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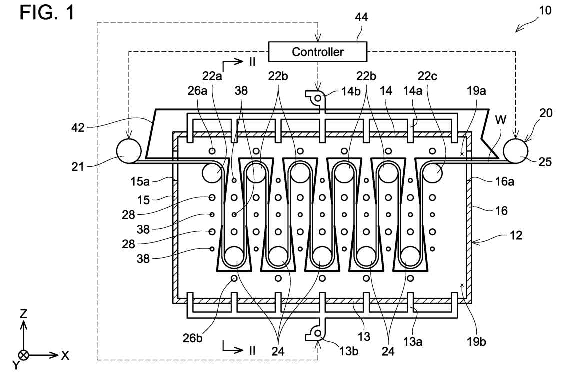
(54) HEAT TREATMENT FURNACE

(57) The description herein discloses a heat treatment furnace that performs heat treatment efficiently on a treatment-target object conveyed on a conveying path defined by a plurality of guide rollers. This heat treatment furnace includes a furnace body, a conveyor device configured to convey a treatment-target object from a conveying inlet to a conveying outlet through a treatment chamber, a plurality of guide rollers disposed in the treatment chamber, and a heating device disposed in the treatment chamber and configured to heat the treatment-target object. The heating device includes first heaters, each of which is disposed inside and/or near its corresponding one of the plurality of guide rollers and configured to heat the treatment-target object. The heating device further includes second heaters each disposed on the conveying path of the treatment-target object near an intermediate position between its corresponding guide rollers that are adjacent in a conveying direction and configured to heat the treatment-target object. The second heaters are each a heater configured to emit electromagnetic waves in an infrared region.

FIG. 1



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Description

Technical Field

[0001] The art disclosed herein relates to a heat treatment furnace configured to perform heat treatment on a treatment-target object.

Background Art

[0002] In a heat treatment furnace described in WO 2014/163175 A1; a treatment-target object is laid out from a conveying inlet to a conveying outlet through a treatment chamber. The treatment-target object is conveyed into the treatment chamber from the conveying inlet, is heat treated while it is conveyed within the treatment chamber, and is conveyed out from the conveying outlet. In this heat treatment furnace, the treatment-target object is guided by a plurality of guide rollers disposed in the treatment chamber, and the treatment-target object is conveyed on a predetermined conveying path within the treatment chamber.

Summary of Invention

Technical Problem

[0003] In the above heat treatment furnace, the treatment-target object is conveyed from the conveying inlet to the conveying outlet on the conveying path defined by the plurality of guide rollers. Due to this, in order to efficiently perform the heat treatment on the treatment-target object, the treatment-target object must be heated suitably at respective positions on the conveying path. The description herein discloses an art configured to enable efficient heat treatment on a treatment-target object conveyed on a conveying path defined by a plurality of guide rollers.

Solution to Technical Problem

[0004] A heat treatment furnace disclosed herein comprises a furnace body, a conveyor device, a plurality of guide rollers, and a heating device. The furnace body comprises a conveying inlet, a conveying outlet, and a treatment chamber disposed between the conveying inlet and the conveying outlet. The conveyor device is configured to convey a treatment-target object, which is laid out from the conveying inlet to the conveying outlet, from the conveying inlet to the conveying outlet through the treatment chamber. The plurality of guide rollers is disposed in the treatment chamber and configured to guide the treatment-target object conveyed by the conveyor device. The treatment-target object is conveyed from the conveying inlet to the conveying outlet on a conveying path defined by the plurality of guide rollers. The heating device comprises first heaters each disposed inside and/or near its corresponding one of the plurality of guide rollers and configured to heat the treatment-target object, and second heaters each disposed on the conveying path near an intermediate position between its corresponding guide rollers adjacent to each other in a conveying direction of the treatment-target object and configured to heat the treatment-target object. The second heaters are each a heater configured to emit electromagnetic waves in an infrared region.

[0005] In the above heat treatment furnace, the heating device comprises the first heaters each disposed inside and/or near the corresponding guide roller and the second heaters each disposed on the conveying path near the intermediate position between the corresponding guide rollers adjacent to each other. Further, the heaters configured to emit the electromagnetic waves in the infrared region are used as the second heaters. According to the above, heat supplied from the first and second heaters to the treatment-target object can suitably be controlled, and the treatment-target object can efficiently be subjected to heat treatment. The second heaters may each be a heater of which wavelength cannot be controlled and configured to emit electromagnetic waves in a preset wavelength region (infrared region), or alternatively, they may each be a heater capable of controlling a wavelength region of electromagnetic waves to be emitted.

Brief Description of Drawings

[0006]

FIG. 1 is a vertical cross-sectional view of a heat treatment furnace of a first embodiment.
FIG. 2 is a cross-sectional view along a line II-II of FIG. 1.
FIG. 3 is a cross-sectional view of a heater of the first embodiment.
FIG. 4 is a cross-sectional view of an intake pipe of the first embodiment.

Description of Embodiments

[0007] In the heat treatment furnace disclosed herein, the first heaters may each be a heater disposed on the conveying path of the treatment-target object near a corresponding position where the corresponding guide roller is disposed and configured to emit electromagnetic waves in the infrared region that are of a same type as the second heaters. Further, the treatment-target object may be positioned between the first heaters and the guide rollers. According to such a configuration, the first heaters that heat the treatment-target object at positions where the guide rollers are disposed are of the same type of heaters as the second heaters, thus the configuration of the heating furnace can be simplified.

[0008] In the heat treatment furnace disclosed herein, wherein each of the first heaters may be disposed inside the corresponding one of the guide rollers and comprise a passage through which a heat medium for heating the guide rollers flows. According to such a configuration as well, the treatment-target object can be heated through the guide rollers.

[0009] The heat treatment furnace disclosed herein may further comprise an intake device configured to supply gas into the treatment chamber. The intake device may be disposed at a position within the treatment chamber that is different from positions where the first heaters are disposed and different from positions where the second heaters are disposed, and comprise a plurality of intake pipes configured to eject the gas onto the treatment-target object. Further, the second heaters and the intake pipes may be disposed alternately along the conveying path. According to such a configuration, since the intake pipes are disposed at positions different from the positions where the first heaters and the second heaters are disposed, thus a degree of freedom in the positions to dispose the intake pipes increases, and the intake pipes can be disposed at optimal positions. Further, since the gas is ejected from the intake pipes toward the treatment-target object, the ejected gas collides with a surface of the treatment-target object, and it becomes easy to uniformize a temperature of the surface of the treatment-target object. Especially, since the second heaters and the intake pipes are disposed alternately along the conveying path, the temperature of the surface of the treatment-target object can be further uniformized. Due to this, a heat treatment efficiency of the treatment-target object can be improved.

