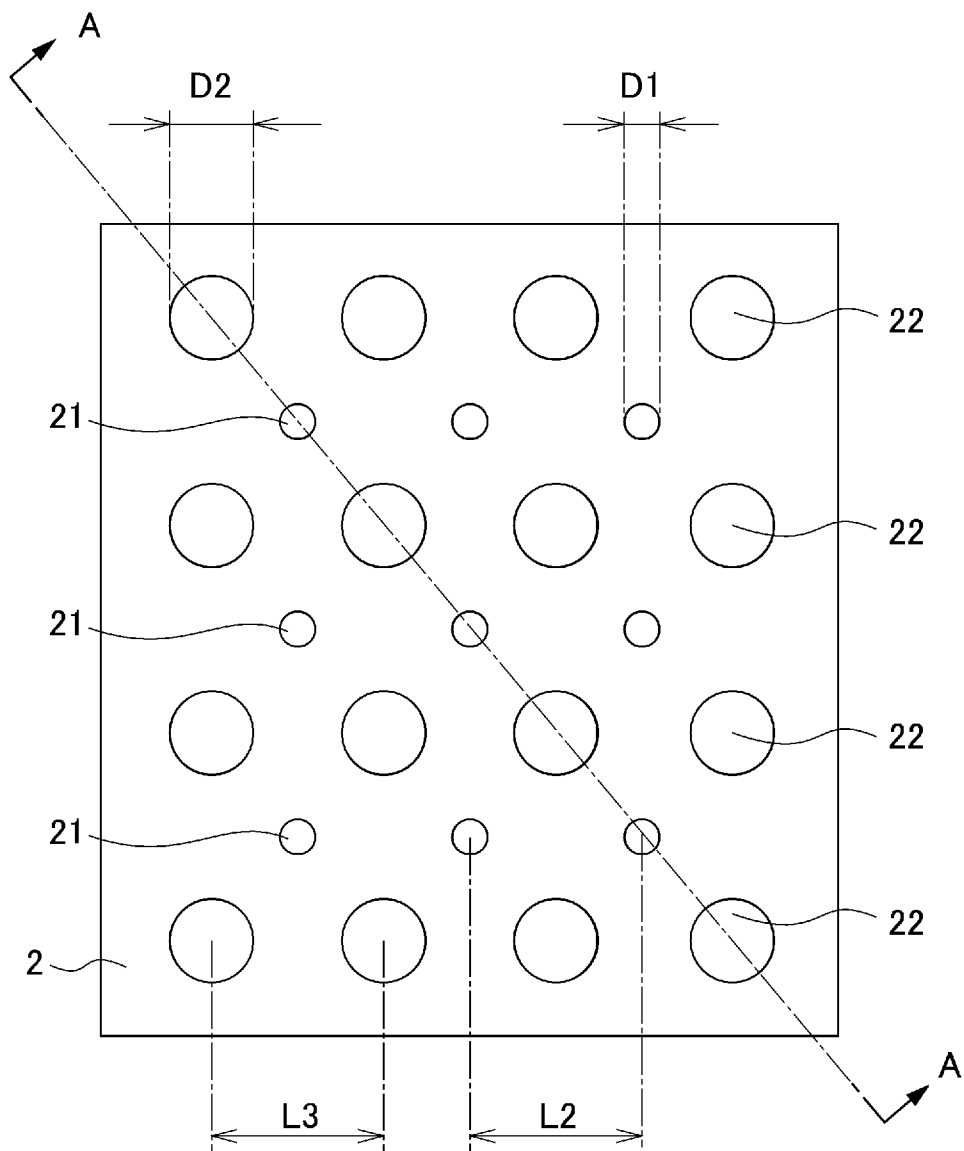
wherein the two leg portions can be driven rotatably in a back and forth direction and a side to side direction about a connection portion thereof with the torso portion, and

wherein the torso portion can be driven to incline in a vertical direction and driven rotatably in a waistline direction.

