

STORAGE FACILITY

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 [0001] The present invention relates to a storage facility that includes storage layers at a plurality of levels that are next to each other in an up-down direction.

2. Description of the Related Art

10 [0002] JP 2020-152556A (Patent Document 1) discloses an example of this type of storage facility. The following description of related art will cite, in parenthesis, the reference signs used in Patent Document 1. An automated warehouse system (1) of Patent Document 1 includes storage stages (24) at a plurality of levels in which loads (2) are storable. A plurality of storage lines (26), in which loads (2) are storable next to each other in an X-axis direction
15 (horizontal direction), are next to each other in a Y-axis direction (a horizontal direction orthogonal to the X-axis direction) on each of the storage stages (24) at a plurality of levels. The loads (2) are transported on each storage stage (24) by a transportation mechanism that includes a first shuttle (6), which travels in the X-axis direction in the storage lines (26), and a second shuttle (8),
20 which travels in the Y-axis direction and on which the first shuttle (6) is mountable.

[0003] The automated warehouse system (1) of Patent Document 1 stops, in response to a malfunction occurring in any of the storage stages (24), operation on a storage stage (24) on which the malfunction has occurred and operation
25 on a designated storage stage (24). Traveling of both the first shuttle (6) and the second shuttle (4) is stopped on the storage stages (24) whose operation is stopped, as stated in paragraph 0042 of Patent Document 1. Thus, transportation of the loads (2) is stopped over the entire storage stages (24) on both the storage stage (24) where the malfunction has occurred and the
30 designated storage stage (24). Patent Document 1 states that performing this type of control prevents a decrease in the working efficiency of the automated warehouse system (1) even while recovery work is being performed.

SUMMARY OF THE INVENTION

35 [0004] With the above configuration of the storage facility of Patent Document 1, if a malfunction has occurred in a storage section ("storage line" of Patent

Document 1), transportation of articles is stopped over the entire storage layers in both a malfunctioning storage layer, which is a storage layer ("storage stage" of Patent Document 1) that includes the storage section where the malfunction has occurred, and a designated storage layer different from the malfunctioning storage layer. This prevents a decrease in the working efficiency of the storage facility compared to the case of stopping transportation of articles in the entire storage facility. However, transportation of articles is also uniformly stopped over an entire storage layer different from the malfunctioning storage layer, thus stopping transportation of articles in an unnecessarily wide area. This may limit the effect of preventing a decrease in the working efficiency.

[0005] There is a demand to realize a technology that more effectively prevents a decrease in the working efficiency of a storage facility in case of a malfunction occurring in any of the storage sections.

[0006] A storage facility according to the present disclosure is a storage facility having storage layers at a plurality of levels that are next to each other in an up-down direction, each of the storage layers including a plurality of rows of storage sections in each of which articles are storable next to each other in a first direction, which is a specific direction along a horizontal plane, the plurality of rows being next to each other in a second direction intersecting the first direction as viewed in the up-down direction, the storage facility comprising: a first shuttle configured to travel in the first direction and transport the articles in the storage sections; a second shuttle on which the first shuttle is mountable, the second shuttle being configured to travel in the second direction outside the storage sections; and a control device configured to control traveling of the first shuttle and the second shuttle, wherein each of the storage layers includes first rails on which the first shuttle travels, the first rails corresponding to the plurality of rows of storage sections, and second rails on which the second shuttle travels, the control device executes first control and second control in response to a malfunction occurring in at least one of the storage sections, the first control is control to stop traveling of both the first shuttle and the second shuttle in a malfunctioning storage layer, which is one of the storage layers that includes a malfunctioning storage section, which is one of the storage sections and in which the malfunction has occurred, and the second control is control to prohibit the first shuttle from entering an immediately above storage section, which is one of the storage sections that is

immediately above the malfunctioning storage section, in an upper adjacent storage layer, which is one of the storage layers that is adjacent, on an upper side, to the malfunctioning storage layer.

