ARTICLE TRANSPORT SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to an article transport system in which an article is transported between an article storage unit that stores the article at a first temperature and an external space at a second temperature higher than the first temperature.

2. Description of the Related Art

[0002]

In Japanese Unexamined Patent Application Publication No. 2000-142913, an automated warehouse where articles such as grains are stored in an article storage unit (in storage racks (1)) in which the temperature and humidity are controlled and maintained by an air-conditioning system including an air conditioner (24) and a duct (25) is disclosed (note that each reference sign in brackets in Background Art is described in the Document to be referred to). In this automated warehouse, a stacker crane (4) is used to load and unload each article. Further, in this automated warehouse, a first partition wall (16) and a second partition wall (17) formed of a heat-insulating material and provided to divide the storage racks (1) are provided except a place where the stacker crane (4) travels. The internal space of the automated warehouse is divided by these two partition walls (16, 17) into an internal space (20) on a loading and unloading side, an internal space (18) on the back side opposite to the loading and unloading side, and an intermediate internal space (19) there between. Further, in the traveling place of the stacker crane (4), a first door (21) and a second door (22) are provided in the first partition wall (16) and the second partition wall (17) to be able to block the traveling place, respectively.

[0003]

In this automated warehouse, when articles are loaded into the storage rucks (1), both the first door (21) and the second door (22) are opened to load the articles from the external space to the internal space by the stacker crane (4). When articles are unloaded, the articles are moved in advance to the internal space (20) on the loading and unloading side, and the internal space (18) on the back side and the intermediate internal space (19) are emptied according to the amount of articles stored. Then, the temperature and humidity control of the internal space (18) on the back side and the intermediate internal space (19) by the air-conditioning system can be stopped in this

order. In other words, the operating rate of the air-conditioning system can be changed according to the amount of articles stored to prevent wasteful operation and reduce the storage costs.

SUMMARY OF THE INVENTION

[0004]

In this automated warehouse, since no partition wall as described above is provided on the loading and unloading side, the air from the external space and the air in the internal space (particularly in the internal space (20) on the loading and unloading side) are mixed easily. Therefore, when the temperature difference between the internal space of the storage racks (1) and the external space is large, there is a possibility that the temperature of the internal space of the storage racks (1) may deviate significantly from a proper temperature. Especially, when articles to be stored in the automated warehouse need to be refrigerated or frozen, there is a possibility that the temperature difference between the external space and the internal space of the storage racks (1) will be larger.

[0005]

In view of the above, it is desired to provide a technique that can prevent the temperature of the article storage unit from changing when transporting an article between the article storage unit with the article stored therein at a first temperature and the external space at a second temperature higher than the first temperature.

[0006]

As one aspect, an article transport system, in which an article is transported between an article storage unit storing the article at a first temperature and an external space at a second temperature higher than the first temperature, includes: a lifter which transports the article in a vertical direction; a cover part with which a transport route of the lifter is covered; a first loading and unloading port provided in the cover part to open to the side of the article storage unit; and a second loading and unloading port provided in the cover part to open to the side of the external space, wherein the first loading and unloading port is placed above the second loading and unloading port, and the lifter transports the article between the first loading and unloading port and the second loading and unloading port.

[0007]

According to this configuration, even when a second temperature air warmer than the first temperature enters the article transport system from the second loading and unloading port, since a space covered with the cover part exists between the external

space and the article storage unit, the second temperature air is prevented from reaching the article storage unit. Further, since relatively warm air rises more than cold air, the warm air entering from the second loading and unloading port moves up in the space covered with the cover part. The first loading and unloading port is positioned above the space covered with the cover part to allow communication between the space and the side of the article storage unit, and the second temperature air rising in the space covered with the cover part could enter the side of the article storage unit through the first loading and unloading port. However, since the air higher than the first temperature stays on the upside, the impact on the temperature of the article storage unit is limited. Therefore, according to this configuration, temperature changes in the article storage unit can be suppressed when the article is transported between the article storage unit storing the article at the first temperature and the external space at the second temperature higher than the first temperature.