[0010] In the heat treatment furnace disclosed herein, an ejecting direction of the gas ejected from the plurality of intake pipes may perpendicularly intersect the surface of the treatment-target object. According to such a configuration, the gas from the intake pipes can be ejected with great force onto the surface of the treatment-target object.

[0011] In the heat treatment furnace disclosed herein, the plurality of guide rollers may comprise: a first guide roller configured to change the conveying direction of the treatment-target object, which is conveyed from the conveying inlet, to a first direction; a second guide roller configured to change the conveying direction of the treatment-target object, which is conveyed in the first direction, to a second direction different from the first direction; and a third guide roller configured to change the conveying direction of the treatment-target object, which is conveyed in the second direction, toward the conveying outlet. The furnace body may comprise a first wall located on a first direction side as seen from a center of the treatment chamber and a second wall located on a second direction side as seen from the center of the treatment chamber. The first wall may comprise a first exhaust port configured to discharge atmospheric gas in the treatment chamber, and the second wall may comprise a second exhaust port configured to discharge the atmospheric gas in the treatment chamber. When the treatment-target object is laid out from the conveying inlet to the conveying outlet, the treatment chamber is divided into a space on a first wall side and a space on a second wall side by the treatment-target object. Since the atmospheric gas in the treatment chamber is discharged from both sides of the first wall and the second wall, airflow in the treatment chamber can be optimized.

[0012] In the heat treatment furnace disclosed herein, the plurality of intake pipes may comprise: a first intake pipe disposed in the space interposed between the treatment-target object and the first wall; and a second intake pipe disposed in the space interposed between the treatment-target object and the second wall. According to such a configuration, the intake pipes are disposed in both of the two spaces divided by the treatment-target object, thus the airflow in the treatment chamber can be optimized.

[0013] In the heat treatment furnace disclosed herein, an inner surface of the treatment chamber may have 50% or more reflectivity of reflecting the electromagnetic waves in the infrared region. According to such a configuration, the electromagnetic waves emitted from the heaters are efficiently irradiated onto the treatment-target object, and the treatment-target object can efficiently be heated.

[0014] In the heat treatment furnace disclosed herein, the conveyor device may further comprise a conveying inlet roller disposed on an outer side of the furnace body and near the conveying inlet, and having the treatment-target object rolled thereon; and a conveying outlet roller disposed on the outer side of the furnace body and near the conveying outlet, and configured to roll up the treatment-target object having conveyed inside the treatment chamber. The treatment-target object rolled on the conveying inlet roller may be fed out from the conveying inlet roller and may be conveyed in the treatment chamber by rotation of the conveying inlet roller and the conveying outlet roller. According to such a configuration, the heat treatment can be performed continuously on the treatment-target object rolled on the conveying inlet roller.

[0015] In the heat treatment furnace disclosed herein, the treatment-target object may include a film and a paste applied to at least one of front and rear surfaces of the film. The heating device may be configured to remove moisture contained in the paste. Such a treatment-target object has a small heat capacity and thus an influence imposed by the guide rollers is large. Due to this, an effect of suppressing a decrease in the heat treatment efficiency of the treatment-target object (that is, a moisture removal rate) becomes significant by having the first heaters.

[0016] In the heat treatment furnace disclosed herein, the second heaters may adjust a wavelength of the electromagnetic waves to be emitted in accordance with a characteristic of the treatment-target object. According to such a configuration, the treatment-target object can suitably be heated in accordance with the characteristic of the treatment-target object.

[0017] In the heat treatment furnace disclosed herein, the plurality of second heaters may be disposed along the conveying path from the conveying inlet toward the conveying outlet. The wavelength of the electromagnetic waves emitted from each of the second heaters may be adjusted in accordance with a position on the conveying path where the second heater is disposed. The heat treatment on the treatment-target object progresses as the treatment-target object is conveyed in the treatment chamber along the conveying path. Due to this, since the wavelengths of the electromagnetic waves are adjusted in accordance with the progression of the heat treatment, the heat treatment can suitably be carried out on the treatment-target object.

[0018] In the heat treatment furnace disclosed herein, the heating device may be configured to remove moisture contained in the treatment-target object. The wavelengths of the electromagnetic waves emitted from the second heaters may be adjusted so as to be gradually longer from the conveying inlet toward the conveying outlet. The moisture contained in the treatment-target object gradually decreases from the conveying inlet toward the conveying outlet. By configuring the wavelengths of the electromagnetic waves emitted from the second heaters to be gradually longer from the conveying inlet toward the conveying outlet, the moisture contained in the treatment-target object can efficiently be removed.

[0019] In the heat treatment furnace disclosed herein, atmosphere in the treatment chamber may be inert gas atmosphere with a dew point of 0°C or lower. According to such a configuration, condensation of moisture contained in atmospheric gas can be suppressed.

First Embodiment

[0020] Hereinbelow, a heat treatment furnace 10 of a first embodiment will be described. The heat treatment furnace 10 of the present embodiment is a drying furnace (dehydrating device) configured to remove moisture contained in a workpiece W (an example of a treatment-target object). The workpiece W is a sheet body extending continuously in a longitudinal direction, and may for example be a film used in a liquid crystal display, an organic EL, or a battery. With such a film (sheet body), the film itself may contain moisture, and in a case where a covering layer is disposed on the film, this covering layer may contain moisture. Due to this, the moisture contained in the film is firstly removed, the film from which the moisture has been removed is cut into a desired size, and a final product is thereby produced. The heat treatment furnace 10 of the present embodiment may be used to remove the moisture from such a sheet body.

[0021] Hereinbelow, a configuration of the heat treatment furnace 10 will be described with reference to the drawings. As shown in FIGS. 1 and 2, the heat treatment furnace 10 includes a rectangular solid-shaped furnace body 12, a conveyor device 20 configured to carry in and carry out a workpiece W to and from the furnace body 12, a heating device (26, 28) configured to heat the workpiece W, and an intake device (38, etc.) configured to supply cooling gas to a surface of the workpiece W.

[0022] The furnace body 12 includes a lower wall 13, an upper wall 14 facing the lower wall 13, side walls 17, 18 (see FIG. 2) having one ends thereof connected to the lower wall 13 and other ends thereof connected to the upper wall 14, and a carry-in side wall 15 and a carry-out side wall 16 closing ends of a treatment chamber (19a, 19b) surrounded by these walls 13, 14, 17, 18.

