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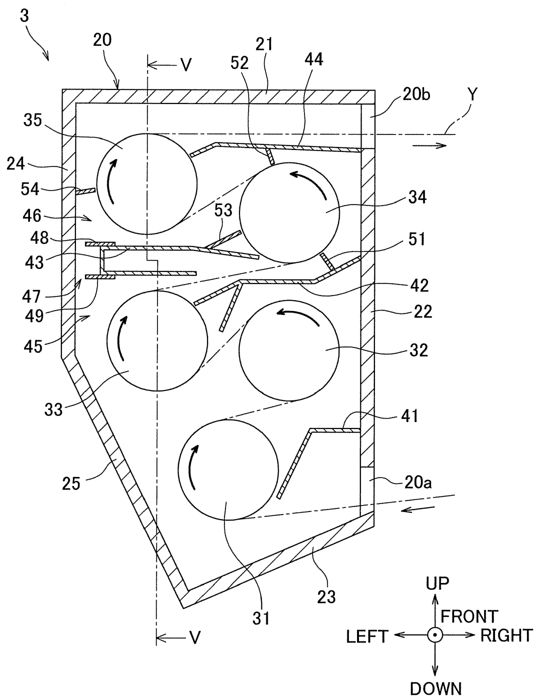
(54) **SPUN YARN DRAWING APPARATUS**

(57) Power consumption is restrained while the temperature of a preheating roller is suitably controlled. A spun yarn drawing apparatus 3 includes: a preheating roller 33 which heats yarns Y before drawn; a conditioning roller 35 which is provided downstream in a yarn running direction of the preheating roller 33 and is higher in temperature and speed than the preheating roller 33; and a thermal insulation box 20 which houses the preheating roller 33 and the conditioning roller 35, the yarns Y being drawn between the preheating roller 33 and the conditioning roller 35, the spun yarn drawing apparatus further including: partition portions 43a and 43b provided between the preheating roller 33 and the conditioning roller 35; a communication passage 47 which causes a low-temperature space 45 which is on the preheating roller 33 side of the partition portions 43a and 43b to communicate with a high-temperature space 46 which is on the conditioning roller 35 side of the partition portions 43a and 43b; and shutters 48 and 49 which are provided to change the flow passage area of the communication passage 47.

FIG.2



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a spun yarn drawing apparatus configured to draw yarns.

[0002] For example, Patent Literature 1 (Japanese Unexamined Patent Publication No. 2014-101610) discloses a spun yarn drawing apparatus in which preheating rollers (heating roller in Patent Literature 1) and conditioning rollers are housed in a thermal insulation box (heat retaining box in Patent Literature 1). The conditioning rollers are provided downstream in the yarn running direction of the preheating rollers, and are higher in temperature and speed than the preheating rollers. After yarns are heated to a drawing temperature by the preheating rollers, the yarns are drawn between a preheating roller which is the most downstream one in the yarn running direction and a conditioning roller which is the most upstream one in the yarn running direction, and the drawn yarns are conditioned by the conditioning rollers.

[0003] In such a spun yarn drawing apparatus, heat transfer occurs in the thermal insulation box from around the hot conditioning rollers to around the cold preheating rollers. When an amount of heat transfer is too large, the temperatures of the preheating rollers may exceed the set temperature and temperature control may become impossible. Under this circumstance, in Patent Literature 1, the preheating rollers are covered with a shielding cover. With this, an influence of heat from the conditioning rollers on the preheating rollers is restrained, and the preheating rollers are accurately maintained at the set temperature.

SUMMARY OF THE INVENTION

[0004] However, when the preheating rollers are covered with the shielding cover as in Patent Literature 1, it is disadvantageous that heat from the hot conditioning rollers cannot be utilized for heating the preheating rollers. The power consumption of the spun yarn drawing apparatus is therefore high.

[0005] In consideration of the problem above, a spun yarn drawing apparatus of the present invention aims at restraining power consumption while suitably controlling the temperature of a preheating roller.

[0006] The present invention relates to a spun yarn drawing apparatus including: at least one preheating roller which heats yarns before drawn; at least one conditioning roller which is provided downstream in a yarn running direction of the at least one preheating roller and is higher in temperature and speed than the at least one preheating roller; and a thermal insulation box which houses the at least one preheating roller and the at least one conditioning roller, the yarns being drawn between the at least one preheating roller and the at least one conditioning roller, the spun yarn drawing apparatus further including: at least one partition portion provided between the at least one preheating roller and the at least one conditioning roller; a communication passage which causes a low-temperature space which is on the preheating roller side of the at least one partition portion to communicate with a high-temperature space which is on the conditioning roller side of the at least one partition portion; and at least one shutter which is provided to change the flow passage area of the communication passage.

[0007] According to the present invention, the flow amount of air flowing in the communication passage is controlled and therefore an amount of heat transferred from the high-temperature space to the low-temperature space is controlled, by adjusting the opening degree of the at least one shutters provided in the communication passage. In order to restrain the power consumption while maintaining the temperature of the at least one preheating roller at the set temperature, it is preferable that heat is transferred from the high-temperature space to the low-temperature space as much as possible on condition that the temperature of the at least one preheating roller does not exceed the set temperature. However, the optimal amount of heat transfer is changed based on conditions such as the outside temperature and the set temperature of each roller determined in accordance with the type of the yarns. In the present invention, by the adjustment of the opening degree of the at least one shutter in accordance with the conditions, the power consumption is restrained while the temperature of the at least one preheating roller is suitably controlled, irrespective of the conditions.

[0008] The present invention is preferably arranged such that the communication passage is a passage formed at a location different from a yarn path between the at least one preheating roller and the at least one conditioning roller.

[0009] Because the communication passage is provided to be independent from the yarn path, backward flow of heat from the low-temperature space to the high-temperature space due to an accompanied flow generated by the running yarns is prevented, with the result that heat is efficiently transferred from the high-temperature space to the low-temperature space. Furthermore, the movement of the at least one shutter is not obstructed by the yarns.

[0010] The present invention is preferably arranged such that the communication passage is formed between an inner surface of the thermal insulation box and the at least one partition portion.

[0011] This facilitates air to flow along the inner surface of the thermal insulation box, with the result that heat is efficiently transferred from the high-temperature space to the low-temperature space.

[0012] The present invention is preferably arranged such that the at least one preheating roller and the at least one conditioning roller are disposed to protrude from a back surface portion toward a front surface portion of the thermal insulation box, and the communication passage is formed between an inner surface of a side face portion of the thermal insulation box and the at least one partition portion.

[0013] Provided that the communication passage is formed between the inner surface of the front surface portion (or the back surface portion) of the thermal insulation box and the at least one partition portion, when plural yarns are placed on the at least one preheating roller and the at least one conditioning roller so as to be lined up along the axial direction, the yarns which are close to the front surface portion (or the back surface portion) tend to be shaken due to an influence of air flowing in the communication passage, whereas the yarns close to the back surface portion (or the front surface portion) are unlikely to be shaken. In this way, there is a difference in yarn shaking. Such a difference is unfavorable because it causes the quality of yarns to be uneven. In this regard, when the communication passage is formed between the inner surface of the side face portion of the thermal insulation box and the at least one partition portion as described above, an influence of air flowing in the communication passage is substantially balanced between the yarns. It is therefore possible to restrain the quality of the yarns from becoming uneven.

[0014] The present invention is preferably arranged such that the at least one shutter is movable toward and away from the side face portion of the thermal insulation box.

[0015] This makes it possible to easily adjust the flow passage area of the communication passage by the at least one shutter.

[0016] The present invention is preferably arranged such that the front surface portion of the thermal insulation box is an openable door, and a sealing member is provided between the door and the at least one partition portion.