[0008]

Further features and benefits of the article transport system will become clear from an exemplary and non-limiting embodiment to be described with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a side view schematically illustrating a configuration example of an article storage equipment including an article transport system;

Fig. 2 is a side view schematically illustrating another configuration example of the article storage equipment including the article transport system; and

Fig. 3 is a side view schematically illustrating still another configuration example of the article storage equipment including the article transport system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010]

An embodiment of an article transport system will be described below based on the drawings. Fig. 1 is a side view schematically illustrating a configuration example of an article storage equipment 200 including an article transport system 100. As illustrated in Fig. 1, the article storage equipment 200 includes an article storage unit 1 which stores articles B at a first temperature, and the article transport system 100 in which the articles B are transported between an external space 2 at a second temperature and the article storage unit 1. Here, the articles B are articles that need to be

refrigerated or frozen, and the second temperature is a temperature higher than the first temperature. In the embodiment, the articles B are articles kept frozen in the article storage unit 1, and the first temperature is, for example, a temperature in a range of about minus 25 degrees Celsius to minus 15 degrees Celsius. Therefore, the article storage unit 1 is covered with a heat-insulating wall material 8 and configured as a freezer including refrigeration equipment. The second temperature is a normal temperature which, for example, about 0 to 40 degrees Celsius including seasonal changes.

[0011]

As illustrated in Fig. 1, the article storage unit 1 is configured as storage racks each having multiple storage parts 201 that store the articles B, respectively. The article storage unit 1 stores each of the articles B in each of the storage parts 201, and further includes a stacker crane 9 having a fork 91 used to take out an article B from each of the storage parts 201. The stacker crane 9 includes a moving carriage 94 moving along traveling rails 92, a pair of masts 93 vertically installed on the moving carriage 94, a lifting body 95 that lifts up or lifts down along the masts 93, and the fork 91 as a transfer device installed on the lifting body 95. The fork 91 moves in and out between the storage part 201 and the lifting body 95 to transfer the article B between the lifting body 95 and the storage part 201. The stacker crane 9 draws the fork 91 into the side of the lifting body 95 in such a state that the article B is supported on the fork 91, and travels on the traveling rails 92 to transport the article B between the article storage unit 1 and a first loading and unloading conveyor 81. As illustrated in Fig. 1, the first loading and unloading conveyor 81 is placed on an upside Y1 of the article storage equipment 200 in a vertical direction Y.

[0012]

As illustrated in Fig. 1, the article transport system 100 includes a lifter (first lifter 3) which transports the article B in the vertical direction Y, a cover part (first cover part 4) with which a transport route of the first lifter 3 is covered, a first loading and unloading port 11 provided in the first cover part 4 to open to the side of the article storage unit 1, and a second loading and unloading port 12 provided in the first cover part 4 to open to the side of the external space 2. The first loading and unloading port 11 is placed on the upside Y1 above the second loading and unloading port 12. As will be described later, the first cover part 4 is formed of a heat-insulating wall material.

[0013]

The first loading and unloading conveyor 81 described above is installed to penetrate through the first cover part 4 via the first loading and unloading port 11. The

first lifter 3 includes a mast (first mast 33), a lifting part (first lifting part 32) that moves up and down along the first mast 33, and a first conveyor 31 installed on the first lifting part 32. The article B can be passed between the first conveyor 31 and the first loading and unloading conveyor 81 by moving up the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the first loading and unloading conveyor 81.

[0014]

In the second loading and unloading port 12, a second loading and unloading conveyor 82 is installed to penetrate through the first cover part 4 via the second loading and unloading port 12. The article B can be passed between the first conveyor 31 and the second loading and unloading conveyor 82 by moving down the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the second loading and unloading conveyor 82. In other words, the first lifter 3 transports the article B between the first loading and unloading port 11 and the second loading and unloading port 12. The second loading and unloading conveyor 82 placed in the second loading and unloading port 12 extends from the external space 2 to a first lifter installation space 30 so that the article B can be loaded and unloaded between the external space 2 and the article storage equipment 200 through the second loading and unloading conveyor 82.

[0015]

Thus, in the form exemplified in Fig. 1, the article B can be loaded and unloaded between the external space 2 and the article storage unit 1 by the article transport system 100 including the first lifter 3.

[0016]

Since the second loading and unloading port 12 allows communication between the external space 2 and a space (first lifter installation space 30) covered with the first cover part 4, air warmer than the first temperature may enter the first lifter installation space 30. Then, since relatively warm air rises more than cold air, the warm air entering from the second loading and unloading port 12 could reach the first loading and unloading port 11 placed on the upside Y1 above the second loading and unloading port 12. Since the first loading and unloading port 11 allows communication between the first lifter installation space 30 and the article storage unit 1 at the first temperature, the warm air entering from the external space 2 could enter the article storage unit 1. However, as illustrated in Fig. 1, since the first loading and unloading port 11 is placed on the upside Y1, the warm air stays on the upside Y1 of the article storage unit 1 to prevent the temperature on a downside Y2 of the article storage unit 1 from rising.

