

Description

ARTICLE CARRYING SYSTEM

5 Technical Field

[0001]

The present invention relates to a system and a method for carrying an article from a space having low cleanliness to another space having high cleanliness.

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Background Art

[0002]

A clean room designed such that the number of floating fine particles and floating microorganisms in the air is minimized is basic facilities essentially required for research and development and manufacturing sites in many industries from semiconductors, electronic parts, precision machines and so forth to regenerative medical products, pharmaceutical preparations, beauty preparations, and food. To control floating fine particles and floating microorganisms in the clean room leads to yield increase of products or contamination prevention.

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[0003]

In order to maintain the cleanliness in the clean room, there is such a strict rule that an operator should enter the clean room after wearing a dustproof clothing in a front room of the clean room and taking an air
5 shower in order to remove fine particles and so forth sticking to the dustproof clothing. Especially, in the case of a bio clean room, it is necessary to provide a plurality of front rooms so as not to allow not only fine particles but also microorganisms and so forth to enter
10 the bio clean room (Non-patent Document 1) such that, while fine particles and microorganisms sticking not only to the operator but also to articles brought in by the operator are removed and sterilized by cleansing or the like, the cleanliness is increased stepwise.

15 [0004]

Furthermore, when an article is to be carried in, an operator is placed in each front room such that the operator moves only an article between rooms without moving between the front rooms or between a front room
20 and the clean room. This makes it possible to maintain the cleanliness of the clean room with higher certainty. Although the works described above are necessary for maintaining the cleanliness in the clean room, much working time and many operators as well as maintenance of

structure facilities for exclusive use are required and
give rise to increase of the operation cost and
degradation of the working efficiency as a whole. However,
a technology for solving such problems as described above
5 is not known.

Prior Art Document

Non-patent Document

[0005]

10 Non-patent Document 1: Modern Media, volume 50, No.
3, 2004, pp. 54-60

Summary of Invention

Technical Problem

15 [0006]

It is an object of the present invention to provide
a system and a method for carrying an article from a
space having low cleanliness into another space having
high cleanliness.

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Technical Solution

[0007]

The inventor of present application has found while
continuing to conductor intensive research in order to

solve the aforesaid subject that the working efficiency can be increased not by utilizing a plurality of front rooms such that the cleanliness is increased step by step for each front room but by increasing the cleanliness of
5 an article through a series of successive working steps until it reaches a target level and completed the present invention.

[0008]

In particular, the present invention relates to the
10 followings.

[1] A system that carries an article from a space having low cleanliness into another space having high cleanliness, including:

a fine particle removal unit that removes fine
15 particles sticking to an article;

a microorganism removal unit that removes microorganisms sticking to the article; and

a cleanliness measurement unit that measures cleanliness of the article, in which

20 the cleanliness in the cleanliness measurement unit is equal to cleanliness of the space having the high cleanliness.

[2] The system according to [1] above, in which the cleanliness in the cleanliness measurement unit is

International Organization for Standardization (ISO)
Class 1 to 9.

[3] The system according to [1] or [2] above, in
which air of given high cleanliness can be used by at
5 least one selected from a group of the fine particle
removal unit, the microorganism removal unit, and the
cleanliness measurement unit.

[4] The system according to any one of [1] to [3]
above, in which air of given high cleanliness flows from
10 the space having high cleanliness to the space having low
cleanliness.

[5] The system according to [3] or [4] above, in
which air of given high cleanliness is air in a space
having high cleanliness.

15 [6] The system according to any one of [1] to [5]
above, in which the space having the high cleanliness is
a bio clean room.

[7] A method for carrying an article from a space
having low cleanliness into another space having high
20 cleanliness, including:

a step for removing fine particles sticking to an
article;

a step for removing microorganisms sticking to the
article; and

a step for measuring cleanliness of the article, in which

the steps are performed successively and automatically.

5 [8] The method according to [7] above, wherein the steps are performed using the system according to any one of [1] to [6] above.

[0009]

 [9] A system that carries a frozen article from a
10 space having low cleanliness into another space having high cleanliness, including:

a fine particle removal unit that removes fine particles sticking to a frozen article;

 a microorganism removal unit that removes
15 microorganisms sticking to the frozen article;

a thawing unit for thawing the frozen article; and

a cleanliness measurement unit that measures cleanliness of the frozen article, in which

 the cleanliness in the cleanliness measurement unit
20 is equal to cleanliness of the space having the high cleanliness.

 [10] The system according to [9] above, in which the cleanliness in the cleanliness measurement unit is ISO Class 1 to 9.

[11] The system according to [9] or [10] above, in which air of given high cleanliness flows from the space having high cleanliness toward the space having low cleanliness.

5 [12] The system according to any one of [9] to [11] above, in which fine particle removal can be performed by the fine particle removal unit, the microorganism removal unit, and the thawing unit.

 [13] The system according to any one of [9] to [12]
10 above, in which the space having the high cleanliness is a bio clean room.

 [14] A method for carrying a frozen article from a space having low cleanliness into another space having high cleanliness, including:

15 a step for removing fine particles sticking to a frozen article;
 a step for removing microorganisms sticking to the frozen article;
 a step for thawing the frozen article; and
20 a step for measuring cleanliness of the frozen article, in which
 the steps are performed successively and automatically.