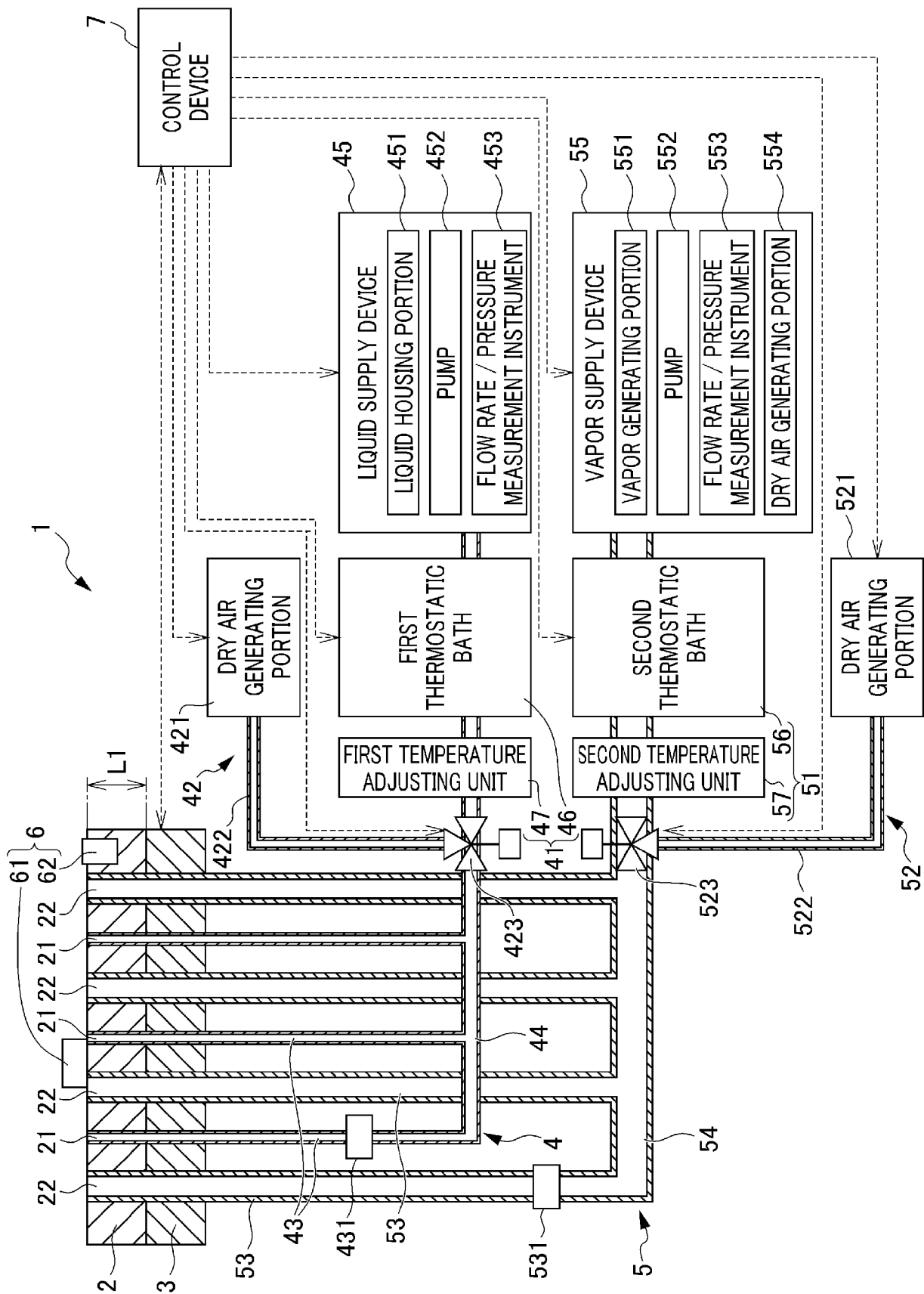
[Fig. 1]



