

TRANSPORT FACILITY

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

5 [0001]

The present invention is directed to a transport facility having a vertically movable body that is movable vertically to transport articles, and a tubular body provided to a plurality of floors, or more specifically to a transport facility in which the tubular body has a vertical travel path within the tubular body along which the vertically movable body travels between the plurality of floors, and access openings are provided at least on two floors and are used when articles are taken in and out of the tubular body.

DESCRIPTION OF THE RELATED ART

[0002]

15 This type of transport facilities are used to transport articles among a number of different floors. For example, a transport facility is configured to transfer articles to a vertically movable body through an access opening provided on the floor from which the articles are transported, to cause the vertically movable body carrying an article to be moved vertically, and thereafter to transfer the article to another transporting device or to an operator through an access opening provided on the floor to which the article is transported.

In the transport facility described in JP No. 7-176587, the peripheral wall of the tubular body is formed with a fire wall material so that the tubular body may not be damaged by fire. By forming the peripheral wall of the tubular body with a fire wall material, flames and smokes are kept from entering the tubular body from any part of the tubular body damaged by fire. The fire door which can be opened and closed and which covers the access opening is provided in each of the access opening for taking articles in and out of the tubular body. When a fire breaks out, flames and smokes are kept from entering the tubular body through the access opening by covering the access opening by the fire door. As such, in the transport facility described in JP No. 7-176587, an attempt is made to prevent spreading of the fire to a different floor by preventing the flames from entering the tubular body and to suppress the spread of the fire by preventing the tubular body from acting as a chimney (chimney effect) by preventing the smokes from entering the tubular

body.

[0003]

However, in the conventional transport facility described above, a fire door needs to be provided to each of the plurality of access openings provided to each of the plurality of floors and the peripheral walls provided to a number of floors need to be formed as fire walls. Therefore, the structure to suppress the spread of fire, such as providing many fire doors or forming peripheral walls of the tubular body as fire walls, becomes expensive.

[0004]

The present invention was made in light of the current status of the art described above and its object is to provide a transport facility which can offer a lower-cost alternative for a structure for suppressing spreading of a fire.

SUMMARY OF THE INVENTION

[0005]

To achieve this object, a transport facility in accordance with the invention comprises a vertically movable body that is movable vertically to transport articles; a tubular body provided to a plurality of floors, wherein the tubular body has a vertical travel path within the tubular body along which the vertically movable body travels between the plurality of floors, and access openings that are provided at least on two floors and are used when articles are taken in and out of the tubular body. The invention is characterized in that a fire door, that can be opened and closed and that is extendable across the vertical travel path to block an inside of the tubular body, is provided between two adjacent floors. In the present specification, blocking an inside of the tubular body does not mean to block flow of air completely, but instead means to restrict the flow of air to the extent that flames or smokes are prevented from entering other floors as described below.

[0006]

That is, with the fire door open, the vertically movable body can be vertically moved along the vertical transport path to transport articles among or between a plurality of floors. With the fire door closed, spreading of fire to other floors can be prevented by preventing fires and smokes from entering other floors.

That is, with the fire door closed, even if fires and smokes enter the tubular body from article access openings, spreading of the fire to other floors

and the chimney effect by the tubular body can be prevented by the fire door provided between adjacent floors. In addition, even if the tubular body is damaged by fire and fires and smokes enter the tubular body from the damaged portion, spreading of the fire to other floors and the chimney effect by the tubular body can likely be prevented by the fire door provided between adjacent floors.

Thus, the invention can provide a transport facility in which a structure to suppress spreading of fires is less costly because spreading of the fire to other floors and the chimney effect by the tubular body can be prevented by the provision of the fire door provided between adjacent floors.
[0007]

Another characterizing feature of a transport facility in accordance with the present invention is that the fire door is formed with a plurality of door bodies arranged in a horizontal direction.

[0008]

That is, even where it is difficult for a single door to block or close off the inside of the tubular body because, for example, a guide rail for guiding vertical movements of the vertically movable body and a wire element for suspending the vertically movable body are provided within the tubular body, it is possible to properly block the inside of the tubular body by dividing up its inside into separate areas and blocking them with a plurality of door bodies arranged in a horizontal direction. Therefore, a transport facility with a fire door that can facilitate a proper blocking of the inside of the tubular body.

[0009]

Another characterizing feature of a transport facility in accordance with the present invention is that the transport facility further includes a guide rail provided within the tubular body and extending along the vertical travel path for guiding vertical movements of the vertically movable body, wherein the plurality of door bodies are located so as to surround a periphery of the guide rail when the fire door is closed.

[0010]

That is, the fire door is configured to block the entire inside area of the tubular body with the plurality of the door bodies surrounding the guide rail when the fire door is closed in the tubular body. Thus, a transport facility can be provided where the entire tubular body can be properly blocked by the fire door with a simple structure.