[0017] When there is a gap between the door and the at least one partition portion, heat may be transferred from the high-temperature space to the low-temperature space through the gap, with the result that the control of the amount of heat transfer through the communication passage may not be properly done. Because the sealing member is provided between the door and the at least one partition portion as described above, the gap between the door and the at least one partition portion is eliminated, and hence the control of the amount of heat transfer through the communication passage can be accurately done.

[0018] The present invention is preferably arranged such that the sealing member is attached to the at least one partition portion.

[0019] Provided that the sealing member is attached to the door, the sealing member must be accurately positioned in accordance with the position of the at least one partition portion. Meanwhile, when the sealing member is attached to the at least one partition portion, accurate positioning of the sealing member is unnecessary, and hence the attachment can be easy done.

[0020] The present invention is preferably arranged such that a shielding member is provided to extend toward the outer circumferential surface of the at least one conditioning roller from a location in the side face portion of the thermal insulation box, the location being on the conditioning roller side of the communication passage, the at least one conditioning roller rotating so that a part of the outer circumferential surface of the at least one conditioning roller, which opposes a leading end portion of the shielding member, moves away from the communication passage.

[0021] With this arrangement, an accompanied flow generated by the running yarns is blocked by the shielding member, and hence escape of heat in the accompanied flow away from the communication passage is restrained. As a result, heat is efficiently transferred from the high-temperature space to the low-temperature space.

[0022] The present invention is preferably arranged such that a plurality of the at least one shutter are provided to be lined up in a direction in which air flows in the communication passage.

[0023] With this arrangement, the flow amount and the way of flowing of air in the communication passage are finely controllable by adjusting the opening degrees of the shutters.

[0024] The present invention is preferably arranged such that a plurality of the at least one partition portion are provided between the low-temperature space and the high-temperature space to be lined up in a direction in which air flows in the communication passage.

[0025] Because the partition portions are provided in this manner, heat insulation between the high-temperature space and the low-temperature space is improved, and hence control of the amount of heat transfer through the communication passage is accurately done.

[0026] The present invention is preferably arranged such that a plurality of the at least one preheating roller are provided to be lined up in the yarn running direction, the at least one partition portion is provided between a last preheating roller which is most downstream one of the preheating rollers in the yarn running direction and the at least one conditioning roller, and the at least one shutter is provided in the communication passage which causes the low-temperature space which is on the last preheating roller side of the at least one partition portion to communicate with the high-temperature space which is on the conditioning roller side of the at least one partition portion.

[0027] When plural preheating rollers are provided, because the yarns Y are serially heated by the preheating rollers, an amount of heat consumed by the heating of the yarns is small at the last preheating roller. The last preheating roller is provided in the vicinity of the at least one conditioning roller. On this account, as compared to the other preheating rollers, the temperature of the last preheating roller tends to be increased by an influence of heat from the at least one conditioning roller. Furthermore, because the yarns are drawn between the last preheating roller and the at least one conditioning roller, the temperature of the last preheating roller must be controlled particularly accurately. For this reason, the present invention which makes it possible to suitably control the temperature is particularly effective for the last preheating roller.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028]

FIG. 1 is a schematic diagram of a spun yarn take-up machine including a spun yarn drawing apparatus of an embodiment.
FIG. 2 shows the spun yarn drawing apparatus in a detailed manner.
FIG. 3 is an enlarged view of a communication passage and its surroundings.
Each of FIG. 4(a) and FIG. 4(b) is a top view of an upper shutter.
FIG. 5 is a cross section taken along the V-V line in FIG. 2.
FIG. 6 is a table showing a result of a verification experiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Spun Yarn Take-Up Machine]

[0029] The following will describe an embodiment of an spun yarn drawing apparatus related to the present invention. FIG. 1 is a schematic diagram of a spun yarn take-up machine including the spun yarn drawing apparatus of the present embodiment. As shown in FIG. 1, the spun yarn take-up machine 1 is configured to draw, by a spun yarn drawing apparatus 3, yarns Y serially spun out from a spinning apparatus 2 and made of a solidified molten fibrous material such as polyester, and then to wind the yarns Y by a yarn winding apparatus 4. It is defined that the directions shown in FIG. 1 indicate the directions of the spun yarn take-up machine 1.

[0030] The spinning apparatus 2 is configured to generate the yarns Y by continuously spinning out a molten fibrous material such as polyester. To the yarns Y spun out from the spinning apparatus 2, oil is applied at an oil guide 10. The yarns Y are then sent to the spun yarn drawing apparatus 3 via a guide roller 11. The spun yarn drawing apparatus 3 is an apparatus for drawing the yarns Y and is provided below the spinning apparatus 2. The spun yarn drawing apparatus 3 includes plural godet rollers 31 to 35 housed in a thermal insulation box 20. The details of the spun yarn drawing apparatus 3 will be given later.

[0031] The yarns Y drawn by the spun yarn drawing apparatus 3 are sent to the yarn winding apparatus 4 via a guide roller 12. The yarn winding apparatus 4 is an apparatus for winding the yarns Y and is provided below the spun yarn drawing apparatus 3. The yarn winding apparatus 4 includes members such as a bobbin holder 13 and a contact roller 14. The bobbin holder 13 is cylindrical in shape and extends away from the viewer of FIG. 1. The bobbin holder 13 is rotationally driven by an unillustrated motor. To the bobbin holder 13, bobbins B are attached along the axial direction to be side by side. By rotating the bobbin holder 13, the yarn winding apparatus 4 simultaneously winds the yarns Y onto the bobbins B, so as to produce packages P. The contact roller 14 makes contact with the surfaces of the packages P to adjust the shape of each package P by applying a predetermined contact pressure to each package P.

[Draw Spinning Apparatus]

[0032] FIG. 2 shows the spun yarn drawing apparatus 3 in a detailed manner. The spun yarn drawing apparatus 3 includes the thermal insulation box 20 and plural (five in the present embodiment) godet rollers 31 to 35 housed in the thermal insulation box 20. The thermal insulation box 20 is a box formed by a top surface portion 21, a right side portion 22, a lower right inclined portion 23, a left side portion 24, a lower left inclined portion 25, a back surface portion 26 (see FIG. 5), and a front surface portion 27 (see FIG. 5). The front surface portion 27 is, for example, attached to the left side portion 24 by an unillustrated hinge, and is an openable door as the front surface portion 27 swings in the front-rear direction about the hinge. At a lower part of the right side portion 22, an inlet 20a is formed to introduce yarns Y into the thermal insulation box 20. At a upper part of the right side portion 22, an outlet 20b is formed to take the yarns Y out from the thermal insulation box 20.

[0033] The godet rollers 31 to 35 are heating rollers which are rotationally driven by an unillustrated motor and each includes an unillustrated heater. The godet rollers 31 to 35 are disposed to protrude from the back surface portion 26 toward the front surface portion 27 of the thermal insulation box 20 as shown in FIG. 5. The godet rollers 31 to 35 rotate in the directions indicated by arrows in FIG. 2. The yarns Y introduced into the thermal insulation box 20 through the inlet 20a are serially wound onto the outer circumferential surfaces of the godet rollers 31 to 35, and are ultimately taken out from the thermal insulation box 20 through the outlet 20b.

[0034] The lower three godet rollers 31 to 33 are preheating rollers for preliminarily heating the yarns Y before drawing them. The roller surface temperature of each of these rollers is arranged to be equal to or higher than the glass transition temperature of the yarns Y (e.g., set at about 80 degrees centigrade). Meanwhile, the upper two godet rollers 34 and 35 are conditioning rollers for thermally setting the drawn yarns Y. The surface temperature of each of these rollers is arranged to be higher than the surface temperatures of the lower three godet rollers 31 to 33 (e.g., set at about 130 to 140 degrees centigrade). The rotational speeds, i.e., yarn feeding speeds of the upper two godet rollers 34 and 35 are higher than those of the lower three godet rollers 31 to 33. Hereinafter, the godet rollers 31 to 33 will be referred to as preheating rollers, whereas the godet rollers 34 and 35 will be referred to as conditioning rollers.