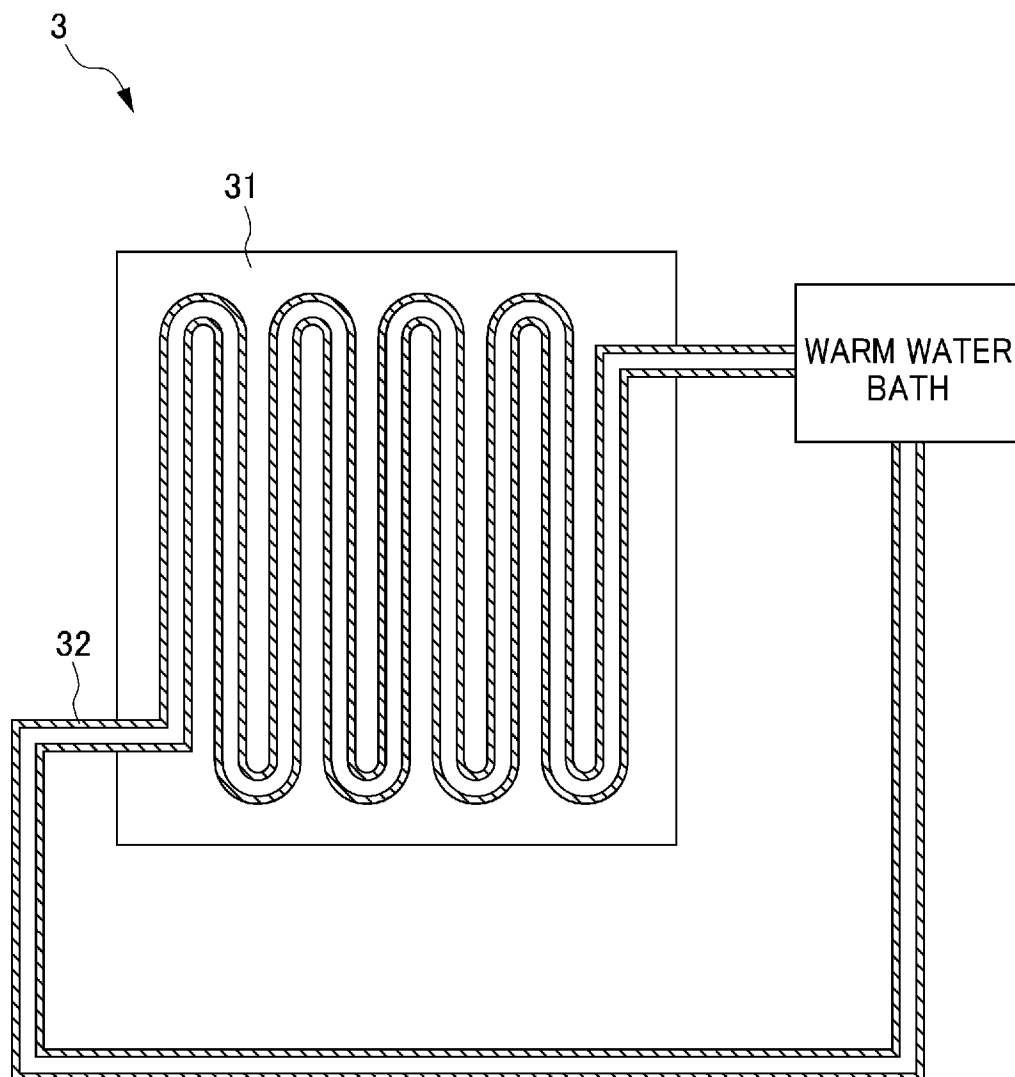
[Fig. 2]