[0011]

Yet another characterizing feature of a transport facility in accordance with the present invention is that the transport facility further includes a wire element wound around a rotating body located upwardly of the vertical travel path, the wire element having one end portion connected to the vertically movable body to suspend the vertically movable body and the other end portion connected to a balance weight to suspend the balance weight; a guide rail for guiding vertical movements of the vertically movable body and the balance weight, the guide rail provided within the tubular body at a location closer to the balance weight than a center of the tubular body in a direction defined by the locational arrangement of the vertically movable body and the balance weight in a sectional view taken at a horizontal plane, wherein a vertically extending engaging groove for the vertically movable body is formed, in a side of the guide rail on a side in which the vertically movable body is located, for guiding vertical movements of the vertically movable body, the engaging groove for the vertically movable body being broader in a back portion than in an opening portion communicated to outside in a sectional view taken at a horizontal plane, wherein a vertically extending engaging groove for the balance weight is formed in a side of the guide rail on a side in which the balance weight is located for guiding vertical movements of the balance weight, the engaging groove for the balance weight being broader in a back portion than in an opening portion communicated to outside in a sectional view taken at the horizontal plane; and wherein the fire door has a main door body for blocking a portion, of the area to be blocked by the fire door, that is located on a side in which the vertically movable body is located with respect to the guide rail within the tubular body, a vertically-movable-body-side sub-door for blocking the engaging groove for the vertically movable body of the guide rail of the guide rail in the area to be blocked by the fire door, and a weight-side sub-door for blocking the engaging groove for the weight of the guide rail in the area to be blocked by the fire door.

[0012]

That is, the fire door is configured to block the entire tubular body by virtue of the fact that the portion, on a side in which the vertically movable body is located with respect to the guide rail, is blocked by the main door body, the engaging groove for the vertically movable body in the guide rail is blocked by the vertically-movable-body-side sub-door, and the engaging groove for the

weight is blocked by the weight-side sub-door. More specifically, the engaging groove for the vertically movable body and the engaging groove for the weight are both formed to be broader in a back portion than the opening portion communicated with outside in a cross sectional view taken at a horizontal plane. Therefore, it is difficult to have a structure where the groove for the vertically movable body and the groove for the weight are blocked by the main door body which blocks the portion in the tubular body on the side in which the vertically movable body is located with respect to the guide rail. However, with the structure of the present characterizing feature, the engaging groove for the vertically movable body and the engaging groove for the weight can be properly blocked with a fire with a simple structure by blocking the engaging groove for the vertically movable body and the engaging groove for the weight separately by a respective door body. Thus, a transport facility can be provided in which the entire tubular body can be properly blocked by a fire door having a simple structure.

[0013]

Another characterizing feature of the transport facility in accordance with the present invention is that the vertically-movable-body-side sub-door is located in a back portion of the engaging groove for the vertically movable body and can be moved between an open posture that is vertically or approximately vertically oriented and a closed posture that is horizontally or approximately horizontally oriented by pivoting about a pivot axis extending laterally and in that the main door body is capable of being wound around or rolled out between an open state in which the main door body is wound around a door storage portion and a closed state in which the main door body is rolled out from the door storage portion, and in that the main door has an operating portion that presses on the vertically-movable-body-side sub-door to move the vertically-movable-body-side sub-door from the open posture to the closed posture as the main door body is rolled out from the door storage portion.

[0014]

That is, the vertically-movable-body-side sub-door is pressed on or pushed by the operating portion of the main door body as the main door body is rolled out from the door storage portion to be moved to its open state, such that the vertically-movable-body-side sub-door is moved from the open posture to the closed posture.

That is, the vertically-movable-body-side sub-door is opened by using the main door body as it is rolled out as an actuating force; therefore, the structure of the fire door can be made simple since there is no need to provide an actuating means specifically for opening the vertically-movable-body-side sub-door. Thus, a transport facility can be provided in which a structure for preventing spreading of fire to other floor can be made simple.

[0015]

Another characterizing feature of the transport facility of the present invention is that the transport facility further includes a wire element wound around a rotating body located upwardly of the vertical travel path, the wire element having one end portion connected to the vertically movable body to suspend the vertically movable body and the other end portion connected to a balance weight to suspend the balance weight; and a guide rail provided within the tubular body and extending along the vertical travel path, wherein the guide rail has a groove for guiding vertical movements of the vertically movable body and a groove for guiding vertical movements of the balance weight, and wherein the fire door has a main door body for blocking a predetermined portion, of the area to be blocked by the fire door, that is located on a side in which the vertically movable body is located with respect to the guide rail, a vertically-movable-body-side sub-door for blocking an area of the groove for guiding the vertical movements of the vertically movable body in the area to be blocked by the fire door, a weight-side sub-door for blocking an area of the groove for guiding the vertical movements of the weight in the area to be blocked by the fire door, and a closure plate for blocking a predetermined portion on a side in which the balance weight is located with respect to the guide rail in the area to be blocked by the fire door.

[0016]

That is, by blocking the groove for guiding vertical movements of the vertically movable body and the groove for guiding vertical movements of the balance weight separately by respective door body, the groove for guiding vertical movements of the vertically movable body and the groove for guiding vertical movements of the balance weight can be properly blocked with a fire door with a simple structure. Thus, a transport facility can be provided in which the entire tubular body can be properly blocked by a fire door with a simple structure.

[0017]

Another characterizing feature of the transport facility in accordance with the present invention is that each of the access openings extends through a portion of a peripheral wall of the tubular body on a side where the vertically movable body is located as viewed from the guide rail.

5 [0018]

With the characterizing feature described above, the articles that were transported by the vertically movable body can be taken in and out of the tubular body easily.