[0035] The yarns Y introduced into the thermal insulation box 20 through the inlet 20a are, to begin with, preliminarily heated to a drawable temperature while being transferred by the preheating rollers 31 to 33. The preliminarily-heated yarns Y are drawn on account of a difference in yarn feeding speed between the preheating roller 33 which is the most downstream one in the yarn running direction and the conditioning roller 34 which is the most upstream one in the yarn running direction. The yarns Y are then further heated while being transferred by the conditioning rollers 34 and 35, with the result that the drawn state is thermally set. The yarns Y having been drawn in this way go out from the thermal insulation box 20 through the outlet 20b.

[0036] In the thermal insulation box 20, flow control members 41 to 44 are disposed. The flow control members 41 to 44 are plate-shaped members provided to protrude from the back surface portion 26 toward the front surface portion 27 of the thermal insulation box 20. The flow control members 41 to 44 adjust the flow of air in the thermal insulation box 20. To be more specific, the flow control members 41 to 44 are disposed so that the flow of air from the inlet 20a to the outlet 20b inside the thermal insulation box 20 is more or less along the yarn running direction.

[0037] In the thermal insulation box 20, furthermore, shielding members 51 to 54 are disposed. The shielding members 51 to 54 extend toward the outer circumferential surface of the conditioning roller 34 or 35, and a leading end portion of each shielding member is close to the outer circumferential surface of the conditioning roller 34 or 35. In the thermal insulation box 20, an accompanied flow is generated in accordance with the running of the yarns Y. As the accompanied flow advances toward the downstream side in the yarn running direction while being amplified, a large amount of heat escapes through the outlet 20b, with the result that the heat keeping effect of the thermal insulation box 20 is deteriorated. On this account, the deterioration of the heat keeping effect is restrained by blocking the accompanied flow by the shielding members 51 to 54 in order to restrain the amplification of the accompanied flow. The shielding members 51, 52, and 54 are arranged to be swingable about their base parts in order not to obstruct yarn placement onto the conditioning rollers 34 and 35. For details, see Japanese Unexamined Patent Publication No. 2016-216882.

[Coexistence of Controllability of Last Preheating Roller and Energy Saving]

[0038] When plural preheating rollers 31 to 33 are provided as in the present embodiment, because the yarns Y are serially heated by the preheating rollers 31 to 33, an amount of heat consumed by the heating of the yarns Y is small at the last preheating roller 33 which is the most downstream one in the yarn running direction. Furthermore, because the last preheating roller 33 is provided in the vicinity of the hot conditioning roller 35, the last preheating roller 33 is susceptible to an influence of heat from the conditioning roller 35. Due to these reasons, the surface temperature of the last preheating roller 33 may exceed the set temperature, and temperature control may not be properly done. This problem is particularly conspicuous in the summer time when the outside temperature is high.

[0039] In order to solve this problem, a heat shielding member may be provided between the last preheating roller 33 and the conditioning roller 35. By the heat shielding member, an influence of heat from the conditioning roller 35 is retrained, and hence excessive increase in the surface temperature of the last preheating roller 33 is restrained. However, as a side effect, effective temperature increase of the last preheating roller 33 by utilizing heat from the conditioning roller 35 becomes impossible, with the result that the power consumption of the spun yarn drawing apparatus 3 is disadvantageously high. Under this circumstance, in the present embodiment, an amount of heat transferred from the conditioning roller 35 to the last preheating roller 33 is controllable. With this arrangement, the power consumption of the spun yarn drawing apparatus 3 is restrained while the surface temperature of the last preheating roller 33 is maintained at the set temperature. The following will describe the details.

[0040] In the present embodiment, a flow control member 43 which also serves as the heat shielding member is disposed between the last preheating roller 33 and the conditioning roller 35. Hereinafter, a space which is below the flow control member 43 and where the last preheating roller 33 is provided is referred to as a low-temperature space 45, whereas a space which is above the flow control member 43 and where the conditioning roller 35 is provided is referred to as a high-temperature space 46. Between the inner surface of the left side portion 24 of the thermal insulation box 20 and the flow control member 43, a communication passage 47 is formed to allow the low-temperature space 45 and the high-temperature space 46 to communicate with each other. Furthermore, shutters 48 and 49 are provided to change the flow passage area of the communication passage 47. While materials of the flow control member 43 and the shutters 48 and 49 are not limited, these members are made of stainless steel in the present embodiment, in consideration of corrosion resistance and strength.

[0041] FIG. 3 is an enlarged view of the communication passage 47 and its surroundings. Each of FIG. 4(a) and FIG. 4(b) is a top view of the upper shutter 48. FIG. 4(a) shows a state in which the upper shutter 48 is fully closed, whereas FIG. 4(b) shows a state in which the upper shutter 48 is fully open. In FIG. 4(a) and FIG. 4(b), the upper shutter 48 is depicted by thick lines.

[0042] As shown in FIG. 3, in the flow control member

43, the following portions are integrally formed: an upper partition portion 43a which extends in the left-right direction; a lower partition portion 43b which is provided below and spaced apart from the upper partition portion 43a and extends in the left-right direction; and a connecting portion 43c which connects a left end part of the upper partition portion 43a with a left end part of the lower partition portion 43b and extends in the up-down direction. Alternatively, the portions 43a to 43c may be independent members.

[0043] As shown in FIG. 4(b), a rear left corner portion of the upper partition portion 43a is arranged as a rectangular cutout portion 43d, and this cutout portion 43d is the upper end of the communication passage 47. Although not illustrated, a rear left corner portion of the lower partition portion 43b is also arranged as a rectangular cutout portion, and this cutout portion is the lower end of the communication passage 47. To put it differently, the communication passage 47 is a passage between the cutout portion 43d formed in the upper partition portion 43a and the cutout portion formed in the lower partition portion 43b.

[0044] In the upper partition portion 43a, two slots 43e which are long in the left-right direction are formed to be lined up in the front-rear direction. The upper shutter 48 is a rectangular plate member and is attached to the upper surface of the upper partition portion 43a. The upper shutter 48 is sized to be able to close the cutout portion 43d. In the upper shutter 48, two unillustrated round holes are formed to be lined up in the front-rear direction. These round holes correspond to the two slots 43e formed in the upper partition portion 43a, respectively. As shown in FIG. 3, bolts 71 are inserted into the round holes of the upper shutter 48 and the slots 43e of the upper partition portion 43a, and nuts 72 are screwed onto the bolts 71. In this way, the upper shutter 48 is fixed to the upper partition portion 43a. The lower partition portion 43b and the lower shutter 49 are similarly arranged. The lower shutter 49 is fixed to the lower partition portion 43b by bolts 73 and nuts 74.

[0045] With the arrangement above, by moving the upper shutter 48 in the left-right direction along the slots 43e after the nuts 72 are loosened, it is possible to change the opening degree of the upper shutter 48 (i.e., the opening degree of the cutout portion 43d of the upper partition portion 43a) so as to adjust the flow passage area of the communication passage 47. Similarly, by moving the lower shutter 49 in the left-right direction along the slots after the nuts 74 are loosened, it is possible to change the opening degree of the lower shutter 49 (i.e., the opening degree of the cutout portion of the lower partition portion 43b) so as to adjust the flow passage area of the communication passage 47.

[0046] For example, as shown in FIG. 4(a), the communication passage 47 is closed when the shutters 48 and 49 are moved leftward until making contact with the inner surface of the left side portion 24 of the thermal insulation box 20. Meanwhile, when the shutters 48 and 49 are moved rightward away from the left side portion 24, the communication passage 47 is gradually opened, and the communication passage 47 can be fully opened as shown in FIG. 4(b). Furthermore, the flow amount and the way of flowing of air in the communication passage 47 are finely controllable by adjusting the opening degree of each of the shutters 48 and 49.

