(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 198 176 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.06.2023 Bulletin 2023/25

(21) Application number: **22210091.9**

(22) Date of filing: **29.11.2022**

(51) International Patent Classification (IPC):
D01D 4/02 (2006.01) ***D01D 5/08*** (2006.01)
D01D 13/02 (2006.01) ***D01D 5/084*** (2006.01)

(52) Cooperative Patent Classification (CPC):
D01D 4/025; D01D 5/084; D01D 13/02

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **17.12.2021 JP 2021205094**

(71) Applicant: **TMT Machinery, Inc.**
Osaka-shi, Osaka 541-0041 (JP)

(72) Inventors:
- **KOJIMA, Shogo**
  Kyoto-shi, Kyoto, 612-8686 (JP)
- **OKADA, Kazuma**
  Kyoto-shi, Kyoto, 612-8686 (JP)

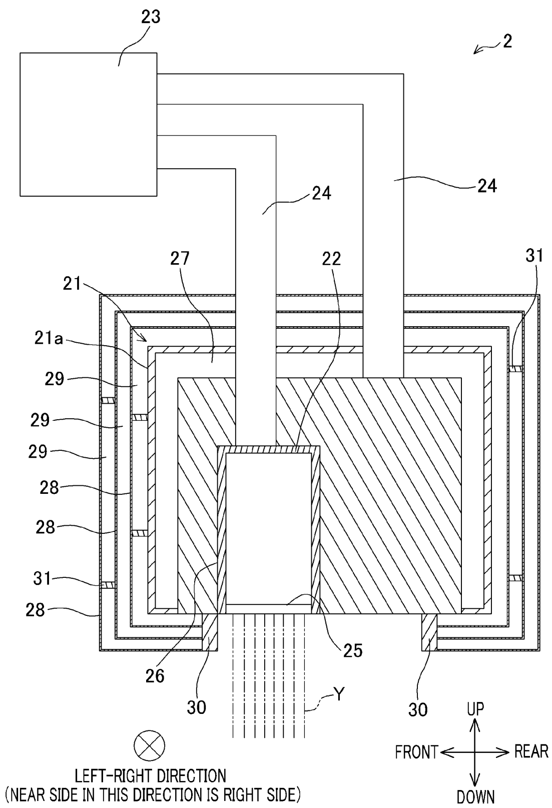
(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) **SPINNING APPARATUS**

(57) An object of the present invention is to decrease power consumption by reducing heat emission from a heat source unit to the outside of an apparatus.

A spinning apparatus 2 of the present invention includes: a spinning beam 21; a heating medium enclosed space 27 which is provided in the spinning beam 21 and which allows a spinning pack 22 to be heated; at least one shielding plate 28 provided to cover an outer surface of the spinning beam 21; and at least one air layer 29 provided between an inner surface of the at least one shielding plate 28 and the outer surface of the spinning beam 21.

FIG.3



EP 4 198 176 A2

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a spinning apparatus including a spinning beam into which a spinning pack is inserted.

[0002] A spinning apparatus configured to spin out hot molten polymer downward has been known. For example, Patent Literature 1 (Japanese Laid-Open Patent Publication No. H7-11507) discloses a spinning apparatus (melt spinning device) including a spinning pack which has a spinneret at its lower portion and a spinning beam. The spinning pack is provided inside the spinning beam. The hot molten polymer is supplied to the spinning pack, and then spun out downward from the spinneret provided at the lower portion of the spinning pack. In the spinning apparatus of Patent Literature 1, a heat source unit (a heating wire and a heating medium) provided for retaining the temperature of molten polymer passing through the spinning pack is provided in the spinning beam.

[0003] The heat from the heat source unit is transferred not only to the inside of the spinning beam but also to the outside of the spinning beam, i.e., the outside of the spinning apparatus. When the heat from the heat source unit is emitted to the outside of the spinning apparatus, the spinning pack is not supplied with sufficient heat. This decreases the efficiency of heating molten polymer by the heat source unit. The molten polymer is in the spinning pack. Therefore, a spinning apparatus such as that of Patent Literature 1 is typically structured so that the outside of a spinning beam is covered by a heat insulating material in order to reduce heat emission from a heat source unit to the outside of the spinning apparatus.

SUMMARY OF THE INVENTION

[0004] The performance of a heat insulating material depends on the heat conductivity and thickness of the heat insulating material. The heat conductivity is unique to the type of the heat insulating material. The thickness of the heat insulating material covering a spinning beam must be sufficient to reduce heat emission from a heat source unit to the outside of a spinning apparatus. Especially, the heat conductivity of rock wool which is widely used as the heat insulating material is significantly increased in an area with high temperature. Therefore, when the rock wool is used as the heat insulating material, the thickness of the heat insulating material must be large in the high-temperature area provided for retaining the temperature of molten polymer.

[0005] However, a working space for an operator and a space for providing other facilities such as a cooler are required around the spinning beam. This causes the thickness of the heat insulating material covering the spinning beam to have a limit. Therefore, the thickness of the heat insulating material may not be sufficient. As a result, an amount of emission of heat from the spinning beam increases, and the efficiency of heating molten polymer by heat decreases. The heat is supplied from the heat source unit, and the molten polymer is in the spinning pack. This results in increase of power consumption because the heating temperature of the heat source unit is required to be increased.

[0006] An object of the present invention is to provide a spinning apparatus which reduces heat emission from a heat source unit to the outside of an apparatus so as to decrease power consumption.

[0007] A spinning apparatus of the present invention includes: a spinning pack in which a spinneret is provided at a lower end portion of the spinning pack and which is configured to spin out molten polymer stored in the spinning pack downward from the spinneret; a spinning beam into which the spinning pack is inserted; a heat source unit which is provided in the spinning beam and which is configured to heat the spinning pack; at least one shielding member which is provided to cover an outer surface of the spinning beam and which blocks radiation from the heat source unit; and at least one gas layer provided between an inner surface of the at least one shielding member and the outer surface of the spinning beam.

[0008] According to the present invention, the at least one shielding member and the at least one gas layer are provided outside of the spinning beam. Even when the thickness of the at least one gas layer is small, heat conduction from the heat source unit to the outside of the spinning apparatus is sufficiently reduced. This is because the heat conductivity of the at least one gas layer is small. The transfer of radiant heat from the heat source unit to the outside of the spinning apparatus is suppressed by the at least one shielding plate. With these arrangements, heat emission from the heat source unit to the outside of the spinning apparatus is reduced so as to decrease power consumption.

[0009] In the spinning apparatus of the present invention, the at least one gas layer is preferably sealed.

[0010] When the at least one gas layer is open to the outside of the spinning apparatus, exchange of air occurs between the at least one gas layer and the outside of the spinning apparatus so that convection occurs. When the convection occurs, heat transfer is likely to occur. This results in decrease of performance of heat insulation by the at least one gas layer. According to the present invention, the at least one gas layer is sealed so as to prevent the exchange of air between the at least one gas layer and the outside of the spinning apparatus. It is therefore possible to suppress the occurrence of convection.

[0011] The spinning apparatus of the present invention further includes, preferably, a sealing member which is formed of a heat insulating material and which connects the at least one shielding member to the spinning beam. In addition to that, the at least one gas layer is preferably sealed by the at least one shielding member, the spinning beam, and the sealing member.

[0012] According to the present invention, the sealing member formed of the heat insulating material is used to seal the at least one gas layer. It is therefore possible to reduce the heat emission from the heat source unit to the outside of the spinning apparatus via the sealing member.

[0013] In the spinning apparatus of the present invention, preferably, gas layers and shielding members are alternately provided outside of the spinning beam.

[0014] According to the present invention, the gas layers and the shielding members are alternately provided outside of the spinning beam. In other words, the gas layers and the shielding members are layered. With this arrangement, the gas layers further reduce the heat conduction, and the shielding members further reduce the radiant heat. As a result, the heat emission from the heat source unit to the outside of the spinning apparatus is further reduced.

[0015] The spinning apparatus of the present invention further includes, preferably, supporters each of which penetrates one of the gas layers and by which the outer surface of the spinning beam is connected to one of the shielding members and each adjacent two of the shielding members are connected to one another. In addition to that, one of the supporters which penetrates one of the gas layers and another of the supporters which penetrates another of the gas layers are connected to different positions of one of the shielding members which is provided between the one of the gas layers and the another of the gas layers, the another of the gas layers being adjacent to the one of the gas layers.

[0016] When one of the shielding members is warped, the one of the shielding members may make contact with the outer surface of the spinning beam or other shielding members. In this case, heat from the heat source unit is emitted to the outside of the spinning apparatus via the shielding members. Therefore, the gas layers cannot reliably reduce the heat conduction. In the present invention, the supporters are provided to reduce the contact between one of shielding members and the spinning beam and the contact between the shielding members. When the one of the supporters which penetrates the one of the gas layers and the another of the supporters which penetrates the another of the gas layers which is adjacent to the one of the gas layers are connected to the same positions of the one of the shielding members which is provided between the one of the gas layers and the another of the gas layers, the heat transfer is likely to occur at the each two of the supporters. In this case, a heat-conduction reduction effect by the gas layers decreases. In the present invention, the one of the supporters which penetrates the one of the gas layers and the another of the supporters which penetrates the another of the gas layers which is adjacent to the one of the gas layers are connected to the different positions of the one of the shielding members which is provided between the one of the gas layers and the another of the gas layers. Therefore, when the one of the supporters which penetrates the one of the gas layers and the another of the supporters which penetrates the another of the gas layers which is adjacent to the one of the gas layers are connected to the different positions of the one of the shielding members which is provided between the one of the gas layers and the another of the gas layers, a heat conduction path of heat transferred via the supporters is formed to be longer than that in a case where the one of the supporters which penetrates the one of the gas layers and the another of the supporters which penetrates the another of the gas layers which is adjacent to the one of the gas layers are connected to the same positions of the one of the shielding members which is provided between the one of the gas layers and the another of the gas layers. With this arrangement, the heat emission from the heat source unit to the outside of the spinning apparatus is reduced while the contact between the spinning beam and one of the shielding members and the contact between the shielding members are reduced.