 [15] The method according to [14] above, in which

the frozen article is a frozen cell, and at the step for thawing the frozen article, the frozen cell is thawed at a thawing temperature of 36°C to 38°C in a thawing time period of two minutes or less.

5 [16] The method according to [14] or [15] above, in which the steps are performed using the system according to any one of [9] to [13] above.

[0010]

 [17] A system that carries a packaged article from
10 a space having low cleanliness into another space having high cleanliness, including:

 a sealing degree measurement unit that measures a sealing degree of a packaged article;

 a fine particle removal unit that removes fine
15 particles sticking to the packaged article;

 a microorganism removal unit that removes microorganisms sticking to the packaged article; and

 a cleanliness measurement unit that measures cleanliness of the packaged article, in which

20 the cleanliness in the cleanliness measurement unit is equal to cleanliness of the space having the high cleanliness.

 [18] The system according to [17], in which the cleanliness in the cleanliness measurement unit is ISO

Class 1 to 9.

[19] The system according to [17] or [18], in which measurement of the sealing degree of the packaged article is performed first.

5 [20] The system according to any one of [17] to [19] above, in which air of given high cleanliness flows from the space having high cleanliness toward the space having low cleanliness.

 [21] The system according to any one of [17] to
10 [20] above, further including:

 a defective article carrying unit capable of carrying a defective article.

 [22] The system according to any one of [17] to [21] above, in which the units have a module structure so
15 as to be connected to and disconnected from each other.

 [23] A method for carrying a packaged article from a space having low cleanliness into another space having high cleanliness, including:

 a step for measuring a sealing degree of a packaged
20 article;

 a step for removing fine particles sticking to the packaged article;

 a step for removing microorganisms sticking to the packaged article; and

a step for measuring cleanliness of the packaged article, in which

the steps are performed successively and automatically.

- 5 [24] The method according to [23] above, in which the steps are performed using the system according to any one of [17] to [22] above.

Advantageous Effects

10 [0011]

With the system of the present invention, it is possible to improve the working efficiency when an article is carried into a space having high cleanliness to reduce the equipment cost and the work cost. With the
15 system of the present invention including the thawing unit, since a thawing work that is to be originally performed after the article is carried in can be performed during a carrying-in work, the work time period as a whole can be reduced, and besides, it can be
20 prevented that fine particles and microorganisms are carried in while they are mixed in frost or condensed water sticking to a frozen article as they are. With the system of the present invention including a sealing degree measurement unit, it can be prevented with

certainty that fine particles or microorganisms entering from a pinhole of a packaged article into the inside of the packaged article are brought into the space having high cleanliness.

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Brief Description of Drawings

[0012]

[FIG. 1]

FIG. 1 is a view schematically depicting a system according to a first embodiment of the present invention.

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[FIG. 2]

FIG. 2 is a view schematically depicting a system according to a second embodiment of the present invention.

[FIG. 3]

FIG. 3 is a view schematically depicting a system according to a third embodiment of the present invention.

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Modes for Carrying Out the Invention

[0013]

An aspect of the present invention relates to a system that carries an article from a space having low cleanliness into another space having high cleanliness, including a fine particle removal unit that removes fine particles sticking to an article, a microorganism removal

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unit that removes microorganisms sticking to the article,
and a cleanliness measurement unit that measures
cleanliness of the article. The cleanliness in the
cleanliness measurement unit is equal to cleanliness of
5 the space having the high cleanliness.

[0014]

In the present invention, the "space having high
cleanliness" refers to a space in which the temperature,
humidity, air pressure, number of fine particles or the
10 like is controlled such as, for example, a clean room, a
clean booth, a clean bench, a sterile room or the like.
Further, in the present invention, the "space having low
cleanliness" signifies that a space in which the
cleanliness is lower than that in the "space having high
15 cleanliness" such as, for example, a space in which the
number of fine particles is greater than that in the
"space having high cleanliness."

[0015]

In the present invention, the "cleanliness" refers,
20 for example, to the cleanliness in US federal standards
209E, International standard ISO14644-1, ISO14644-2, and
Japanese Industrial Standards (JIS) standard JISB9920
that are adopted for a clean room. In the present
specification, the cleanliness is described in accordance

with the ISO standard for the convenience of the description. While the system of the present invention is not restricted, the system is, for example, configured such that the cleanliness in the cleanliness measurement
5 unit is equal to that in ISO, Class 1 to 9.

[0016]

In the present invention, the "fine particle removal unit" is a section for removing fine particles floating in the fine particle removal unit or fine
10 particles sticking an article in the fine particle removal unit and confirming the degree of fine particle removal. Accordingly, in the present invention, "to remove fine particles sticking to an article" signifies that fine particles sticking to an article or floating
15 fine particles that may possibly stick to an article are removed. The fine particles may include not only dust or dirt but also microorganisms sticking to them. For example, removal of fine particles may be indirect removal by gas spray, direct removal by a brush or the
20 like, or shaking off removal through vibration of an article. Further, a mechanism for collecting removed fine particles may be provided.