[0017]

Further, the amount of saturated water vapor is different between the warm air and the cold air, and in many cases, the warm air contains more water vapor than the cold air. When the warm and moist air from the external space 2 reaches the article storage unit 1, the air is cooled and the article storage unit 1 may be misted with condensation. However, such dew condensation can also be prevented by preventing the air from the external space 2 from entering the article storage unit 1 like in this configuration.

[0018]

Further, in the present embodiment, air curtains 20 are provided in the first loading and unloading port 11 and the second loading and unloading port 12, where the air curtains 20 are located on an article transport route K between the article storage unit 1 and the external space 2 as illustrated in Fig. 1. Specifically, a first air curtain 21 is provided in the first loading and unloading port 11, and a second air curtain 22 is provided in the second loading and unloading port 12. As described above, since the second loading and unloading port 12 allows the communication between the external space 2 and the first lifter installation space 30, air warmer than the first temperature is easier to enter the first lifter installation space 30. However, it can make such warm air difficult to enter the first lifter installation space 30 by providing the second air curtain 22 in the second loading and unloading port 12. Further, it can make the warm air entering the first lifter installation space 30 difficult to enter the article storage unit 1 by providing the first air curtain 21 in the first loading and unloading port 11.

[0019]

Note that the air curtains 20 do not need to be provided in both the first loading and unloading port 11 and the second loading and unloading port 12, and it may also be such a form that either one of the first air curtain 21 and the second air curtain 22 is provided. Further, for example, the air curtains 20 may be placed in the middle of the first lifter installation space 30 in the vertical direction Y. In other words, the article transport system 100 should have at least one air curtain 20 on the article transport route K to interfere with the flow of air on the article transport route K.

[0020]

Further, as described above, the first cover part 4 is formed of the heat-insulating wall material. The temperature of the first lifter installation space 30 covered with the first cover part 4 can rise not only by the air flowing from the second loading and unloading port 12 but also by radiant heat from the external space 2 at the second temperature. Then, the temperature on the side of the article storage unit 1 can also rise

by radiant heat from the first lifter installation space 30. However, when the first cover part 4 is formed of the heat-insulating wall material, the rise in the temperature of the first lifter installation space 30 by the radiant heat from the external space 2 at the second temperature, and the rise in the temperature on the side of the article storage unit 1 by the radiant heat from the first lifter installation space 30 can be suppressed. In other words, since the first cover part 4 located between the external space 2 and the article storage unit 1 is formed of the heat-insulating wall material, heat in the external space 2 higher than that in the article storage unit 1 is prevented from being transferred to the article storage unit 1.

[0021]

Fig. 2 is a side view schematically illustrating another configuration example of the article storage equipment 200 including the article transport system 100. Common parts to those in the article storage equipment 200 exemplified in Fig. 1 are given the same reference signs. In a form exemplified in Fig. 2, the article transport system 100 further includes a second lifter 5 to transport an article in the vertical direction Y nearer to the side of the article storage unit 1 than the first loading and unloading port 11, a second cover part 6 with which a transport route of the second lifter 5 is covered, a third loading and unloading port 13 provided in the second cover part 6 to open to the side of the article storage unit 1, a fourth loading and unloading port 14 provided in the second cover part 6 to open to the side of the first loading and unloading port 11, and a first intermediate conveyor 71 (intermediate conveyance device; first intermediate conveyance device) to convey an article between the first loading and unloading port 11 and the fourth loading and unloading port 14. The fourth loading and unloading port 14 is placed above the third loading and unloading port 13. As illustrated in Fig. 2, the fourth loading and unloading port 14 is placed at the same height as the first loading and unloading port 11 in this example. The first intermediate conveyor 71 penetrates through the first cover part 4 and the second cover part 6 to connect the first loading and unloading port 11 and the fourth loading and unloading port 14.

[0022]

In the form exemplified in Fig. 2, the first loading and unloading conveyor 81 is installed to penetrate through the second cover part 6 via the third loading and unloading port 13. Like the first lifter 3, the second lifter 5 includes a second mast 53, a lifting part (second lifting part 52) that moves up and down along the second mast 53, and a second conveyor 51 installed on the second lifting part 52. The article B can be passed between the second conveyor 51 and the first loading and unloading conveyor 81

by moving down the second lifting part 52 so that the top surface of the second conveyor 51 will be the same height as the top surface of the first loading and unloading conveyor 81.