[0047] FIG. 5 is a cross section taken along the V-V line in FIG. 2. In order to prevent the door 27 of the thermal insulation box 20 from becoming unclosable, a front end portion of the flow control member 43 is arranged to be slightly separated from the closed door 27, as shown in FIG. 5. With this arrangement, however, an airflow between the high-temperature space 46 and the low-temperature space 45 is generated through a gap between the upper partition portion 43a and the door 27 and a gap between the lower partition portion 43b and the door 27. As a result, an amount of heat transferred from the high-temperature space 46 to the low-temperature space 45 may be larger than expected.

[0048] In order to restrain this problem, a sealing member 63 is attached to a front edge portion of the upper partition portion 43a in the present embodiment, as shown in FIGs. 4(a) and 4(b) and FIG. 5. The sealing member 63 is made of silicon or rubber, for example, and is shaped and sized so that the sealing member 63 is closely in contact with the inner surface of the door 27 when the door 27 is closed. In order to prevent interference between the upper shutter 48 and the sealing member 63, a gap is provided between the upper shutter 48 and the door 27 as shown in FIGs. 4(a) and 4(b).

[0049] As described above, escape of heat from the thermal insulation box 20 together with an accompanied flow is restrained by the shielding members 51 to 54. In particular, the shielding member 54 contributes to efficient transfer of heat from the high-temperature space 46 to the low-temperature space 45. As shown in FIG. 3, the shielding member 54 extends toward the outer circumferential surface of the conditioning roller 35 from a location in the left side portion 24 of the thermal insulation box 20, which location is on the conditioning roller 35 side of (i.e., above) the communication passage 47. The conditioning roller 35 rotates clockwise so that a part A of the outer circumferential surface of the conditioning roller 35, which faces a leading end portion of the shielding member 54, moves away from the communication passage 47. With this arrangement, an accompanied flow flowing around the conditioning roller 35 is blocked by the shielding member 54, and hence escape of heat in the accompanied flow from the shielding member 54 to the downstream side in the yarn running direction is restrained. As a result, a larger amount of heat is transferred from the high-temperature space 46 to the low-temperature space 45 through the communication passage 47.

[0050] In the spun yarn drawing apparatus 3 structured as described above, the flow amount of air flowing in the communication passage 47, i.e., an amount of heat transfer is controllable by suitably adjusting the opening degrees of the upper shutter 48 and the lower shutter 49 in accordance with conditions such as the type of the yarns Y and the outside temperature. Two conflicting requirements, i.e., controllability of the last preheating roller 33 and power saving of the spun yarn drawing apparatus 3, are both satisfied with good balance, by adjusting the flow passage area of the communication passage 47 to transfer heat from the high-temperature space 46 to the low-temperature space 45 as much as possible, on condition that the temperature of the last preheating roller 33 does not exceed the set temperature.

[Verification Experiment]

[0051] An experiment was done to verify how temperatures of the components and the power consumption of the spun yarn drawing apparatus 3 are changed in response to the adjustment of the opening degrees of the shutters 48 and 49. FIG. 6 is a table showing a result of the verification experiment.

(Experiment Conditions)

[0052] A set temperature of the preheating rollers 31 to 33 was 80°C.

[0053] A set temperature of the conditioning rollers 34 and 35 was 134°C.

[0054] Experiment cases were a case where the shutters 48 and 49 were fully open and a case where the shutters 48 and 49 were fully closed.

(Measured Values)

[0055] Switch-ON percentages of the heaters of the preheating rollers 31 to 33 and the conditioning rollers 34 and 35

Temperatures of the low-temperature space 45 and the high-temperature space 46

Power consumption of the spun yarn drawing apparatus 3

[0056] The switch-ON percentage of a heater indicates the ratio of the time during which the heater is driven to maintain the surface temperature of each of the heating rollers 31 to 35 at the set temperature. Therefore the lower the switch-ON percentage of a heater is, the more the power saving is achieved. However, when the switch-ON percentage of a heater is 0, the temperature of the roller is likely to exceed the set temperature even if the heater is not driven. The switch-ON percentage of a heater is therefore preferably equal to or higher than a predetermined percent (e.g., 1%) in consideration of the controllability. Temperatures of the low-temperature space 45 and the high-temperature space 46 were measured at locations L and H shown in FIG. 3 and FIG. 5, respectively.

[0057] When the shutters 48 and 49 were fully open, the temperature of the low-temperature space 45 was increased by at least 20°C and the switch-ON percentage of the heater of the last preheating roller 33 was decreased by about 7%, as compared to the case where the shutters were fully closed. This indicates that, when the shutters 48 and 49 were fully open, a large amount of heat was transferred from the high-temperature space 46 to the low-temperature space 45 through the communication passage 47. It is remarkable that the temperature of the high-temperature space 46 was only slightly decreased and the switch-ON percentage of the heater of the conditioning roller 35 was scarcely changed when the shutters 48 and 49 were fully open, as compared to the case where the shutters were fully closed. This seems to indicate that heat which was previously wastefully discharged from the high-temperature space 46 to the outside of the thermal insulation box 20 through the outlet 20b was effectively utilized for heating the last preheating roller 33, as the communication passage 47 was opened. In fact, when the shutters 48 and 49 were fully open, the power consumption of the spun yarn drawing apparatus 3 was reduced by about 25% as compared to the case of full close.

[0058] In the experiment, the switch-ON percentage of the heater of the last preheating roller 33 was 23.1% even when the shutters 48 and 49 were fully open. Therefore there is room for further improvement in power saving. In the same conditions as the experiment above, the flow passage area of the communication passage 47 may be slightly increased to increase the flow amount of air flowing in the communication passage 47. In any case, the experiment verifies that, by adjusting the opening degrees of the shutters 48 and 49 to change the flow passage area of the communication passage 47, it is possible to maximally achieve the power saving of the spun yarn drawing apparatus 3 while maintaining the controllability of the last preheating roller 33.

[Advantageous Effects]

[0059] As described above, in the spun yarn drawing apparatus 3 of the present embodiment, the flow amount of air flowing in the communication passage 47 is controlled and therefore an amount of heat transferred from the high-temperature space 46 to the low-temperature space 45 is controlled, by adjusting the opening degrees of the shutters 48 and 49 provided in the communication passage 47. In order to restrain the power consumption while maintaining the temperature of the preheating roller 33 at the set temperature, it is preferable that heat is transferred from the high-temperature space 46 to the low-temperature space 45 as much as possible on condition that the temperature of the preheating roller 33 does not exceed the set temperature. However, the optimal amount of heat transfer is changed based on conditions such as the outside temperature and the set temperature of each roller determined in accordance with the type of the yarns Y. In the present embodiment, by the adjustment of the opening degrees of the shutters 48 and 49 in accordance with the conditions, the power consumption is restrained while the temperature of the preheating roller 33 is suitably controlled, irrespective of the conditions.

[0060] In the present embodiment, as shown in FIG. 2, the communication passage 47 is a passage which is formed at a location different from the yarn path between the preheating roller 33 and the conditioning roller 35. Because the communication passage 47 is provided to be independent from the yarn path, backward flow of heat from the low-temperature space 45 to the high-temperature space 46 due to an accompanied flow generated by the running yarns Y is prevented, with the result that heat is efficiently transferred from the high-temperature space 46 to the low-temperature space 45. Furthermore, the movement of the shutters 48 and 49 is not obstructed by the yarns Y.

[0061] In the present embodiment, the communication passage 47 is formed between the inner surface of the thermal insulation box 20 and the partition portions 43a and 43b. This facilitates air to flow along the inner surface of the thermal insulation box 20, with the result that heat is efficiently transferred from the high-temperature space 46 to the low-temperature space 45.

