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(54) REFRIGERATION DEVICE

(57) A refrigeration apparatus includes: a housing that surrounds an internal space (refrigeration chamber) where a refrigeration target is stored; and a negative pressure release port that includes a pipe (cylindrical body) attached to the housing so as to protrude into the internal space, a heating element provided in the pipe, and a rib joining the pipe and the heating element.

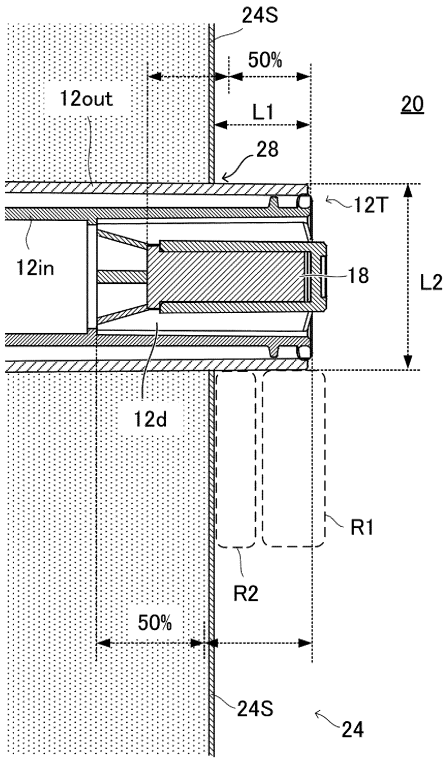

FIG. 5

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Description

Technical Field

[0001] The present disclosure relates to a refrigeration apparatus.

Background Art

[0002] There is known an ultra-low temperature refrigeration apparatus for storing cells, microorganisms, etc. The refrigeration apparatus includes a thermal insulation case body that is separated from the external space by a thermal insulating member and that has internal space storing an object, and a thermal insulation door that is provided at an opening on the front side of the thermal insulation case body.

[0003] When the thermal insulation door is closed, the internal space is sealed and maintained in a cryogenic state. Meanwhile, when the thermal insulation door is opened for taking the object in and out, air from the internal space flows out into the external space and air from the external space flows into the internal space.

[0004] When the thermal insulation door is closed in such a situation, the flowed air is rapidly cooled and contracted, resulting in a negative pressure state in the internal space. This generates a pressure difference between the external space and the internal space, and the thermal insulation door will possibly not open with an attempt to open the thermal insulation door again.

[0005] To solve the problem, such a refrigeration apparatus is provided with a negative pressure release port in some cases. The negative pressure release port includes a path communicating the internal space with the external space, and air flows through the path. When the internal space is in the negative pressure state, air from the external space flows into the internal space through the negative pressure release port, and thus no pressure difference is generated between the external space and the internal space.

[0006] Incidentally, when external air including moisture flows into the internal space in the cryogenic state, the moisture contained in the air freezes in the path or around a terminal section of the path on the internal space side, and the path is possibly blocked.

[0007] Patent Literature (hereinafter, referred to as PTL) 1 discloses an apparatus including a conduit having a thermally conductive body, a first opening exposed to the internal space, and a second opening exposed to the external space, and a part of the thermally conductive body of the conduit is wound by a heated coil.

[0008] The negative pressure release port disclosed in PTL 1 prevents freezing in a path or around a terminal section of the path on the internal space side by heating the body.

Citation List

Patent Literature

[0009] PTL 1
Japanese Patent Application Laid-Open No. 2006-292352

Summary of Invention

Technical Problem

[0010] In the negative pressure release port disclosed in PTL 1, most of the ice formed from the moisture contained in the air flowed from the path adheres to the lower side of the first opening of the negative pressure release port and the inner surface of a thermal insulation case body composing the internal space. When the ice formed on the lower side of the first opening and the inner surface of the thermal insulation case body grows as time passes, the moisture contained in the air possibly flows back using the ice as a foundation instead of flowing down to the internal space side from the first opening. When the moisture flows back in the path, the moisture freezes in the path and blocks the path. Thus, improvement has been required.

[0011] It is an objective of the present disclosure to provide a refrigeration apparatus capable of better preventing a situation where a path in a negative pressure release port is blocked by freezing.

Solution to Problem

[0012] A refrigeration apparatus according to the present disclosure includes: a housing that surrounds a refrigeration chamber where a refrigeration target is stored; and a negative pressure release port that includes a cylindrical body attached to the housing so as to protrude into the refrigeration chamber, a heating element provided in the cylindrical body, and a rib joining the cylindrical body and the heating element.

Advantageous Effects of Invention

[0013] According to the present disclosure, it is possible to better prevent a situation where a path in a negative pressure release port is blocked by freezing.

Brief Description of Drawings

[0014]

FIG. 1 is a front view of a refrigeration apparatus;
FIG. 2 is a perspective view illustrating an overall configuration of the refrigeration apparatus with an outer door and an inner door both opened;
FIG. 3 is a cross-sectional view taken along the line A-A in FIG. 1;

FIG. 4 is a cross-sectional view of a negative pressure release port; and

FIG. 5 is a cross-sectional view illustrating only important sections of the negative pressure release port and a housing.

Description of Embodiments

(Refrigeration apparatus 1)

[0015] Hereinafter, a refrigeration apparatus according to an embodiment of the present disclosure will be described in detail with reference to the accompanying drawings. FIG. 1 is a front view of the refrigeration apparatus. FIG. 2 is a perspective view illustrating an overall configuration of the refrigeration apparatus with an outer door and an inner door both opened.

[0016] Refrigeration apparatus 1 includes housing 2, inner door 3, outer door 4, and machine chamber 5.

[0017] Note that, in the following description, the outer door 4 side of refrigeration apparatus 1 is referred to as the front, and the housing 2 side is referred to as the back. In addition, a vertical direction in the following description corresponds to the vertical direction in FIGS. 1 and 2.

[0018] Housing 2 is a case body including internal space 20 that is open toward the front. Internal space 20 is a space for storing a target object to be stored frozen (refrigeration target) in refrigeration apparatus 1. Note that internal space 20 is an example of a refrigeration chamber of the present disclosure.

[0019] Opening 21 of housing 2 is divided into two openings 21a and 21b, which are vertically arranged, by partition 22. Note that opening 21 of housing 2 is a collective term for an opening of inner case 24 (see FIG. 4 described later) and an opening of outer case 25 (see FIG. 4 described later).

[0020] Internal space 20 is divided into two internal spaces 20a and 20b, which are vertically arranged, by partition 22 and partition plate 23. Partition 22 is an example of a partition member of the present disclosure.