[0017]

In the present invention, the "microorganism

removal unit" is a section for removing microorganisms floating in the microorganism removal unit or microorganisms sticking to an article in the microorganism removal unit and confirming the degree of microorganism removal. Accordingly, in the present invention, "to remove microorganisms sticking to an article" signifies that microorganisms sticking to an article and floating microorganisms that may be possibly stick to an article are removed. The microorganisms include bacteria, fungi, viruses, micro algae, protozoans and so forth. The microorganisms may be disinfected by disinfectant or may be sterilized by heat, ultraviolet light, supersonic waves, ozone, vapor or the like. Further, a mechanism for collecting disinfected or removed microorganisms may be provided.

[0018]

In the present invention, the "cleanliness measurement unit" refers to a section for measuring the cleanliness in the cleanliness measurement unit. Accordingly, in the present invention, "to measure the cleanliness of an article" signifies that the cleanliness in the cleanliness measurement unit is measured in a state in which an article is accommodated in the cleanliness measurement unit. The cleanliness in the

cleanliness measurement unit is configured so as to be equal to the cleanliness of the space having high cleanliness, and by measuring the variation of the cleanliness when an article is accommodated, the
5 cleanliness of the article can be confirmed.

[0019]

The system of the present invention may include, in addition to the aforesaid units, a computer capable of automatically operating the fine particle removal unit,
10 the microorganism removal unit, and the cleanliness measurement unit, and a program for causing the computer to operate.

[0020]

Another aspect of the present invention relates to
15 a method for carrying an article from a space having low cleanliness to another space having high cleanliness, including a step for removing fine particles sticking to an article, a step for removing microorganisms sticking to the article, and a step for measuring cleanliness of
20 the article. The steps are performed successively and automatically.

In the following, the present invention is described in detail on the basis of preferred embodiments thereof with reference to the drawings. Note that the

size of the components in the figures is suitably emphasized for the convenience of description and does not indicate an actual ratio or size. Further, the following description is given assuming that an article
5 is carried from the downstream side toward the upstream side and the space having high cleanliness is positioned on the upstream side. Further, the downstream side of each unit is sometimes referred to as entrance, and the upstream side is sometimes referred to as exit.

10 [0021]

(First Embodiment)

First, a system according to a first embodiment of the present invention is described. FIG. 1 is a view schematically depicting the system according to the first
15 embodiment of the present invention. In the present embodiment, the system includes a microorganism removal unit 4 configured from a fine particle removal unit 1, a disinfectant spraying unit 2, and a disinfectant removal unit 3, and a cleanliness measurement unit 5.

20 [0022]

The fine particle removal unit 1, the disinfectant spraying unit 2, the disinfectant removal unit 3, and the cleanliness measurement unit 5 individually have a box type shape and are successively disposed from the

downstream to the upstream in this order. A door D is provided on the entrance side and the exit side of each unit such that, by closing the door D of each unit, the unit forms an enclosed space. An air tightness test apparatus is provided in each unit such that it can test whether the airtight state is configured in each unit. Further, by opening the door D of each unit, the units are spatially communicated with each other to form a tunnel structure such that an article can be carried from the downstream side to the upstream side in the tunnel structure by transport means T. The doors D on the entrance side and the exit side of each unit are configured so as to operate independently of each other such that the units can be spatially communicated with or isolated from each other. Further, an infrared sensor S is provided in each unit such that it can be confirmed whether an article exists in the unit.

[0023]

The fine particle removal unit 1 includes a wind pressure generation apparatus 11 for removing fine particles sticking to an article by wind pressure, and a fine particle measurement apparatus 12 for confirming whether fine particles are removed.

The "wind pressure generation apparatus 11" refers

to an apparatus that can remove fine particles sticking to an article by wind pressure. The wind pressure generation apparatus 11 has a structure like an air nozzle that pushes out air from one side to the other side strongly, and as such air, air circulating in the system may be used or external air may be used as it is or after it is purified. The air nozzle is preferably set to such an orientation that fine particles are pushed out in the downstream direction of the system. Otherwise, the air nozzle may be formed so as to be movable or an article may be made rotatable such that wind may prevail throughout the article, or both of them may be combined.

[0024]

The "fine particle measurement apparatus 12" refers to an apparatus that can count the magnitude or the number of fine particles existing in the air, namely, an apparatus that can measure the air cleanliness in the system. The fine particle measurement apparatus 12 can use a particle counter or the like that irradiates a laser beam or the like into the air and can measure, in response to the scattering intensity of light from fine particles, the magnitude or the number of particles.

[0025]

The "disinfectant spraying unit 2" refers to a

section that sprays disinfectant to an article and confirms the degree of disinfection. The disinfectant spraying unit 2 includes a disinfectant spraying apparatus 21 for spraying disinfectant to an article, and
5 a temperature detection apparatus 22 for confirming on the basis of the surface temperature of the article that the disinfectant has been sprayed thoroughly to the surface of the article.

[0026]

10 The “disinfectant removal unit 3” refers to a section for removing disinfectant sprayed to the article surface and confirming the degree of the removal of the disinfectant. The disinfectant removal unit 3 includes a wind pressure generation apparatus 31 for removing
15 disinfectant sprayed to an article, and a humidity measurement apparatus 32 for confirming that the disinfectant has been removed from the article.