[0062] In the present embodiment, the preheating roller 33 and the conditioning roller 35 are provided to protrude from the back surface portion 26 toward the front surface portion 27 of the thermal insulation box 20, and the communication passage 47 is formed between the inner surface of the side face portion 24 of the thermal insulation box 20 and the partition portions 43a and 43b. Provided that the communication passage 47 is formed between the inner surface of the front surface portion 27 (or the back surface portion 26) of the thermal insulation box 20 and the partition portions 43a and 43b, when plural yarns Y are placed on the preheating roller 33 and the conditioning roller 35 so as to be lined up along the axial direction, the yarns Y which are close to the front surface portion 27 (or the back surface portion 26) tend to be shaken due to an influence of air flowing in the communication passage 47, whereas the yarns Y close to the back surface portion 26 (or the front surface portion 27) are unlikely to be shaken. In this way, there is a difference in yarn shaking. Such a difference is unfavorable because it causes the quality of yarns Y to be uneven. In this regard, when the communication passage 47 is formed between the inner surface of the side face portion 24 of the thermal insulation box 20 and the partition portions 43a and 43b as described above, an influence of air flowing in the communication passage 47 is substantially balanced between the yarns Y. It is therefore possible to restrain the quality of the yarns Y from becoming uneven.

[0063] In the present embodiment, the shutters 48 and 49 are structured to be movable toward or away from the side face portion 24 of the thermal insulation box 20. This makes it possible to easily adjust the flow passage area of the communication passage 47 by the shutters 48 and 49.

[0064] In the present embodiment, the front surface portion 27 of the thermal insulation box 20 is arranged as an openable door, and the sealing member 63 is provided between the door 27 and the upper partition portion 43a. When there is a gap between the door 27 and the upper partition portion 43a, heat may be transferred from the high-temperature space 46 to the low-temperature space 45 through the gap, with the result that the control of the amount of heat transfer through the communication passage 47 may not be properly done. Because the sealing member 63 is provided between the door 27 and the upper partition portion 43a as described above, the gap between the door 27 and the upper partition portion 43a is eliminated, and hence the control of the amount of heat transfer through the communication passage 47 can be accurately done.

[0065] In the present embodiment, the sealing member 63 is attached to the upper partition portion 43a. Provided that the sealing member 63 is attached to the door 27, the sealing member 63 must be accurately positioned in accordance with the position of the upper partition portion 43a. Meanwhile, when the sealing member 63 is attached to the upper partition portion 43a, accurate positioning of the sealing member 63 is unnecessary, and hence the attachment can be easy done.

[0066] In the present embodiment, the shielding member 54 is provided to extend toward the outer circumferential surface of the conditioning roller 35 from a location in the side face portion 24 of the thermal insulation box 20, which location is on the conditioning roller 35 side of the communication passage 47, and the conditioning roller 35 rotates so that the part A of the outer circumferential surface of the conditioning roller 35, which faces the leading end portion of the shielding member 54, moves away from the communication passage 47. With this arrangement, an accompanied flow generated by the running yarns Y is blocked by the shielding member 54, and hence escape of heat in the accompanied flow away from the communication passage 47 is restrained. As a result, heat is efficiently transferred from the high-temperature space 46 to the low-temperature space 45.

[0067] In the present embodiment, plural shutters 48 and 49 are provided to be lined up in the direction D in which air flows in the communication passage 47 (see FIG. 3). With this arrangement, the flow amount and the way of flowing of air in the communication passage 47 are finely controllable by adjusting the opening degree of each of the shutters 48 and 49.

[0068] In the present embodiment, plural partition portions 43a and 43b are provided between the low-temperature space 45 and the high-temperature space 46 to be lined up in the direction D in which air flows in the communication passage 47. Because the partition portions 43a and 43b are provided in this manner, heat insulation between the high-temperature space 46 and the low-temperature space 45 is improved, and hence control of the amount of heat transfer through the communication passage 47 is accurately done.

[0069] In the present embodiment, the partition portions 43a and 43b are provided between the last preheating roller 33 and the conditioning roller 35, whereas the shutters 48 and 49 are provided in the communication passage 47 which allows the low-temperature space 45 and the high-temperature space 46 to communicate with each other. When plural preheating rollers 31 to 33 are provided, because the yarns Y are serially heated by the preheating rollers 31 to 33, an amount of heat consumed by the heating of the yarns Y is small at the last preheating roller 33. The last preheating roller 33 is provided in the vicinity of the conditioning roller 35. On this account, as compared to the other preheating rollers 31 and 32, the temperature of the last preheating roller 33 tends to be increased by an influence of heat from the conditioning roller 35. Furthermore, because the yarns Y are drawn between the last preheating roller 33 and the conditioning roller 35, the temperature of the last preheating roller 33 must be controlled particularly accurately. For this reason, the present invention which makes it possible to suitably control the temperature is particularly effective for the last preheating roller 33.

[Other Embodiments]

[0070] The following will describe modifications of the above-described embodiment.

[0071] In the embodiment above, the communication passage 47 is formed between the left side portion 24 of the thermal insulation box 20 and the partition portions 43a and 43b (flow control member 43). The location where the communication passage 47 is formed is not limited to this. For example, a communication passage 47 may be provided by forming openings in the partition portions 43a and 43b. Furthermore, the number of communication passages may be two or more.

[0072] In the above-described embodiment, the communication passage 47 is formed at a location different from the yarn path. Alternatively, the yarn path may be formed in the communication passage. The shutters cannot be fully closed in this case, but the opening degrees of the shutters are adjustable as long as the yarn path is not blocked.

[0073] In the above-described embodiment, plural partition portions 43a and 43b are provided to be lined up in the direction D in which air flows in the communication passage 47, and plural shutters 48 and 49 are provided to be lined up in the direction D. In this regard, each of the number of partition portions and the number of shutters may be at least one.

[0074] In the above-described embodiment, the shutters 48 and 49 are structured to be movable in the left-right direction. The specific structure of each shutter is not limited to this, and the shutter may be opened and closed in a swing manner, for example.

[0075] In the embodiment above, the flow passage area of the communication passage 47 is adjusted as an operator moves the shutters 48 and 49. Alternatively, an unillustrated shutter driver for moving the shutters 48 and 49 may be provided, and the flow passage area of the communication passage 47 may be adjusted by this shutter driver. In this case, problems such as the temperature of the last preheating roller 33 is uncontrollable is prevented by automatically adjusting the opening degrees of the shutters 48 and 49 in accordance with the temperature of a particular part (e.g., the temperature of the low-temperature space 45 or the surface temperature of the last preheating roller 33).

[0076] In the embodiment above, the sealing member 63 is attached to the upper partition portion 43a in order to eliminate the gap between the door 27 of the thermal insulation box 20 and the upper partition portion 43a. Alternatively, the sealing member 63 may be attached to the door 27. Alternatively, the sealing member 63 may be omitted.

[0077] In the embodiment above, heat is efficiently transferred from the high-temperature space 46 to the low-temperature space 45 because the shielding member 54 is provided. Alternatively, the shielding member 54 may be omitted.

[0078] In the embodiment above, the temperature of the last preheating roller 33 is efficiently increased because of the communication passage 47. Likewise, in order to efficiently increase the temperature of the preheating roller 32, a communication passage may be provided between the right side portion 22 of the thermal insulation box 20 and the flow control member 42, and a shutter is provided in this communication passage. Alternatively, a communication passage may be provided by forming an opening in the flow control member 42.

[0079] In the embodiment above, plural preheating rollers 31 to 33 and plural conditioning rollers 34 and 35 are provided. In this connection, plural preheating rollers and plural conditioning rollers are not prerequisite. Only at least one preheating roller and at least one conditioning roller are required.