[0021] Partition plate 23 is a plate member partitioning the inside of internal space 20. There may be a plurality of partition plates 23 provided. In the case where a plurality of partition plates 23 are provided, internal spaces 20a and 20b are divided into a plurality of spaces. Partition plate 23 is attachable/detachable, and can be attached to a desired position in the vertical direction of internal spaces 20a and 20b. FIG. 2 illustrates an example where three partition plates 23 are attached and one of them is placed at substantially the same height as partition 22.

[0022] Note that a plurality of partition plates 23 need not always be attached at the time of using refrigeration apparatus 1. For example, a case, rack, etc. for storing a target object may be arranged in internal space 20 without partition plates 23 other than partition plate 23 placed at the same height as partition 22.

[0023] Housing 2 includes inner case 24, outer case 25 provided outside of inner case 24 with a gap, and thermal insulation material 26 (see FIG. 4 described later) such as urethane foam filled in the gap between inner case 24 and outer case 25. Inner case 24 and outer case 25 are open toward the front. Inner surfaces of inner case 24 compose internal space 20 described above.

[0024] Inner door 3 includes two inner doors 3a and 3b provided vertically. Two inner doors 3a and 3b are provided respectively corresponding to openings 21a and 21b. The front right edges of inner doors 3a and 3b are fixed to the front right edge of housing 2 with a plurality of hinges 6 (6a and 6b) provided vertically.

[0025] Outer door 4 is a door that can be closed so as to cover entire opening 21 and inner door 3 when inner doors 3a and 3b close openings 21a and 21b. Outer door 4 is fixed to the front right edge of housing 2, outside (i.e., right side) of inner door 3, with a plurality of hinges 7 provided vertically.

[0026] With such a configuration, opening 21 of housing 2 can be doubly opened and closed by inner door 3 and outer door 4. To be more specific, inner door 3a swings horizontally with hinge 6a as the center of swinging, and can open and close opening 21a by a user operation. Inner door 3b swings horizontally with hinge 6b as the center of swinging, and can open and close opening 21b by a user operation. In this manner, openings 21a and 21b can be individually opened and closed by inner doors 3a and 3b. In addition, outer door 4 swings horizontally with hinges 7 as the center of swinging, and can open and close entire opening 21 from the outside of inner door 3.

[0027] Inner door 3 includes a thermal insulation material inside so that internal space 20 is maintained at a low temperature.

[0028] The perimeter of the opening of outer case 25 in housing 2 (top, right side, bottom, and left side) is provided with packing 211 for outer door 4 all around. The perimeter of the opening of inner case 24 is provided with packing 212 for inner door 3. That is, packing 212 for inner door 3 is provided inward relative to packing 211 for outer door 4. Further, packing 212 for inner door 3 is provided at not only the perimeter of the opening of inner case 24 but also the outer surface of partition 22.

[0029] When outer door 4 is closed, packing 211 is in close contact with the inner surface of outer door 4 at every part of the perimeter of the opening of outer case 25. When inner door 3 is closed, packing 212 is in close contact with inner door 3 at the perimeter of the opening of inner case 24 and the front surface of partition 22. As described above, providing packings 211 and 212 allows housing 2, inner door 3, and outer door 4 to make closer contact when inner door 3 and outer door 4 are closed, thereby improving the sealing performance for internal space 20.

[0030] Additionally, outer door 4 is provided with handle 40 held by a user to open or close. Handle 40 includes a lock mechanism (not illustrated). The lock mechanism

is for locking outer door 4 in the closed position or unlocking to open outer door 4. Locking outer door 4 by the lock mechanism improves the airtightness and thermal insulation of refrigeration apparatus 1.

[0031] Machine chamber 5 is provided at the lower section of housing 2 in the present embodiment. Inside machine chamber 5, various devices and a controller composing freezing circuitry (not illustrated) are provided to refrigerate internal space 20. The freezing circuitry can refrigerate internal space 20 to a cryogenic temperature, e.g., -80 degrees.

[0032] Further, the left side surface of housing 2 is provided with negative pressure release port 8 that connects external space 27 (see FIG. 4) and internal space 20 of housing 2, and introduces outside air into internal space 20. Negative pressure release port 8 is provided for generating no pressure difference between external space 27 and internal space 20. Note that, although the present embodiment describes a case where negative pressure release port 8 is provided on the left side surface of housing 2, the present disclosure is not limited to this and negative pressure release port 8 may be provided on the right side surface of housing 2, for example.

[0033] FIG. 3 is a cross-sectional view taken along the line A-A in FIG. 1. As illustrated in FIG. 3, negative pressure release port 8 is provided at the same height as partition 22 in the vertical direction when viewed from the internal space 20 side. In addition, the width of negative pressure release port 8 in the vertical direction is shorter than the width of the front surface of partition 22 in the vertical direction, when viewed from the internal space 20 side.

[0034] As illustrated in FIG. 3, negative pressure release port 8 is open toward space S. This space S is a space hidden by partition 22 in the front view of refrigeration apparatus 1, and is separated from internal space 20 by partition 22. That is, such a configuration of negative pressure release port 8 open toward space S prevents a target object from directly making contact with the outside air flowed from negative pressure release port 8 since the target object is not placed in space S. This prevents the temperature rise of the target object due to the direct contact with the outside air warmer than cold air in internal space 20 and prevents condensation and freezing on the surface of the target object.

(Negative Pressure Release Port 8)

[0035] Next, negative pressure release port 8 will be described in detail. FIG. 4 is a cross-sectional view of negative pressure release port 8. As illustrated in FIG. 4, inner case 24, outer case 25, and thermal insulation material 26 of housing 2 are provided with through hole 28 to communicate external space 27 of housing 2 with internal space 20. In the following description, the inside of inner case 24, i.e., a surface on the internal space 20 side, is referred to as inner surface 24S, and the outside of outer case 25, i.e., a surface on the external space 27 side, is referred to as outer surface 25S. Additionally, for each configuration, an end portion inside housing 2 (the internal space 20 side) is referred to as one end, and an end portion outside housing 2 (the external space 27 side) is referred to as the other end.

[0036] Negative pressure release port body 11 in inserted into through hole 28.

[0037] As illustrated in FIG. 4, negative pressure release port body 11 includes pipe 12, a pair of packings 13, valve guide 14, valve spring 15, valve body 16, base 17, and heating element 18.

[0038] As illustrated in FIG. 4, pipe 12 is a substantially cylindrical member formed of a resin such as polybutylene terephthalate (PBT), for example. Pipe 12 has a double structure of outer pipe 12out, which is provided outside, and inner pipe 12in, which is provided inside.

[0039] Outer pipe 12out includes cylindrical section 121, first flange 122, expanded cylindrical section 123, and second flange 124.