[0027]

The “disinfectant spraying apparatus 21” refers to
20 an apparatus that sprays disinfectant to an article through a nozzle or the like. Although the disinfectant is not specifically restricted only if it can kill microorganisms, disinfectant including, for example, alcohol-based, peroxide-based, chlorine-based, iodine-

based, aldehyde-based disinfectant or the like can be applied. The temperature of the disinfectant upon spraying can be set suitably in accordance with the working temperature of the disinfectant. Further, the
5 nozzle may be formed as that of a movable type or an article may be made rotatable or else both of them may be combined such that the disinfectant may prevail the entire article.

[0028]

10 The "temperature detection apparatus 22" refers to an apparatus that can detect the surface temperature of an article and confirm whether the disinfectant has been sprayed thoroughly to the article surface. If volatile disinfectant such as alcohol sticks to an article, then
15 the surface temperature of the article is dropped by heat of vaporization of the disinfectant, and therefore, by detecting that a drop of the surface temperature ranges over the overall article, uneven sticking of the disinfectant can be confirmed. The temperature detection
20 apparatus 22 can be configured from an apparatus that visually displays a temperature distribution as an image like a thermography and an analysis apparatus that analyzes the temperature distribution. Further, the temperature detection apparatus 22 may include a

mechanism for rotating an article in order to confirm the surface temperature of the article over the overall area.

[0029]

The "wind pressure generation apparatus 31" has a configuration and a function similar to those of the wind pressure generation apparatus 11 of the fine particle removal unit 1. Accordingly, the wind pressure generation apparatus 31 not only can remove disinfectant on the article surface by wind pressure but also can remove fine particles that may possibly remain on the article surface. Consequently, since removal of fine particles is performed twice, removal of fine particles can be performed with a higher degree of certainty. Otherwise, the air nozzle may be formed so as to be movable or an article may be made rotatable such that wind may prevail throughout the article, or both of them may be combined.

[0030]

The "humidity measurement apparatus 32" refers to a section that measures the humidity in the disinfectant removal unit 3 to confirm the degree of removal of disinfectant. In the case where disinfectant remains, the humidity is high because of evaporation of the disinfectant, and as the disinfectant is removed, the humidity decreases. Therefore, the degree of removal of

the disinfectant can be confirmed from the humidity.
Accordingly, the disinfectant removal unit 3 may include
a mechanism for recovering the removed disinfectant.

[0031]

5 The cleanliness measurement unit 5 includes an air
circulation apparatus 51 for circulating air having high
cleanliness, and a fine particle measurement apparatus 52
for measuring fine particles in the cleanliness
measurement unit 5.

10 [0032]

 The “air circulation apparatus 51” refers to an
apparatus for circulating air having high cleanliness,
and such air having high cleanliness may be generated by
filtering external air or air in a space having high
15 cleanliness may be taken in and used as such air. The air
circulation apparatus 51 may be configured such that air
having high cleanliness circulates in the cleanliness
measurement unit 5 or such that air having high
cleanliness flows from the upstream side to the
20 downstream side of the system. Further, air from the air
circulation apparatus 51 may be sent to the locations
independently through a duct (not depicted) or the like
such that it can be used by the wind pressure generation
apparatus 11, the wind pressure generation apparatus 31

and so forth. Consequently, the inside of the system can be kept in a state in which the cleanliness is high. The “fine particle measurement apparatus 52” includes a function similar to that of the fine particle measurement apparatus 12 in the fine particle removal unit 1.

[0033]

The “door D” refers to a door of the opening and closing type provided on the entrance side and the exit side of each unit and can form the inside of the unit as an enclosed space. A door D may be shared by different units, and, for example, a door D1 on the exit side of the fine particle removal unit 1 and a door D2 on the entrance side of the disinfectant spraying unit 2 may be the same door. In the present specification, the doors of the units are sometimes referred to collectively as doors D. The “transport means T” refers to an apparatus such as a belt conveyor that can transport an article in the fine particle removal unit 1, the disinfectant spraying unit 2, the disinfectant removal unit 3, and the cleanliness measurement unit 5. The “air tightness test apparatus” refers to an apparatus that can place the inside of each unit into a negative pressure state or a positive pressure state to confirm leak of gas. The “infrared sensor S” refers to an apparatus that can irradiate

infrared rays to the inside of each unit and confirm reflection of the infrared rays to confirm the presence of an article.

[0034]

5 In the following, a method of use of the system according to the first embodiment of the present invention is described. Note that the following expression is given assuming that, in order to carry an article into a clean room, the cleanliness measurement
10 unit 5 is connected to the clean room and the air circulation apparatus 51 feeds air having high cleanliness in the clean room from the upstream toward the downstream of the system while the units and the apparatus operate automatically by a computer provided in
15 the system.