[0017] In the spinning apparatus of the present invention, the gas layers are preferably air layers. In addition to that, preferably, the thickness of each of the air layers is equal to or more than 1 mm and is less than 10 mm.

[0018] As the thickness of the each of the air layers increases, the heat-conduction reduction effect increases. However, when the thickness of the each of the air layers is large, heat convection is likely to occur so that the heat transfer easily occurs. When the thickness of the each of the air layers is too small, the spinning beam may make contact with the shielding members. In this case, the heat from the heat source unit is likely to be emitted to the outside of the spinning apparatus via the shielding members. In the present invention, the thickness of the each of the air layers is arranged so that (i) the spinning beam is unlikely to make contact with the shielding members, (ii) the performance of heat insulation is sufficient, (iii) and the heat convection in the air layers is able to be suppressed. With this arrangement, the heat emission from the heat source unit to the outside of the spinning apparatus is further reliably reduced.

[0019] In the spinning apparatus of the present invention, a heat insulation member is preferably provided outside of the shielding members.

[0020] In the present invention, after the gas layers and the shielding members reduce a significant amount of heat transferring from the heat source unit to the outside of the spinning apparatus, the heat insulation member further reliably insulates the heat. It is therefore possible to further efficiently reduce the heat emission from the heat source unit to the outside of the spinning apparatus. Even when the thickness of the heat insulation member is not sufficient, the performance of heat insulation by the heat insulation member is sufficient.

[0021] The spinning apparatus of the present invention further includes, preferably, a covering member which causes the outer surface of the spinning beam to be flat by covering an uneven portion formed on the outer surface of the spinning beam.

[0022] The uneven portion may be formed on the outer surface of the outer wall of the spinning beam because of a protruding member and a gap. When (i) the uneven portion is formed on the outer surface of the outer wall of the spinning beam and (ii) the shielding member is provided to cover the outer surface of the outer wall of the spinning beam, the thickness of one of the air layers which is provided between the outer surface of the outer wall of the spinning beam and one of the shielding members is uneven. In this case, the performance of heat insulation by the gas layers is uneven. It is therefore impossible to ensure the sufficient performance of heat insulation at a part of the one of the gas layers, whose thickness is smaller than that of other part of the one of the gas layers. In the present invention, the covering member is able to cover the uneven portion formed on the outer surface of the outer wall of the spinning beam so as to cause the outer surface of the spinning beam to be flat. Therefore, even when the uneven portion is formed on the outer surface of the spinning beam, (i) the thickness of the one of the gas layers which is provided between the outer surface of the outer wall of the spinning beam and the one of the shielding members is even and (ii) the performance of heat insulation by the gas layers is sufficient.

[0023] In the spinning apparatus of the present invention, the shielding members preferably cover at least the entire outer surface of the spinning beam except a lower surface of the spinning beam.

[0024] According to the present invention, the gas layers and the shielding members cover a large part of the outer surface of the spinning beam. It is therefore possible to relatively evenly reduce, on the entire outer surface of the spinning beam, the heat conduction from the heat source unit to the outside of the spinning apparatus. This suppresses the dispersion of temperature outside of the spinning apparatus due to the heat from the heat source unit. As a result, the dispersion of temperature is also suppressed in the vicinity of the spinneret, and a negative effect on the quality of a yarn spun out from the spinneret due to the dispersion of temperature is suppressed.

[0025] In the spinning apparatus of the present invention, the shielding members preferably cover the lower surface of the spinning beam except a part below the spinning pack.

[0026] According to the present invention, the gas layers and the shielding members cover a part of the lower surface of the spinning beam. It is therefore possible to especially suppress the transfer of the heat from the heat source unit to components provided below the spinning apparatus. As a result, the dispersion of temperature is further suppressed in the vicinity of the spinneret provided below the spinning apparatus. This suppresses the negative effect on the quality of the yarn spun out from the spinneret due to the dispersion of temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

FIG. 1 is a profile of a yarn production system of an embodiment.

FIG. 2 is a perspective view of a spinning apparatus of the present embodiment.

FIG. 3 is a cross section taken along a line III-III in FIG. 2.

FIG. 4 shows performances of heat insulation by an apparatus of Example and an apparatus of Comparative Example.

FIG. 5 is a cross section of a spinning apparatus of a modification.

FIG. 6 is a cross section of a spinning apparatus of another modification.

FIG. 7 is a spinning beam of the present embodiment, viewed from below.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Overall Structure of Yarn Production System 1)

[0028] The following will describe a preferred embodiment of the present invention with reference to figures. FIG. 1 is a profile of a yarn production system 1 including a spinning apparatus 2 of the present embodiment. FIG. 2 is a perspective view of the spinning apparatus 2. FIG. 3 is a cross section taken along a line III-III in FIG. 2. Hereinafter, an up-down direction in FIG. 1 is regarded as an up-down direction of the yarn production system 1, and a left-right direction in FIG. 1 is regarded as a front-rear direction of the yarn production system 1. Furthermore, a direction perpendicular to the sheet of FIG. 1 is regarded as a left-right direction. In this regard, a direction toward the viewer of FIG. 1 is regarded as a right direction.

[0029] As shown in FIG. 1, the yarn production system 1 includes the spinning apparatus 2 and a spun yarn take-up apparatus 3. The spinning apparatus 2 is configured to spin out molten polymer downward as yarns Y. The spinning apparatus 2 will be detailed later. The spun yarn take-up apparatus 3 is configured to take up the yarns Y spun out from the spinning apparatus 2, and includes a cooler 4, oil nozzles 5, guides 6, a comb teeth guide 7, godet rollers 8 and 9, and a winding device 10.

[0030] The cooler 4 is provided below the spinning apparatus 2. The cooler 4 is configured to cool the yarns Y by supplying cooling air to the yarns Y spun out from the spinning apparatus 2. The cooler 4 includes a cooling cylinder (not illustrated) which is substantially cylindrical in shape and the both ends of which are open in the up-down direction. In this regard, the yarns Y are able to run downward in the unillustrated cooling cylinder. That is, the cooler 4 is configured to supply the cooling air to the yarns Y running in the cooling cylinder.

[0031] The oil nozzles 5 are provided below the cooler 4, and configured to apply oil to the respective yarns Y cooled by the cooler 4. The guides 6 are provided below the respective oil nozzles 5 at regular intervals in the left-right direction, and configured to individually guide the oiled yarns Y.

[0032] The comb teeth guide 7 is provided below an approximate center of a group of the guides 6 in the left-right direction and the front-rear direction. The yarns Y guided by the guides 6 run downward while being aligned at regular intervals in the left-right direction of the comb teeth guide 7.

[0033] The godet rollers 8 and 9 are provided downstream of the comb teeth guide 7 in a yarn running direction as shown in FIG. 1, and rotationally driven by unillustrated motors. The yarns Y spun out from the spinning apparatus 2 pass the cooler 4, the oil nozzles 5, the guides 6, and the comb teeth guide 7, and are wounded onto the godet rollers 8 and 9 in this order. The godet rollers 8 and 9 are configured to send the yarns Y to the winding device 10.

[0034] The winding device 10 is configured to wind the yarns Y onto bobbins B retained by bobbin holders 11, so as to form packages P. The winding device 10 is provided with two bobbin holders 11. Each bobbin holder 11 is a shaft member extending in the front-rear direction, and is cantilevered at its rear end portion by a turret 13 provided on a frame 12. Each bobbin holder 11 is able to retain the bobbins B aligned in an axial direction of the bobbin holder 11. For example, when eight yarns Y are sent from the spinning apparatus 2, eight yarns Y are wound onto eight bobbins B.

[0035] The winding device 10 further includes a supporting frame 14 which extends in the front-rear direction to be substantially parallel to the bobbin holders 11. The supporting frame 14 is cantilevered at its rear end portion by the frame 12. Above the supporting frame 14, a guide supporter 15 is provided to extend in the front-rear direction. On the guide supporter 15, supporting guides 16 are provided to be aligned in the front-rear direction to correspond to the respective bobbins B attached to each bobbin holder 11. On the supporting frame 14, traverse units 17 are provided to be aligned in the front-rear direction to correspond to the respective bobbins B attached to each bobbin holder 11. Each traverse unit 17 is configured to traverse a yarn Y in the front-rear direction about a corresponding supporting guide 16.

[0036] The winding device 10 further includes a contact roller 18 which is rotatably supported by the supporting frame 14. The contact roller 18 is provided below the supporting frame 14. Operations of the winding device 10 are controlled by an unillustrated controller. The winding device 10 is configured to start the winding of the yarns Y, which are traversed by the traverse units 17, on new bobbins B attached to one bobbin holder 11 positioned above the other bobbin holder 11. The contact roller 18 is suitably moved up or down and/or the turret 13 is suitably rotationally driven while the yarns Y are wound. In this way, the packages P are formed along the increase in diameter of the packages P.

(Spinning Apparatus 2)

[0037] The following will detail the spinning apparatus 2 with reference to FIG. 2 and FIG. 3. The spinning apparatus 2 includes a spinning beam 21, spinning packs 22, a polymer tank 23, and polymer pipes 24.