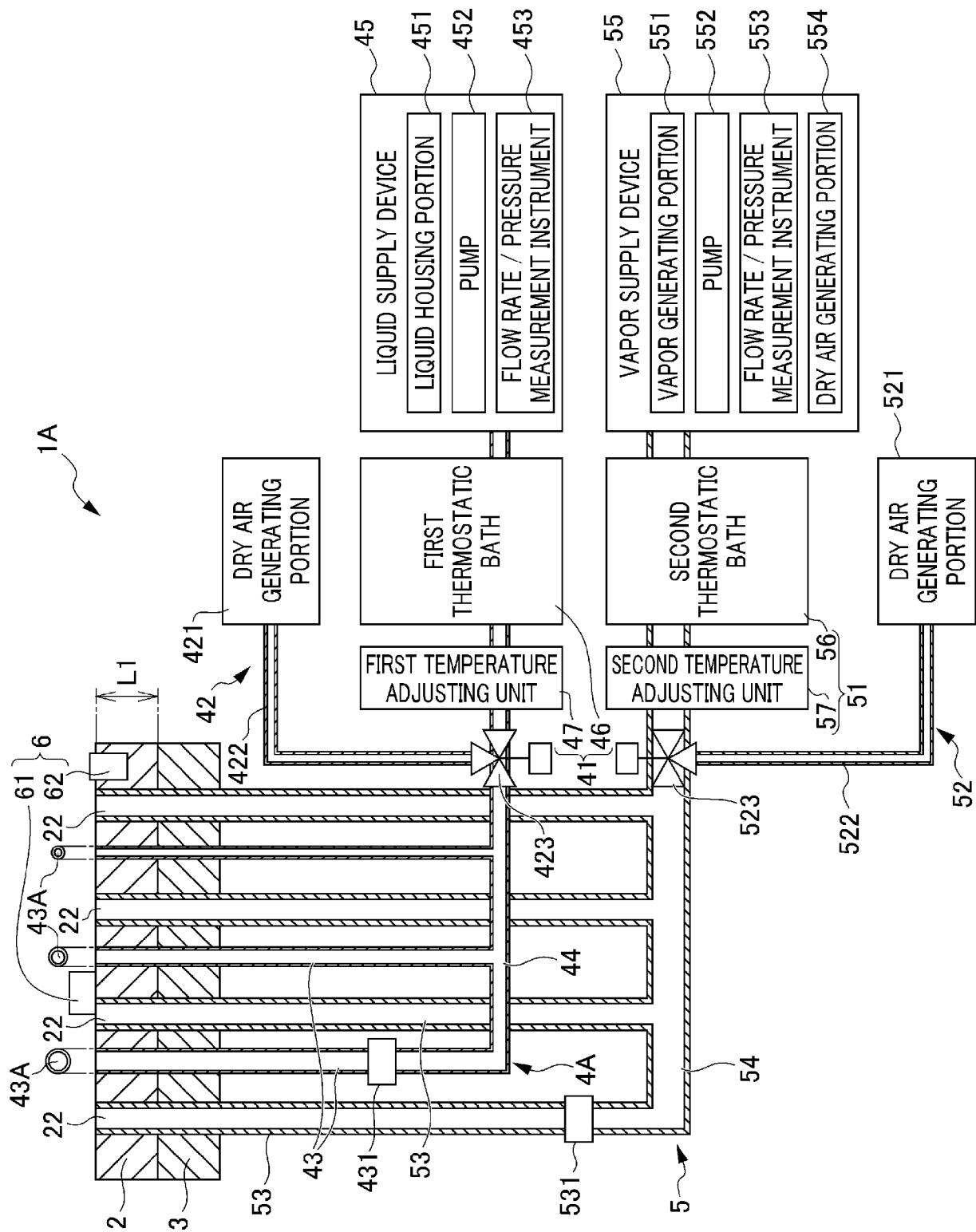
[Fig. 3]