BRIEF DESCRIPTION OF THE DRAWINGS

10 [0019]

Fig. 1 shows a perspective view of the transport facility,

Fig. 2 shows a front view of the transport facility,

Fig. 3 shows a cross sectional view of the vertically movable transport device taken at a horizontal plane,

15 Fig. 4 shows a cross sectional view of the vertically movable transport device taken at a horizontal plane,

Fig. 5 shows a vertical cross sectional view of a lower section of the vertically movable transport device,

20 Fig. 6 shows a vertical cross sectional view of an upper section of the vertically movable transport device,

Fig. 7 shows a cross sectional plan view of the vertically movable transport device,

Fig. 8 shows a side view of the vertically movable body,

Fig. 9 shows a plan view of the fire door in the open state,

25 Fig. 10 shows a side view of the fire door in the open state,

Fig. 11 shows a plan view of the fire door in the closed state,

Fig. 12 shows a side view of the fire door in the closed state,

Fig. 13 shows views of the fire door in operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

30 [0020]

Hereafter, an embodiment of the present invention is described with reference to the drawings. Fig. 1 shows a perspective view of the transport facility. Fig. 2 shows a front view of the transport facility. In the example shown in Figs. 1 and 2, the transport facility is provided with a vertically movable transport device 2, a ceiling transport device 3, and an on-the-floor transport device 4. The vertically movable transport device 2 transports

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articles 1, each of which is a container for storing semiconductor substrates, between a plurality of floors. The ceiling transport devices 3 are provided on predetermined floors and travel in the vicinity of the ceiling to transport articles 1. The on-the-floor transport devices 4 are provided on predetermined floors, and travel on the floor surface. The articles 1 that have been transported by the vertically movable transport device 2 to an upper floor U or a lower floor D of the plurality of the floors are transported on each floor by the ceiling transport device 3 or the on-the-floor transport device 4.

[0021]

On the upper floor U and the lower floor D that form a part of the plurality of floors, down-flow-type clean rooms are formed in which clean air, which is cleaned by a air cleaning means 6, is caused to flow downwardly from the ceiling side to the floor side. The ceiling transport devices 3 and the on-the-floor transport devices 4 are provided in the clean rooms on the upper floor U and on the lower floor D. The vertically movable transport device 2 is provided between the clean room on the upper floor U, and the clean room on the lower floor D.

While an intermediate floor M is provided between the upper floor U and the lower floor D, the clean room is not formed on this intermediate floor M. The ceiling transport vehicle 3 or the on-the-floor transport vehicle 4, which delivers and receives articles 1 to and from the vertically movable transport devices 2 is not provided on this floor M.

[0022]

The air cleaning means 6 is explained with reference to Figs. 1 and 2. As shown in Figs. 1 and 2, the air cleaning means 6 includes a porous grating floor 8 which is spaced apart upwardly from slab-floor F which forms the floor, and an air filter 9 having an HEPA filter (High Efficiency Particulate Air Filter) etc. spaced apart downwardly from the slab-floor F which forms the ceiling. In the air cleaning means 6, the air intake room 10 formed below the grating floor 8 and the chamber 11 formed above the air filter 9 are communicated with each other by a recirculation passage or conduit provided with a ventilation fan 12 and a pre-filter 13. With the air cleaning means 6, the air in the clean room is circulated by the ventilation fan 12 while cleaned by the pre-filter 13 and the air filter 9. The cleaned air is then caused to flow from the ceiling side to the floor side.

In the air cleaning means 6, an ambient air intake channel 14 is

connected to the recirculation conduit at an up-stream side position of the ventilation fan 12, and an exhaust channel 15 is connected to the recirculation conduit at a down-stream side of the ventilation fan 12. This configuration allows a part of the air in the clean room circulated by the air cleaning means
5 6 to be replaced with ambient air.

[0023]

As shown in Figs. 1 and 2, the ceiling transport device 3 includes a guide rail 18 so located to pass above the article transfer portion 41 for the vertically movable transport device 2, and an article transport vehicle 19
10 which moves along the guide rail 18.

The article transport vehicle 19 has a vehicle body 20 which is guided and supported by and moved along the guide rail 18 by the propelling force from a linear motor, an outer frame 21 having an inverted U-shape in a lateral view and having a wire-winding portion 22 within the inner space for
15 taking in and feeding out the wires 23 and a grip portion 24. The grip portion 24 is suspended at the distal ends of and supported by the wires 23 for gripping the article 1.

The article transport vehicle 19 is configured to move the vehicle body 20 along the guide rail 18, to stop above the article transfer portion 41, and to
20 transfer the article 1 to the article transfer portion 41 after lowering the grip portion 24 gripping the article 1 and releasing the grip by the grip portion 24, or to receive the article 1 from the article transfer portion 41 by gripping the article on the article transfer portion 41 with the grip portion 24 after lowering the grip portion 24 without an article 1. In this manner, the article
25 transport vehicle 19 transfers articles 1 between itself and the article transfer portion 41.

[0024]

In the present embodiment, an article transport vehicle 26 is provided as an on-the-floor transport device 4. The article transport vehicle 26 is able to
30 and adapted to travel along a travel path on the grating floor 8. This article transport vehicle 26 includes a travel vehicle body 27 having one or more wheels 27a, and a transporting conveyor 28 which mounts or supports an article and horizontally transport the article 1 while supporting it.

The article transport vehicle 26 is configured to deliver and receive
35 articles 1 between itself and the article transfer portion 41 by causing the transporting conveyor 28 to be operated while the travel vehicle body 27 is

stopped at a lateral side of the article transfer portion 41 after it is moved along the travel path.