[0038] As shown in FIG. 2, the spinning beam 21 is substantially rectangular parallelepiped in shape and extends in the left-right direction. FIG. 2 does not show the polymer tank 23, the polymer pipes 24, and shielding plates 28 and air layers 29 which are described later. As shown in FIG. 3, the shape of the spinning beam 21 is substantially rectangular in a cross section orthogonal to the left-right direction. In the spinning beam 21, cylindrical hosing spaces 26 are aligned in a grid along the left-right direction. In this regard, each housing space 26 is open at its lower portion so that a corresponding spinning pack 22 is inserted into each housing space 26. That is, as shown in FIG. 2, the spinning packs 22 inserted into the respective housing spaces 26 of the spinning beam 21 are staggered along the left-right direction. At a lower end portion of each spinning pack 22, a spinneret 25 is provided. In this regard, through holes (not illustrated) are formed in each spinneret 25 so that molten polymer can be pushed out downward through the through holes. The molten polymer is immediately cooled after being pushed out from the through holes of the spinneret 25, so that each yarn Y is formed. As such, the spinning apparatus 2 is configured to spin out molten polymer downward as the yarns Y.

[0039] As shown in FIG. 3, hot molten polymer is stored in the polymer tank 23. The polymer tank 23 is connected to the spinning packs 22 through the polymer pipes 24. The molten polymer stored in the polymer tank 23 is supplied to the spinning packs 22 through the polymer pipes 24 by unillustrated gear pumps. The molten polymer then passes through each spinning pack 22, and is pushed out downward from the through holes of each spinneret 25.

[0040] A heating medium enclosed space 27 (a space where a heating medium is enclosed) is provided inside an outer wall 21a of the spinning beam 21. In the heating medium enclosed space 27, a vapor heating medium heated by an unillustrated heater is enclosed. The vapor heating medium is supplied to the heating medium enclosed space 27 through an unillustrated pipe. In the heating medium enclosed space 27 where the vapor heating medium is enclosed, the spinning packs 22 are heated approximately at the temperature of the vapor heating medium. In the present embodiment, the heating medium enclosed space 27 where the vapor heating medium is enclosed is equivalent to a heat source unit of the present invention.

[0041] The spinning apparatus 2 further includes three shielding plates 28 (shielding members of the present invention) and three air layers 29 (i.e., innermost air layer 29, middle air layer 29, and outermost air layer 29). The shielding plates 28 are provided to cover the outer surface of the outer wall 21a of the spinning beam 21. The shielding plates 28 are provided to cover the entire outer surface of the outer wall 21a with no gap, except a part below each spinning pack 22. The following details a part of each shielding plate 28, which covers the lower surface of the spinning beam 21. As shown in FIG. 7, each shielding plate 28 is provided to cover the entire lower surface of the spinning beam 21 with no gap, except the spinning packs 22 and spaces immediately below the spinning packs 22 and their surroundings. The shape of each shielding plate 28 is substantially rectangular in a cross section orthogonal to the left-right direction, along the spinning beam 21 which is substantially rectangular in cross section. To be more specific, each shielding plate 28 entirely covers an upper surface, a left surface, a right surface, a front surface, and a rear surface of the outer wall 21a of the spinning beam 21. Furthermore, each shielding plate 28 covers the lower surface of the outer wall 21a of the spinning beam 21, except parts below the spinning packs 22. In the present embodiment, the size of the outermost shielding plate 28 is 500 mm in the up-down direction, 500 mm in the front-rear direction, and 1500 mm in the left-right direction. Above the spinning beam 21, each above-described polymer pipe 24 penetrates three shielding plates 28. In this regard, heat insulating adhesive provides a seal between the shielding plates 28 and each polymer pipe 24.

[0042] Each shielding plate 28 is a member which blocks heat radiation from the heating medium enclosed space 27 where the vapor heating medium is enclosed. In the present embodiment, a material of each shielding plate 28 is aluminum. Examples of the material of each shielding plate 28 is copper. Each shielding plate 28 is provided at an area with low temperature such as at the outside of the spinning beam 21, to reflect and reduce radiant heat from an area with high temperature such as from the heating medium enclosed space 27 where the vapor heating medium is enclosed. The material of each shielding plate 28 is a material in which the reflectivity to heat radiation is, e.g., 0.01 to 0.80. However, the disclosure is not limited to this. Furthermore, a surface of each shielding plate 28 is preferably polished or coated with a high reflection coating. The surface of each shielding plate 28 is in contact with the heating medium enclosed space 27. In the present embodiment, the thickness of each shielding plate 28 is 1 mm.

[0043] The air layers 29 are provided between the outer surface of the outer wall 21a of the spinning beam 21 and the innermost shielding plate 28, between the innermost shielding plate 28 and the middle shielding plate 28, and between the middle shielding plate 28 and the outermost shielding plate 28. At the outside of the spinning beam 21, three air layers 29 and three shielding plates 28 are alternately provided. The thickness of each air layer 29 is equal to or more than 1 mm, and is less than 10 mm. In the present embodiment, the thickness of each of three air layers 29 is 8 mm.

[0044] The spinning apparatus 2 of the present embodiment includes a sealing member 30 connecting the outer wall 21a of the spinning beam 21 to end portions of three shielding plates 28. The sealing member 30 is provided for sealing the air layers 29. When the shielding plates 28 are referred to as the first (innermost), second (middle), and third (outermost) shielding plates 28 and the air layers 29 are referred to as the first (innermost), second (middle), and third (outermost) layers 29 from the spinning beam 21, the first air layer 29 is sealed by the first shielding plate 28, the outer wall 21a of the spinning beam 21, and the sealing member 30. The second air layer 29 is sealed by the first shielding plate 28, the second shielding plate 28, and the sealing member 30. The third air layer 29 is sealed by the second shielding plate 28, the third shielding plate 28, and the sealing member 30. The sealing member 30 is formed of, e.g., a heat insulating material. Examples of the heat insulating material forming the sealing member 30 include hard ceramic.

[0045] The spinning apparatus 2 further includes supporters 31. Each supporter 31 penetrates one of the air layers 29 so as to connect the outer surface of the outer wall 21a of the spinning beam 21 to the first shielding plate 28, to connect the first shielding plate 28 to the second shielding plate 28, or to connect the second shielding plate 28 to the third shielding plate 28. One pair of two supporters 31 penetrating one air layer 29 and another pair of two supporters 31 penetrating another air layer 29 adjacent to the one air layer 29 are connected to different positions of the same shielding plate 28 provided between the one air layer 29 and the another air layer 29. To be more specific, one pair of two supporters 31 penetrating the first air layer 29 and another pair of two supporters 31 penetrating the second air layer 29 are connected to different positions of the first shielding plate 28. Furthermore, one pair of the two supporters 31 penetrating the second air layer 29 and another pair of two supporters 31 penetrating the third air layer 29 are connected to different positions of the second shielding plate 28. The two supporters 31 penetrating the first air layer 29 connect the first shielding plate 28 to the front surface of the outer wall 21a of the spinning beam 21. The two supporters 31 penetrating the second air layer 29 connect the second shielding plate 28 to the first shielding plate 28 behind the spinning beam 21. The two supporters 31 penetrating the third air layer 29 connect the third shielding plate 28 to the second shielding plate 28 in front of the spinning beam 21. As such, each two supporters 31 form a pair, and each two pairs which respectively penetrate two adjacent air layers 29 are preferably provided to oppose one another over the spinning beam 21. Each two pairs which respectively penetrate two adjacent air layers 29 may not be provided to oppose one another over the spinning beam 21 but may be respectively provided on adjacent surfaces (e.g., on the front surface and upper surface of the spinning beam 21).

[0046] In the present embodiment, six supporters 31 are provided for each spinning pack 22. To be more specific, each of the spinning packs 22 provided along the left-right direction is provided with the following supporters 31: the two supporters 31 connecting the outer surface of the outer wall 21a of the spinning beam 21 to the first shielding plate 28; the two supporters 31 connecting the first shielding plate 28 to the second shielding plate 28; and the two supporters 31 connecting the second shielding plate 28 to the third shielding plate 28.

[0047] In the present embodiment, each supporter 31 is formed of a heat insulating material such as hard ceramic. Each supporter 31 may be columnar in shape, or shaped as a pipe.

(Example)

[0048] The performance of heat insulation by a spinning apparatus of Example was compared to that by a spinning apparatus of Comparative Example. To simplify an experiment, an experimental apparatus is structured so that the shielding plates 28 cover the entire lower surface of a spinning beam in each of Example and Comparative Example. The experimental apparatus is substantially cubic in shape. In the experimental apparatus, the heat source unit of the present invention is not the heating medium enclosed space 27 where the vapor heating medium is enclosed but a rubber heater in which an exotherm is sandwiched by silicon rubber components.

[0049] In the experimental apparatus of Example, the outside of the spinning beam 21 is covered by laminating three shielding plates 28 and three air layers 29. In the experimental apparatus of Comparative Example, the outside of the spinning beam 21 is covered by a heat insulating material made of rock wool.

[0050] In the experimental apparatus of each of Example and Comparative Example, (i) the set temperature of the rubber heater was set to 300 degrees centigrade and (ii) the change of surface temperature of the experimental apparatus over time was measured. The measurement results are shown in FIG. 4. In FIG. 4, the surface temperature of the experimental apparatus of Comparative Example is T1, and the surface temperature of the experimental apparatus of Example is T2.