[0007] According to this configuration, the control device executes the first control in response to a malfunction occurring in any of the storage sections, and stops traveling of both the first shuttle and the second shuttle in the storage layer (malfunctioning storage layer) that includes the storage section (malfunctioning storage section) where the malfunction has occurred. Accordingly, it is possible to appropriately ensure safety of the operator who moves to the malfunctioning storage section in the malfunctioning storage layer and performs work to handle the malfunction in the malfunctioning storage section. Further, according to this configuration, the control device executes the second control, in addition to the first control, in response to a malfunction occurring in any of the storage sections, and prohibits the first shuttle from entering the storage section (immediately above storage section) immediately above the malfunctioning storage section, in the storage layer (upper adjacent storage layer) adjacent, on the upper side, to the malfunctioning storage layer. Thus prohibiting the first shuttle from entering the immediately above storage section at a position relatively close to the malfunctioning storage section in the upper adjacent storage layer prevents contact between the operator who performs work to handle the malfunction in the malfunctioning storage section and the first shuttle present in the upper adjacent storage layer, and appropriately ensures security of the operator. Meanwhile, not prohibiting the first shuttle from entering storage sections in a region relatively separated from the malfunctioning storage section in the upper adjacent storage layer limits the region where transportation of the articles is stopped in the upper adjacent storage layer to a part of the upper adjacent storage layer, and prevents a decrease in the working efficiency of the storage facility caused by executing the second control.

[0008] As described above, this configuration can more effectively prevent a decrease in the working efficiency of the storage facility in case of a malfunction occurring in any of the storage sections.

[0009] Further features and advantages of the storage facility will become apparent from the following description of the embodiments, which will be described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a plan view of a storage facility.

FIG. 2 is a partial vertical front view of the storage facility.

FIG. 3 is a partial perspective view of the storage facility.

5 FIG. 4 is a diagram illustrating first control, second control, and third control.

FIG. 5 is a control block diagram.

FIG. 6 is a control flow diagram.

10 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0011] An embodiment of a storage facility will be described with reference to the drawings. A storage facility 100 includes storage layers 90 at a plurality of levels in an up-down direction Z (vertical direction), as shown in FIGS. 1 and 2. FIG. 2 illustrates the storage facility 100 that includes the storage layers
15 90 at three levels in the up-down direction Z. Three levels L in FIG. 2 include a first level L1, a second level L2, and a third level L3 in ascending order from a lower side Z2 in the up-down direction Z.

[0012] A first direction X refers to a specific direction along a horizontal plane, and a second direction Y refers to a direction intersecting the first direction X
20 as viewed in the up-down direction Z (in a plan view), i.e. as viewed in a direction along the up-down direction Z, as shown in FIGS. 1 and 2. In the present specification, “along a plane” is not limited to being parallel to the plane but also includes being slightly inclined relative to the plane. Further, “along a direction” is not limited to being parallel to the direction but also
25 includes being slightly inclined relative to the direction. The first direction X herein is a direction parallel to a horizontal plane. The second direction Y herein is a horizontal direction orthogonal to the first direction X as viewed in the up-down direction Z. That is, the first direction X and the second direction Y are two horizontal directions orthogonal to each other.

[0013] A first side X1 in the first direction X refers to one side in the first
30 direction X, and a second side X2 in the first direction X refers to the other side in the first direction X. A first side Y1 in the second direction Y refers to one side in the second direction Y, and a second side Y2 in the second direction Y refers to the other side in the second direction Y. The first side X1 in the first
35 direction X herein is the side closer to a travel path of a later-described second shuttle 12 in the first direction X, and the second side X2 in the first direction

X is the opposite side to the first side X1. Accordingly, the first side X1 in the first direction X is opposite between two opposing regions in the first direction X relative to the travel path of the second shuttle 12. The first side Y1 in the second direction Y herein is the side closer to a loading section 92 and an unloading section 93, which will be described later, in the second direction Y, and the second side Y2 in the second direction Y is opposite to the first side Y1.

[0014] Each of the storage layers 90 at a plurality of levels includes storage sections 91 in which articles W are storable in the first direction X, as shown in FIG. 1. The number of articles W storable in the first direction X in one storage section 91 is variable depending on the dimension of the article W in the first direction X. In the example shown in FIG. 1, up to eight articles W are storable next to each other in the first direction X in one storage section 91.