[0040] One end of cylindrical section 121 is provided so as to protrude from inner surface 24S of inner case 24 to the internal space 20 side together with one end of cylindrical section 12a of inner pipe 12in to be described later.

[0041] The other end side of cylindrical section 121 is connected to the one end side of expanded cylindrical section 123 via first flange 122. The other end side of expanded cylindrical section 123 is exposed to external space 27 from outer surface 25S of outer case 25, and second flange 124 is extended along outer surface 25S.

[0042] Inner pipe 12in is provided inside of outer pipe 12out. Seal member 12S, such as an O-ring, is provided between the ends of inner pipe 12in and outer pipe 12out on the one end side. Holding section 12b for holding heating element 18 is provided on the one end side of cylindrical section 12a, and rib 12d is further provided to join inner wall 12c of cylindrical section 12a and holding section 12b. As described above, one end of inner pipe 12in is provided so as to protrude from inner surface 24S to the internal space 20 side together with one end of cylindrical section 121.

[0043] Holding section 12b is provided at the center part of inner pipe 12in, and includes holding cylindrical section 12ba, which extends in the axis direction of inner pipe 12in, and holding bottom section 12bb, which holds one end of heating element 18.

[0044] There are ribs 12d provided at three positions, for example, at equal intervals in the circumferential direction, and each of ribs 12d joins the outer circumferential surface of holding cylindrical section 12ba and inner wall 12c of cylindrical section 12a. Space between adjacent ribs 12d functions as a path for air to pass through.

[0045] The other end of cylindrical section 12a is provided with expanded section 12e via an expanded tapered section. The other end side of expanded section 12e is provided with flange section 12f extending to the outer diameter side. Further, as illustrated in FIG. 4, ex-

panded section 12e includes extended section 12g extending to the other end side from flange section 12f.

[0046] As illustrated in FIG. 4, packing 13 is a ring member and formed with annular groove 13a on the side surface. As illustrated in FIG. 4, packing 13 on the one end side is held between inner pipe 12in and valve guide 14, with annular groove 13a fitting into extended section 12g of inner pipe 12in, and seals between inner pipe 12in and valve guide 14.

[0047] Packing 13 on the other end side is held between valve guide 14 and base 17, with annular groove 13a fitting into annular protrusion 17d of base 17, the detail of which will be described later, and seals between valve guide 14 and base 17.

[0048] Valve guide 14 is a stepped cylindrical member formed of a resin, as illustrated in FIG. 4. Valve guide 14 includes first cylindrical section 14a, disk section 14b, which extends from the other end of first cylindrical section 14a to the outer diameter side, and second cylindrical section 14c, which extends from the end of disk section 14b on the outer dimeter side to the other end side.

[0049] The one end surface of disk section 14b is in contact with packing 13 on the one end side, as described above, and the other end surface of disk section 14b is in contact with valve spring 15. The other end surface of second cylindrical section 14c is in contact with packing 13 on the other end side, as described above. The inner circumferential surface of second cylindrical section 14c is provided with a plurality of ribs 14d extending to the inner diameter side, and the inner diameter ends of ribs 14d guide the outer circumferential surface of valve body 16. In addition, space between adjacent ribs 14d functions as a path for air to pass through.

[0050] Valve spring 15 is a so-called coil spring formed by winding wire. In the present embodiment, the wire diameter of valve spring 15 is 0.5 mm, for example, and the set load is 7 grams, for example. Thus, negative pressure release port 8 is opened with a slight pressure difference between internal space 20 and external space 27.

[0051] As illustrated in FIG. 4, valve body 16 includes disk section 16a, tapered section 16b, which extends from the outer circumferential end of disk section 16a to the one end side while expanding the diameter, cylindrical section 16c, which extends from the outer circumferential end of tapered section 16b to the one end side. Further, disk section 16a is provided with erected section 16d, which erects to the one end side.

[0052] As illustrated in FIG. 4, tapered section 16b forms a valve together with packing 13 on the other end side. The outer circumferential surface of cylindrical section 16c is guided by the inner diameter ends of ribs 14d of valve guide 14 as described above.

[0053] Erected section 16d is composed of center section 16da, which is erected in the center of disk section 16a, and six radial plate sections 16db, which extend from center section 16da to the outside in the diameter direction, as illustrated in FIG. 4.

[0054] The inner circumferential surface of valve spring 15 is guided to the outer diameter end of radial plate section 16db. Additionally, space between adjacent radial plate sections 16db functions as a path for air to pass through.

[0055] Base 17 includes, as illustrated in FIG. 4, cylindrical section 17a, and third flange 17b, which extends from the other end of cylindrical section 17a to the outside in the diameter direction.

[0056] Base 17 also includes, as illustrated in FIG. 4, fourth flange 17c, which extends from the other end of cylindrical section 17a to the inside in the diameter direction. The one end side surface of fourth flange 17c is formed with annular protrusion 17d into which annular groove 13a of packing 13 on the other end side fits, as described above. In addition, the outer circumference of cylindrical section 17a is provided with a threaded hole (not illustrated) into which a screw securing inner pipe 12in and base 17 is screwed.

[0057] In the present embodiment, packing 13, valve guide 14, valve spring 15, valve body 16, and base 17 compose a check valve that allows air to flow into internal space 20 from external space 27 and prevents air from flowing out of internal space 20 to external space 27.

[0058] Note that the configuration of the check valve is not limited to the above. For example, a ball may be used as valve body 16, and a spring other than the coil spring may be used as valve spring 15. Further, a different form of check valve may be used, such as a reed valve. Having said that, the configuration of the check valve in the present embodiment is suitable from the viewpoint of mounting space and securing the area of the path.

[0059] In the present embodiment, inner pipe 12in has a stepped cylindrical shape with small and large diameter sections, and the check valve is connected to the large diameter section of inner pipe 12in. This allows the diameter of the check valve to be larger, thereby securing a high air flow rate through the check valve.

[0060] Heating element 18 is held by holding section 12b, as illustrated in FIG. 4, and includes a power line (not illustrated) connected to a power supply apparatus (not illustrated). Note that, although details are not illustrated in FIG. 4, the power line passes through the inside of inner pipe 12in, and is led out of inner pipe 12in from a hole provided at flange section 12f of inner pipe 12in.

[0061] The body of heating element 18 is formed by a nichrome wire wound around a glass rod. Heating element 18 is supplied with power from the power supply apparatus (not illustrated) via the power line, generates heat, and heats air inside of inner pipe 12in.

[0062] In the present embodiment, heating element 18 is configured to generate heat at 120 degrees Celsius during the operation of refrigeration apparatus 1. Note that the amount of heat generated by heating element 18 may be varied according to the temperature inside of inner pipe 12in, providing a temperature sensor in inner pipe 12in. This reduces energy consumption.