[0051] As shown in FIG. 4, the surface temperature of the experimental apparatus of Example was lower than the surface temperature of the experimental apparatus of Comparative Example at the start of measurement. After 150 minutes elapsed, the surface temperature of the experimental apparatus of Example was lower than the surface temperature of the experimental apparatus of Comparative Example by 10 degrees centigrade. This shows that, when the shielding plates 28 and the air layers 29 are layered, heat emission from the rubber heater which is the heat source unit to the outside of the experimental apparatus is further reduced as compared to a case where the heat insulating material made of rock wool is provided outside of the spinning beam 21. According to the measurement results described above, by covering the outside of he spinning beam 21 with the shielding plates 28 and the air layers 29, the heat emission from the heat source unit to the outside of the spinning apparatus is further reduced as compared to a case where a known heat insulating material is used.

(Effects)

[0052] The spinning apparatus 2 of the present embodiment includes: the spinning beam 21; the heating medium enclosed space 27 which is provided in the spinning beam 21 and which allows the spinning packs 22 to be heated; the shielding plates 28 provided to cover the outer surface of the spinning beam 21; and the air layers 29 provided between the inner surface of the outermost shielding plate 28 and the outer surface of the spinning beam 21. With this arrangement, the shielding plates 28 and the air layers 29 are provided outside of the spinning beam 21. Even when the thickness of each air layer 29 is small, heat conduction from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 is sufficiently reduced. This is because the heat conductivity of each air layer 29 is small. The transfer of radiant heat from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 via each shielding plate 28 is suppressed. With these arrangements, heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 is reduced so as to decrease power consumption. In the present embodiment, heat emission to the outside of the spinning apparatus 2 is reduced. It is therefore possible to suppress the deterioration of a working environment of an operator in the vicinity of the spinning apparatus 2.

[0053] The spinning apparatus 2 of the present embodiment is formed of a heat insulating material, and further includes the sealing member 30 connecting the spinning beam 21 to the shielding plates 28. The air layers 29 are sealed by the shielding plates 28, the spinning beam 21, and the sealing member 30. In the present embodiment, the sealing member 30 formed of a heat insulating material is used to seal the air layers 29. It is therefore possible to reduce the heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 via the sealing member 30.

[0054] In the spinning apparatus 2 of the present embodiment, the air layers 29 and the shielding plates 28 are alternately provided at the outside of the spinning beam 21. That is, the air layers 29 and the shielding plates 28 are alternately provided at the outside of the spinning beam 21. In other words, the air layers 29 and the shielding plates 28 are layered. With this arrangement, the air layers 29 further reduce the heat conduction, and the shielding plates 28 further reduce the radiant heat. As a result, the heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 is further reduced.

[0055] The spinning apparatus 2 of the present embodiment further includes the supporters 31 each of which penetrates one of the air layers 29 and by which the outer surface of the spinning beam 21 is connected to the first shielding plate 28, the first shielding plate 28 is connected to the second shielding plate 28, and the second shielding plate 28 is connected to the third shielding plate 28. One pair of two supporters 31 penetrating one air layer 29 and another pair of two supporters 31 penetrating another air layer 29 adjacent to the one air layer 29 are connected to different positions of the same shielding plate 28 provided between the one air layer 29 and the another air layer 29.

[0056] When one shielding plate 28 is warped, the one shielding plate 28 may make contact with the outer surface of the spinning beam 21 or other shielding plates 28. In this case, the heat from the heating medium enclosed space 27 is emitted to the outside of the spinning apparatus 2 via the one shielding plate 28. Therefore, the air layers 29 cannot reliably reduce the heat conduction. In the present embodiment, the supporters 31 are provided to reduce the contact between one shielding plate 28 and the spinning beam 21 and the contact between the shielding plates 28. When one pair of two supporters 31 penetrating one air layer 29 and another pair of two supporters 31 penetrating another air layer 29 adjacent to the one air layer 29 are connected to the same positions of one shielding plate 28 provided between the one air layer 29 and the another air layer 29, heat transfer is likely to occur at each two pairs. In this case, a heat-conduction reduction effect by the air layers 29 decreases. In the present embodiment, one pair of two supporters 31 penetrating one air layer 29 and another pair of two supporters 31 penetrating another air layer 29 adjacent to the one air layer 29 are connected to different positions of the same shielding plate 28 provided between the one air layer 29 and the another air layer 29. Therefore, when one pair of two supporters 31 penetrating one air layer 29 and another pair of two supporters 31 penetrating another air layer 29 adjacent to the one air layer 29 are connected to different positions of the same shielding plate 28 provided between the one air layer 29 and the another air layer 29, a heat conduction path of heat transferred via the supporters 31 is formed to be longer than that in a case where one pair of the two supporters 31 penetrating the one air layer 29 and another pair of the two supporters 31 penetrating the another air layer 29 adjacent to the one air layer 29 are connected to the same positions of one shielding plate 28 provided between the one air layer 29 and the another air layer 29. With this arrangement, the heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 is reduced while the contact between the spinning beam 21 and one shielding plate 28 and the contact between the shielding plates 28 are reduced.

[0057] In the spinning apparatus 2 of the present embodiment, the thickness of each air layer 29 is equal to or more than 1 mm and is less than 10 mm. As the thickness of each air layer 29 increases, the heat-conduction reduction effect increases. However, when the thickness of each air layer 29 is large, heat convection is likely to occur so that the heat transfer easily occurs. When the thickness of each air layer 29 is too small, the spinning beam 21 may make contact with one shielding plate 28 and adjacent shielding plates 28 may make contact with one another. In this case, the heat from the heating medium enclosed space 27 is likely to be emitted to the outside of the spinning apparatus 2 via each shielding plate 28. In the present embodiment, the thickness of each air layer 29 is arranged so that (i) the spinning beam 21 is unlikely to make contact with the shielding plates 28, (ii) the shielding plates 28 are unlikely to make contact with one another, (iii) the performance of heat insulation is sufficient, (iv) and the heat convection in each air layer 29 is able to be suppressed. With this arrangement, the heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 2 is further reliably reduced.

[0058] In the spinning apparatus 2 of the present embodiment, each shielding plate 28 covers the entire outer surface of the spinning beam 21 except a part of the lower surface of the spinning beam 21. With this arrangement, the air layers 29 and the shielding plates 28 cover a large part of the outer surface of the spinning beam 21. It is therefore possible to relatively evenly reduce, on the entire outer surface of the spinning beam 21, the heat conduction from the heating medium enclosed space 27 to the outside of the spinning apparatus 2. This suppresses the dispersion of temperature outside of the spinning apparatus 2 due to the heat from the heating medium enclosed space 27. As a result, the dispersion of temperature is also suppressed in the vicinity of each spinneret 25, and a negative effect on the quality of yarns Y spun out from the spinnerets 25 due to the dispersion of temperature is suppressed.

[0059] In the spinning apparatus 2 of the present embodiment, each shielding plate 28 covers the lower surface of the spinning beam 21 except the parts below the spinning packs 22. With this arrangement, the air layers 29 and the shielding plates 28 cover a part of the lower surface of the spinning beam 21. It is therefore possible to especially suppress the transfer of heat from the heating medium enclosed space 27 to components provided below the spinning apparatus 2. As a result, the dispersion of temperature is further suppressed in the vicinity of each spinneret 25 provided below the spinning apparatus 2. This suppresses the negative effect on the quality of yarns Y spun out from the spinnerets 25 due to the dispersion of temperature.

[0060] In the spinning apparatus 2 of the present embodiment, each shielding plate 28 is provided to cover the entire side surfaces of the outer wall 21a and the entire lower surface of the spinning beam 21 with no gap except the spinning packs 22 and the spaces immediately below the spinning packs 22 and their surroundings. This further effectively suppresses the dispersion of temperature outside of the spinning apparatus 2 due to the heat from the heating medium enclosed space 27.

(Modifications)

[0061] The following will describe modifications of the above-described embodiment. The members identical with those in the embodiment above will be denoted by the same reference numerals and the explanations thereof are not repeated.

[0062] In the present invention, a heat insulation member 41 formed of a heat insulating material may be additionally provided outside of the shielding plates 28. For example, as shown in FIG. 5, a spinning apparatus 102 of a modification includes the heat insulation member 41 provided outside of the outermost shielding plate 28 (the third shielding plate 28). When viewed in the left-right direction, the shape of the heat insulation member 41 is substantially rectangular along the spinning beam 21 which is substantially rectangular. The heat insulation member 41 extends to below the lower surface of the spinning beam 21 so that an end portion of the heat insulation member 41 is not provided below the spinning packs 22 but below the spinning beam 21. Examples of a material of the heat insulation member 41 include rock wool. In this modification, after the air layers 29 and the shielding plates 28 reduce a significant amount of heat transferring from the heating medium enclosed space 27 to the outside of the spinning apparatus 102, the heat insulation member 41 reliably insulates the heat. It is therefore possible to further efficiently reduce the heat emission from the heating medium enclosed space 27 to the outside of the spinning apparatus 102. Even when the thickness of the heat insulation member 41 is not sufficient, the performance of heat insulation by the heat insulation member 41 is sufficient.

[0063] In the embodiment above, the spinning apparatus 2 includes the shielding plates 28 made of aluminum. However, the spinning apparatus 2 may include aluminum sheets as the shielding members. In this case, for example, the spinning apparatus 2 includes (i) a framework provided to surround the spinning beam 21 and (ii) aluminum sheets attached to the framework to cover the outer surface of the spinning beam 21. The framework is connected to the sealing member 30 and the outer wall 21a of the spinning beam 21. The aluminum sheets attached to the framework are provided to cover the entire outer surface of the outer wall 21a of the spinning beam 21 with no gap, except the parts below the spinning packs 22. For example, the aluminum sheets are attached to the framework so as to form three layers at the outside of the spinning beam 21. Furthermore, air layers are formed between the outer wall 21a of the spinning beam 21 and one aluminum sheet and between each adjacent two of the aluminum sheets. That is, three aluminum sheets which are equivalent to the shielding members and three air layers are alternately provided at the outside of the spinning beam 21.