Claims

1. A spun yarn drawing apparatus comprising:

   at least one preheating roller which heats yarns before drawn;
   at least one conditioning roller which is provided downstream in a yarn running direction of the at least one preheating roller and is higher in temperature and speed than the at least one preheating roller; and
   a thermal insulation box which houses the at least one preheating roller and the at least one conditioning roller,
   the yarns being drawn between the at least one preheating roller and the at least one conditioning roller, the spun yarn drawing apparatus fur-

ther including:

at least one partition portion provided between the at least one preheating roller and the at least one conditioning roller;
a communication passage which causes a low-temperature space which is on the preheating roller side of the at least one partition portion to communicate with a high-temperature space which is on the conditioning roller side of the at least one partition portion; and
at least one shutter which is provided to change the flow passage area of the communication passage.

2. The spun yarn drawing apparatus according to claim 1, wherein, the communication passage is a passage formed at a location different from a yarn path between the at least one preheating roller and the at least one conditioning roller.

3. The spun yarn drawing apparatus according to claim 1 or 2, wherein, the communication passage is formed between an inner surface of the thermal insulation box and the at least one partition portion.

4. The spun yarn drawing apparatus according to claim 3, wherein,
the at least one preheating roller and the at least one conditioning roller are disposed to protrude from a back surface portion toward a front surface portion of the thermal insulation box, and
the communication passage is formed between an inner surface of a side face portion of the thermal insulation box and the at least one partition portion.

5. The spun yarn drawing apparatus according to claim 4, wherein, the at least one shutter is movable toward and away from the side face portion of the thermal insulation box.

6. The spun yarn drawing apparatus according to claim 4 or 5, wherein,
the front surface portion of the thermal insulation box is an openable door, and
a sealing member is provided between the door and the at least one partition portion.

7. The spun yarn drawing apparatus according to claim 6, wherein, the sealing member is attached to the at least one partition portion.

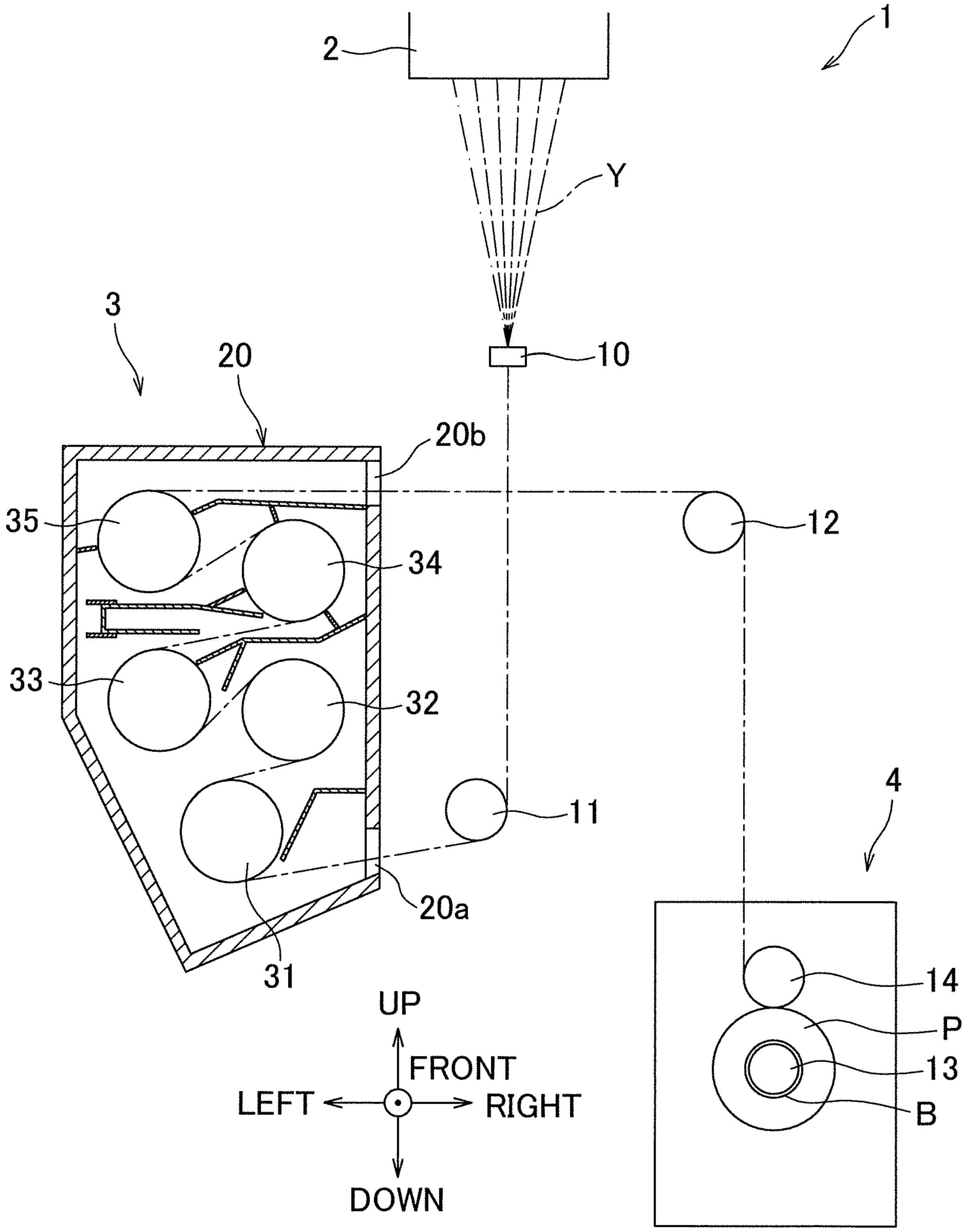
8. The spun yarn drawing apparatus according to any one of claims 4 to 7, further comprising
a shielding member which extends toward the outer circumferential surface of the at least one conditioning roller from a location in the side face portion of the thermal insulation box, the location being on the conditioning roller side of the communication passage,
the at least one conditioning roller rotating so that a part of the outer circumferential surface of the at least one conditioning roller, which opposes a leading end portion of the shielding member, moves away from the communication passage.

9. The spun yarn drawing apparatus according to any one of claims 1 to 8, wherein, a plurality of the at least one shutter are provided to be lined up in a direction in which air flows in the communication passage.

10. The spun yarn drawing apparatus according to any one of claims 1 to 9, wherein, a plurality of the at least one partition portion are provided between the low-temperature space and the high-temperature space to be lined up in a direction in which air flows in the communication passage.

11. The spun yarn drawing apparatus according to any one of claims 1 to 10, wherein,
a plurality of the at least one preheating roller are provided to be lined up in the yarn running direction,
the at least one partition portion is provided between a last preheating roller which is most downstream one of the preheating rollers in the yarn running direction and the at least one conditioning roller, and
the at least one shutter is provided in the communication passage which causes the low-temperature space which is on the last preheating roller side of the at least one partition portion to communicate with the high-temperature space which is on the conditioning roller side of the at least one partition portion.