[0063] Next, a position relation of configurations of negative pressure release port 8 and housing 2 will be described in detail. FIG. 5 is a cross-sectional view illustrating only important sections of negative pressure release port 8 and housing 2. FIG. 5 illustrates outer pipe 12out, inner pipe 12in (rib 12d, in particular), and heating element 18 of negative pressure release port body 11, inner surface 24S of inner case 24, and through hole 28.

[0064] As illustrated in FIGS. 4 and 5, one end of pipe 12 is attached so as to protrude from inner surface 24S into internal space 20. In addition, heating element 18 is positioned to the terminal section of pipe 12 (hereinafter, referred to as terminal section 12T) protruding to the internal space 20 side, the detail of which will be described later. With such a configuration, moisture contained in air flowed through the path of negative pressure release port 8 from external space 27 does not condensate or freeze in the path until the moisture reaches terminal section 12T. When the air in the path flows out of terminal section 12T to the internal space 20 side, the moisture instantly condenses and freezes due to the extremely low temperature in internal space 20, and adheres around terminal section 12T of protruded pipe 12.

[0065] The moisture contained in the air flowed out of terminal section 12T to the internal space 20 side is likely to freeze while dropping downward by gravity, and thus ice is mainly formed in a range (range R1 illustrated in FIG. 5) around terminal section 12T on the outer circumferential surface of outer pipe 12out. This appropriately prevents ice from forming in a range (range R2 illustrated in FIG. 5) around the opening of through hole 28 on the internal space 20 side and close to inner surface 24S. When ice is formed in the range around the inner side opening of through hole 28 and close to inner surface 24S, the ice is in contact with both inner surface 24S and the outer circumferential surface of outer pipe 12out; accordingly, the ice is difficult to fall off. Thus, it is infinitely preferable that the above-described configuration prevents the situation where the ice is in contact with both inner surface 24S and the outer circumferential surface of outer pipe 12out.

[0066] In the range (range R1 illustrated in FIG. 5) around terminal section 12T on the outer circumferential surface of outer pipe 12out, moisture generated by condensation freezes while dropping downward by gravity, resulting in forming icicle-shaped ice extending downward from the outer circumferential surface of outer pipe 12out around terminal section 12T.

[0067] In negative pressure release port 8 of refrigeration apparatus 1 according to the present embodiment, such a configuration causes the moisture contained in air flowed through the path from external space 27 to freeze mainly in the range (range R1 illustrated in FIG. 5) extending downward from the outer circumferential surface of outer pipe 12out, so that the path is not blocked. With such a configuration, ice formed on the outer circumferential surface of outer pipe 12out tends to be icicle in shape extending downward, and ice is difficult to grow at the same height as terminal section 12T. This appropriately prevents a situation where moisture condensed on the internal space 20 side of terminal section 12T flows back in the path using ice grown at the same height as terminal section 12T as a foundation. Further, the icicle-shaped ice generated on the outer circumferential surface of terminal section 12T has a small contact area with the outer circumferential surface in relation to its own weight; accordingly, the ice tends to fall off by its own weight after growing to a certain degree. This appropriately prevents a situation where the path is blocked around terminal section 12T due to a large amount of ice grown around terminal section 12T.

[0068] In the present embodiment, protrusion amount (length) L1 of terminal section 12T to internal space 20 is 50% or more of outer diameter L2 of outer pipe 12out. Securing a sufficient length for the protrusion in such a manner allows moisture condensed around terminal section 12T to easily freeze in the icicle shape extending downward. Thus, the configuration described above enables the ice to easily fall off by its own weight before growing toward inner surface 24S from the terminal section 12T side on the outer circumferential surface of outer pipe 12out and reaching inner surface 24S.

[0069] Note that, in the present embodiment, the protrusion length of terminal section 12T of pipe 12 to internal space 20 is 50% or more of the outer diameter of pipe 12 (outer pipe 12out), but the present disclosure is not limited to this. Such a protrusion length of terminal section 12T may be set by repeating experiments, for example, to an appropriate length with which moisture generated by condensation easily freezes in the icicle shape extending downward and the icicle-shaped ice easily falls off by its own weight.

[0070] Next, a description will be given of arrangement positions of rib 12d and heating element 18 in inner pipe 12in. As illustrated in FIG. 5, rib 12d and heating element 18 are placed across inner surface 24S in the longitudinal direction, i.e., direction along the center axis of through hole 28. Terminal section 12T of pipe 12 and the end of heating element 18 on the internal space 20 side are placed on substantially the same plane parallel to inner surface 24S.

[0071] Rib 12d is placed so that half (50%) or more of the longitudinal direction length is on the outside of inner surface 24S of inner case 24, i.e., the external space 27 side. In addition, heating element 18 is placed so that half (50%) or more of the longitudinal direction length is located inward relative to inner surface 24S of inner case 24, i.e., the internal space 20 side.

[0072] Such arrangement positions produce the following effect. Since the end of heating element 18 on the internal space 20 side is placed on substantially the same plane as terminal section 12T, heating element 18 can surely heat air in the path and air around terminal section 12T via rib 12d. This reliably prevents moisture contained in the air in the path from freezing to block the path around terminal section 12T.

[0073] Heating element 18 is placed across inner surface 24S so that half or more of its length is located inward relative to inner surface 24S. In other words, entire heating element 18 is never completely on the outside of inner surface 24S, that is, never completely embedded in through hole 28. Such an arrangement position prevents a situation where heat generated by heating element 18 is not adequately transferred to the area around terminal section 12T protruding to internal space 20, for example. In addition, entire heating element 18 is never completely located inward relative to inner surface 24S, that is, never completely gets into the internal space 20 side with respect to the opening of through hole 28 on the internal space 20 side. Such an arrangement position prevents a situation where the low temperature in internal space 20 is transferred to the path on the external space 27 side with respect to heating element 18 and freezing is caused in the path on the external space 27 side with respect to heating element 18.

[0074] Further, rib 12d is placed across inner surface 24S so that half or more of its length is on the outside of inner surface 24S. Thus, heat generated by heating element 18 is transferred, via rib 12d and pipe 12, to inner surface 24S around the opening of through hole 28 on the internal space 20 side. Such heat appropriately prevents ice contacting both inner surface 24S and the outer circumferential surface of pipe 12 from forming around the opening of through hole 28 on the internal space 20 side.

[0075] Although an embodiment of the present disclosure has been described above, the present disclosure is not limited to the above embodiment, and can be implemented with variations as appropriate without departing from the spirit or scope of the present disclosure.