[0023] The lower wall 13 is a rectangular plate member as seen in a plan view, and is disposed below the treatment chamber (19a, 19b). As shown in FIG. 1, a plurality of exhaust ports 13a is disposed on the lower wall 13 with a substantially constant interval in a x direction. Five exhaust ports 13a disposed at a center among the plurality of exhaust ports 13a are disposed at positions facing guide rollers 24 to be described later. The exhaust port 13a disposed at one end in the x direction among the plurality of exhaust ports 13a is disposed at a position near the carry-in side wall 15. The exhaust port 13a disposed at another end in the x direction among the plurality of exhaust ports 13a is disposed at a position near the carry outside wall 15. Each of the plurality of exhaust ports 13a is connected to a discharging fan 13b. When the discharging fan 13b operates, atmospheric gas in the treatment chamber (19a, 19b) is discharged outside the treatment chamber (19a, 19b).

[0024] The upper wall 14 has a same shape as the lower wall 13, and is disposed above the treatment chamber (19a, 19b). Similar to the lower wall 13, a plurality of exhaust ports 14a is disposed on the upper wall 14 with a substantially constant interval in the x direction. Each of the plurality of exhaust ports 14a is disposed at a position facing its corresponding one of the plurality of exhaust ports 13a. Each of the plurality of exhaust ports 14a is connected to a discharging fan 14b. When the discharging fan 14b operates, the atmospheric gas in the treatment chamber (19a, 19b) is discharged outside the treatment chamber (19a, 19b).

[0025] A conveying inlet 15a is defined in the carry-in side wall 15 and a conveying outlet 15b is defined in the carry outside wall 16. Height-wise positions of the conveying inlet 15a and the conveying outlet 15b are at same positions, and the conveying inlet 15a and the conveying outlet 15b face each other. As it is apparent from FIG. 1, the treatment chamber (19a, 19b) is disposed between the conveying inlet 15a and the conveying outlet 15b.

[0026] An inner surface of each of the walls 13, 14, 15, 16, 17, 18 constituting the furnace body 12 (that is, inner surfaces thereof on a treatment chamber (19a, 19b) side) is mirror-finished. As a result of this, reflectivity of these surfaces in regard to electromagnetic waves in an infrared region (more specifically, electromagnetic waves emitted by heaters 26, 28 to be described later) is set to 50% or higher. Due to this, the electromagnetic waves emitted by the heaters 26, 28 can efficiently be irradiated onto the workpiece W.

[0027] The conveyor device 20 includes a conveying inlet roller 21 disposed on an outer side of the furnace body 12 near the conveying inlet 15a, a conveying outlet roller 25 disposed on the outer side of the furnace body 12 near the conveying outlet 16a, and a plurality of guide rollers (22a, 22b, 22c, 24) disposed in the treatment chamber (19a, 19b):

[0028] The workpiece W is rolled on the conveying inlet roller 21. The workpiece W rolled on the conveying inlet roller 21 is laid out from the conveying inlet 15a to the conveying outlet 16a through the treatment chamber (19a, 19b). Specifically, the workpiece W is laid out on the guide rollers (22a, 22b, 22c, 24) from the conveying inlet roller 21 through the conveying inlet 15a, and is further laid out on the conveying outlet roller 25 from the guide rollers (22a, 22b, 22c, 24) through the conveying outlet 16a.

[0029] The conveying outlet roller 25 is a roller configured to roll up the workpiece W carried out from the treatment chamber (19a, 19b). A driving device that is not shown is connected to the conveying outlet roller 25, and the conveying outlet roller 25 is driven to rotate by this driving device. When the conveying outlet roller 25 rotates, the workpiece W rolled on the conveying inlet roller 21 is fed out to the treatment chamber (19a, 19b). The workpiece W having been fed out from the conveying inlet roller 21 is guided by the guide rollers (22a, 22b, 22c, 24) and moves on a predetermined conveying path in the treatment chamber (19a, 19b), is fed out of the treatment chamber (19a, 19b) from the conveying outlet 16a, and is rolled up by the conveying outlet roller 25. That is, the guide rollers (22a, 22b, 22c, 24) define the conveying path of the workpiece W in the treatment chamber (19a, 19b).

[0030] The guide rollers (22a, 22b, 22c, 24) include a plurality of upper guide rollers (22a, 22b, 22c) disposed near the upper wall 14 and a plurality of lower guide rollers 24 disposed near the lower wall 13. In the present embodiment, contact rollers that contact the workpiece W are used as the guide rollers (22a, 22b, 22c, 24), however, contactless rollers that guide the workpiece W contactless may be used instead.

[0031] The upper guide rollers (22a, 22b, 22c) are disposed with a substantially constant interval in the x direction. Specifically, the upper guide roller 22a (being an example of a first conveying roller recited in the claims) is disposed adjacent to the conveying inlet 15a, and the upper guide roller 22c (being an example of a third conveying roller recited in the claims) is disposed adjacent to the conveying outlet 16a. The plurality of guide rollers 22b is disposed at a regular interval between the upper guide roller 22a and the upper guide roller 22c. Height-wise positions of the respective upper guide rollers (22a, 22b, 22c) are same.

[0032] The plurality of lower guide rollers 24 (being an example of a second conveying roller recited in the claims) is respectively disposed with a constant interval in the x direction, similar to the upper guide rollers (22a, 22b, 22c). The interval between the adjacent lower guide rollers 24 in the x direction is set to be same as the interval between the upper guide rollers (22a, 22b, 22c) in the x direction. A position of each of the plurality of lower guide rollers 24 in the x direction is at a center position between adjacent upper guides (22a, 22b, 22c) corresponding thereto. Height-wise positions of the plurality of lower guide rollers 24 are same.

[0033] As aforementioned, since the upper guide rollers (22a, 22b, 22c) and the lower guide rollers 24 are disposed, the workpiece W conveyed from the conveying inlet 15a in the x direction is conveyed downward by the upper guide roller 22a and then conveyed upward by the lower guide roller 24, and is thereafter conveyed repeatedly along an up and down direction by the upper conveying rollers 22b and the lower conveying rollers 24. Further, the workpiece W being conveyed upward from the lower conveying roller 24 disposed farthest on a conveying outlet 16a side is conveyed toward the conveying outlet 16a by the upper guide roller 22c. As above, by repeatedly conveying along the up and down direction within the treatment chamber (19a, 19b), a space in the treatment chamber (19a, 19b) can efficiently be used, and a treatment time for drying the workpiece W is ensured. As it is apparent from FIG. 1, the treatment chamber (19a, 19b) is divided into an upper treatment chamber 19a located on an upper wall 14 side and a lower treatment chamber 19b located on a lower wall 13 side by the workpiece W laid out on the guide rollers (22a, 22b, 22c, 24).