[0025]

Figs. 3 and 4 show cross sections of the vertically movable transport device taken at a horizontal plane. Fig. 5 shows a vertical sectional view showing a lower section (the portion provided on the lower floor D) of the vertically movable transport device, and Fig. 6 is a vertical sectional view showing an upper section (the portion provided on the upper floor U) of the vertically movable transport device.

The vertically movable transport device 2, which the transport facility is provided with, includes a vertically movable body 33 which is caused to move vertically to vertically transport articles 1, and a tubular body 32 provided to a plurality of floors. A vertical travel path, along which the vertically movable body 33 travels vertically between a plurality of floors, is defined within the tubular body 32. The tubular body 32 has one or more access openings 31 (or article taking in and out openings) used to take articles 1 in and out of the tubular body 32 on each of at least two floors. Each of the access openings 31 is formed in a part of the peripheral wall of the tubular body 32 that is located on the side in which the vertically movable body 33 is provided as seen from the guide rail 39. Therefore, articles 1 transported by the vertically movable body 33 can be easily taken in and out of the access opening 31 to the inside and outside of the tubular body 32.

[0026]

More specifically, the vertically movable transport device 2 includes a tubular body 32 provided to two or more floors for forming the vertical travel path and defining the access openings 31 for each of the two or more floors for taking articles in and out, the vertically movable body 33 which moves vertically along the vertical travel path within the tubular body 32 to transport articles 1, one or more upper-side belts for vertical movement 37 that function as a wire element, and that are wound around an upper rotating body 35 which is a rotating body provided above or upwardly of the vertical travel path of the vertically movable body 33, and that suspend and support the vertically movable body 33 at one end portion, and suspend and support a balance weight 34 at the other end portion, and a guide rail 39 made of steel for guiding the vertical movements of the vertically movable body 33 and the balance weight 34. In the present embodiment, the side on which the

vertically movable body 33 is provided as seen from the guide rail 39 is defined to be the front side, and the side on which the balance weight 34 is provided as seen from the guide rail 39 is defined to be the back side. And, the direction perpendicular to the front-and-back (or fore-and-aft) direction is defined to be the lateral or width direction.

[0027]

As shown in Figs. 5 and 6, the tubular body 32 includes three portions, namely, a portion provided on the upper floor U, a portion provided on the intermediate floor M, and a portion provided on the lower floor D. Each of these three portions is formed in a shape of a tube that extends in the vertical or up-and-down direction for defining the vertical travel path of the vertically movable body 33 within the tube. The cross-sectional area of the tubular body 32 in the horizontal direction is greater than the opening 64 formed in the slab floor F. That is, the tubular body 32 is not formed to extend through the opening 64 formed in the slab-floor F provided between adjacent floors.

And the tubular body 32 has portions, provided on the lower floor D and also on the upper floor U, each with a broad portion 32a near the floor formed more broadly in the fore-and-aft than the rest of the portion. In the description of the tubular body 32 in the present specification, the front-and-back (or fore-and-aft) direction refers to the direction in which the tubular body 32 is broad, and the front refers to the direction in which the access openings 31 are formed.

Incidentally, openings are formed in the grating floor 8 and in the air filter 9 for the tubular body 32 to extend through. And, the upper surface of the slab-floor F defines the floor, and its undersurface defines the ceiling surface.

[0028]

Defined in the broad portion 32a of the tubular body 32 are one or more access openings 31 that open toward the front for the on-the-floor transport devices, and inside of which article transfer portions 41 for delivering and receiving articles 1 to and from the on-the-floor transport devices 4 are provided. The broad portion 32a also defines one or more access openings 31 for the ceiling transport devices that open upwardly, and article transfer portions 41 for delivering and receiving articles 1 to and from the ceiling transport device 3 are provided inside the access openings 31.

And, in the broad portion 32a of the tubular body 32, article support

portions 42 are provided in the front side of the vertical travel path to be located in the periphery of the vertical travel path. The article support portions 42 are provided at a total of four locations with one pair of horizontally spaced support portions 42 located vertically spaced from another pair with each pair provided in association with each article transfer portion 41.

A transport devices 43 is provided to transport articles 1 between a respective article transfer portion 41 and the corresponding article support portion 42. An opening-and-closing door 44 which can be opened and closed and which covers the respective access opening 31 is provided.

In addition, article storage portions 45 for storing articles 1 are provided in the tubular body 32 on both lateral sides of the vertical travel path to be located in the periphery thereof. Two or more of these article storage portions 45 are arranged in the vertical direction so as to be able to store a plurality of articles 1 within the tubular body 32.

[0029]

Fig. 7 is a cross-sectional plan view of the vertically movable transport device. Fig. 8 is a side view showing the vertically movable body.

As shown in Fig. 7, the guide rail 39 is provided within the tubular body 32 offset from the center of the tubular body 32, in a cross sectional view taken at a horizontal plane, toward the location of the balance weight 34 (toward the back) in a direction extending between the vertically movable body 33 and the balance weight 34 (i.e. the fore-and-aft direction mentioned above). The guide rail 39 is arranged to be located rearwardly of the vertical travel path of the vertically movable body 33. That is, a large space for the vertically movable body 33 to move vertically is secured on the front side of the guide rail 39.