FIG.1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20b
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20a
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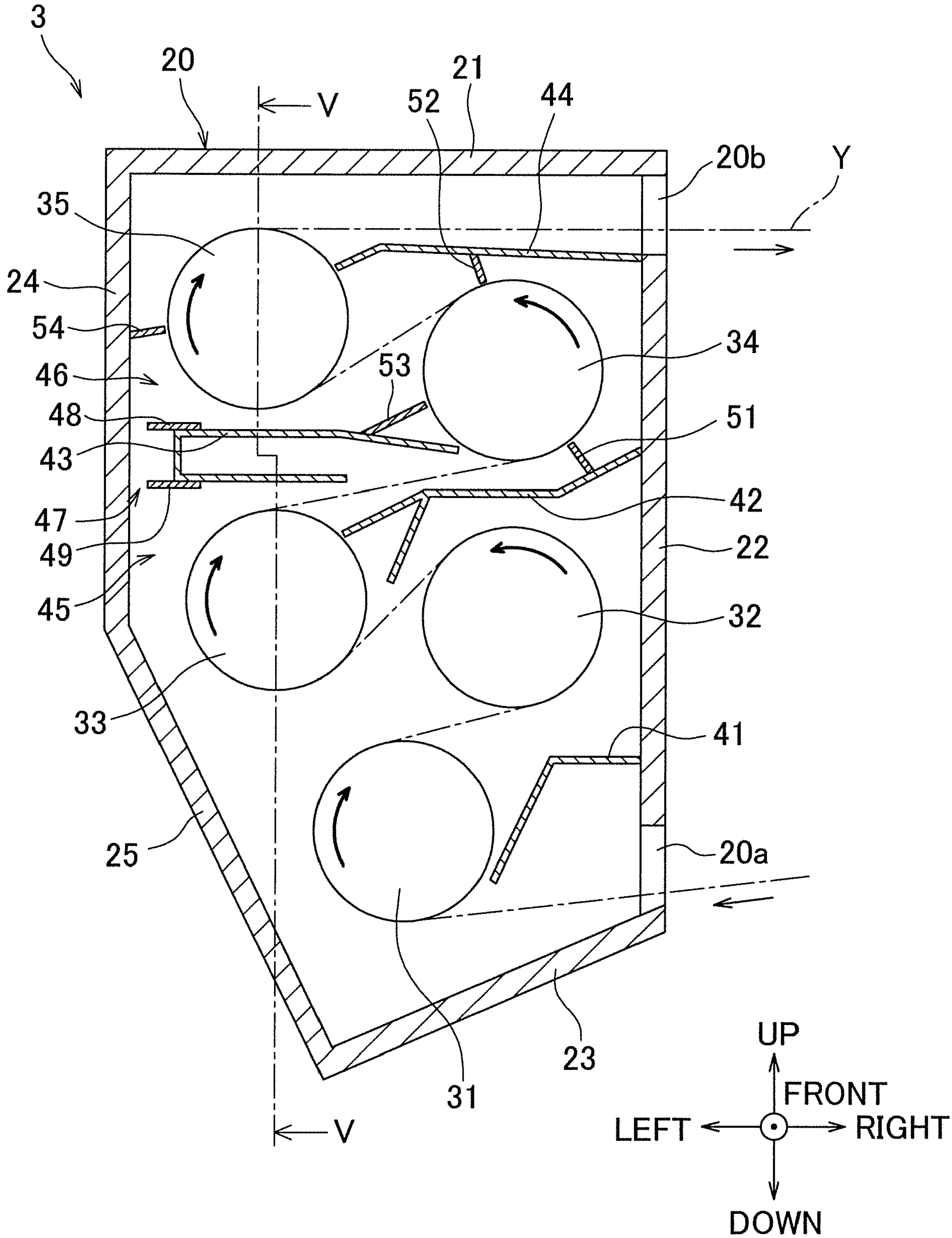
FIG.2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20a
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V

FIG.3

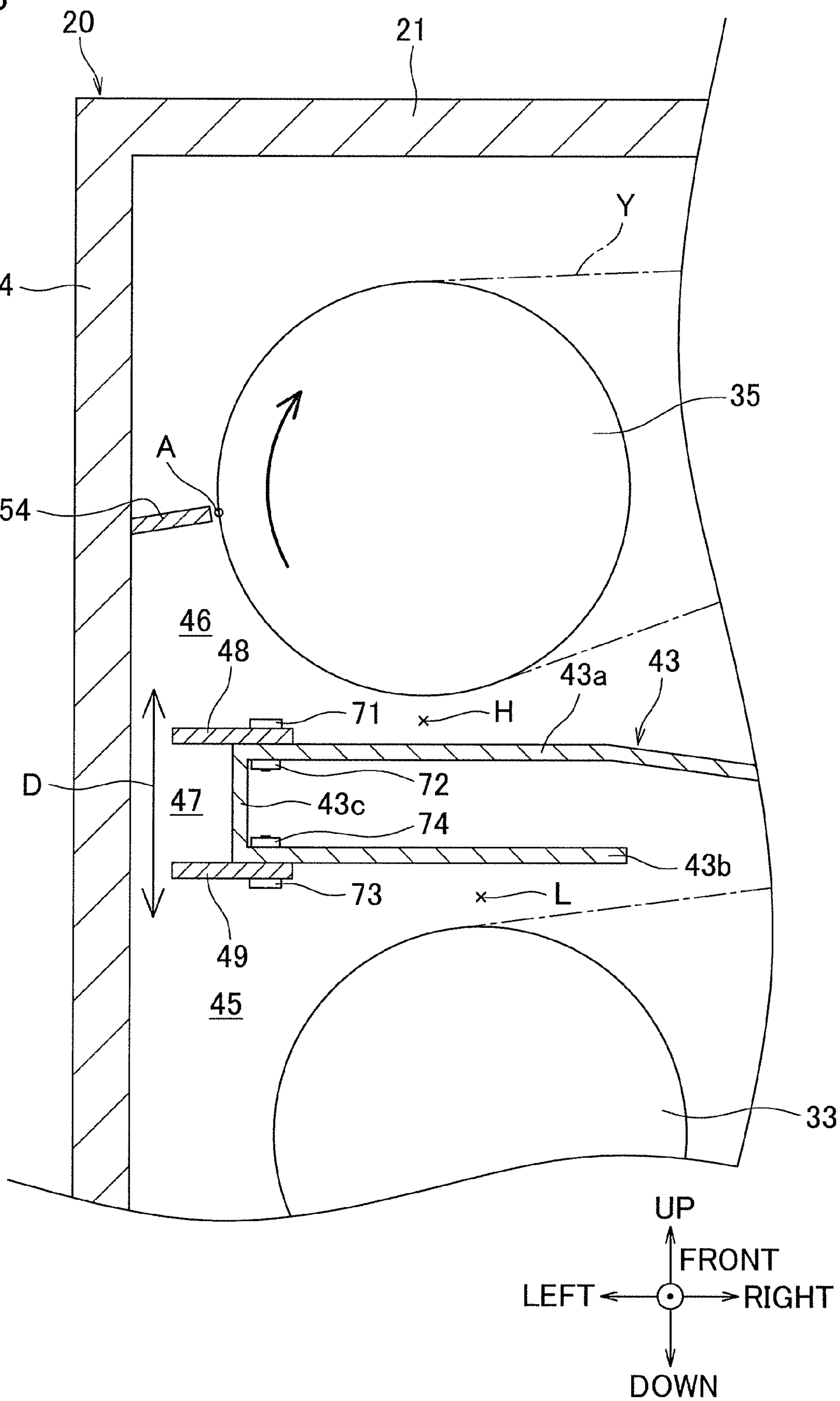
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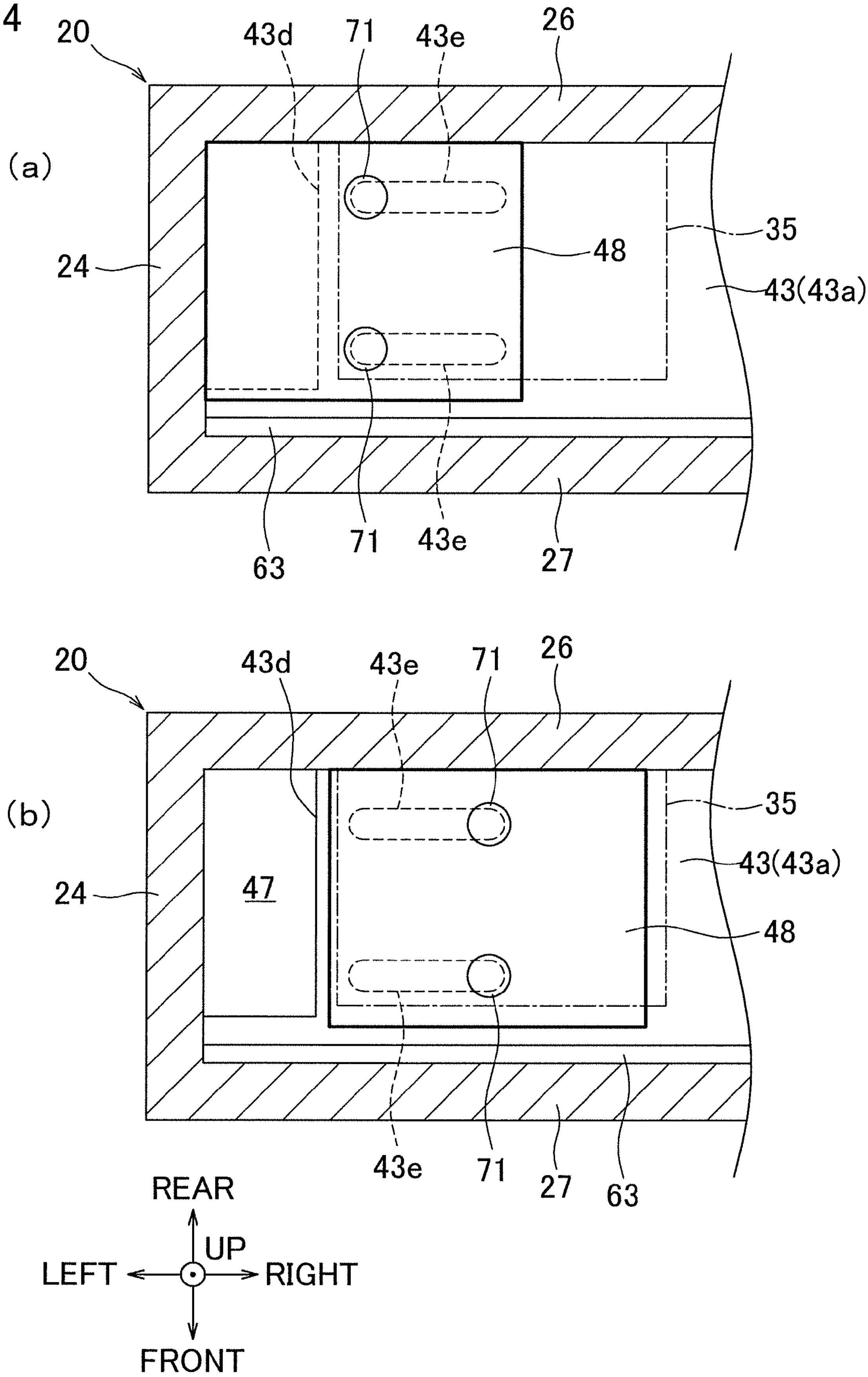
FIG.4