[0064] In the embodiment above, an uneven portion may be formed on the outer surface of the outer wall 21a of the spinning beam 21 because of a protruding member and a gap. In this case, a suitable covering member preferably causes the uneven portion formed on the outer surface of the outer wall 21a of the spinning beam 21 to be flat. For example, as shown in FIG. 6, the spinning apparatus 2 includes a covering member 50 which covers a recess 51 and a protrusion 52 (corresponding to an uneven portion of the present invention) formed on the outer surface of the outer wall 21a of the spinning beam 21 and causes the outer surface of the outer wall 21a of the spinning beam 21 to be flat. The covering member 50 may be preferably formed of a heat insulating material. However, the covering member 50 may not be formed of the heat insulating material. For example, the covering member 50 may be formed of a member equal to that forming the outer wall 21a of the spinning beam 21. When (i) the recess 51 and the protrusion 52 are formed on the outer surface of the outer wall 21a of the spinning beam 21 and (ii) the shielding plates 28 are provided to cover the outer surface of the outer wall 21a of the spinning beam 21, the thickness of one air layer 29 provided between the outer surface of the outer wall 21a of the spinning beam 21 and the first shielding plate 28 is uneven. In this case, the performance of heat insulation by the first air layer 29 is also uneven. It is therefore impossible to ensure the sufficient performance of heat insulation at a part of the first air layer 29, whose thickness is smaller than that of other part of the first air layer 29. When the covering member 50 which covers the recess 51 and the protrusion 52 formed on the outer surface of the outer wall 21a of the spinning beam 21 and causes the outer surface of the outer wall 21a of the spinning beam 21 to be flat is provided, the thickness of the first air layer 29 provided between the outer surface of the outer wall 21a of the spinning beam 21 and the first shielding plate 28 is even. It is therefore possible to ensure the sufficient performance of heat insulation by the first air layer 29.

[0065] In the embodiment above, the spinning apparatus 2 further includes the sealing member 30 connecting the outer wall 21a of the spinning beam 21 to the end portions of three shielding plates 28. The air layers 29 are sealed by the shielding plates 28, the outer wall 21a of the spinning beam 21, and the sealing member 30. However, the spinning apparatus 2 may not include the sealing member 30. In this case, for example, the air layers 29 may be sealed in such a way that (i) the end portions of the shielding plates 28 are folded and (ii) the end portions of the shielding plates 28 are connected to the spinning beam 21. The sealing member 30 may connect the outer wall 21a of the spinning beam 21 to parts of the shielding plates 28, which are not the end portions of the shielding plates 28.

[0066] In the embodiment above, the sealing member 30 is a member connecting the outer wall 21a of the spinning beam 21 to the end portions of three shielding plates 28. However, the sealing member 30 may include: a first sealing member connecting the first shielding plate 28 to the outer wall 21a of the spinning beam 21; a second sealing member connecting the second shielding plate

28 to the first shielding plate 28; and a third sealing member connecting the third shielding plate 28 to the second shielding plate 28. In this case, the first air layer 29 is sealed by the first shielding plate 28, the outer wall 21a of the spinning beam 21, and the first sealing member. The second air layer 29 is sealed by the second shielding plate 28, the first shielding plate 28, and the second sealing member. The third air layer 29 is sealed by the third shielding plate 28, the second shielding plate 28, and the third sealing member. The sealing member 30 may not connect the first shielding plate 28 to the outer wall 21a of the spinning beam 21. In this case, the first air layer 29 is not sealed.

[0067] In the embodiment above, the shielding plates 28 and the air layers 29 are layered so that the entire outer surface of the outer wall 21a of the spinning beam 21 is covered with no gap except the parts below the spinning packs 22. In other words, each shielding plate 28 is provided to cover the entire side surfaces of the outer wall 21a and the entire lower surface of the spinning beam 21 with no gap except the spinning packs 22 and the spaces immediately below the spinning packs 22 and their surroundings. However, the shielding plates 28 and the air layers 29 may be layered so that the outer surface of the outer wall 21a of the spinning beam 21 is covered only at a part excluding the parts below the spinning packs 22. In other words, each shielding plate 28 is provided to cover the entire side surfaces of the outer wall 21a and the entire lower surface of the spinning beam 21 with no gap except the spinning packs 22 and the spaces immediately below the spinning packs 22 and their surroundings. For example, each shielding plate 28 may cover a part of the entire side surfaces of the outer wall 21a. Each shielding plate 28 may be provided so that the entire lower surface of the spinning beam 21 is covered at a part excluding the spinning packs 22 and the spaces immediately below the spinning packs 22 and their surroundings.

[0068] In the embodiment above, the single sealing member 30 connects the outer wall 21a of the spinning beam 21 to the end portions of the shielding plates 28. However, the single sealing member 30 may connect the outer wall 21a of the spinning beam 21 only to the end portion of the first shielding plate 28. In this case, the following sealing members 30 may be additionally provided: a sealing member 30 connecting the outer surface of the first shielding plate 28 to the end portion of the second shielding plate 28; and a sealing member 30 connecting the outer surface of the second shielding plate 28 to the end portion of the third shielding plate 28.

[0069] The heat source unit of the present invention may not be the heating medium enclosed space 27 where the vapor heating medium is enclosed. For example, the heat source unit may be a heater. In the present invention, the supporters 31 may be members made of metal such as iron.

[0070] In the embodiment above, six supporters 31 are provided for each spinning pack 22. However, seven or more supporters 31 or five or less supporters 31 may be provided for each spinning pack 22. The number of the supporters 31 aligned along the left-right direction may be smaller or larger than the number of the spinning packs 22.

[0071] In the embodiment above, gas layers are the air layers 29. However, the gas layers may not be the air layers 29. For example, the gas layers may be nitrogen layers. In the embodiment above, three air layers 29 and three shielding plates 28 are layered at the outside of the spinning beam 21. However, two air layers 29 and two shielding plates 28 may be layered at the outside of the spinning beam 21, or four or more air layers 29 and four or more shielding plates 28 may be layered at the outside of the spinning beam 21. Alternatively, one air layer 29 and one shielding plate 28 may be layered at the outside of the spinning beam 21.

[0072] In the embodiment above, the thickness of each air layer 29 is equal to or more than 1 mm and is less than 10 mm. However, the thickness of each air layer 29 may be more than 0 mm and less than 1 mm or may be more than 10 mm.

Claims

1. A spinning apparatus (2) comprising: a spinning pack (22) in which a spinneret (25) is provided at a lower end portion of the spinning pack (22) and which is configured to spin out molten polymer stored in the spinning pack (22) downward from the spinneret (25);

   a spinning beam (21) into which the spinning pack (22) is inserted;
   a heat source unit (27) which is provided in the spinning beam (21) and which is configured to heat the spinning pack (22);
   at least one shielding member (28) which is provided to cover an outer surface of the spinning beam (21) and which blocks radiation from the heat source unit (27); and
   at least one gas layer (29) provided between an inner surface of the at least one shielding member (28) and the outer surface of the spinning beam (21).

2. The spinning apparatus (2) according to claim 1, wherein, the at least one gas layer (29) is sealed.

3. The spinning apparatus (2) according to claim 2, further comprising a sealing member (30) which is formed of a heat insulating material and which connects the at least one shielding member (28) to the spinning beam (21), wherein,
   the at least one gas layer (29) is sealed by the at least one shielding member (28), the spinning beam (21), and the sealing member (30).

4. The spinning apparatus (2) according to any one of claims 1 to 3, wherein, gas layers (29) and shielding members (28) are alternately provided outside of the spinning beam (21) .

5. The spinning apparatus (2) according to claim 4, further comprising supporters (31) each of which penetrates one of the gas layers (29) and by which the outer surface of the spinning beam (21) is connected to one of the shielding members (28) and each adjacent two of the shielding members (28) are connected to one another, wherein,
one of the supporters (31) which penetrates one of the gas layers (29) and another of the supporters (31) which penetrates another of the gas layers (29) are connected to different positions of one of the shielding members (28) which is provided between the one of the gas layers (29) and the another of the gas layers (29), the another of the gas layers (29) being adjacent to the one of the gas layers (29) .

6. The spinning apparatus (2) according to any one of claims 1 to 5, wherein, the gas layers (29) are air layers (29), and
the thickness of each of the air layers (29) is equal to or more than 1 mm and is less than 10 mm.