[0034] The heating device is disposed in the treatment chamber (19a, 19b) and is configured to heat the workpiece W conveyed by the conveyor device 20. The heating device includes first heaters (26a, 26b) disposed near the guide rollers (22a, 22b, 22c, 24) and second heaters 28 disposed at heights of the upper guide rollers (22a, 22b, 22c) and the lower guide rollers 24. As shown in FIG. 2, the first heaters (26a, 26b) and the second heaters 28 extend in an axial direction of the guide rollers (22a, 22b, 22c, 24), and are configured capable of heating an entirety of the workpiece W in a width direction (y direction).

[0035] As shown in FIG. 1, the first heaters (26a, 26b) include a plurality of first upper heaters 26a disposed above the upper guide rollers (22a, 22b, 22c) and a plurality of first lower heaters 26b disposed below the lower guide rollers 24. Each of the first upper heaters 26a is disposed facing its corresponding one of the upper guide rollers (22a, 22b, 22c), and each of the first lower heaters 26b is disposed facing its corresponding one of the lower guide rollers 24. Due to this, the workpiece W is positioned between the first upper heaters 26a and the upper guide rollers (22a, 22b, 22c), and the workpiece W is directly heated by the first upper heaters 26a. Similarly, the workpiece W is positioned between the first lower heaters 26b and the lower guide rollers 24, and the workpiece W is directly heated by the first lower heaters 26b.

[0036] Two second heaters 28 are disposed below each of the upper guide rollers (22a, 22b, 22c) with an interval in a z direction. Further, two second heaters 28 are disposed above each of the lower guide rollers 24 with an interval in the z direction. Due to this, eleven second heaters 28 are aligned with an interval in the x direction, and two second heaters 28 are disposed with an interval in the y direction. As it is apparent from the drawings, the second heaters 28 are disposed at positions facing the workpiece W laid out on the upper guide rollers (22a, 22b, 22c) and the lower guide rollers 24 (that is, near respective intermediate positions between pairs of guide rollers adjacent in the conveying direction of the workpiece W). Since the second heaters 28 extend in the axial direction of the guide rollers (22a, 22b, 22c, 24), the entirety of the workpiece W laid out on the upper guide rollers (22a, 22b, 22c) and the lower guide rollers 24 in the width direction is heated by the second heaters 28.

[0037] The first heaters (26a, 26b) are known heaters configured capable of adjusting a wavelength for emitting electromagnetic waves in an infrared region, and the first heaters (26a, 26b) and the second heaters 28 have a same structure. Due to this, the structure of a second heater 28 will herein be described briefly.

[0038] As shown in FIG. 3, the second heater 28 includes a filament 30, an inner pipe 32 housing the filament 30, and an outer pipe 34 housing the inner pipe 32. The filament 30 is for example a heat generating body made of tungsten, and power is supplied thereto from an external power source that is not shown. When the power is supplied to the filament 30 and reaches a predetermined temperature (such as 1200 to 1700°C), electromagnetic waves including infrared light are emitted from the filament 30. The inner pipe 32 is constituted of an infrared-transmitting material that allows only electromagnetic waves in a certain wavelength region (which is the infrared region in the present embodiment) among the electromagnetic waves emitted from the filament 30 to transmit therethrough. By suitably selecting the infrared-transmitting material constituting the inner pipe 32, the wavelength of the electromagnetic waves emitted outside the inner pipe 32 from the filament 30 can be adjusted to a desired wavelength. The outer pipe 34 is also constituted of the same infrared-transmitting material as the inner pipe 32. As such, the electromagnetic waves having been transmitted through the inner pipe 32 is emitted to outside by being transmitted through the outer pipe 34. A space 36 between the inner pipe 32 and the outer pipe 34 is a cooling medium passage in which a cooling medium (such as air) flows. A temperature of the outer pipe 34 is suppressed from becoming too high by the cooling medium being supplied to the space 36 (that is, the cooling medium passage). Due to this, overheating of the workpiece W is suppressed. A heater configured capable of controlling the wavelength of the electromagnetic waves in the infrared region is described in detail, for example in JP 4790092 B1.

[0039] The intake device includes a plurality of intake pipes 38 extending in the treatment chamber (19a, 19b) in the y direction, and an intake fan (not shown) disposed outside the treatment chamber (19a, 19b) and configured to supply cooling gas to the plurality of intake pipes 38. As shown in FIG. 4, the intake pipes 38 each have ejection holes 39a, 39b at two locations in a circumferential direction. Due to this, the cooling gas supplied from the intake fan to the intake pipes 38 is ejected into the treatment chamber (19a, 19b) from the ejection holes 39a, 39b. In the present embodiment, an orientation along which the intake pipes 38 are arranged is adjusted such that an ejecting direction of the cooling gas ejected from the ejection holes 39a, 39b perpendicularly intersects the surface of the workpiece W. As shown in FIG. 4, the ejection holes 39a, 39b are disposed at positions facing each other with an axis line of the intake pipe 38 in between them. Due to this, in a case where the workpiece W is positioned on the intake pipe 38 on both a conveying inlet 15a side and a conveying outlet 16a side, the cooling gas ejected from the ejection holes 39a of the intake pipe 38 is ejected to the workpiece W on one side and the cooling gas ejected from the ejection holes 39b of the intake pipe 38 is ejected to the workpiece W on the other side. Further, as shown in FIG. 2, the ejection holes 39a, 39b are defined in plurality with an interval in between each other in the y direction in each intake pipe 38. Due to this, the cooling gas ejected from the ejection holes 39a, 39b is ejected over the entirety of the workpiece W in the width direction (y direction).

[0040] As shown in FIG. 1, two intake pipes 38 are disposed below each of the upper guide rollers (22a, 22b, 22c) with an interval in the z direction. Further, two intake pipes 38 are disposed above each of the lower guide rollers 24 with an interval in the z direction. As it is apparent from FIG. 1, the intake pipes 38 are disposed at positions different from positions where the first heaters (26a, 26b) and the second heaters 28 are disposed. Specifically, the second heaters 28 and the intake pipes 38 are disposed alternately with a regular interval in the z direction (conveying direction). Further, as aforementioned, the treatment chamber (19a, 19b) is divided into the upper treatment chamber 19a and the lower treatment chamber 19b by the workpiece W laid out on the guide rollers (22a, 22b, 22c, 24), and the intake pipes 38 are disposed in each of the upper treatment chamber 19a and the lower treatment chamber 19b.