A vertically oriented or extending engaging groove 47 for the vertically movable body for guiding vertical movements of the vertically movable body is formed in the guide rail 39 on the side the vertically movable body 33 is located. The engaging groove 47 for the vertically movable body is broader in the back portion than an opening portion communicated to outside in a horizontal cross sectional view. In addition, a vertically oriented or extending engaging groove 48 for the weight for guiding vertical movements of the balance weight is formed in the guide rail 39 on the side the balance weight 34 is located. The engaging groove 48 for the weight is broader in the back

portion than an opening portion communicated to outside in a horizontal cross sectional view. That is, the vertically oriented engaging groove 47 for the vertically movable body is formed in the vertically extending guide rail 39 along the guide rail 39 on the side in which the vertically movable body 33 is located. The vertically oriented engaging groove 48 for the weight is formed in the guide rail 39 along the guide rail 39 on the side in which the balance weight 34 is located.

To describe in more detail, the guide rail 39 is formed to have an approximate H-shape in a horizontal cross sectional view. In order to form the engaging groove 47 for the vertically movable body such that the back portion thereof has a greater lateral width than the opening portion, vertically-movable-body-side projecting portions 49, which project laterally inwardly, are formed at front ends of a pair of side portions 40 that are located at both lateral ends, and extend in the fore-and-aft direction. In order to form the engaging groove 47 for the weight such that the back portion thereof has a greater lateral width than the opening portion, weight-side projecting portions 50, which project laterally inwardly, are formed at rear ends of a pair of side portions 46.

[0030]

As shown in Figs. 5 - 7, a pair of upper-side belts for vertical movement 37 is provided in the guide rail 39 where the belts 37 are horizontally spaced apart and are provided with gear teeth. Each of the upper-side belts for vertical movement 37 is wound around the upper rotating body 35 with its one end portion connected with an upper end of the vertically movable body 33, and the other end portion connected with an upper end of the balance weight 34.

In addition, one down-side belt 38 for vertical movement is provided in the guide rail 39. This down-side belt 38 for vertical movement is wound around a front and back pair of lower rotating bodies 36 provided in a lower part of the travel path of the vertically movable body 33 with one end portion connected with a lower end portion of the vertically movable body 33, and the other end portion connected with a lower end portion of the balance weight 34.

The vertically movable body 33 is moved vertically along the vertical travel path by rotating the upper rotating body 35 in a forward direction or in a reverse direction.

[0031]

As shown in Fig. 7, the portion of each of the upper-side belts for vertical movement 37 that extends downwardly from the upper rotating body 35 toward the vertically movable body 33 is located forwardly of the engaging groove 47 for the vertically movable body, and the portion extending
5 downwardly toward the balance weight 34 is located within the engaging groove 48 for the weight.

With respect to the downward-side belt 38 for vertical movement, the portion extending upwardly from the lower rotating body 36 toward the vertically movable body 33 is located forwardly of the engaging groove 47 for
10 the vertically movable body, and the portion extending upwardly toward the balance weight 34 is located within the engaging groove 48 for the weight.
[0032]

As shown in Figs. 7 and 8, a plurality of guide rollers 53 guided by the guide rail 39 are provided to the vertically movable body 33. Thus, the
15 vertically movable body 33 is configured to be vertically moved while guided by the plurality of guide rollers 53 to restrict undesirable displacements in the fore-and-aft and lateral directions.

As guide rollers 53 provided to the vertically movable body 33, there are provided upper and lower sets, each set with six guide rollers 53 that
20 contact and are guided by three surfaces of the pair of vertically movable body side projecting portions 49 of the guide rail 39; thus a total of 12 guide rollers 53 are provided.
[0033]

An article transfer device 54, that is capable of and configured to
25 transfer articles 1 between itself and an article storage portion 45 or an article support portion 42, is supported by the vertically movable body 33.

This article transfer device 54 includes a swing base 55 which can rotate freely about a vertical axis P1, a support 56 for mounting and supporting an article 1, and a linkage 57 which is provided on the swing base
30 55 and supports the support 56 such that the support 56 can be extended and retracted. The article transfer device 54 is configured to be able to change the direction in which the support 56 is extended and retracted by pivoting the swing base 55, and to be able to switch between a configuration in which the support 56 is retrieved to a position above the vertically movable body 33, and
35 a configuration in which the support 56 projects toward an article storage portion 45 or an article support portion 42, by extending and retracting the

linkage 57.

That is, the article transfer device 54 is configured to transfer the article 1 between itself and a corresponding article storage portion 45 or article support portion 42 with the swing base 55 rotated so that the direction in which support 56 is extended and retrieved corresponds to the article support portion 42 or the article storage portion 45 to which the article 1 is to be transferred.

[0034]

A plurality of guide rollers 53 guided by the guide rail 39 are provided to the balance weight 34. The balance weight 34 is configured to be vertically moved while guided by the plurality of guide rollers 53 to restrict undesirable displacements in the fore-and-aft and lateral directions and is provided within the engaging groove 48 for the weight.

As guide rollers 53 provided to the balance weight 34, there are provided upper and lower sets, each set with four guide rollers 53 that contact and are guided by the pair of weight side projecting portions 50 and inner projecting portions 51 of the guide rail 39; thus a total of eight guide rollers 53 are provided.

[0035]

As shown in Fig. 7, a support member 60, which supports the fixed member 59 for fixing a vertically intermediate portion of the wiring 58 for the electric supply lines, the communication lines, etc., is provided on one lateral side of the guide rail 39. Wiring 58 is connected to the vertically movable body 33. A ladder used for maintenance is supported to the other lateral side of the guide rail 39.