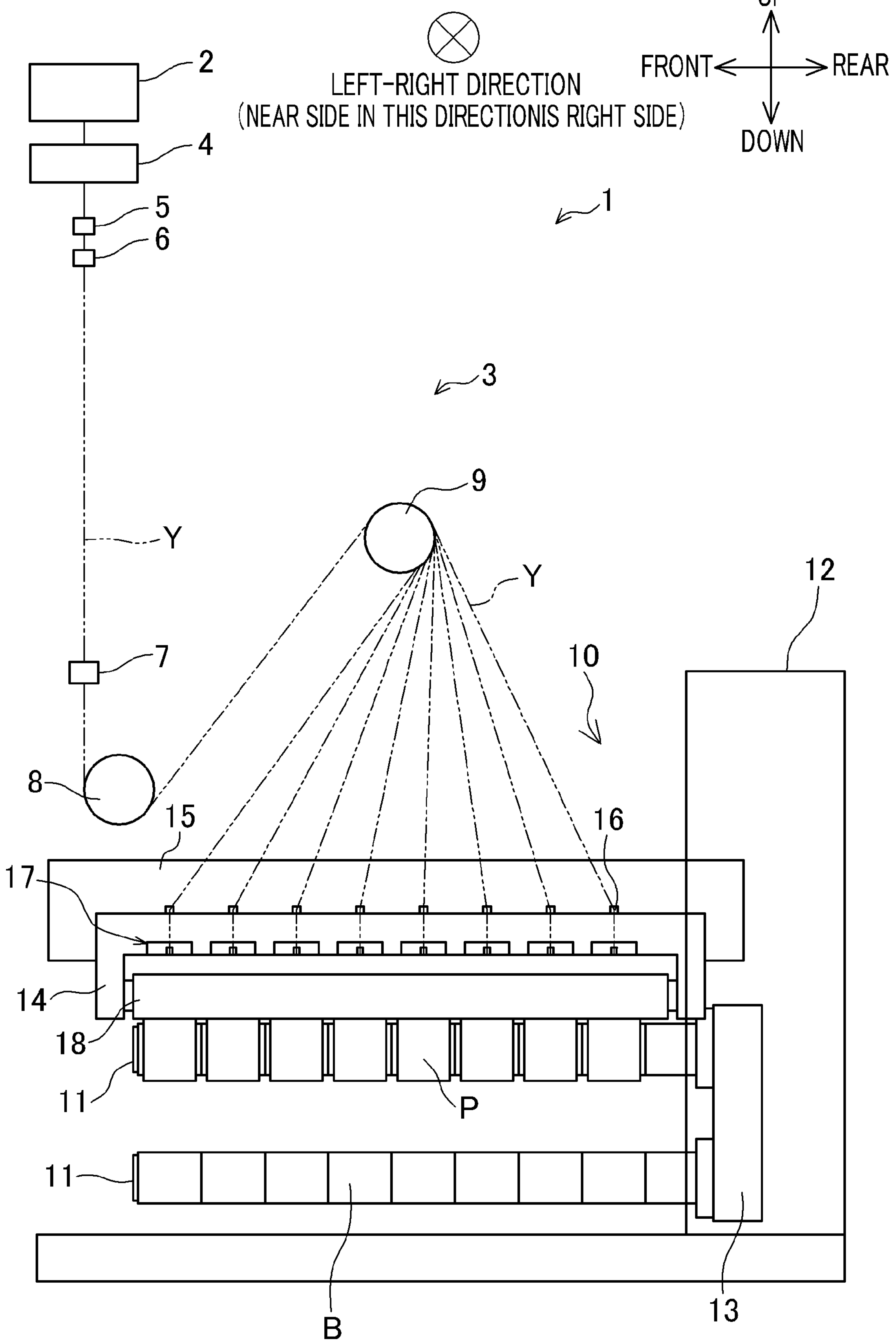
7. The spinning apparatus (2) according to any one of claims 1 to 6, wherein, a heat insulation member (41) is provided outside of the shielding members (28).

8. The spinning apparatus (2) according to any one of claims 1 to 7, further comprising a covering member (50) which causes the outer surface of the spinning beam (21) to be flat by covering an uneven portion formed on the outer surface of the spinning beam (21).

9. The spinning apparatus (2) according to any one of claims 1 to 8, wherein, the shielding members (28) cover at least the entire outer surface of the spinning beam (21) except a lower surface of the spinning beam (21).

10. The spinning apparatus (2) according to any one of claims 1 to 9, wherein, the shielding members (28) cover the lower surface of the spinning beam (21) except a part below the spinning pack (22).

FIG.1


LEFT-RIGHT DIRECTION
(NEAR SIDE IN THIS DIRECTIONIS RIGHT SIDE)
UP
FRONT
REAR
DOWN
1
2
3
4
5
6
7
8
9
10
11
11
12
13
14
15
16
17
18
Y
Y
P
B