[0035]

 When the system of the present invention is to be used, an article is carried in from the entrance side of the fine particle removal unit 1. If the presence of an
20 article is detected by the infrared sensor S, then the system closes the doors on the entrance side and the exit side of the fine particle removal unit 1 to enclose the inside of the fine particle removal unit 1. If the enclosed state is confirmed by the air tightness test

apparatus, then the wind pressure generation apparatus 11 is activated to remove and collect fine particles sticking to the article. The fine particle measurement apparatus 12 counts the number of fine particles in the fine particle removal unit 1 to confirm the degree of removal of fine particles. In the case where the number of fine particles exceeds a predetermined reference value, the procedure described above is repeated. Along with this, also it is possible to perform the procedure changing the direction of the air nozzle or the direction of rotation of the article.

[0036]

If the number of fine particles is equal to or smaller than the predetermined reference value, then the doors D on the entrance side and the exit side of the fine particle removal unit 1 are opened and the article is carried to the disinfectant spraying unit 2 by the transport means T. If the presence of the article is detected by the infrared sensor S, then the doors on the opposite sides of the disinfectant spraying unit 2 are closed to enclose the disinfectant spraying unit 2. If the enclosed state is confirmed by the air tightness test apparatus, then the disinfectant spraying apparatus 21 is activated to spray disinfectant at a suitable working

temperature to the article to disinfect microorganisms sticking to the article, and the temperature detection apparatus 22 detects the distribution of the surface temperature of the article to confirm the degree of spray of the disinfectant. In the case where the distribution of the surface temperature of the article is lower than the predetermined reference value, the procedure described above is repeated. Along with this, also it is possible to perform the procedure changing the direction of the nozzle or the direction of rotation of the article.

[0037]

If the distribution of the surface temperature of the article is equal to or higher than the predetermined reference value, then the doors D on the entrance side and the exit side of the disinfectant spraying unit 2 are opened and the article is carried to the disinfectant removal unit 3 by the transport means T. If the presence of the article is detected by the infrared sensor S, then the doors on the opposite sides of the disinfectant removal unit 3 are closed to establish an enclosed state. If the enclosed state is confirmed by the air tightness test apparatus, then the wind pressure generation apparatus 31 is activated to remove the disinfectant sticking to the article. The humidity measurement

apparatus 32 measures the variation of the humidity in the disinfectant removal unit 3, which is caused by evaporation of the disinfectant, to confirm the degree of removal of the disinfectant. In the case where the

5 humidity in the disinfectant removal unit 3 exceeds a predetermined reference value, the procedure described above is repeated. Along with this, also it is possible for the procedure to be performed changing the direction of the air nozzle or changing the direction of rotation

10 of the article.

[0038]

If the humidity in the disinfectant removal unit 3 is equal to or lower than the predetermined reference value, then the doors D on the entrance side and the exit

15 side of the disinfectant removal unit 3 are opened and the article is carried to the cleanliness measurement unit 5 by the transport means T. If the presence of the article is detected by the infrared sensor S, then the doors on the opposite sides of the cleanliness

20 measurement unit 5 are closed to establish an enclosed state. If the enclosed state is confirmed by the air tightness test apparatus, then the fine particle measurement apparatus 52 is activated to confirm the cleanliness of the article. Since, in the cleanliness

measurement unit 5, air of high cleanliness from the air circulation apparatus 51 is circulating, the cleanliness of the article can be confirmed under an environment equal to that of a space of the carrying destination
5 having high cleanliness.

[0039]

In the case where the cleanliness of the article is equal to or higher than the predetermined reference value, the doors on the opposite sides of the cleanliness
10 measurement unit 5 are opened and the article is carried into a space having high cleanliness by the transport means T. In the case where the cleanliness of the article is lower than the predetermined reference value, the article is recovered as a defective article, or the
15 article is returned to the downstream side by the transport means T to perform removal of fine particles and microorganisms from the article again. In the system, air of high cleanliness from the air circulation apparatus 51 is flowing from the upstream side to the
20 downstream side such that fine particles or microorganisms can be prevented from entering the clean room and the cleanliness in the units can be kept high.

[0040]

The wind pressure generation apparatus 11 of the

fine particle removal unit 1 or the wind pressure generation apparatus 31 of the disinfectant removal unit 3 can perform removal of fine particles or microorganisms utilizing air of high cleanliness fed thereto from the upstream side. Further, since air of high cleanliness is taken in from the outside of the system, there is no necessity to attach a dust filler that is expensive to the system itself.

[0041]

10 Although the system according to the first embodiment of the present invention has been described, the present invention is not limited to this.

 The system of the present invention may be connected to and used together with a space having high cleanliness or may be used outside a space of high cleanliness, for example, in a preceding room to the clean room such that it is used when a worker carries an article into the clean room. In the case where the system of the present invention is used in a bio clean room or the like, as disinfectant for microorganisms, a disinfectant is used preferably which is high in safety such as peracetic acid-based disinfectant, hydrogen peroxide, ethanol or the like. An inputting unit or a display unit may be provided such that an operator can

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manually perform various operations for the units, the apparatus provided in the units, the doors for partitioning the units, the transport means and so forth. The fine particle removal unit, the disinfectant spraying unit, the disinfectant removal unit, and the cleanliness measurement unit may be configured such that they are integrated in one area, namely, in one box such that a series of operations are performed in the same space. In this case, a wind pressure generation apparatus, a fine particle measurement apparatus, an air circulation apparatus and so forth can be shared by the respective units.