[0036]

As shown in Fig. 1, a fire door 63 is provided between adjacent floors, can be opened and closed and blocks, covers, or closes off the inside of the tubular body 32 with the door laterally extending across the vertical travel path of the vertically movable body 33. The fire door 63 is made of steel.

Fig. 9 is a plan view showing the fire door in its open position. Fig. 10 is a side view showing the fire door in the open position. As shown in Figs. 9 and 10, a rectangular frame body 65 is provided above the slab-floor F arranged between the intermediate floor M and the lower floor D so as to surround the rectangular opening 64 formed in the floor F. The fire door 63 is provided in the interior space surrounded by the frame body 65. And, the fire

door 63 is configured to block or close off the inside of the tubular body 32 by blocking or closing off the opening 64 formed in the slab-floor F. And, the tubular body 32 is arranged to surround the periphery of the frame body 65.

[0037]

5 Fig. 11 shows a plan view showing the fire door in its closed position, Fig. 12 shows a side view showing the fire door in the closed position, and Fig. 13 includes figures showing the fire door in operation. As shown in Figs. 9 - 13, the fire door 63 includes a plurality of door bodies 66, 67, and 68 arranged next to one another in the horizontal direction, and includes a main door body 10 66 which blocks or close off the portion of the opening 64 (in the tubular body 32) on the side in which the vertically movable body 33 is located with respect to the guide rail 39, a vertically-movable-body-side sub-door body 67 which blocks the engaging groove 47 for the vertically movable body in the guide rail 39, and a weight-side sub-door body 68 which blocks the engaging groove 48 15 for the weight in the guide rail 39. Incidentally, each of the frame body 65, the main door body 66, the vertically-movable-body-side sub-door body 67, and the weight-side sub-door body 68 is made of steel material.

And, the portion of the opening 64 (in the tubular body 32), on the side opposite to the side on which the vertically movable body 33 is located with 20 respect to the guide rail 39, is blocked or closed off by a fixed closure plate 69 fixed in its blocking position.

[0038]

The main door body 66 can be operated to be rolled up or rolled out between a rolled up state (see Figs. 9 and 10) where the main door body 66 is 25 rolled up around the door storage portion 71 and rolled out state where the main door body 66 is rolled out or fed out from the door storage portion 71 (see Figs. 11 and 12).

A shutter opening and closing motor 74 for rotating or actuating a gear (not shown) which engages or meshes with teeth or otherwise unevenness 30 formed in the undersurface of the main door body 66. The main door body 66 is configured to slide to be moved between its rolled up state and rolled out state to be opened and closed as the gear is rotated or actuated in the forward or reverse direction by the shutter opening and closing motor 74.

[0039]

35 The vertically-movable-body-side sub-door body 67 is provided in the back portion of the engaging groove 47 for the vertically movable body such

that the sub-door 67 can be moved, by pivoting about a laterally extending axis (referred to as the pivot axis), between an open posture (see Figs. 9 and 10) in which it assumes a vertical or approximately vertical posture and a closed posture in which it assumes a horizontal or approximately horizontal posture (see Figs. 11 and 12).

The vertically-movable-body-side sub-door body 67 is configured to be pivotable about the pivot axis located above, or displaced upwardly with respect to, a vertical center of the sub-door body 67 so that it is urged toward its open posture under its own weight of the portion below the pivot axis, and is held in the open posture with a magnet 75 (see Figs. 10 and 13).

And the vertically-movable-body-side sub-door body 67 is so located in the engaging groove 47 as to move away from the vertical travel path of the vertically movable body 33 by the change of posture to the open posture and as to block the engaging groove 47 to prevent vertical passage as it is moved or switched to its closed posture.

[0040]

The weight-side sub-door body 68 is arranged on and above the fixed closure plate 69 to be slidable in the fore-and-aft direction between a retracted position (see Figs. 9 and 10) in which it is located in the back side of the engaging groove 48 for the weight, and projects slightly from the fixed closure plate 69 toward the side the guide rail 39 is located, and a blocking position (see Figs. 11 and 12) in which it projects from the fixed closure plate 69 to a great degree toward the side the guide rail 39 is located and enters into the engaging groove 48 for the weight.

A door opening and closing motor 70 is provided for rotating or actuating a pinion gear which meshes or engages a gear on the rack formed in the upper surface of the weight-side sub-door body 68. By rotating the pinion gear in a forward and reverse directions by the door opening and closing motor 70, the weight-side sub-door body 68 can be slid to be moved between the retracted position, retracted from the vertical travel path of the balance weight 34, and the blocking position for vertically blocking the engaging groove 48 for the weight.

The lateral width of this weight-side sub-door body 68 is formed more broadly than the lateral width of the back portion of the engaging groove 48 for the weight; therefore, cut-out portions are formed in the guide rail 39 so that the weight-side sub-door body 68 can slide between the retracted position

and the blocking position.

[0041]

The main door body 66 has a operating portion 72 which presses on or pushes the vertically-movable-body-side sub-door body 67 as the main door
5 body 66 is rolled out from the door storage portion 71 to switch the posture of the vertically-movable-body-side sub-door body 67 from the open posture to the closed posture. More specifically, as shown in Fig. 13, the main door body 66 is configured such that, as it is being switched or moved to the closed state, the bar-shaped operating portion 72 provided in the distal end portion of the
10 main door body 66 moves past between the pair of upper-side belts for vertical movement 37 so that the distal end portion of the operating portion 72 presses on a portion of the vertically-movable-body-side sub-door body 67 that is located above the pivot axis, toward the back portion side (back side) to pivot and to move the portion of the vertically-movable-body-side sub-door body 67
15 located below the pivot axis to the entrance side (front side), which switches the vertically-movable-body-side sub-door body 67 to its closed posture.