[0076] The above embodiment has described the case of two inner doors 3, but the present disclosure is not limited to this, and there may be more than two inner doors. In this case, the present embodiment can be applied by increasing the number of partitions.

[0077] In the embodiment described above, through hole 28 into which negative pressure release port body 11 of negative pressure release port 8 is inserted is formed almost horizontally, as illustrated in FIG. 4, and pipe 12 composing negative pressure release port body 11 is placed almost horizontally in through hole 28. The present disclosure is, however, not limited to this, and, for example, the opening of through hole 28 on the internal space 20 side may be formed at a position lower than the opening on the external space 27 side, and entire through hole 28 may be slightly inclined from the external space 27 side to the internal space 20 side. Pipe 12 may also be placed along through hole 28, inclining from the external space 27 side to the internal space 20 side.

[0078] When water droplets condensed around terminal section 12T on the internal space 20 side of negative pressure release port 8 freeze and form icicle, such an inclination makes the contact area smaller between the root portion of the icicle and the outer circumferential surface of terminal section 12T. Thus, the grown icicle easily falls off by its own weight. This further prevents water droplets from freezing and growing at terminal section 12T on the internal space 20 side of negative pressure release port 8, and effectively avoids a situation where negative pressure release port 8 is blocked by ice, which is even more preferable.

[0079] Further, the present disclosure does not specify the terminal shape of terminal section 12T of pipe 12 of negative pressure release port 8, i.e., the shape of terminal section 12T viewed from the front from the internal space 20 side. For example, the shape of terminal section 12T may be approximately circular as illustrated in FIG. 3, or may be polygonal (e.g., triangular, quadrangular, etc.). Note that it is more preferable that the terminal shape of terminal section 12T is polygonal, from the viewpoint of the smaller contact area between icicle and the outer circumferential surface of terminal section 12T.

[0080] The disclosure of Japanese Patent Application No. 2019-228077, filed on December 18, 2019, including the specification, drawings and abstract, is incorporated herein by reference in its entirety.

Industrial Applicability

[0081] The present disclosure facilitates providing a refrigeration apparatus capable of preventing a situation where a path in a negative pressure release port is blocked by freezing. The present disclosure thus has great industrial applicability.

Reference Signs List

[0082]

1 Refrigeration apparatus
2 Housing
3, 3a, 3b Inner door
4 Outer door
5 Machine chamber
6, 6a, 6b Hinge
7 Hinge
8 Negative pressure release port
11 Negative pressure release port body
12 Pipe
12out Outer pipe
121 Cylindrical section
122 First flange
123 Expanded cylindrical section
124 Second flange
12in Inner pipe
12a Cylindrical section
12b Holding section
12ba Holding cylindrical section
12bb Holding bottom section
12c Inner wall
12d Rib
12e Expanded section

12f Flange section
12g Extended section
12T Terminal section
13 Packing
13a Annular groove
14 Valve guide
14a First cylindrical section
14b Disk section
14c Second cylindrical section
14d Rib
15 Valve spring
16 Valve body
16a Disk section
16b Tapered section
16c Cylindrical section
16d Erected section
16da Center section
16db Radial plate section
17 Base
17a Cylindrical section
17b Third flange
17c Fourth flange
17d Annular protrusion
18 Heating element
20, 20a, 20b Internal space
21, 21a, 21b Opening
211 Packing
212 Packing
22 Partition
23 Partition plate
24 Inner case
24S Inner surface
25 Outer case
25S Outer surface
26 Thermal insulation material
27 External space
28 Through hole
40 Handle

Claims

1. A refrigeration apparatus, comprising:

a housing that surrounds a refrigeration chamber where a refrigeration target is stored; and
a negative pressure release port that includes a cylindrical body attached to the housing so as to protrude into the refrigeration chamber, a heating element provided in the cylindrical body, and a rib joining the cylindrical body and the heating element.

2. The refrigeration apparatus according to claim 1, wherein the rib is placed at a position across an inner surface of the housing.

3. The refrigeration apparatus according to claim 2, wherein the rib is placed so that 50% or more of a length of a portion where the rib is joined to the cylindrical body is located outside of the inner surface of the housing.

4. The refrigeration apparatus according to any one of claims 1 to 3, wherein the heating element is placed at a position across an inner surface of the housing.

5. The refrigeration apparatus according to claim 4, wherein the heating element is placed so that 50% or more of a length of the heating element is located inward relative to the inner surface of the housing.

6. The refrigeration apparatus according to any one of claims 1 to 5, wherein an end of the cylindrical body on a side of the refrigeration chamber and an end of the heating element on the side of the refrigeration chamber are placed on substantially a same plane.

7. The refrigeration apparatus according to any one of claims 1 to 6, wherein a protrusion length of the cylindrical body from an inner surface of the housing is 50% or more of an outer diameter of the cylindrical body.

8. The refrigeration apparatus according to any one of claims 1 to 7, wherein a protrusion length of the cylindrical body from an inner surface of the housing is a length with which ice formed on a terminal on an outer circumferential surface of the cylindrical body on a side of the refrigeration chamber falls off from the cylindrical body by its own weight before reaching the inner surface of the housing, the ice being formed due to freezing of moisture contained in air passed through the cylindrical body.

9. The refrigeration apparatus according to any one of claims 1 to 8, further comprising:

a partition member that is provided between a plurality of openings of the housing;
a plurality of inner doors that are each provided with a thermal insulation material inside and that respectively cover the plurality of openings;
an outer door that covers the plurality of inner doors; and
a packing that is pressed between the plurality of inner doors and the partition member when the plurality of inner doors are closed, wherein,
the negative pressure release port is placed at a position hidden by the partition member in a front view.