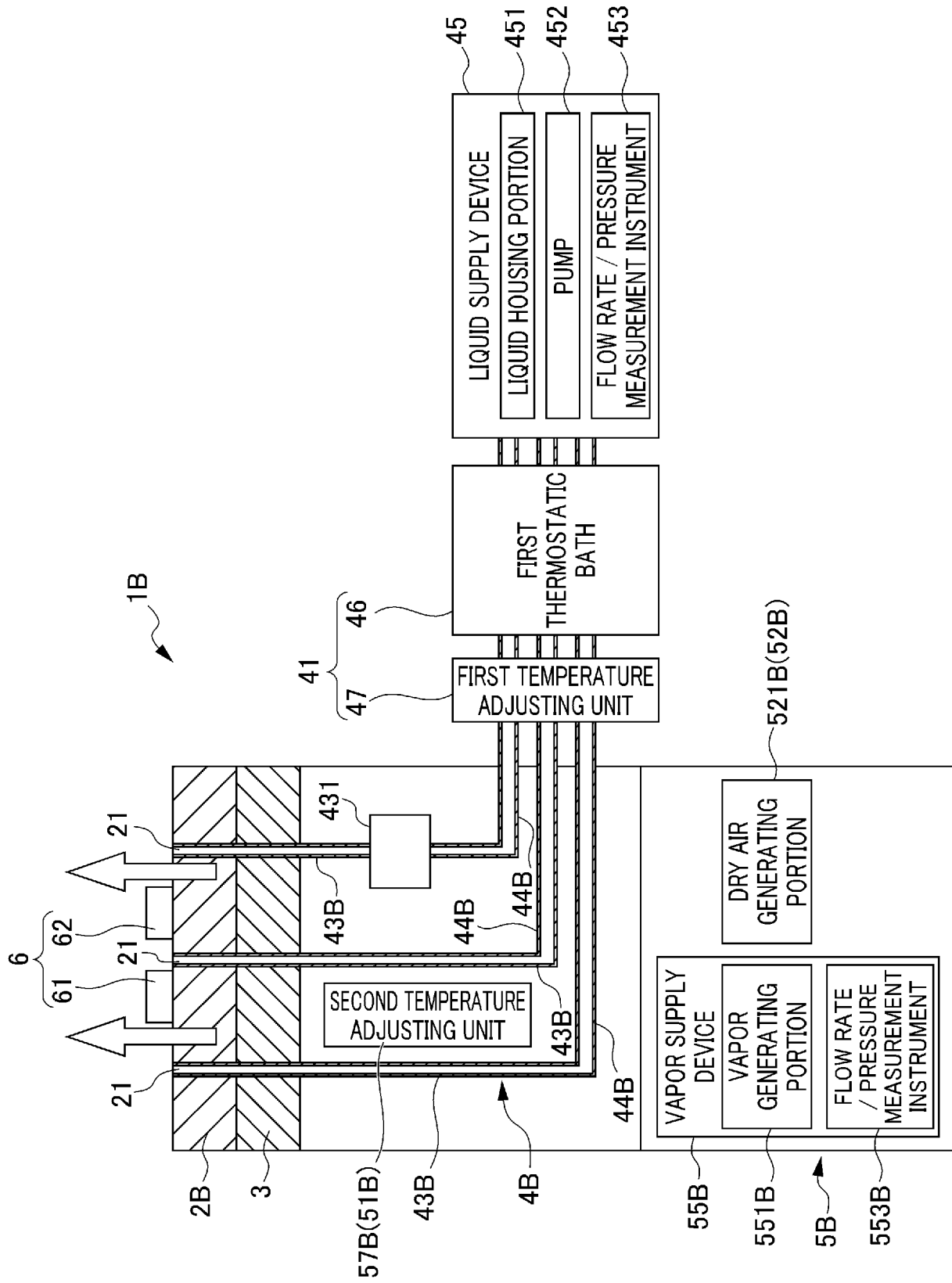
[Fig. 4]



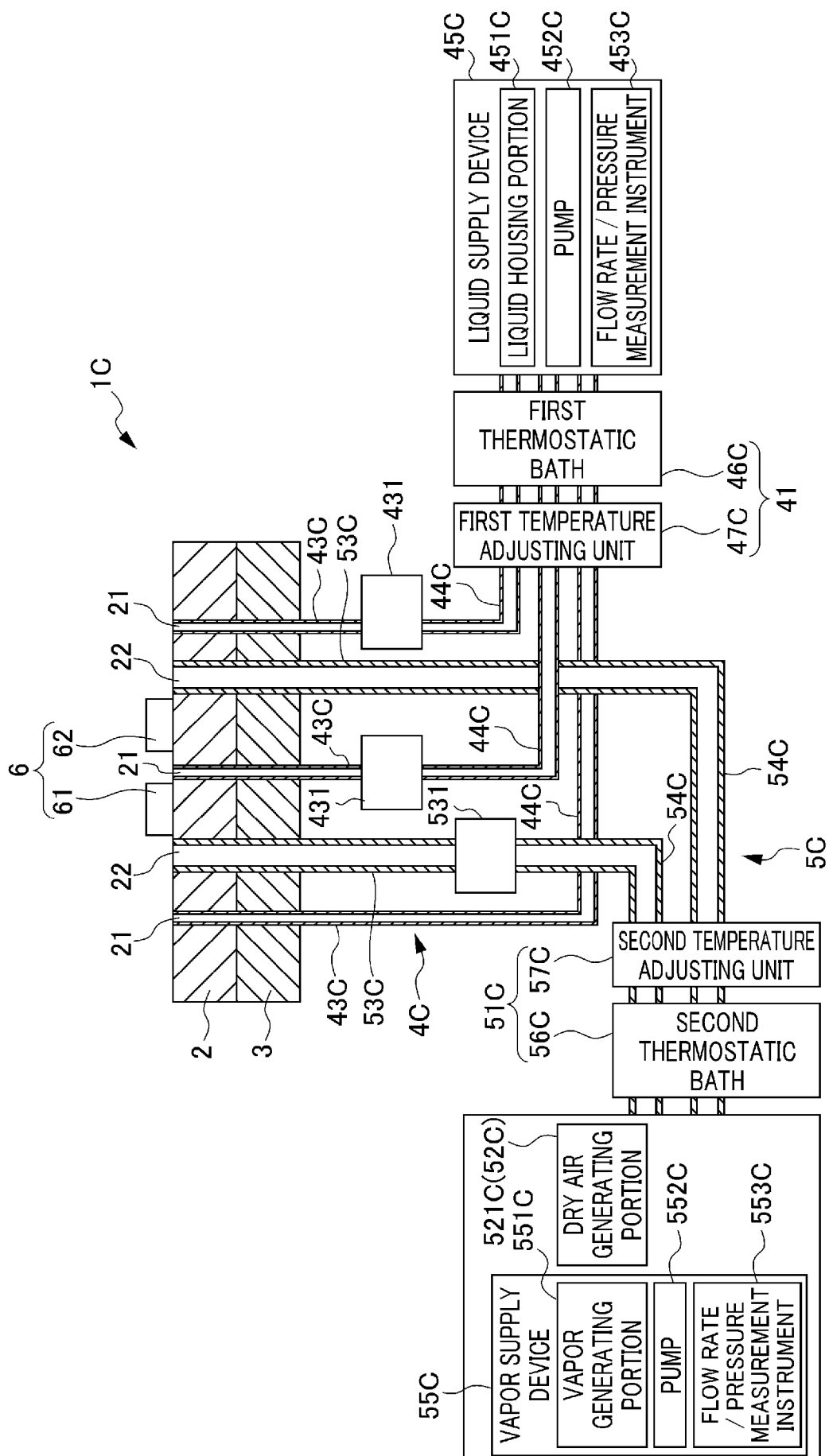
[Fig. 5]