[0023]

The first intermediate conveyor 71 is installed to penetrate through the first cover part 4 via the first loading and unloading port 11 and to penetrate through the second cover part 6 via the fourth loading and unloading port 14. The article B can be passed between the second conveyor 51 and the first intermediate conveyor 71 by moving up the second lifting part 52 so that the top surface of the second conveyor 51 will be the same height as the top surface of the first intermediate conveyor 71. In other words, the second lifter 5 transports the article B between the third loading and unloading port 13 and the fourth loading and unloading port 14.

[0024]

Further, like in the form exemplified in Fig. 1, the article B can be passed between the first conveyor 31 and the first intermediate conveyor 71 by moving up the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the first intermediate conveyor 71. Then, the article B can be passed between the first conveyor 31 and the second loading and unloading conveyor 82 by moving down the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the second loading and unloading conveyor 82. Since one end of the first intermediate conveyor 71 is placed in the first loading and unloading port 11 and one end of the second loading and unloading conveyor 82 is placed in the second loading and unloading port 12, the first lifter 3 transports the article B between the first loading and unloading port 11 and the second loading and unloading port 12 even in the form exemplified in Fig. 2.

[0025]

Thus, in the form exemplified in Fig. 2, the article B can be loaded and unloaded between the external space 2 and the article storage unit 1 by the article transport system 100 including the first lifter 3 and the second lifter 5.

[0026]

In this form, a space (second lifter installation space 50) covered with the second cover part 6 further exists between the article storage unit 1 and the external space 2. Then, the second lifter installation space 50 and the article storage unit 1 communicate with each other through the third loading and unloading port 13 provided on the downside Y2. As described above, the warm air rises more than the cold air. Therefore, even when the warm air from the external space 2 enters the first lifter

installation space 30 and the second lifter installation space 50, the warm air stays on the upside Y1 of the second lifter installation space 50 to prevent the warm air from entering the article storage unit 1 from the third loading and unloading port 13 provided on the downside Y2.

[0027]

Further, like in the form exemplified in Fig. 1, air curtains 20 are provided on the article transport route K between the article storage unit 1 and the external space 2 even in the form exemplified in Fig. 2. In the form exemplified in Fig. 2, air curtains 20 are also provided in the third loading and unloading port 13 and the fourth loading and unloading port 14 in addition to the first air curtain 21 and the second air curtain 22 in the first loading and unloading port 11 and the second loading and unloading port 12. Specifically, a third air curtain 23 is provided in the third loading and unloading port 13 and a fourth air curtain 24 is provided in the fourth loading and unloading port 14. Since the air curtains 20 are provided in the respective loading and unloading ports, the warm air of the external space 2 and the cold air of the article storage unit 1 are restricted from being mixed with each other.

[0028]

Note that the air curtains 20 do not have to be installed in all of the first loading and unloading port 11, the second loading and unloading port 12, the third loading and unloading port 13, and the fourth loading and unloading port 14, and the form may also be such that an air curtain 20 is installed in at least one place. Further, the air curtain 20 may be installed, for example, in a middle part of the first lifter installation space 30 in the vertical direction Y, or in a middle part of the second lifter installation space 50 in the vertical direction Y. In other words, the article transport system 100 has only to include at least one air curtain 20 on the article transport route K to interfere with the flow of air on the article transport route K.

[0029]

Further, like the first cover part 4, the second cover part 6 is also formed of the heat-insulating wall material. Since the second cover part 6 located between the first lifter installation space 30 and the article storage unit 1 is formed of the heat-insulating wall material, heat in the external space 2 higher than that in the article storage unit 1 can be prevented from being transferred to the article storage unit 1 through the first lifter installation space 30 and the second lifter installation space 50.

[0030]

Fig. 3 is a side view schematically illustrating still another configuration example of the article storage equipment 200 including the article transport system 100.

Common parts to those in the article storage equipment 200 exemplified in Fig. 1 and Fig. 2 are given the same reference signs. In contrast to the form exemplified in Fig. 2, the article transport system 100 in the form exemplified in Fig. 3 further includes a fifth loading and unloading port 15 provided in the first cover part 4 to open to the side of the second lifter 5, a sixth loading and unloading port 16 provided in the second cover part 6 to open to the side of the first lifter 3, and a second intermediate conveyor 72 (second intermediate conveyance device) to convey the article B between the fifth loading and unloading port 15 and the sixth loading and unloading port 16. The fifth loading and unloading port 15 is placed on the downside Y2 below the first loading and unloading port 11 and on the upside Y1 above the second loading and unloading port 12, and the sixth loading and unloading port 16 is placed on the upside Y1 above the third loading and unloading port 13 and on the downside Y2 below the fourth loading and unloading port 14. Therefore, the second intermediate conveyor 72 is placed on the upside Y1 above the first loading and unloading conveyor 81 and the second loading and unloading conveyor 82 and on the downside Y2 below the first intermediate conveyor 71. As illustrated in Fig. 3, the second intermediate conveyor 72 is installed to penetrate through the first cover part 4 via the fifth loading and unloading port 15 and to penetrate through the second cover part 6 via the sixth loading and unloading port 16.