[0042]

As shown in Fig. 9, a pair of recessed portions 66a is formed in a distal end portion of the main door body 66. The recessed portions 66a are formed by
20 forming the distal end portion of the main door body 66 such that it is recessed inwardly (i.e. to the front side) from the contour of the distal end portion of the vertically-movable-body-side sub-door body 67. And as shown in Fig. 13, as the main door body 66 is moved to its closed state, the pair of upper-side belts for vertical movement 37 are pushed by the pair of recessed portions 66a toward
25 where the guide rail 39 is located. With the main door body 66 switched to the closed state, the gap formed by the pair-of recessed portions 66a between the main door body 66 and the guide rail 39 is blocked by the pair of upper-side belts for vertical movement 37.

That is, when the main door body 66 and the vertically-movable-body-side sub-door body 67 are closed, a gap is formed by the recessed portion 66a
30 between them. However, the pair of upper-side belts for vertical movement 37 is placed in the gap.

In addition, the recessed portions 66a are formed on the lateral both sides with the operating portion 72 of the main door body 66 located in
35 between.

[0043]

And, as shown in Fig. 9, a recessed portion 68a is formed in the distal end portion of the weight-side sub-door body 68. The recessed portion 68a is formed by forming the distal end portion of the weight-side sub-door body 68 so that it is recessed inwardly (i.e. to the back side) from the contour of the surface of the guide rail 39. And as shown in Fig. 13, as the weight-side sub-door body 68 is slid to be moved to its blocking position, the downward-side belt 38 for vertical movement is pushed by the recessed portions 68a toward where the guide rail 39 is located. With the weight-side sub-door body 68 moved or slid to the blocking position, a gap formed by the recessed portions 68a between the weight-side sub-door body 68 and the guide rail 39 is blocked by the downward-side belt 38 for vertical movement.

That is, when the weight-side sub-door body 68 is closed, a gap is formed by the recessed portion 68a between the weight-side sub-door body 68 and the guide rail 39. However, the upper-side belt 38 for vertical movement 38 is placed in the gap.
[0044]

As shown in Fig. 11, the main door body 66 has a fire-resistant expanding element 73 which expands when heated, at a location that approaches the fixed member 59 when the main door body 66 is in the closed state. With the main door body 66 switched to the closed state, a gap formed between the main door body 66 and the fixed member 59 or the support member 60 is blocked by the fire-resistant expanding element 73 expanded by heat.
[0045]

Although detailed explanation is omitted, the operations of the vertically movable transport device 2, the motor 74 for opening and closing the shutter of the fire door 63, and the motor 70 for opening and closing the door are controlled by a control device not illustrated. The control device controls the operation of the vertically movable transport device 2 to lower the vertically movable body 33 to the lowest position in the vertical travel path when the control device determines that a fire broke out based on an operation information of a fire alarm switch which is actuated manually at the time of a fire break out or on detection information from the fire detection sensor that detects fire. Thereafter, the control device is configured to operate the motor 74 for opening and closing the shutter in order to close the main door body 66 and to control the operation of the motor 70 for opening and closing the door to

move or slide the weight-side sub-door body 68 to the blocking position.

[0046]

[Other Embodiments]

(1) While the fire door 63 is formed with a plurality of door bodies
5 arranged horizontally in the embodiment described above, a fire door having
other configurations may be utilized. For example, when the inside of the
tubular body 32 can be blocked with a single door body, such as when the
guide rail 39 is not provided within the tubular body 32, the fire door 63 may
consist of a single door body.

10 [0047]

(2) While the vertically movable body 33 is suspended and supported
at one end portion of the wire element 37 and the balance weight 34 is
suspended and supported at the other end in the embodiment described above,
other configuration for the wire element 37 may be used. For example, the
15 wire element 37 may be wound around a rotating body 35 provided at an
upward location of the vertical travel path, or around another rotating body
provided separately, to be freely taken in or fed out of the rotating body 35.
This allows a configuration where the vertically movable body 33 may be
suspended and supported at a distal end of the wire element 37 that is fed out
20 without providing any balance weight.

Incidentally, in this case, it is not necessary to form an engaging
groove 48 for the weight in the guide rail 39, or to have a fire door 63 with the
weight-side sub-door body 68.

[0048]

(3) In the embodiment described above, the operating portion 72 is
25 provided in the main door body 66, which presses on the vertically-movable-
body-side sub-door body 67 as the main door body 66 is rolled out from the
door storage portion 71, for moving or switching the vertically-movable-body-
side sub-door body 67 from the open posture and to the closed posture. Instead
30 of providing the operating portion 72 in the main door body 66, a drive means
may be separately provided to carry out a pivot operation of the vertically-
movable-body-side sub-door body 67 to switch the posture of the vertically-
movable-body-side sub-door body 67 from the open posture to the closed
posture.