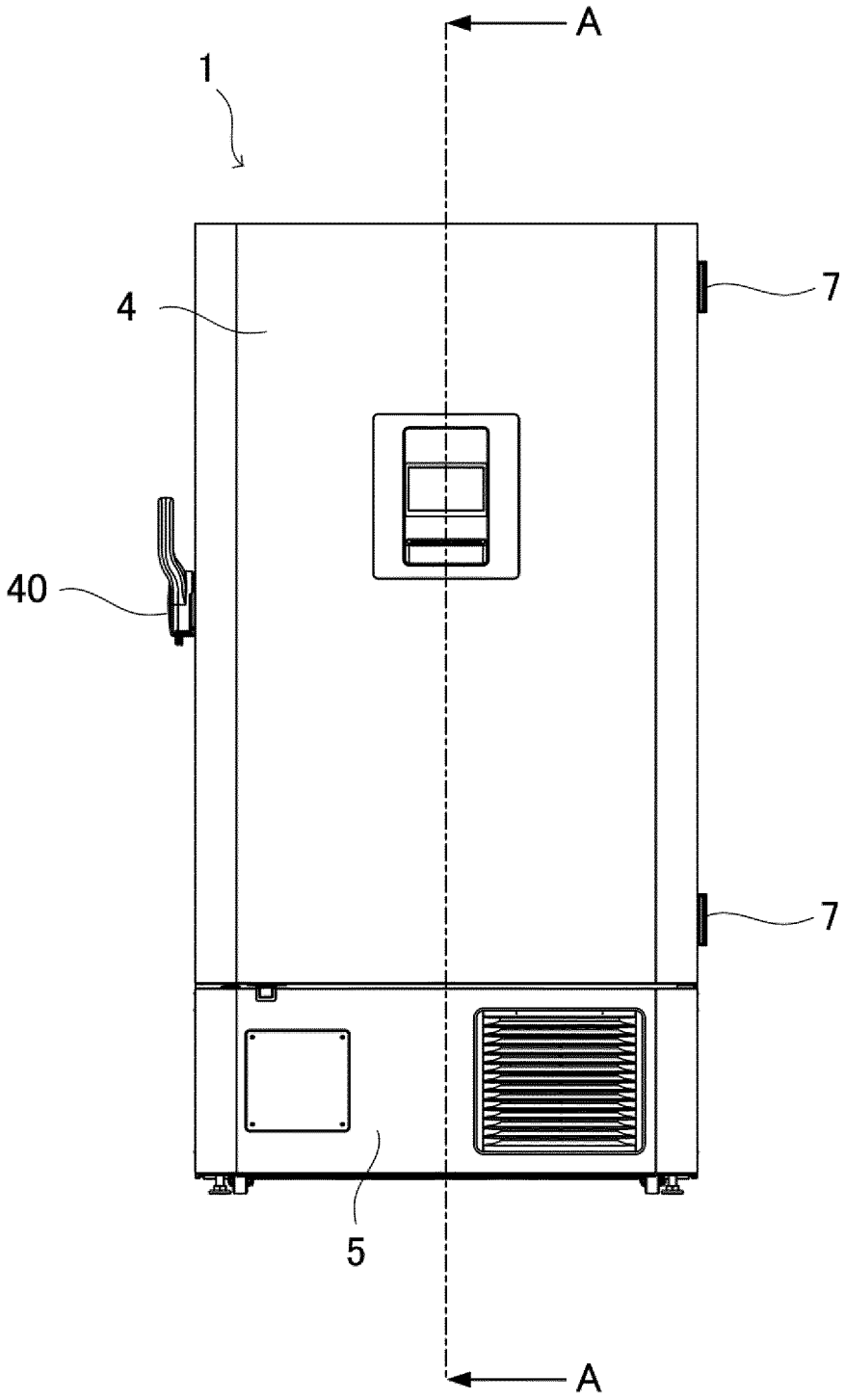
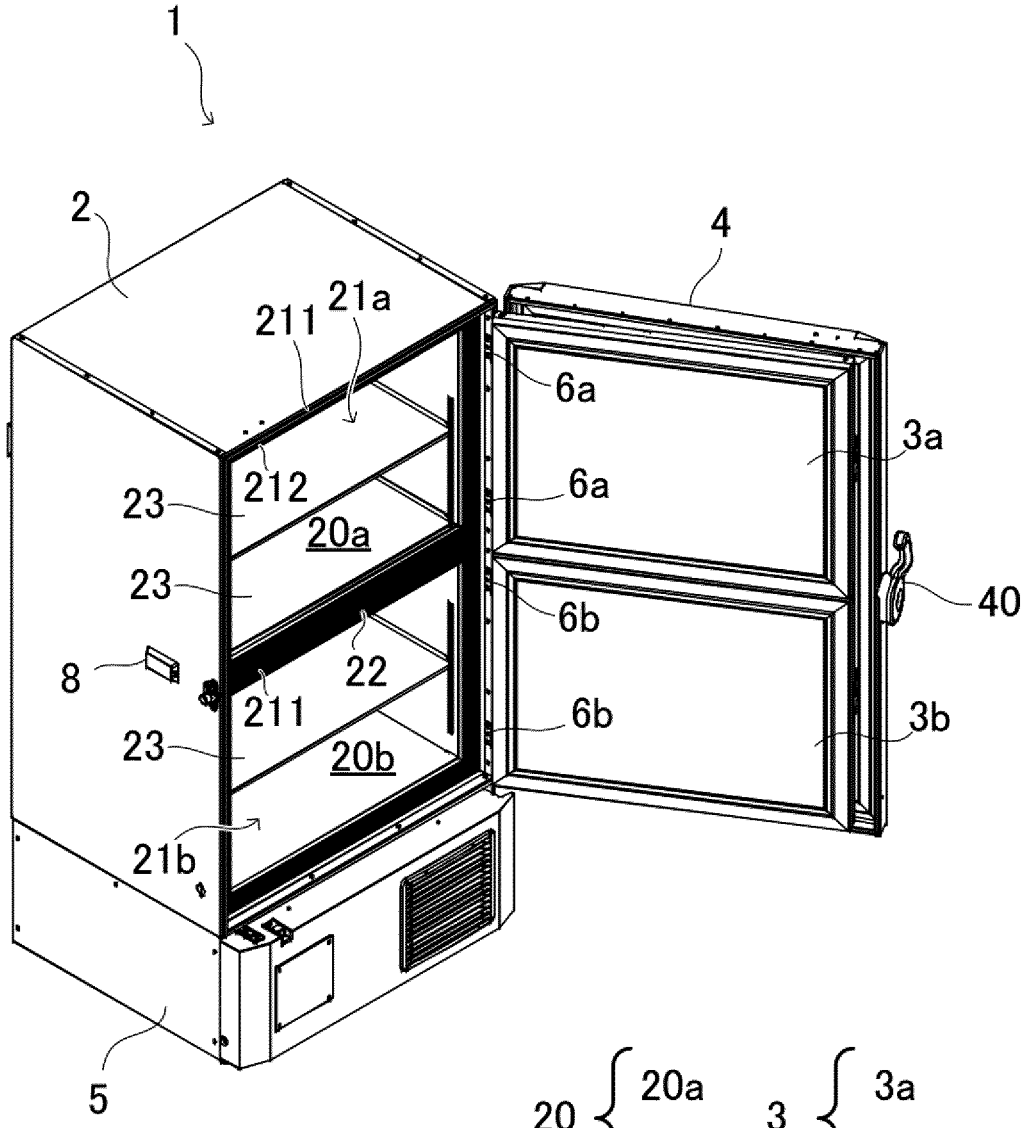