[0042]

The system of the present invention may not include any door. In particular, in the present invention, since air of high cleanliness can be fed from the upstream side to the downstream side of the system, even in a state in which no door is provided, removed fine particles or microorganisms always flow to the downstream side of the system, and the cleanliness measurement unit located on the upstream side is less likely to have an influence of them. The transport means may be configured such that a cradle on which an article is placed is caused to flow by magnetic force to suppress generation of fine particles

and so forth. Further, the system of the present invention may include, in place of the infrared sensor S, some other sensor that can detect the presence of an article, for example, a weight scale or the like.

5 [0043]

Another aspect of the present invention relates to a system that carries a frozen article from a space of a low cleanliness into another space of high cleanliness, the system including a fine particle removal unit that
10 removes fine particles sticking to a frozen article, a microorganism removal unit that removes microorganisms sticking to the frozen article, a thawing unit for thawing the frozen article, and a cleanliness measurement unit that measures cleanliness of the frozen article, the
15 cleanliness in the cleanliness measurement unit being equal to a cleanliness of the space having the high cleanliness.

[0044]

In the present invention, although the "frozen
20 article" is not specifically restricted, it includes, for example, frozen cells, a frozen raw material (for example, serum such as fetal bovine serum (FBS), human serum or the like) and so forth. The freezing temperature of the frozen article is, for example, -196°C to 0°C.

In the present invention, the "thawing unit" is a section for thawing a frozen article and confirming the degree of thawing of the frozen article. Accordingly, in the present invention, "to thaw a frozen article" signifies that heating the frozen article until the degree of the thawing of the frozen article reaches a predetermined reference value.

[0045]

(Second Embodiment)

Now, a system according to a second embodiment of the present invention is described. FIG. 2 is a view schematically depicting the system according to the second embodiment of the present invention. In the present embodiment, the system includes a microorganism removal unit 4 configured from a fine particle removal unit 1, a disinfectant spraying unit 2, and a disinfectant removal unit 3, a thawing unit 6, and a cleanliness measurement unit 5. Note that same sections as components of the system according to the first embodiment are denoted by like reference symbols and, in the following description, description of them is omitted. In the present embodiment, all of articles that are in a frozen state, an article before it is thawed, and an article after thawed are sometimes represented each as

frozen article or article.

[0046]

The thawing unit 6 includes a temperature detection apparatus 62 for confirming the temperature of a frozen
5 article, and a hot wind generation apparatus 61 for thawing the frozen article with hot wind.

The "temperature detection apparatus 62" refers to an apparatus that detects the temperature of the surface or the inside of a frozen article to confirm a degree of
10 freezing of the frozen article. The temperature detection apparatus 62 can be configured as an apparatus that visually displays the surface temperature of an article as an image such as a thermography, an apparatus that visually displays the temperature of the inside of the
15 article such as an ultrasonic thermometer, and an analysis apparatus that analyzes the temperatures.

The "hot wind generation apparatus 61" refers to an apparatus that generates hot wind to thaw a frozen article. The hot wind generation apparatus 61 includes an
20 air nozzle that heats the air by a heater and feeds out the heated air from one side to the other side, and for such air, air that is circulating in the system may be used, outside air may be used, or cleaned air may be used.

[0047]

In the following, a method of use of the system according to the second embodiment of the present invention is described. Note that the following description is given assuming that processing of a frozen
5 article in the fine particle removal unit 1, the disinfectant spraying unit 2, and the disinfectant removal unit 3 is completed.

[0048]

If the presence of a frozen article is detected by
10 the infrared sensor S, then the system closes the entrance side and exit side doors of the thawing unit 6 to enclose the thawing unit 6. If the enclosed state is confirmed by the air tightness test apparatus, then the temperature detection apparatus 62 is activated to detect
15 the temperature of the surface and the inside of the frozen article. The system adjusts the temperature, strength, operation time period and so forth of the hot wind generation apparatus 61 from the temperature distribution of the frozen article and a target
20 temperature distribution when the frozen article is thawed and feeds hot wind to the frozen article to thaw the frozen article. Then, the temperature distribution of the frozen article is confirmed by the temperature detection apparatus 62, and if the temperature

distribution of the frozen article becomes equal to or higher than a predetermined reference value, then the thawed article is transported to the upstream. In the case where the temperature distribution of the frozen
5 article is lower than the predetermined reference value, then the procedure described above is repeated. Along with this, also it is possible to send warm wind changing the direction of the air nozzle or changing the direction of rotation of the article. Further, by increasing the
10 strength of the hot wind of the hot wind generation apparatus 61, also it is possible to perform removal of fine particles, and therefore, removal of fine particles can be performed over three times.

[0049]

15 The thawing temperature of a frozen article is preferably adjusted to the temperature of a space of high cleanliness, which is a carrying destination. Consequently, when an article is carried into a clean room or the like in which the temperature or the humidity
20 is rigidly managed, the influence upon the environment can be minimized. On the other hand, by setting the temperature of hot wind of the hot wind generation apparatus 61 to a temperature at which microorganisms can be sterilized, also removal of microorganisms can be

performed by the thawing unit 6, and therefore, removal of microorganisms can be performed over twice.