35 [0049]

(4) While the embodiment described above had a three-floor

configuration with the upper floor U, the intermediate floor M, and the lower floor D, a two-floor configuration with an upper floor U and a lower floor D or a configuration with four or more floors with two or more intermediate floors M may be utilized. And while the fire door 63 is provided between the intermediate floor M and the lower floor D in the embodiment described above, the fire door 63 may be provided between the upper floor U and the intermediate floor M or between adjacent intermediate floors M when two or more intermediate floors M are provided. What is necessary is simply to provide the fire door 63 between adjacent floors. In addition, two or more fire doors 63 may be provided, such as between the intermediate floor M and the lower floor D and between the upper floor U and the intermediate floor M.

Incidentally, the intermediate floor M may also be configured similar to the upper floor U and the lower floor D by forming a clean room, and providing a ceiling transport vehicle 3 and a on-the-floor transport vehicle 4, and forming the access opening 31 for the intermediate floor M, etc.

[0050]

(5) While only an opening-and-closing doors 44 which do not meet fire prevention standards are provided to the access openings 31 and thus no fire prevention doors are provided in the access openings 31 in the above-mentioned embodiment, both an opening-and-closing door 44 which does not meet fire prevention standards, and a fire prevention door may be provided to the access openings 31. While the peripheral wall of the tubular body 32 does not consist of fire walls in the embodiment described above, the peripheral wall of the tubular body 32 may be formed as a fire wall.

CLAIMS

1. A transport facility comprising:

a vertically movable body that is movable vertically to transport articles;

a tubular body provided to a plurality of floors, wherein the tubular body has a vertical travel path within the tubular body along which the vertically movable body travels between the plurality of floors, and access openings that are provided at least on two floors and are used when articles are taken in and out of the tubular body;

characterized in that

a fire door, that can be opened and closed and that is extendable across the vertical travel path to block an inside of the tubular body, is provided between two adjacent floors.

2. A transport facility as defined in claim 1, characterized in that

the fire door is formed with a plurality of door bodies arranged in a horizontal direction.

3. A transport facility as defined in claim 2, further including:

a guide rail provided within the tubular body and extending along the vertical travel path for guiding vertical movements of the vertically movable body, wherein

the plurality of door bodies are located so as to surround a periphery of the guide rail when the fire door is closed.

4. A transport facility as defined in claim 2, further including:

a wire element wound around a rotating body located upwardly of the vertical travel path, the wire element having one end portion connected to the vertically movable body to suspend the vertically movable body and the other end portion connected to a balance weight to suspend the balance weight;

a guide rail for guiding vertical movements of the vertically movable body and the balance weight, the guide rail being provided within the tubular body at a location closer to the balance weight than a center of the tubular body in a direction defined by the locational arrangement of the vertically movable body and the balance weight in a sectional view taken at a horizontal plane, wherein

a vertically extending engaging groove for the vertically movable body is formed, in a side of the guide rail on a side in which the vertically movable

body is located, for guiding vertical movements of the vertically movable body, the engaging groove for the vertically movable body being broader in a back portion than in an opening portion communicated to outside in a sectional view taken at a horizontal plane, wherein

5 a vertically extending engaging groove for the balance weight is formed in a side of the guide rail on a side in which the balance weight is located for guiding vertical movements of the balance weight, the engaging groove for the balance weight being broader in a back portion than in an opening portion communicated to outside in a sectional view taken at the
10 horizontal plane; and wherein

the fire door has a main door body for blocking a portion, of the area to be blocked by the fire door, that is located on a side in which the vertically movable body is located with respect to the guide rail within the tubular body, a vertically-movable-body-side sub-door for blocking the engaging groove for
15 the vertically movable body of the guide rail of the guide rail in the area to be blocked by the fire door, and a weight-side sub-door for blocking the engaging groove for the weight of the guide rail in the area to be blocked by the fire door.

5. A transport facility as defined in claim 2, characterized in that
20 the vertically-movable-body-side sub-door is located in a back portion of the engaging groove for the vertically movable body and can be moved between an open posture that is vertically or approximately vertically oriented and a closed posture that is horizontally or approximately horizontally oriented by pivoting about a pivot axis extending laterally and in that

25 the main door body is capable of being wound around or rolled out between an open state in which the main door body is wound around a door storage portion and a closed state in which the main door body is rolled out from the door storage portion, and in that the main door has an operating portion that presses on the vertically-movable-body-side sub-door to move the
30 vertically-movable-body-side sub-door from the open posture to the closed posture as the main door body is rolled out from the door storage portion.

6. A transport facility as defined in claim 2, further including:
a wire element wound around a rotating body located upwardly of the vertical travel path, the wire element having one end portion connected to the
35 vertically movable body to suspend the vertically movable body and the other end portion connected to a balance weight to suspend the balance weight; and

a guide rail provided within the tubular body and extending along the vertical travel path, wherein the guide rail has a groove for guiding vertical movements of the vertically movable body and a groove for guiding vertical movements of the balance weight, and wherein

5 the fire door has a main door body for blocking a predetermined portion, of the area to be blocked by the fire door, that is located on a side in which the vertically movable body is located with respect to the guide rail, a vertically-movable-body-side sub-door for blocking an area of the groove for guiding the vertical movements of the vertically movable body in the area to
10 be blocked by the fire door, a weight-side sub-door for blocking an area of the groove for guiding the vertical movements of the weight in the area to be blocked by the fire door, and a closure plate for blocking a predetermined portion on a side in which the balance weight is located with respect to the guide rail in the area to be blocked by the fire door.

15 7. A transport facility as defined in claim 3 or 4, characterized in that each of the access openings extends through a portion of a peripheral wall of the tubular body on a side where the vertically movable body is located as viewed from the guide rail.