FIG. 1


1
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21a
6a
3a
212
6a
23
20a
40
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6b
8
22
211
6b
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20b
21b
5
20 { 20a 20b
3 { 3a 3b
21 { 21a 21b
6 { 6a 6b

FIG. 2

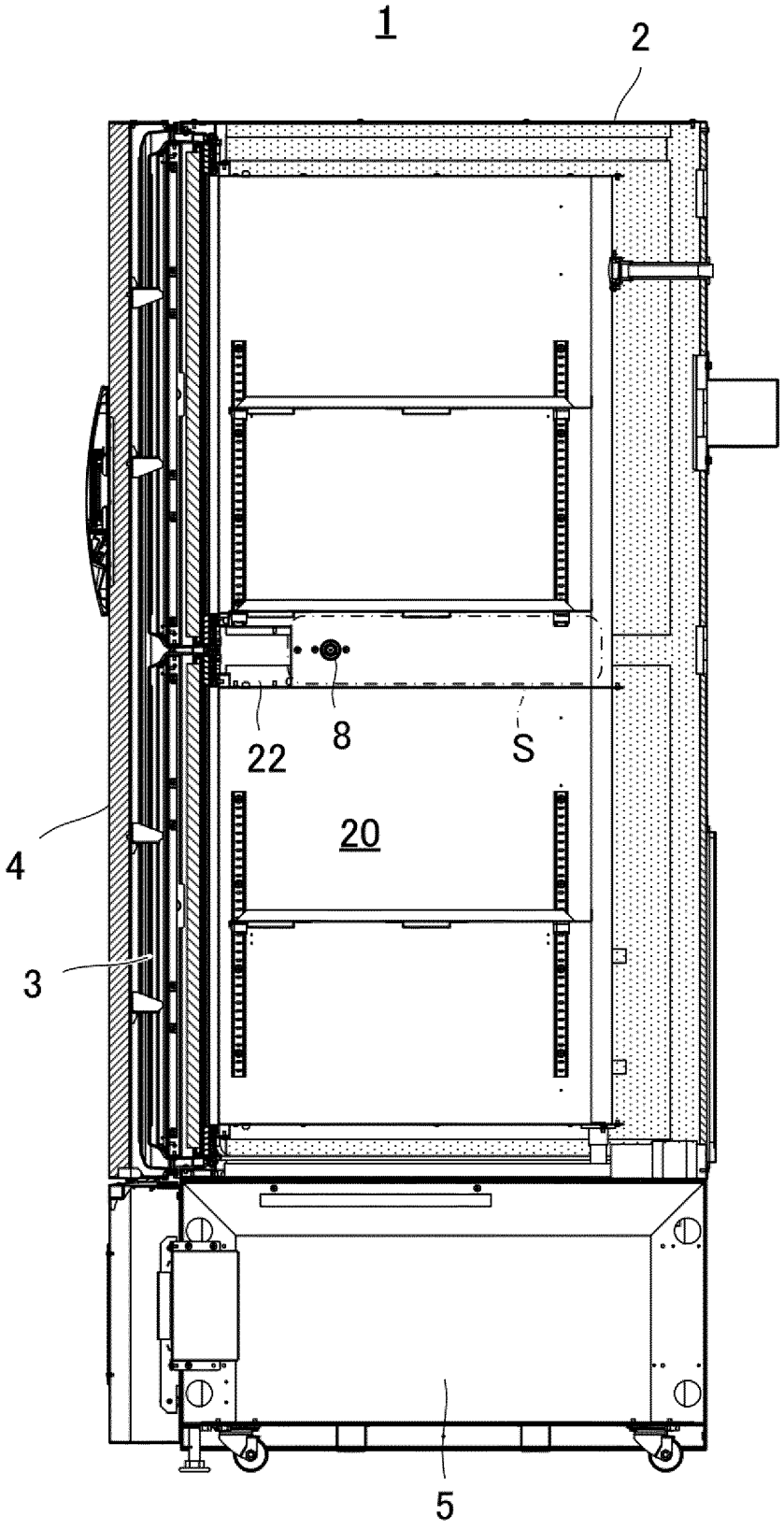
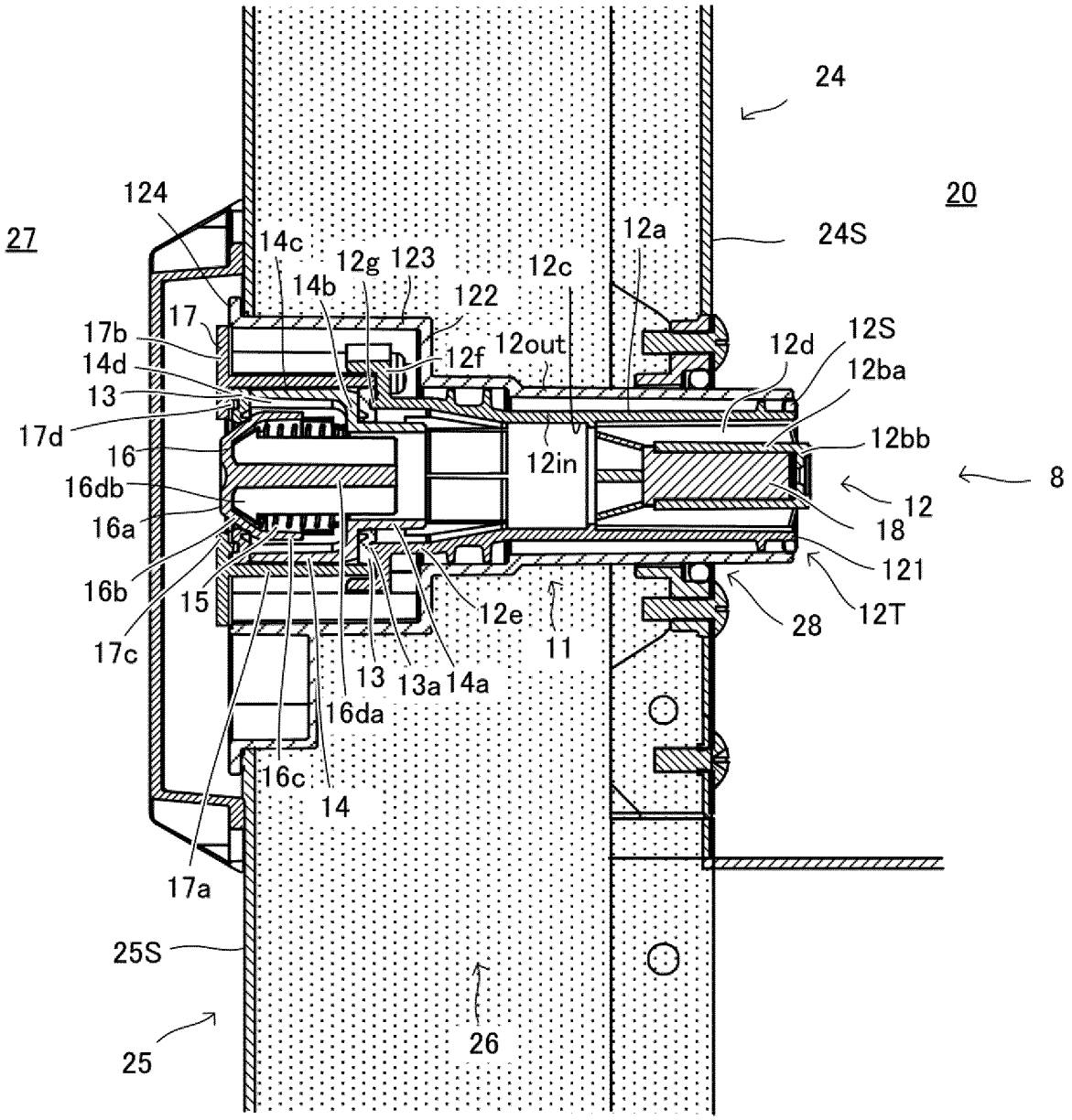