[0050]

In the case where the frozen article is cells, the temperature, strength, time period of use or the like of the hot wind generation apparatus 61 may suitably adjusted to minimize the damage to the cells. In this case, although the thawing temperature is not restricted specifically, it is typically set to 4°C to 50°C, preferably to 30°C to 40°C, and more preferably to 36°C to 38°C. Although the thawing temperature is not restricted specifically if it does not impair the survival rate or the function of the cells after thawed, it typically is two minutes or less, and if it is set especially to 20 seconds or less, then the deterioration of the survival rate can be suppressed significantly. Further, the thawing unit 6 may have a mechanism that can perform thawing while it topples over the container in which the frozen cells are accommodated or oscillating the container leftwardly and rightwardly. Further, since the thawing unit 6 is disposed most on the exit side, in the case where the cells are frozen together with cryoprotectant, it is possible to reduce the exposure time period of the cryoprotectant to the cells after

thawed.

[0051]

Although the system according to the second
embodiment of the present invention has been described,
5 the present invention is not limited to this.

In the system of the present invention, for example,
the thawing unit 6, the fine particle removal unit 1, the
disinfectant spraying unit 2, the disinfectant removal
unit 3, and the cleanliness measurement unit 5 may be
10 disposed in this order from the downstream. In this case,
for example, by removing frost or the like that covers a
frozen article on the downstream side of the system, it
is possible to remove fine particles or microorganisms,
which may possibly stick to the frost, in advance.
15 Accordingly, the thawing unit 6 may include a mechanism
for collecting water or the like that may possibly be
generated upon thawing of the frozen article or a
humidity measurement apparatus for measuring the humidity
in the thawing unit 6.

20 [0052]

A further aspect of the present invention relates
to a system that carries a packaged article from a space
having low cleanliness into another space having high
cleanliness, including a sealing degree measurement unit

that measures the degree of sealing of a packaged article,
a fine particle removal unit that removes fine particles
sticking to the packaged article, a microorganism removal
unit that removes microorganisms sticking to the packaged
5 article, and a cleanliness measurement unit that measures
a cleanliness of the packaged article. The cleanliness in
the cleanliness measurement unit is equal to a
cleanliness of the space having the high cleanliness.

[0053]

10 Although, in the present embodiment, the “packaged
article” is not restricted especially only if it packs an
article, it includes, for example, a packaged article in
which an instrument or the like that is used in a space
of high cleanliness, a packaged article in which a molded
15 part of plastics is packaged, a packaged article in which
a container in which cells or the like are placed is
packaged or the like.

 In the present embodiment, the “sealing degree
measurement unit” refers to a section for confirming the
20 degree of sealing of a packaged article. Accordingly, in
the present invention, “to measure the sealing degree of
a packaged article” signifies that measuring the sealing
degree of a packaged article in state in which an article
is accommodated in the sealing degree measurement unit.

(Third Embodiment)

Now, a system according to a third embodiment of the present invention is described. FIG. 3 is a view schematically depicting the system according to the third
5 embodiment of the present invention. In the present embodiment, the system includes a microorganism removal unit 4 configured from a sealing degree measurement unit 7, a fine particle removal unit 1, a disinfectant spraying unit 2, and a disinfectant removal unit 3, and a
10 cleanliness measurement unit 5 and further includes a defective article carrying unit 8. Note that same sections as components of the system according to the first embodiment or the second embodiment are denoted by like reference symbols and description of them is omitted.
15 In the present embodiment, for the convenience of description, a packaged article is sometimes represented as packaged article, and a packaged article from which a defect is found is sometimes represented as defective article.

20 [0054]

The sealing degree measurement unit 7 includes a pressure adjustment apparatus 71 for adjusting the pressure in the sealing degree measurement unit 7, and a pressure measurement apparatus 72 for measuring the

pressure in the sealing degree measurement unit 7.

The "pressure adjustment apparatus 71" refers to an apparatus that can suck air in the sealing degree measurement unit 7 or feed air into the sealing degree measurement unit 7 to place the inside of the sealing degree measurement unit 7 into negative pressure or positive pressure. The "pressure measurement apparatus 72" refers to an apparatus that can measure a pressure variation in the sealing degree measurement unit 7 to confirm whether a pinhole or the like exists on the packaged article. In particular, the sealing degree measurement unit 7 can pressurize the inside of the sealing degree measurement unit 7 (into negative pressure or positive pressure) and compare pressure variations of a packaged article (acceptable article) in which a pinhole or the like does not exist and a packaged article (defective article) in which a pinhole or the like exists to perform a leak test of the packaged article.

[0055]

The "defective article carrying unit 8" refers to a section neighboring with the units for recovering articles decided as defective articles by the units and transporting the recovered articles. The defective article carrying unit 8 is preferably configured such

that an article is isolated from the outside by such a tunnel structure as described hereinabove. Further, the defective article carrying unit 8 may be configured such that a cradle on which an article is placed is caused to
5 flow by magnetic force and transported.

[0056]

In the following, a method of use of the system according to the third embodiment of the present invention is described.