[0031]

Like in the form exemplified in Fig. 2, the article B can be passed between the second conveyor 51 and the first loading and unloading conveyor 81 by moving down the second lifting part 52 so that the top surface of the second conveyor 51 will be the same height as the top surface of the first loading and unloading conveyor 81 even in the form exemplified in Fig. 3. Further, the article B can be passed between the second conveyor 51 and the first intermediate conveyor 71 by moving up the second lifting part 52 so that the top surface of the second conveyor 51 will be the same height as the top surface of the first intermediate conveyor 71. Further, in the form exemplified in Fig. 3, the article B can be passed between the second conveyor 51 and the second intermediate conveyor 72 by moving up or moving down the second lifting part 52 so that the top surface of the second conveyor 51 will be the same height as the top surface of the second intermediate conveyor 72 located on the downside Y2 below the first intermediate conveyor 71.

[0032]

In other words, in the form exemplified in Fig. 2, the second lifter 5 transports the article B between the third loading and unloading port 13 and the fourth loading and unloading port 14, while in the form exemplified in Fig. 3, the second lifter 5 transports

the article B between the third loading and unloading port 13 and the fourth loading and unloading port 14, and between the third loading and unloading port 13 and the sixth loading and unloading port 16.

[0033]

Further, like in the form exemplified in Fig. 2, the article B can be passed between the first conveyor 31 and the first intermediate conveyor 71 by moving up the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the first intermediate conveyor 71 even in the form exemplified in Fig. 3. Further, in the form exemplified in Fig. 3, the article B can be passed between the first conveyor 31 and the second intermediate conveyor 72 by moving up or moving down the second lifting part 52 so that the top surface of the first conveyor 31 will be the same height as the top surface of second intermediate conveyor 72 located on the downside Y2 below the first intermediate conveyor 71. Then, the article B can be passed between the first conveyor 31 and the second loading and unloading conveyor 82 by moving up or moving down the first lifting part 32 so that the top surface of the first conveyor 31 will be the same height as the top surface of the second loading and unloading conveyor 82.

[0034]

In other words, in the form exemplified in Fig. 2, the first lifter 3 transports the article B between the first loading and unloading port 11 and the second loading and unloading port 12, while in the form exemplified in Fig. 3, the second lifter 5 transports the article B between the first loading and unloading port 11 and the second loading and unloading port 12 (first article transport route K1) and between the fifth loading and unloading port 15 and the second loading and unloading port 12 (second article transport route K2).

[0035]

Thus, even in the form exemplified in Fig. 3, the article B can be loaded and unloaded between the external space 2 and the article storage unit 1 by the article transport system 100 including the first lifter 3 and the second lifter 5. In the forms exemplified in Fig. 1 and Fig. 2, the article B is transported between the external space 2 and the article storage unit 1 along one article transport route K, while in the form exemplified in Fig. 3, the article B is transported between the external space 2 and the article storage unit 1 along an article transport route K of either one of the first article transport route K1 and the second article transport route K2.

[0036]

As is clear from Fig. 3, the distance between the third loading and unloading

port 13 and the fourth loading and unloading port 14 on the first article transport route K1 is longer than the distance between the third loading and unloading port 13 and the sixth loading and unloading port 16 on the second article transport route K2. Further, the distance between the first loading and unloading port 11 and the second loading and unloading port 12 on the first article transport route K1 is longer than the distance between the sixth loading and unloading port 16 and the second loading and unloading port 12 on the second article transport route K2. In other words, the second article transport route K2 is shorter than the first article transport route K1 as the transport route in the article transport system. Therefore, the transport time when the article B is transported along the second article transport route K2 is shorter than that when the article B is transported along the first article transport route K1, thus increasing the transport efficiency.