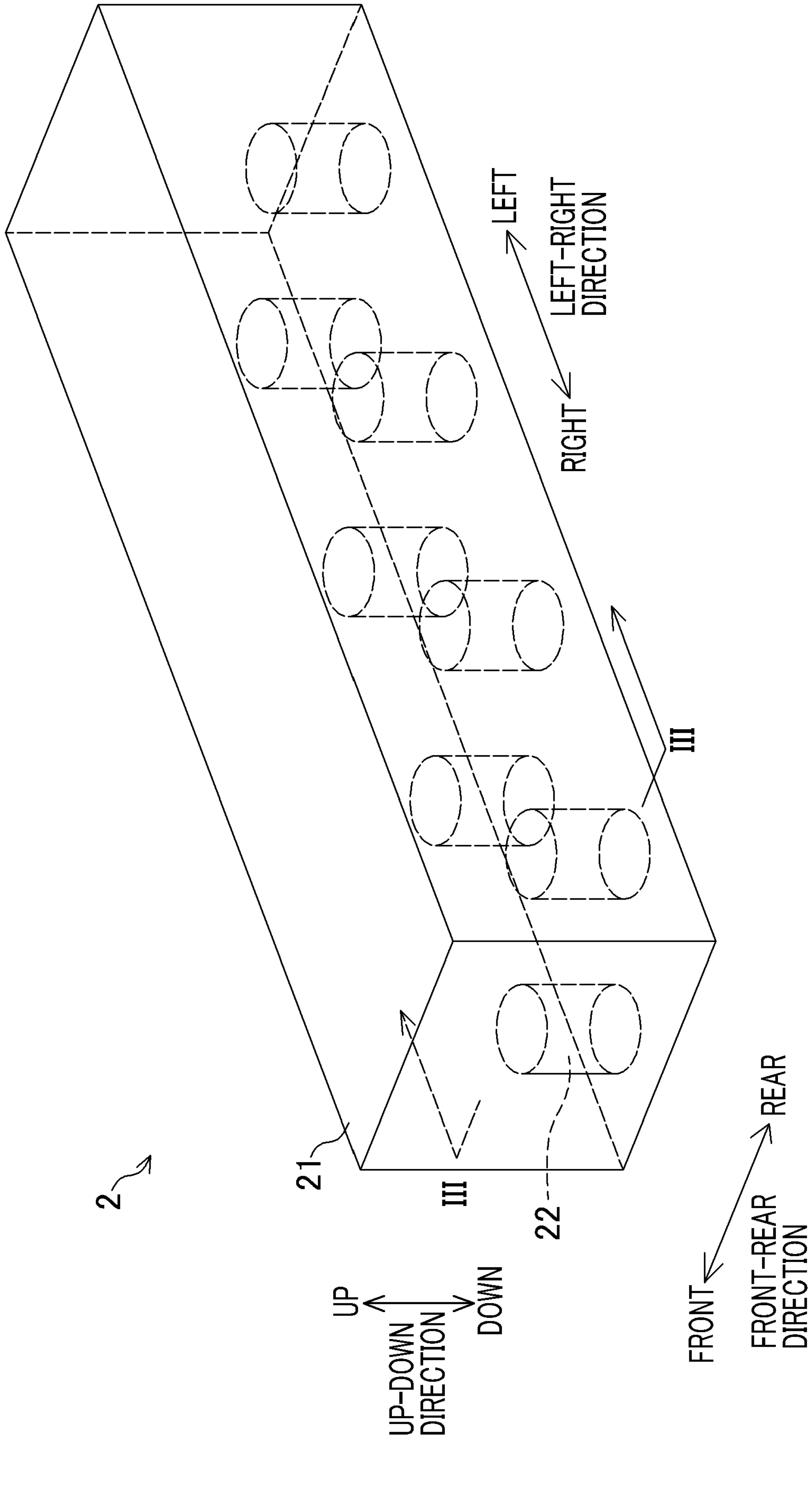

2
21
22
III
III
LEFT
LEFT-RIGHT DIRECTION
RIGHT
UP
UP-DOWN DIRECTION
DOWN
FRONT
REAR
FRONT-REAR DIRECTION

FIG.2

FIG.3

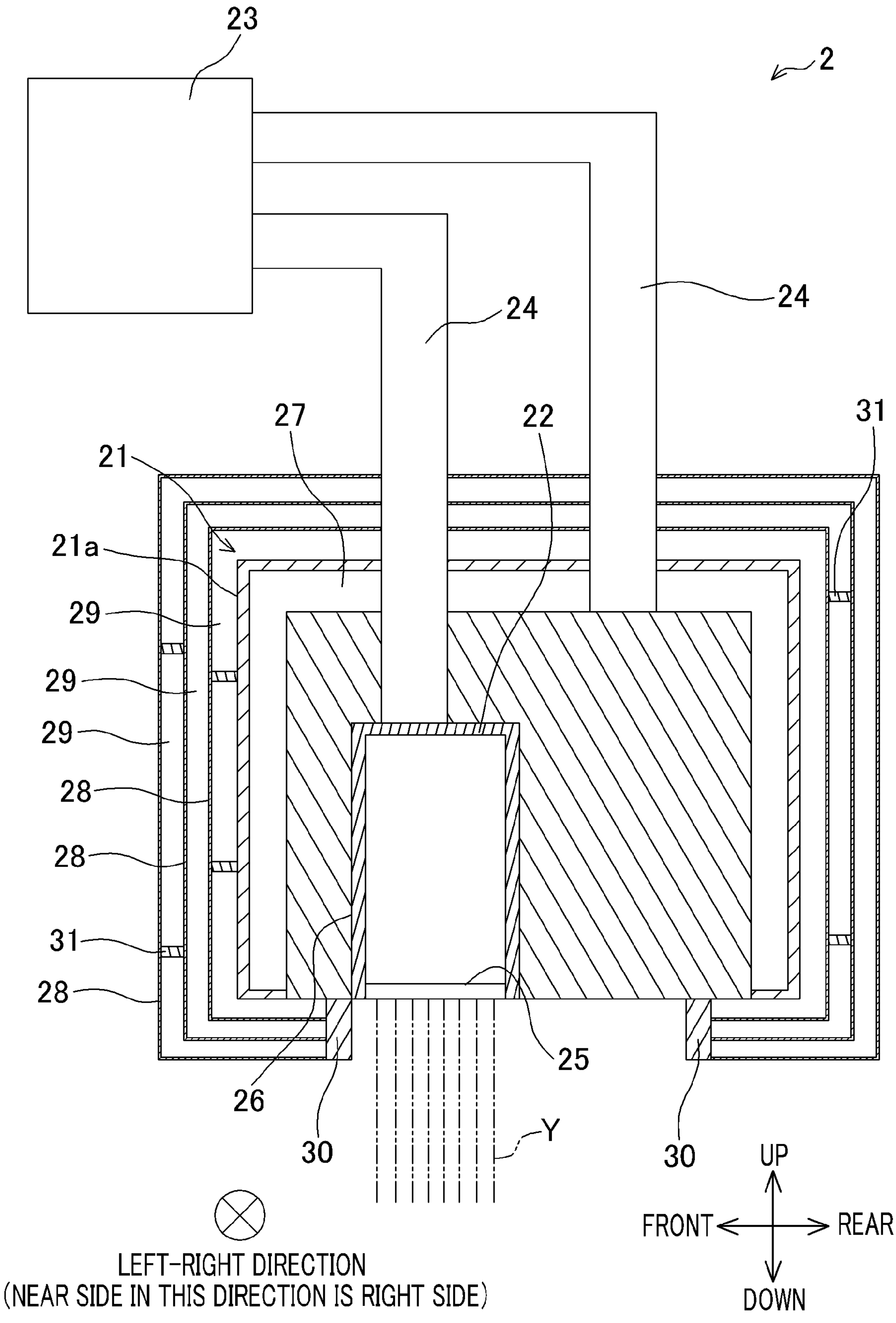
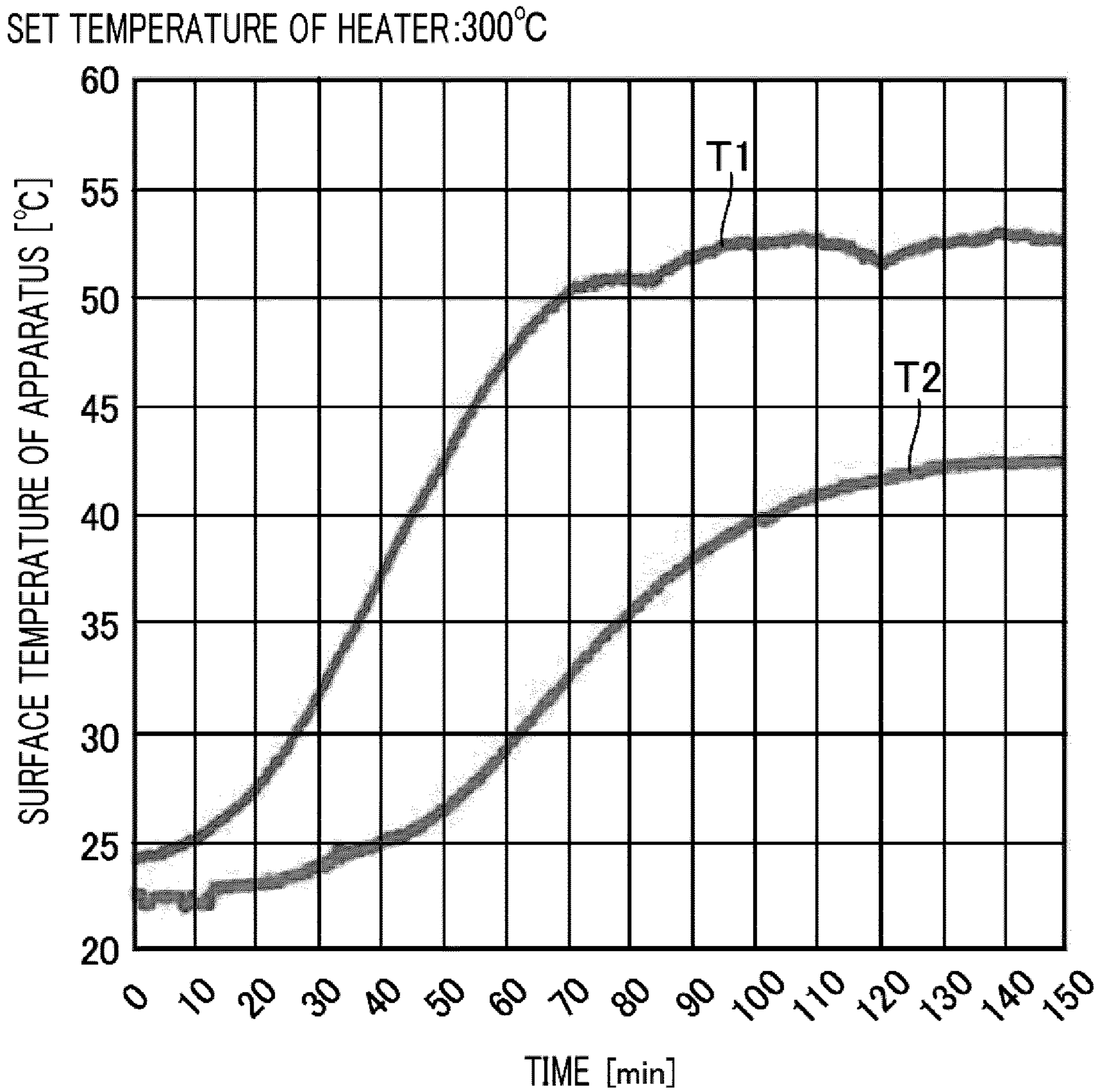
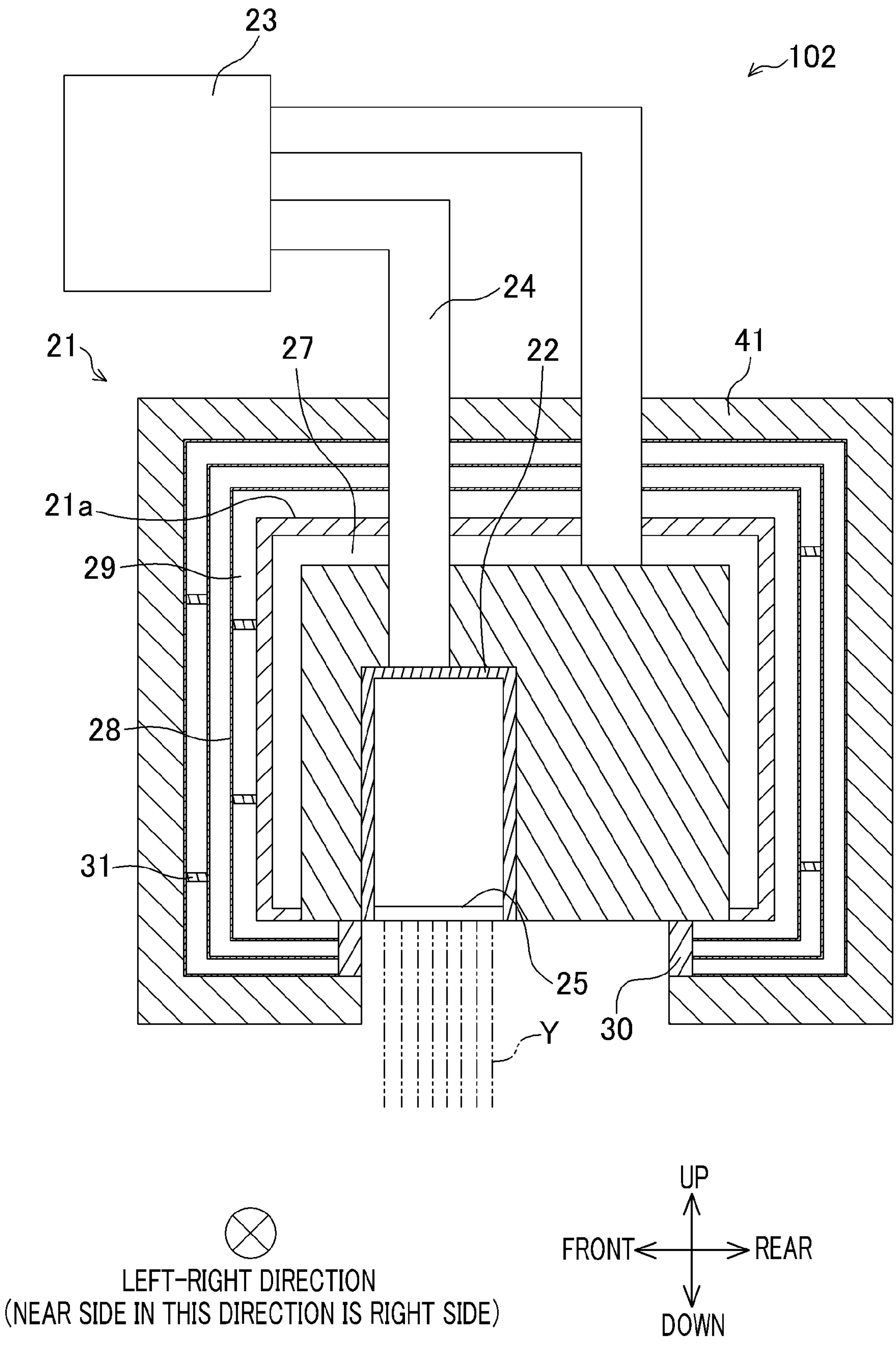