[0041] Inert gas, nitrogen, and Ar gas may be exemplified as the cooling gas supplied to the intake pipes 38. The atmospheric gas in the treatment chamber (19a, 19b) is adjusted by the gas ejected into the treatment chamber (19a, 19b) from the intake pipes 38. In the present embodiment, the atmospheric gas in the treatment chamber (19a, 19b) is adjusted to gas having a dew point at 0°C or lower in order to remove the moisture contained in the workpiece W. Open air, of which dew point is 0°C or lower, may be used as the cooling gas.

[0042] A controller 44 is configured to a processor including a CPU, a ROM, and a RAM, and is configured to control the conveyor device 20, the heating device (26, 28), and the intake device. Specifically, the controller 44 controls a conveying speed and tension of the workpiece W by controlling the conveyor device 20, controls a heating amount of the workpiece W by controlling the heating device (26, 28), and controls a flow rate and speed of the cooling gas ejected from the intake pipes 38 to the workpiece W by controlling the intake device.

[0043] The heat treatment furnace 10 includes a setting device for setting the work piece W, which is rolled on the conveying inlet roller 21, on the conveying outlet roller 25. As shown in FIG. 1, the setting device includes chains 42 configured to circulate within the treatment chamber (19a, 19b) and outside the treatment chamber (19a, 19b) and a driving device (not shown) configured to drive the chain 42. Similar to the workpiece W laid out on the guide rollers (22a, 22b, 22c, 24), each chain 42 extends from the conveying inlet 15a to the conveying outlet 16a with its orientation changed along the up-down direction, extends outside the treatment chamber (19a, 19b) from the conveying outlet 16a, and returns to the conveying inlet 15a. As shown in FIG. 1, a path on which each chain 42 is laid out intersects the path on which the workpiece W is laid out (that is, the conveying path of the workpiece W) at multiple points. Since a position where each chain 42 is disposed is a position on an outer side of the workpiece W in the width direction (y direction), the chains 42 and the workpiece W do not interfere with each other (see FIG. 2). In order to set the workpiece W on the conveying outlet roller 25 by the setting device, firstly the workpiece W rolled on the conveying inlet roller 21 is clamped by clamps not shown disposed on the chains 42. Then, the chains 42 are circulated by the driving device, and the workpiece W is fed out from the conveying inlet roller 21. Due to this, the workpiece W held by the clamps on the chains 42 moves inside the treatment chamber (19a, 19b) together with the chains 42 and moves to the conveying outlet 16a. When the workpiece W moves to the conveying outlet 16a, the clamps are operated to release the workpiece W from the chains 42, and the workpiece W is set on the conveying outlet roller 25. Finally, the conveying outlet roller 25 is rotated to provide the workpiece W with tension, and the workpiece W is laid out from the conveying inlet 15a to the conveying outlet 16a via the guide rollers (22a, 22b, 22c, 24).

[0044] Next, treatment to remove the moisture from the workpiece W using the aforementioned heat treatment furnace 10 will be described. Firstly, the cooling gas is supplied from the intake pipes 38 into the treatment chamber (19a, 19b) and inside of the treatment chamber (19a, 19b) is adjusted to predetermined atmosphere. Then, the controller 44 drives the conveyor device 20 to convey the workpiece W from the conveying inlet 15a to the conveying outlet 16a through the treatment chamber (19a, 19b). At this occasion, the controller 44 controls the heating device (26, 28) to irradiate the electromagnetic waves in the infrared region onto the workpiece W and ejects the cooling gas onto the surface of the workpiece W from the intake pipes 38. When the electromagnetic waves in the infrared region are irradiated from the heating device (26, 28), the moisture contained in the workpiece W absorbs the electromagnetic waves and the moisture thereby evaporates. The moisture evaporated from the workpiece W is removed from the surface of the workpiece W by the cooling gas ejected from the intake pipes 38. The atmospheric gas containing the moisture removed from the surface of the workpiece W is discharged to outside of the treatment chamber (19a, 19b) from the exhaust ports 13a in the lower wall 13 and the exhaust ports 14a in the upper wall 14. The moisture is removed from the workpiece W while it is conveyed from the conveying inlet 15a to the conveying outlet 16a. The workpiece W from which the moisture has been removed is rolled up by the conveying outlet roller 25.

[0045] According to the above heat treatment furnace 10, it includes the first heaters (26a, 26b) facing the guide rollers (22a, 22b, 22c, 24) near the guide rollers (22a, 22b, 22c, 24). Further, it includes the second heaters 28 between the upper guide rollers (22a, 22b, 22c) and the lower guide rollers 24. Due to these heaters 26a, 26b, 28, a heat balance of the workpiece W in a state of contacting the guide rollers (22a, 22b, 22c, 24) can be controlled, and the heat balance of the workpiece W in a state of not contacting the guide rollers (22a, 22b, 22c, 24) can be controlled. Due to this, the heat balance of the workpiece W can suitably be controlled, and efficiency of the treatment of removing the moisture from the workpiece W can drastically be improved. For example, in a case where the workpiece W is excessively cooled due to heat being transmitted from the workpiece W to the guide rollers (22a, 22b, 22c, 24) by the workpiece W being in contact with the guide rollers (22a, 22b, 22c, 24), the heating amount supplied from the first heaters (26a, 26b) to the workpiece W is increased to suppress the workpiece W from being excessively cooled. Due to this, decrease in the efficiency of removing the moisture from the workpiece W can be suppressed.

[0046] Further, in the above heat treatment furnace 10, the intake pipes 38 and the second heaters 38 are disposed alternately in the conveying direction, and the cooling gas from the intake pipes 38 is ejected in a direction perpendicularly intersecting the surface of the workpiece W. Due to this, the moisture having evaporated from within the workpiece W is promptly removed from the surface of the workpiece W, and moisture removal of the workpiece W is thereby promoted. Due to this as well, the efficiency of the moisture removal of the workpiece W can be improved.

[0047] Further, the treatment chamber (19a, 19b) is divided into the upper treatment chamber 19a and the lower treatment chamber 19b by the workpiece W laid out on the guide rollers (22a, 22b, 22c, 24), and the intake pipes 38 and the exhaust ports 14a, 13a are respectively disposed in both the upper treatment chamber 19a and the lower treatment chamber 19b. Due to this, the cooling gas supplied to the upper treatment chamber 19a and the cooling gas supplied to the lower cooling chamber

19b are promptly discharged outside the treatment chamber (19a, 19b) together with the removed moisture. Due to this as well, a gas flow in the treatment chamber (19a, 19b) is optimized, and the efficiency of the moisture removal of the workpiece W can be improved.