[0037]

For example, in a case where a difference between the temperature (second temperature) of the external space 2 and the temperature (first temperature) of the article storage unit 1 is small such as in winter or the like, the temperature of the article storage unit 1 is less likely to rise even when the article B is loaded and unloaded between the external space 2 and the article storage unit 1 compared with a case where the difference therebetween is large such as in summer or the like. Thus, the transport efficiency can be improved by selecting the first article transport route K1 or the second article transport route K2 according to the difference between the first temperature and the second temperature.

[0038]

Further, like in the forms exemplified in Fig. 1 and Fig. 2, air curtains 20 are provided on the article transport route K between the article storage unit 1 and the external space 2 even in the form exemplified in Fig. 3. In the form exemplified in Fig. 3, air curtains 20 are also provided in the fifth loading and unloading port 15 and the sixth loading and unloading port 16 in addition to the first air curtain 21, the second air curtain 22, the third air curtain 23, and the fourth air curtain 24 in the first loading and unloading port 11, the second loading and unloading port 12, the third loading and unloading port 13, and the fourth loading and unloading port 14. Specifically, a fifth air curtain 25 is provided in the fifth loading and unloading port 15 and a sixth air curtain 26 is provided in the sixth loading and unloading port 16. Since the air curtains 20 are provided in the respective loading and unloading ports, the warm air of the external space 2 and the cold air of the article storage unit 1 are restricted from being mixed with each other.

[0039]

As described above, the air curtains 20 do not have to be installed in all of the first loading and unloading port 11, the second loading and unloading port 12, the third loading and unloading port 13, the fourth loading and unloading port 14, the fifth loading and unloading port 15, and the sixth loading and unloading port 16, and the form may also be such that at least one air curtain 20 is installed. In other words, the article transport system 100 has only to include at least one air curtain 20 on the article transport route K to interfere with the flow of air on the article transport route K. In the form exemplified in Fig. 3, two article transport routes K exist in parallel. Therefore, when only one air curtain 20 is installed, it is preferred to install the air curtain 20 in a place common to the first article transport route K1 and the second article transport route K2 (for example, in the second loading and unloading port 12 or the third loading and unloading port 13). Further, the air curtain 20 may be installed, for example, in the middle of the first lifter installation space 30 in the vertical direction Y or in the middle of the second lifter installation space 50 in the vertical direction Y.

[0040]

Other embodiments will be described below. Note that the configuration of each embodiment to be described below is not limited to that applied alone, and it can also be applied in combination with a configuration of any other embodiment as long as there is no contradiction.

[0041]

(1) In the above, the form in which the article B is transported between the article storage unit 1 and the first loading and unloading conveyor 81 using the stacker crane 9 is exemplified, but it is not limited to that using the stacker crane 9, and the form can also be such that the article B is transported by using various types of transport equipment such as an overhead transport vehicle, a ground transport vehicle, a transport trolley installed in each of the storage racks, and a conveyor.

[0042]

(2) In the above, the form in which the air curtains 20 are provided on the article transport route K between the article storage unit 1 and the external space 2 is exemplified, but the form may also be a form having no air curtain 20.

[0043]

(3) In the above, the description is made by exemplifying the forms in which the first cover part 4 and the second cover part 6 are formed of the heat-insulating wall material. However, portions other than the portion located on the boundary with the article storage unit 1 may also be formed of a wall material that is not a heat-insulating

structure. For example, in the first cover part 4 illustrated in Fig. 1, a portion (first boundary portion 41) located on the boundary between the article storage unit 1 and the first lifter installation space 30 may be formed of the heat-insulating wall material, and the other portions may be formed of a wall material that is not the heat-insulating structure. Similarly, in the second cover part 6 illustrated in Fig. 2 and Fig. 3, a portion (second boundary portion 61) located on the boundary between the article storage unit 1 and the second lifter installation space 50 may be formed of the heat-insulating wall material, and the other portions may be formed of a wall material that is not the heat-insulating structure.

[0044]

The overview of the article transport system described above will be described briefly below.

[0045]

As one aspect, an article transport system, in which an article is transported between an article storage unit that stores the article at a first temperature and an external space at a second temperature higher than the first temperature, includes: a lifter which transports the article in a vertical direction; a cover part with which a transport route of the lifter is covered; a first loading and unloading port provided in the cover part to open to the side of the article storage unit; and a second loading and unloading port provided in the cover part to open to the side of the external space, wherein the first loading and unloading port is placed above the second loading and unloading port, and the lifter transports the article between the first loading and unloading port and the second loading and unloading port.