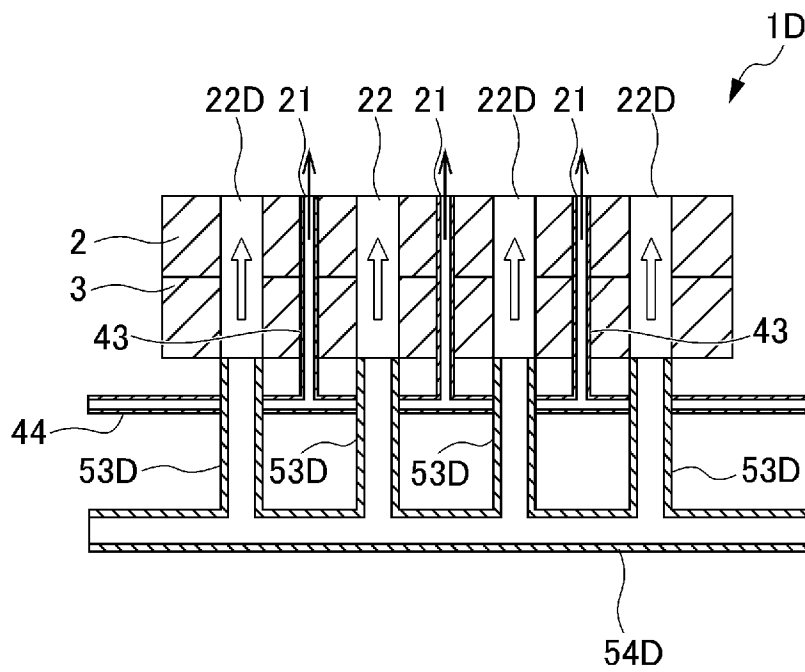
[Fig. 6]



[Fig. 7]



[Fig. 8]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/001933

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G01N33/36 (2006.01) i, G09B23/28 (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)

Int.Cl. G01N33/36, G09B23/28

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

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2011
 Registered utility model specifications of Japan 1996-2011
 Published registered utility model applications of Japan 1994-2011

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	JP 2003-050541 A (TOYOBO CO., LTD) 2003.02.21, Whole document (No Family)	1-11



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

13.06.2011

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Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan

Authorized officer

KUSAKAWA, Takashi

Telephone No. +81-3-3581-1101 Ext. 3252

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2011/001933

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