10 If the presence of a packaged article is detected by the infrared sensor S, then the system closes the entrance side and exit side doors of the sealing degree measurement unit 7 to enclose the sealing degree measurement unit 7. If the enclosed state is confirmed by
15 the air tightness test apparatus, then the pressure adjustment apparatus 71 is activated, for example, to place the inside of the sealing degree measurement unit 7 into negative pressure. Then, the pressure in the sealing degree measurement unit 7 is measured by the pressure
20 measurement apparatus 72. The system calculates the pressure difference between the measured pressure variation and a pressure variation of an acceptable article measured in advance to confirm the degree of sealing of the packaged article. If the pressure

difference is equal to or higher than a predetermined reference value, then packaged article is transported to the upstream direction. If the pressure difference is lower than a predetermined reference value, then since
5 the sterility of the inside of the packaged article cannot be guaranteed, the packaged article is transported as a defective article to the defective article carrying unit 8. By providing the sealing degree measurement unit 7 on the downstream side in this manner, occurrence of a
10 wasteful work at a succeeding step can be prevented.
[0057]

Although the system according to the third embodiment of the present invention has been described, the present invention is not limited to this.

15 Also it is possible to set the defective article carrying unit 8, for example, so as to recover an article decided as a defective article by the cleanliness measurement unit 5 and carry the article to the sealing degree measurement unit 7, the fine particle removal unit
20 1, the disinfectant spraying unit 2 and so forth such that the works are redone.

The system of the present invention may include all of the fine particle removal unit 1, the disinfectant spraying unit 2, the disinfectant removal unit 3, the

thawing unit 6, the sealing degree measurement unit 7,
and the cleanliness measurement unit 5. In this case, for
example, a series of works such as confirmation of the
sealing degree of a packaged article in which a frozen
5 cell container is packaged, thawing of the frozen cells
and so forth can be performed. In such a system as just
described, a carrying-in work can be performed without
using some of the functions in accordance with an article.
For example, in carrying in of a non-frozen article, the
10 thawing unit 6 may be passed through without using the
function of the thawing unit 6. In this manner, in the
system of the present invention, the fine particle
removal unit 1, the disinfectant spraying unit 2, the
disinfectant removal unit 3, the cleanliness measurement
15 unit 5, the thawing unit 6, the sealing degree
measurement unit 7, and the defective article carrying
unit 8 can be suitably selected and used in combination
in accordance with an article. Further, the units may be
formed in a module structure such that they can be
20 connected and disconnected simply.

[0058]

Although the systems according to the first to
third embodiments of the present invention are described
above, the present invention is not limited to them.

Those skilled in the art may suitably combine the systems according to the first to third embodiments described above and the apparatus used in them to design a system having a different configuration.

5 In the present invention, each component can be replaced with an arbitrary element that can exhibit a similar function or also it is possible to add an arbitrary component.

10 Description of Reference Symbols

[0059]

- 1 Fine particle removal unit
- 11 Wind pressure generation apparatus
- 12 Fine particle measurement apparatus
- 15 2 Disinfectant spraying unit
- 21 Disinfectant spraying apparatus
- 22 Temperature detection apparatus
- 3 Disinfectant removal unit
- 31 Wind pressure generation apparatus
- 20 32 Humidity measurement apparatus
- 4 Microorganism removal unit
- 5 Cleanliness measurement unit
- 51 Air circulation apparatus
- 52 Fine particle measurement apparatus

	6 Thawing unit
	61 Hot wind generation apparatus
	62 Temperature detection apparatus
	7 Sealing degree measurement unit
5	71 Pressure adjustment apparatus
	72 Pressure measurement apparatus
	8 Defective article carrying unit
	T Transport means
	D Door
10	S Infrared sensor

Claims

1. A system that carries an article from a space having low cleanliness into another space having high cleanliness, comprising:

5 a fine particle removal unit that removes fine particles sticking to an article;

 a microorganism removal unit that removes microorganisms sticking to the article; and

 a cleanliness measurement unit that measures
10 cleanliness of the article, wherein

 the cleanliness in the cleanliness measurement unit is equal to cleanliness of the space having the high cleanliness.

2. The system according to claim 1, wherein the
15 cleanliness in the cleanliness measurement unit is International Organization for Standardization Class 1 to 9.

3. The system according to claim 1 or 2, wherein air of given high cleanliness can be used by at least one
20 selected from a group of the fine particle removal unit, the microorganism removal unit, and the cleanliness measurement unit.

4. The system according to any one of claims 1 to 3, wherein air of given high cleanliness flows from the

space having high cleanliness to the space having low cleanliness.

5 5. The system according to claim 3 or 4, wherein air of given high cleanliness is air in a space having high cleanliness.

6. The system according to any one of claims 1 to 5, wherein the space having the high cleanliness is a bio clean room.

10 7. A method for carrying an article from a space having low cleanliness into another space having high cleanliness, comprising:

 a step for removing fine particles sticking to an article;

15 a step for removing microorganisms sticking to the article; and

 a step for measuring cleanliness of the article, wherein

 the steps are performed successively and automatically.

20 8. The method according to claim 7, wherein the steps are performed using the system according to any one of claims 1 to 6.