23
2
24
24
27
22
31
21
21a
29
29
29
28
28
31
28
26
30
25
Y
30
LEFT-RIGHT DIRECTION
(NEAR SIDE IN THIS DIRECTION IS RIGHT SIDE)
UP
FRONT
REAR
DOWN

FIG.4



SET TEMPERATURE OF HEATER:300°C
SURFACE TEMPERATURE OF APPARATUS [°C]
60
55
50
45
40
35
30
25
20
T1
T2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
TIME [min]

FIG.5



23
102
24
21
27
22
41
21a
29
28
31
25
30
Y
LEFT-RIGHT DIRECTION
(NEAR SIDE IN THIS DIRECTION IS RIGHT SIDE)
UP
FRONT
REAR
DOWN

FIG.6

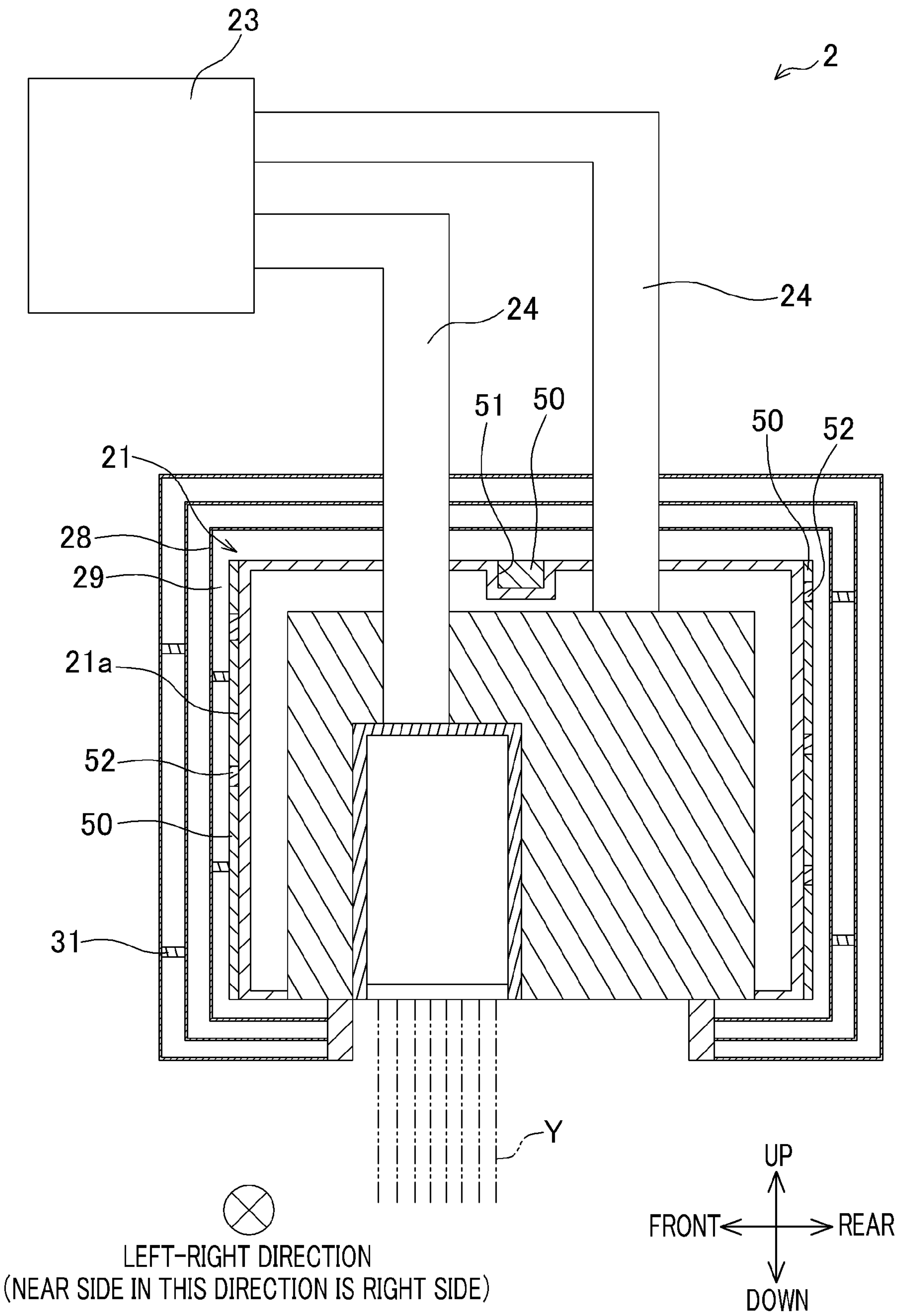
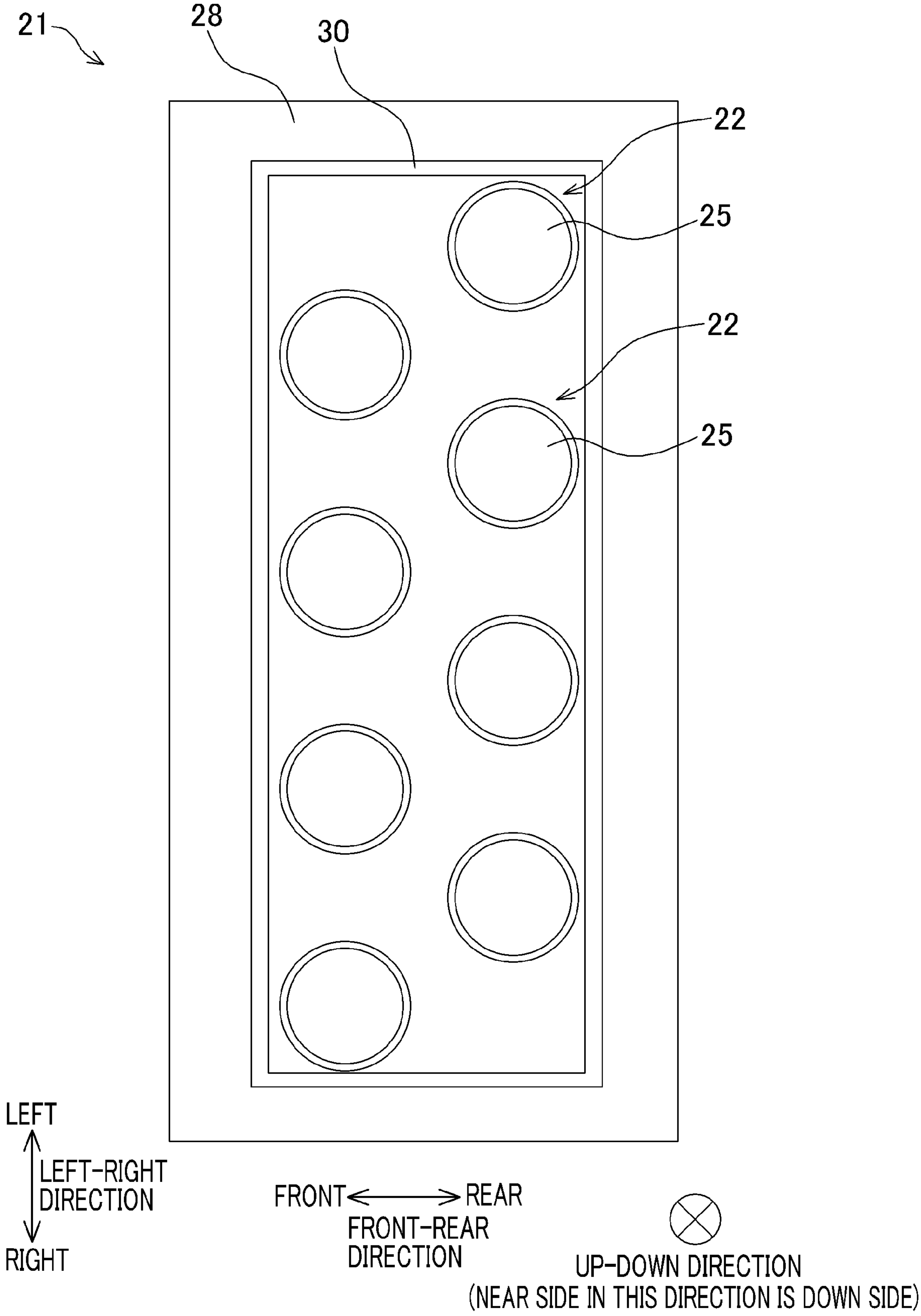

23
2
24
24
51
50
50
52
21
28
29
21a
52
50
31
Y
LEFT-RIGHT DIRECTION
(NEAR SIDE IN THIS DIRECTION IS RIGHT SIDE)
UP
FRONT
REAR
DOWN

FIG.7


21
28
30
22
25
22
25
LEFT
LEFT-RIGHT DIRECTION
RIGHT
FRONT
REAR
FRONT-REAR DIRECTION
UP-DOWN DIRECTION
(NEAR SIDE IN THIS DIRECTION IS DOWN SIDE)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H711507 A **[0002]**