[0048] The heaters (26a, 26b, 28) are configured capable of adjusting the wavelength range of the emitted infrared light by selection of the infrared-transmitting material constituting the inner pipes and the outer pipes. Due to this, the heat treatment efficiency of the workpiece W can be improved by adjusting the wavelength of the electromagnetic waves to be emitted in accordance with a characteristic of the workpiece W. For example, a case will be considered in which a substance constituted of a solid content (phenol-epoxy resin, 10 to 90wt%) and a solvent (water or solution (such as IPA (isopropyl alcohol), NMP (N-methyl-2-pyrrolidone)), etc.) transforming the solid content in a slurry or paste state as the workpiece W is to be dried. In a case of drying such a workpiece W, drying of the water or solution may be performed by heaters (26a, 26b, 28) having selected near-infrared wavelength(s) in a front half of the heat treatment furnace 10, and annealing by the heaters (26a, 26b, 28) having selected far-infrared wavelength(s) may be performed in a rear half of the heat treatment furnace 10.

[0049] Further, in the above embodiment, all of the heaters (26a, 26b, 28) emitted the electromagnetic waves in the same wavelength region, however, no limitation is made to such an example. For example, the wavelengths of the electromagnetic waves emitted from the heaters (26a, 26b, 28) may be adjusted according to positions on the conveying path. For example, in the case of removing the moisture from the workpiece W by the heat treatment furnace 10, a moisture content in the workpiece W gradually decreases from the conveying inlet 15a toward the conveying outlet 16a. Due to this, the wavelengths of the electromagnetic waves emitted from the heaters (26a, 26b, 28) may gradually be made long from the conveying inlet 15a toward the conveying outlet 16a, by which the electromagnetic waves according to the moisture content may be irradiated onto the workpiece W.

[0050] Further, in the above embodiment, the first heaters (26a, 26b) are disposed near the guide rollers (22a, 22b, 22c, 24) and the workpiece W is heated by the first heaters (26a, 26b), however, no limitation is made to such a configuration. For example, passage(s) in which a heat medium flows may be provided inside the guide roller(s), and the workpiece W may be heated by the guide rollers. According to such a configuration as well, the heat balance of the workpiece W in the state of contacting the guide rollers can be controlled, and the heat treatment efficiency on the workpiece W can be improved.

[0051] Technical features described in the description and the drawings may technically be useful alone or in various combinations, and are not limited to the combinations as originally claimed. Further, the art described in the description and the drawings may concurrently achieve a plurality of aims, and technical significance thereof resides in achieving any one of such aims.

Claims

1. A heat treatment furnace comprising:

a furnace body that comprises a conveying inlet, a conveying outlet, and a treatment chamber disposed between the conveying inlet and the conveying outlet;
a conveyor device configured to convey a treatment-target object, which is laid out from the conveying inlet to the conveying outlet, from the conveying inlet to the conveying outlet through the treatment chamber;
a plurality of guide rollers disposed in the treatment chamber and configured to guide the treatment-target object conveyed by the conveyor device; and
a heating device disposed in the treatment chamber and configured to heat the treatment-target object conveyed by the conveyor device, wherein
the treatment-target object is conveyed from the conveying inlet to the conveying outlet on a conveying path defined by the plurality of guide rollers,
the heating device comprises:

first heaters each disposed inside and/or near its corresponding one of the plurality of guide rollers and configured to heat the treatment-target object; and
second heaters each disposed on the conveying path near an intermediate position between its corresponding guide rollers adjacent to each other in a conveying direction of the treatment-target object and configured to heat the treatment-target object, and

the second heaters are each a heater configured to emit electromagnetic waves in an infrared region.

2. The heat treatment furnace according to claim 1, wherein

the first heaters are each a heater disposed on the conveying path of the treatment-target object near a corresponding position where the corresponding guide roller is disposed and configured to emit electromagnetic waves in the infrared region that are of a same type as the second heaters, and
the treatment-target object is positioned between the first heaters and the guide rollers.

3. The heat treatment furnace according to claim 1, wherein each of the first heaters is disposed inside the corresponding one of the guide rollers and comprises a passage through which a heat medium for heating the guide rollers flows.

4. The heat treatment furnace according to any one of claims 1 to 3, further comprising:

an intake device configured to supply gas into the treatment chamber,
wherein the intake device is disposed at a position within the treatment chamber that is different from positions where the first heaters are disposed and different from positions where the second heaters are disposed, and comprises a plurality of intake pipes configured to eject the gas toward the treatment-target object, and
the second heaters and the intake pipes are disposed alternately along the conveying path.

5. The heat treatment furnace according to claim 4, wherein an ejecting direction of the gas ejected from the plurality of intake pipes perpendicularly intersects a surface of the treatment-target object.

6. The heat treatment furnace according to claim 4 or 5, wherein
the plurality of guide rollers comprises:

a first guide roller configured to change the conveying direction of the treatment-target object, which is conveyed from the conveying inlet, to a first direction;
a second guide roller configured to change the conveying direction of the treatment-target object, which is conveyed in the first direction, to a second direction different from the first direction; and
a third guide roller configured to change the conveying direction of the treatment-target object, which is conveyed in the second direction, toward the conveying outlet,
wherein the furnace body comprises a first wall located on a first direction side as seen from a center of the treatment chamber and a second wall located on a second direction side as seen from the center of the treatment chamber,
the first wall comprises a first exhaust port configured to discharge atmospheric gas in the treatment chamber, and
the second wall comprises a second exhaust port configured to discharge the atmospheric gas in the treatment chamber.

7. The heat treatment furnace according to claim 6, wherein
the plurality of intake pipes comprises:

a first intake pipe disposed in a space interposed between the treatment-target object and the first wall; and
a second intake pipe disposed in a space interposed between the treatment-target object and the second wall.

8. The heat treatment furnace according to any one of claims 1 to 7, wherein an inner surface of the treatment chamber has 50% or more reflectivity of reflecting the electromagnetic waves in the infrared region.

9. The heat treatment furnace according to any one of claims 1 to 8, wherein
the conveyor device further comprises:

a conveying inlet roller disposed on an outer side of the furnace body and near the conveying inlet, and having the treatment-target object rolled thereon; and
a conveying outlet roller disposed on the outer side of the furnace body and near the conveying outlet, and configured to roll up the treatment-target object having conveyed inside the treatment chamber,
wherein the treatment-target object rolled on the conveying inlet roller is fed out from the conveying inlet roller and is conveyed in the treatment chamber by rotation of the conveying inlet roller and the conveying outlet roller.