[0046]

According to this configuration, even when a second temperature air warmer than the first temperature enters the article transport system from the second loading and unloading port, since a space covered with the cover part exists between the external space and the article storage unit, the second temperature air is prevented from reaching the article storage unit. Further, since a relatively warm air rises more than a cold air, the warm air entering from the second loading and unloading port moves up in the space covered with the cover part. The first loading and unloading port is positioned above the space covered with the cover part to allow communication between the space and the side of the article storage unit, and the second temperature air rising in the space covered with the cover part could enter the side of the article storage unit through the first loading and unloading port. However, since the air higher than the first temperature stays on the upside, the impact on the temperature of the article storage unit

is limited. Therefore, according to this configuration, temperature changes in the article storage unit can be suppressed when the article is transported between the article storage unit that stores the article at the first temperature and the external space at the second temperature higher than the first temperature.

[0047]

Further, the article transport system is preferred to include at least one air curtain on an article transport route between the article storage unit and the external space to interfere with the flow of air on the article transport route.

[0048]

Since the second loading and unloading port allows communication between the external space and a space covered with the cover part, the air warmer than the first temperature could enter the space covered with the cover part from the external space. Further, since the first loading and unloading port allows communication between the space covered with the cover part and a space on the side of the article storage unit, the warm air from the external space could enter the side of the article storage unit via the space covered with the cover part. However, since a flow of air on the article transport route can be interfered with by providing at least one air curtain on the article transport route between the article storage unit and the external space, the warm air from the external space can be prevented from entering the side of the article storage unit.

[0049]

Further, it is preferred that the cover part be formed of a heat-insulating wall material.

[0050]

The temperature of the space covered with the cover part can rise not only by the air flowing from the second loading and unloading port but also by radiant heat from the external space at the second temperature. Then, the temperature on the side of the article storage unit can also rise by radiant heat from the space covered with the cover part. When the cover part is formed of the heat-insulating wall material, the rise in the temperature of the space covered with the cover part by radiant heat from the external space at the second temperature, and the temperature rise on the side of the article storage unit by radiant heat from the space covered with the cover part can be suppressed. In other words, heat in the external space higher than the article storage unit can be suppressed from being transferred to the article storage unit by forming the cover part, located between the external space and the article storage unit, of the heat-insulating wall material.

[0051]

The article transport system is preferred to set the lifter as a first lifter and the cover part as a first cover part, and to further include: a second lifter which transports the article in the vertical direction on the side of the article storage unit rather than the first loading and unloading port; a second cover part with which a transport route of the second lifter is covered; a third loading and unloading port provided in the second cover part to open to the side of the article storage unit; a fourth loading and unloading port provided in the second cover part to open to the side of the first loading and unloading port; and an intermediate conveyance device which conveys the article between the first loading and unloading port and the fourth loading and unloading port, wherein the fourth loading and unloading port is placed above the third loading and unloading port, and the second lifter transports the article between the third loading and unloading port and the fourth loading and unloading port.

[0052]

According to this configuration, a space covered with the second cover part further exists between the article storage unit and the external space. Then, the space covered with this second cover part and the article storage unit communicate with each other through the third loading and unloading port provided below. The warm air rises more than the cold air. Therefore, even when the warm air enters the space covered with the second cover part from the external space through the space covered with the first cover part, the warm air stays on the upside of the space to prevent the warm air from entering the article storage unit from the third loading and unloading port provided on the downside. Therefore, according to this configuration, temperature changes in the article storage unit can further be suppressed.

[0053]

When the article transport system includes the first lifter, the second lifter, the first cover part, the second cover part, the first loading and unloading port, the second loading and unloading port, the third loading and unloading port, the fourth loading and unloading port, and the intermediate conveyance device, the article transport system is preferred to set the intermediate conveyance device as a first intermediate conveyance device, and to further include: a fifth loading and unloading port provided in the first cover part to open to the side of the second lifter; a sixth loading and unloading port provided in the second cover part to open to the side of the first lifter; and a second intermediate conveyance device which conveys the article between the fifth loading and unloading port and the sixth loading and unloading port, wherein the fifth loading and unloading port is placed below the first loading and unloading port and above the second loading and unloading port, and the sixth loading and unloading port is placed

above the third loading and unloading port and below the fourth loading and unloading port.