FIG. 3



12 { 12in, 12out }

12b { 12ba, 12bb }

16d { 16da, 16db }

FIG. 4

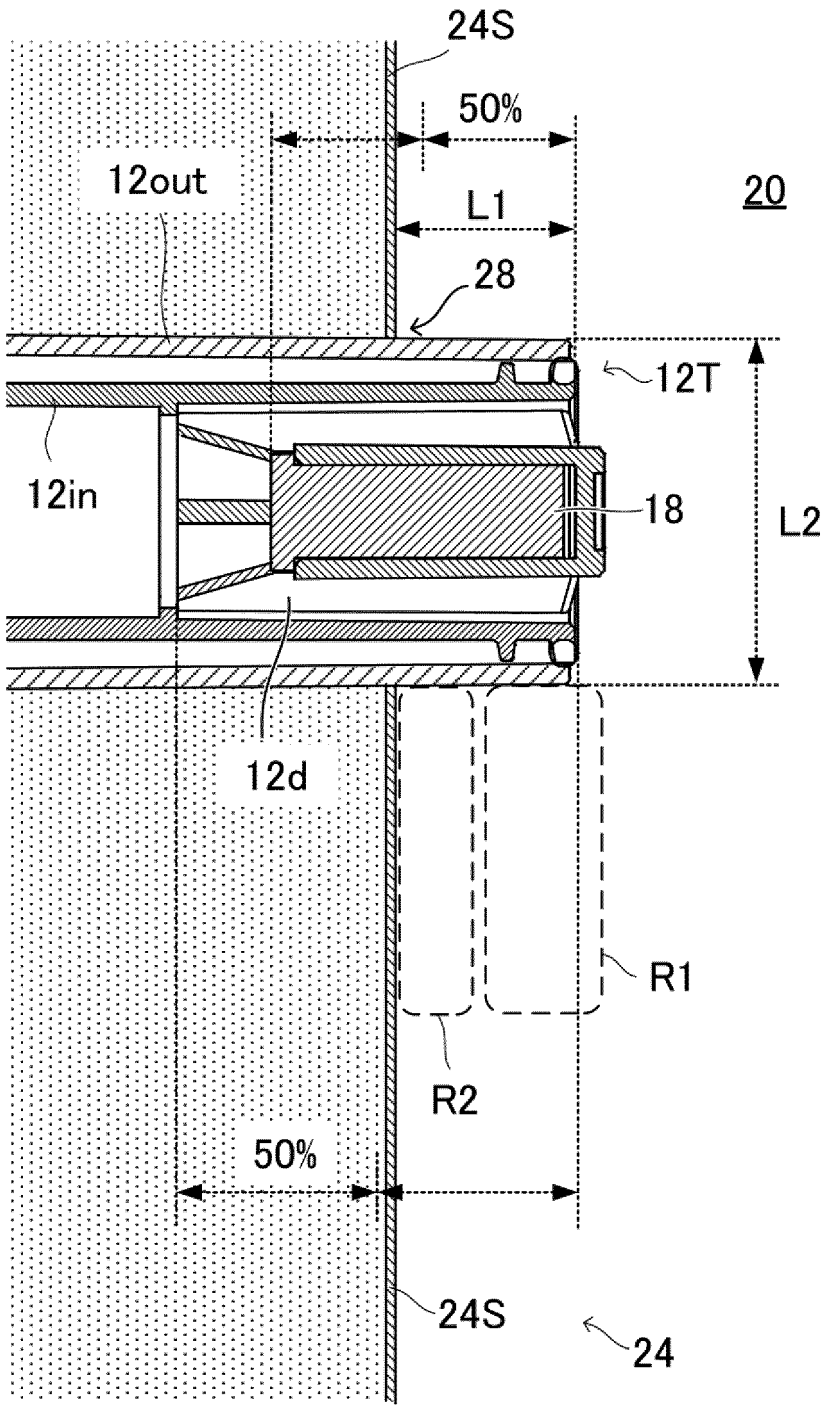


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/044819

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F25D23/00(2006.01)i
FI: F25D23/00302B

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. F25D17/04, F25D23/00

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.
Y A	WO 2018/047624 A1 (PANASONIC HEALTHCARE HOLDINGS CO., LTD.) 15 March 2018 (2018-03-15), paragraphs [0011]-[0083], fig. 1-4	1, 6 2-5, 7-9
Y	JP 2010-25471 A (SANYO ELECTRIC CO., LTD.) 04 February 2010 (2010-02-04), fig. 3	1, 6
Y	US 2003/0054752 A1 (BELLINI) 20 March 2003 (2003-03-20), fig. 1	1, 6
A	US 6374620 B1 (OPX CORPORATION) 23 April 2002 (2002-04-23), column 4, lines 6, 7, fig. 2	1-9

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

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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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
16 December 2020	28 December 2020
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/044819

WO 2018/047624 A1	15 March 2018	US 2019/0204003 A1 paragraphs [0012]-[0087], fig. 1-4 EP 3489598 A1 KR 10-2019-0038635 A CN 109690212 A
JP 2010-25471 A	04 February 2010	(Family: none)
US 2003/0054752 A1	20 March 2003	WO 2002/048626 A1 EP 1342039 A1 BR 6442 A AU 3904001 A AR 31498 A UY 27025 A1
US 6374620 B1	23 April 2002	(Family: none)

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006292352 A **[0009]**
- JP 2019228077 A **[0080]**