10. The heat treatment furnace according to any one of claims 1 to 9, wherein

the treatment-target object includes a film and a paste applied to at least one of front and rear surfaces of the film, and
the heating device is configured to remove moisture contained in the paste.

11. The heat treatment furnace according to any one of claims 1 to 3, wherein the second heaters adjust a wavelength of the electromagnetic waves to be emitted in accordance with a characteristic of the treatment-target object.

12. The heat treatment furnace according to claim 10, wherein

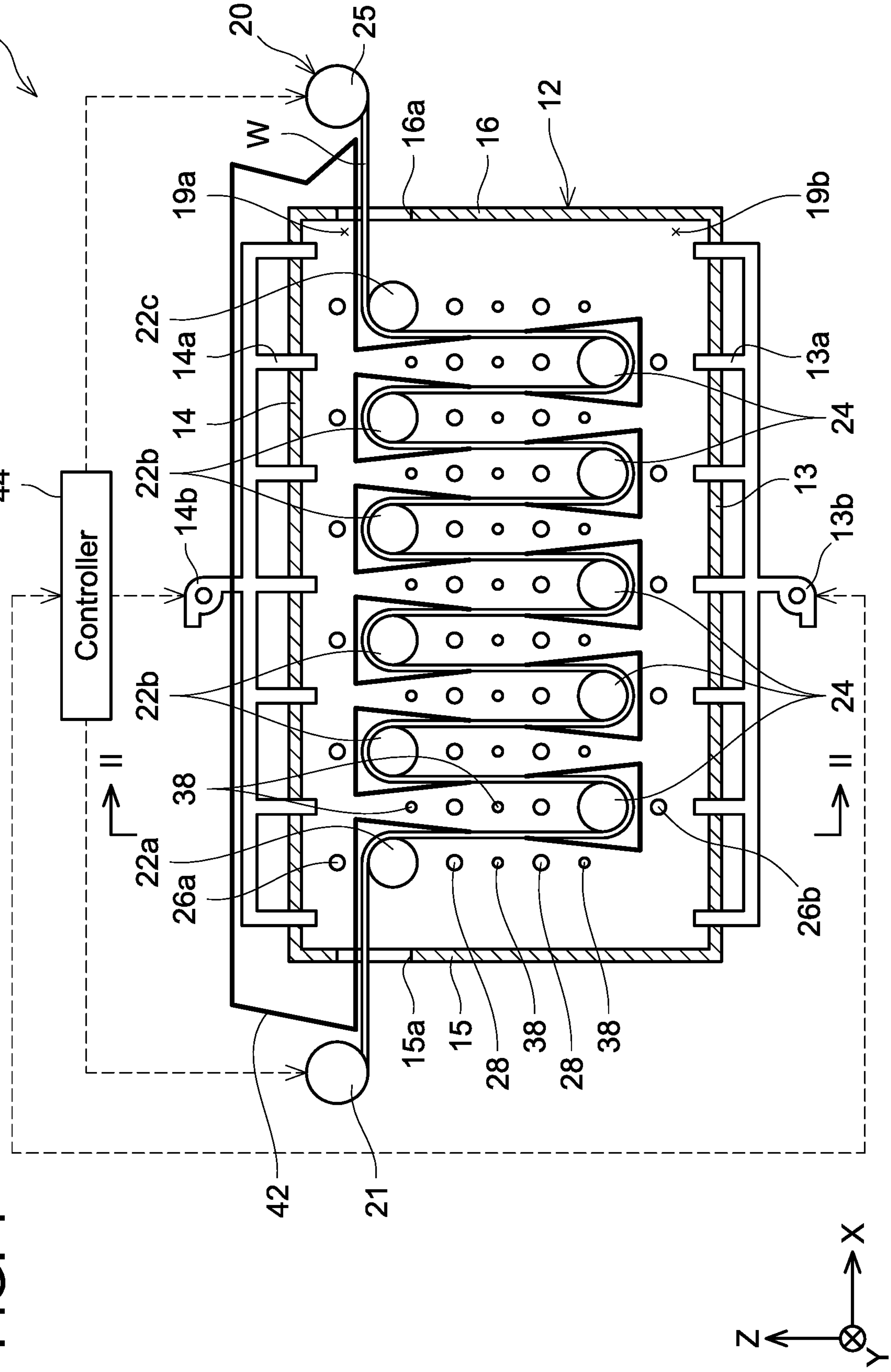
the plurality of second heaters is disposed along the conveying path from the conveying inlet toward the conveying outlet, and
a wavelength of the electromagnetic waves emitted from each of the second heaters is adjusted in accordance with a position on the conveying path where the second heater is disposed.

13. The heat treatment furnace according to claim 12, wherein

the heating device is configured to remove moisture contained in the treatment-target object, and
the wavelengths of the electromagnetic waves emitted from the second heaters are adjusted so as to be gradually longer from the conveying inlet toward the conveying outlet.

14. The heat treatment furnace according to any one of claims 1 to 13, wherein atmosphere in the treatment chamber is inert gas atmosphere with a dew point of 0°C or lower.

FIG. 1


10
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16
16a
W
19a
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22c
14a
13a
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44
Controller
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22a
26a
26b
15a
15
28
42
21
X
Z
Y