[0054]

According to this configuration, two routes can be set as article transport routes for transporting the article between the article storage unit and the external space, that is, a route through the third loading and unloading port, the fourth loading and unloading port, the first loading and unloading port, and the second loading and unloading port (called a first article transport route), and a route through the third loading and unloading port, the sixth loading and unloading port, the fifth loading and unloading port, and the second loading and unloading port (called a second article transport route). The distance between the third loading and unloading port and the fourth loading and unloading port on the first article transport route is longer than the distance between the third loading and unloading port and the sixth loading and unloading port on the second article transport route, and the distance between the first loading and unloading port and the second loading and unloading port on the first article transport route is longer than the distance between the sixth loading and unloading port and the second loading and unloading port on the second article transport route. Therefore, the second article transport route is shorter than the first article transport route between the transport routes in the article transport system. Thus, the transport time to transport the article along the second article transport route is shorter than the transport time to transport the article along the first article transport route, increasing the transport efficiency. For example, in a case where a difference between the temperature (second temperature) of the external space and the temperature (first temperature) of the article storage unit is small such as in winter or the like, the temperature of the article storage unit is less likely to rise even when the article is loaded and unloaded between the external space and the article storage unit, compared with a case where the difference therebetween is large such as in summer or the like. Thus, according to this configuration, the transport efficiency can be improved by selecting the first article transport route or the second article transport route according to the difference between the first temperature and the second temperature.

[0055]

Further, the room temperature of the article storage unit is preferred to rise from bottom to top.

[0056]

Since the article transport system has a structure that makes the warm air from the external space difficult to move down even when the warm air enters the article

transport system, a rise in the room temperature on the bottom side of the article storage unit relatively lower than that on the top side can be suppressed.

Description of the Reference Numerals

[0057]

1 article storage unit

2 external space

3 first lifter (lifter)

4 first cover part (cover part)

5 second lifter

6 second cover part

8 wall material

11 first loading and unloading port

12 second loading and unloading port

13 third loading and unloading port

14 fourth loading and unloading port

15 fifth loading and unloading port

16 sixth loading and unloading port

20 air curtain

71 first intermediate conveyor (intermediate conveyance device; first intermediate conveyance device)

72 second intermediate conveyor (second intermediate conveyance device)

81 first loading and unloading conveyor

82 second loading and unloading conveyor

100 article transport system

B article

K article transport route

K1 first article transport route (article transport route)

K2 second article transport route (article transport route)

Y vertical direction

Y1 upside

Y2 downside

WHAT IS CLAIMED IS:

1. An article transport system, in which an article is transported between an article storage unit storing the article at a first temperature and an external space at a second temperature higher than the first temperature, comprising:

a lifter which transports the article in a vertical direction;

a cover part with which a transport route of the lifter is covered;

a first loading and unloading port provided in the cover part to open to a side of the article storage unit; and

a second loading and unloading port provided in the cover part to open to a side of the external space, wherein

the first loading and unloading port is placed above the second loading and unloading port, and

the lifter transports the article between the first loading and unloading port and the second loading and unloading port.

2. The article transport system according to claim 1, further comprising at least one air curtain provided on an article transport route between the article storage unit and the external space to interfere with a flow of air on the article transport route.

3. The article transport system according to claim 1 or 2, wherein the cover part is formed of a heat-insulating wall material.

4. The article transport system according to any one of claims 1 to 3, wherein the lifter is set as a first lifter and the cover part is set as a first cover part, and the article transport system further comprises:

a second lifter which transports the article in the vertical direction on the side of the article storage unit rather than the first loading and unloading port;

a second cover part with which a transport route of the second lifter is covered;

a third loading and unloading port provided in the second cover part to open to the side of the article storage unit;

a fourth loading and unloading port provided in the second cover part to open to a side of the first loading and unloading port; and

an intermediate conveyance device which conveys the article between the first loading and unloading port and the fourth loading and unloading port, wherein

the fourth loading and unloading port is placed above the third loading and unloading port, and

the second lifter transports the article between the third loading and unloading port and the fourth loading and unloading port.

5. The article transport system according to claim 4, wherein the intermediate conveyance device is set as a first intermediate conveyance device, and the article transport system further comprises:

a fifth loading and unloading port provided in the first cover part to open to a side of the second lifter;

a sixth loading and unloading port provided in the second cover part to open to a side of the first lifter; and

a second intermediate conveyance device which conveys the article between the fifth loading and unloading port and the sixth loading and unloading port,

wherein the fifth loading and unloading port is placed below the first loading and unloading port and above the second loading and unloading port, and the sixth loading and unloading port is placed above the third loading and unloading port and below the fourth loading and unloading port.

6. The article transport system according to any one of claims 1 to 5, wherein a room temperature of the article storage unit rises from bottom to top.