(a)
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43d
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43e
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35
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43(43a)
63
71
43e
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(b)
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43d
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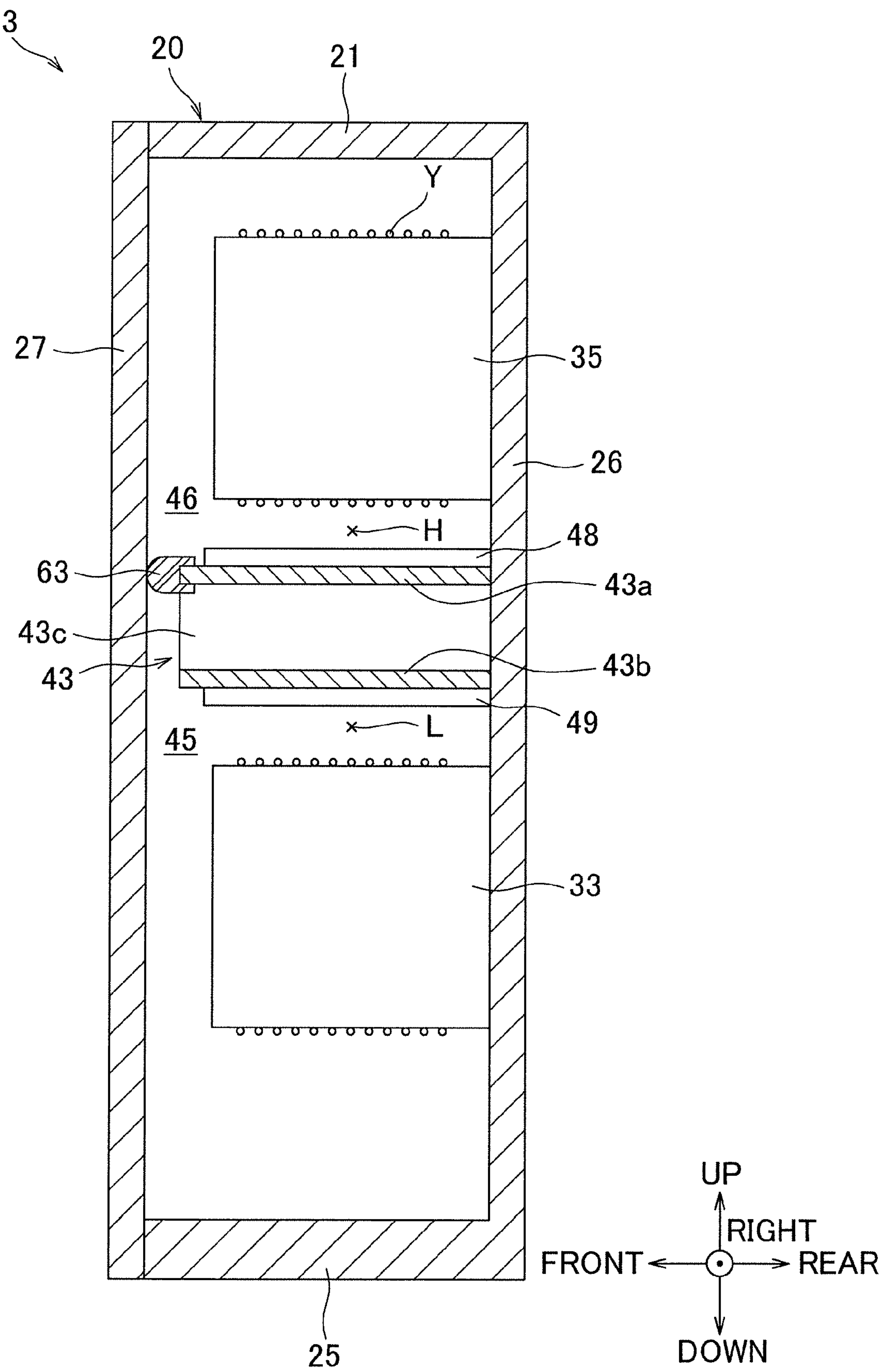
FIG.5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REAR
DOWN
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FIG.6

		SHUTTERS 48 AND 49	
		FULLY OPEN	FULLY CLOSED
SWITCH-ON PERCENTAGE OF HEATER [%]	PREHEATING ROLLER 31	28.2	31.4
	PREHEATING ROLLER 32	22.2	27.2
	PREHEATING ROLLER 33	23.1	30.1
	CONDITIONING ROLLER 34	38.2	41.0
	CONDITIONING ROLLER 35	33.4	35.0
SPACE TEMPERATURE [°C]	LOW-TEMPERATURE SPACE 45	83.5	60.9
	HIGH-TEMPERATURE SPACE46	115.5	116.0
POWER CONSUMPTION [kW]		2395.7	3221.7

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 0067

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			D02J D01D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 April 2019	Van Beurden-Hopkins

3

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