FIG. 2

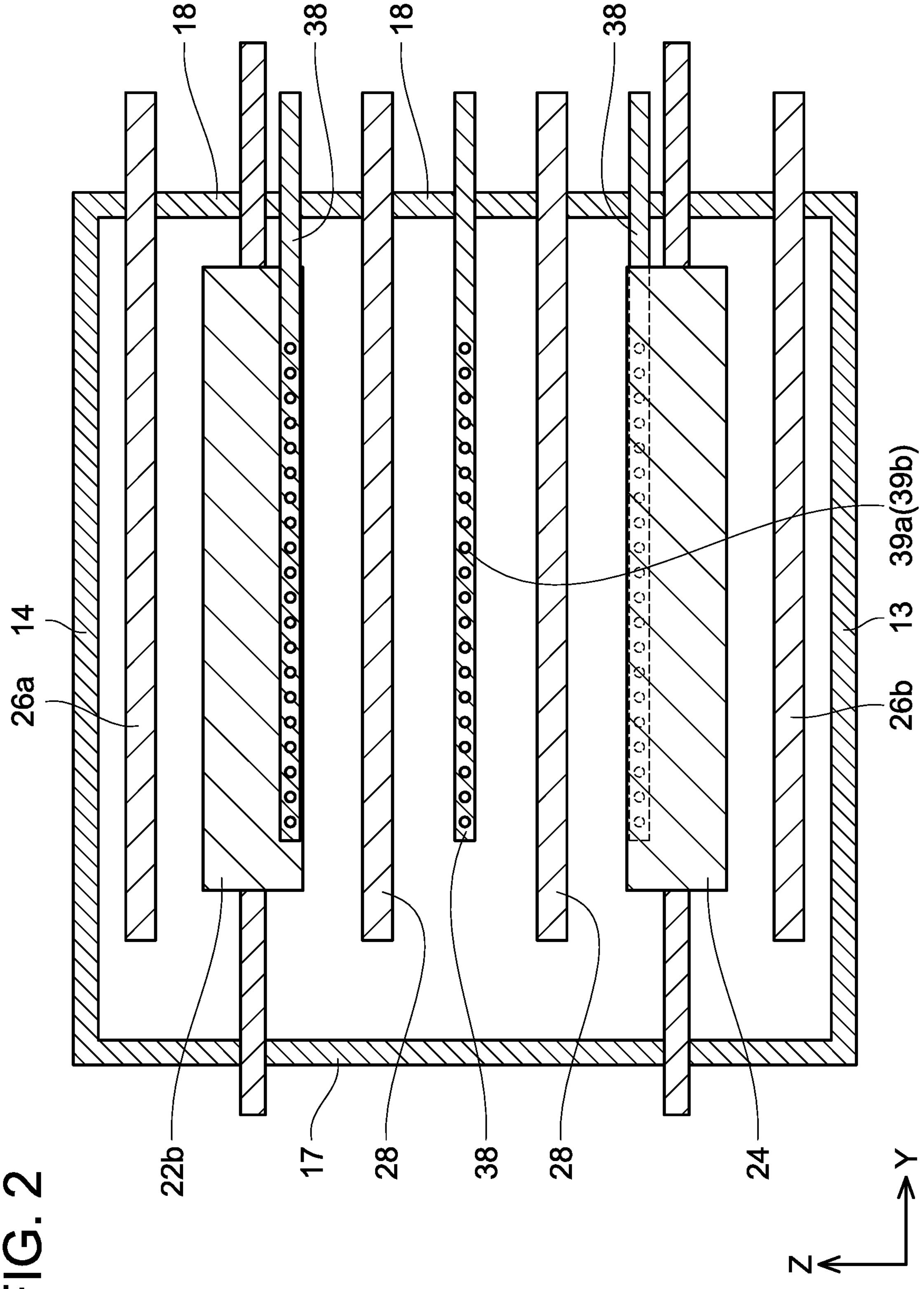


FIG. 3

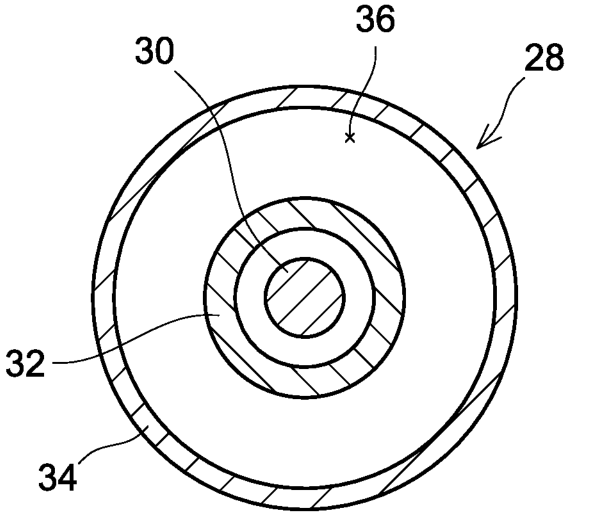
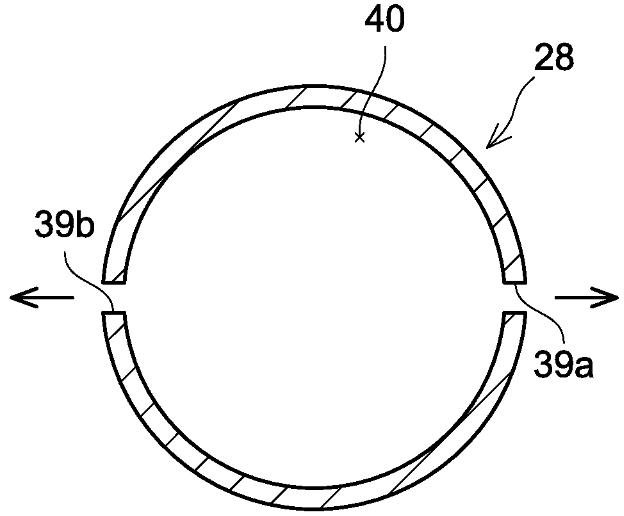


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2020/006127

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. F26B13/08(2006.01)i, F26B23/04(2006.01)i, F27B9/14(2006.01)i, F27B9/36(2006.01)i, F27D11/02(2006.01)i, B29C71/02(2006.01)i
FI: F27B9/14, F27B9/36, F27D11/02 Z, F26B13/08 A, F26B23/04 B, B29C71/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. F26B13/08, F26B23/04, F27B9/00-9/40, F27D11/02, B29B7/00-11/14, B29B13/00-15/06, B29C31/00-31/10, B29C37/00-37/04, B29C71/00-71/02, C08J7/00, C21D9/52-9/66

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2018-66552 A (RICOH CO., LTD.) 26 April 2018, paragraphs [0097]-[0112], fig. 14	1, 11 11, 14
X	JP 2006-315386 A (KYUNG IL TECH CO., LTD.) 24 November 2006, paragraphs [0012], [0013], fig. 2	1
Y A	WO 2014/163175 A1 (NGK INSULATORS, LTD.) 09 October 2014, paragraphs [0019]-[0036], fig. 1	1-9, 11, 14 10, 12-13
Y A	JP 2015-206576 A (ASAHI GLASS CO., LTD.) 19 November 2015, paragraph [0033], fig. 1	1-9, 11, 14 10, 12-13

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

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01.05.2020	19.05.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/006127

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2018-66552 A	26.04.2018	US 2017/0266991 A1 paragraphs [0117]-[0132], fig. 14	
JP 2006-315386 A	24.11.2006	KR 10-0629655 B1	
WO 2014/163175 A1	09.10.2014	TW 201509636 A	
JP 2015-206576 A	19.11.2015	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- WO 2014163175 A1 **[0002]**
- JP 4790092 B **[0038]**