[0015] Each of the storage layers 90 at a plurality of levels includes storage sections 91 in a plurality of rows next to each other in the second direction Y, as shown in FIG. 1. In the example shown in FIG. 1, nine rows of the storage sections 91 are provided in the second direction Y. In the example shown in FIG. 1, a plurality of (here, nine) rows of the storage sections 91 are arranged in the second direction Y, on two sides in the first direction X relative to the travel path of the later-described second shuttle 12.

[0016] The storage facility 100 includes a first shuttle 11, a second shuttle 12, and a control device 40 for controlling traveling of the first shuttle 11 and the second shuttle 12, as shown in FIGS. 1 to 3 and 5. The control device 40 includes a processor, such as a CPU (Central Processing Unit), and storage devices that can be referenced by the processing device, such as a RAM (Random Access Memory) and a ROM (Read Only Memory). Functions of the control device 40 are realized by cooperation between hardware of the control device 40 and programs executed on hardware of the processor or the like. The control device 40 need not be a single piece of hardware but may be a collection of pieces of hardware (a plurality of separated pieces of hardware) that are communicable in a wired or wireless manner.

[0017] The first shuttle 11 travels in the first direction X (here, parallel to the first direction X) and transports an article W in the storage sections 91. For example, at least one (e.g. one) first shuttle 11 is provided in each of the storage layers 90 at a plurality of levels. The second shuttle 12 can receive the first shuttle 11 mounted thereon, and travels in the second direction Y (here, parallel to the second direction Y) outside the storage sections 91. One second

shuttle 12 is provided in each of the storage layers 90 at a plurality of levels, for example. The storage facility 100 thus has article transport vehicles 10 (parent-child shuttles) each including the first shuttle 11 serving as a child shuttle and the second shuttle 12 serving as a parent shuttle.

5 [0018] Each of the storage layers 90 at a plurality of levels has first rails 20 for the first shuttle 11 to travel that are provided in correspondence with respective storage sections 91 in a plurality of rows, and second rails 30 for the second shuttle 12 to travel, as shown in FIGS. 1 and 2. The first rails 20 extend in the first direction X, and the second rails 30 extend in the second
10 direction Y. The first rails 20 (here, a pair of first rails 20 next to each other in the second direction Y) form travel paths of the first shuttle 11, and the second rails 30 (here, a pair of second rails 30 next to each other in the first direction X) form a travel path of the second shuttle 12. The first rails 20 in the example shown in FIG. 1 are provided on two sides in the first direction X
15 relative to the second rails 30 (here, the pair of second rails 30). That is, the travel paths of the first shuttle 11 are formed on two sides in the first direction X relative to the travel path of the second shuttle 12.

[0019] The storage facility 100 includes columns 1 that extend in the up-down direction Z. The columns 1 in the example shown in FIG. 2 stand on a floor
20 while extending from the floor toward an upper side Z1 in the up-down direction Z. The columns 1 support the first rails 20 and the second rails 30. Specifically, the first rails 20 are supported by a plurality of columns 1 by being connected to the columns 1 next to each other in the first direction X. The second rails 30 are supported by a plurality of columns 1 by being connected to
25 the columns 1 next to each other in the second direction Y.

[0020] The first shuttle 11 includes first traveling wheels 11a that roll on first traveling surfaces 21 (see FIG. 3), which are traveling surfaces (here, surfaces facing the upper side Z1) of the first rails 20, as shown in FIG. 2. The first shuttle 11 travels along the first rails 20 due to a drive device (not shown), such
30 as an electric motor, driving the first traveling wheels 11a to rotate. The second shuttle 12 includes second traveling wheels 12a that roll on second traveling surfaces 31, which are traveling surfaces (here, surfaces facing the upper side Z1) of the second rails 30, as shown in FIG. 3. The second shuttle 12 travels along the second rails 30 due to a drive device (not shown), such as
35 an electric motor, driving the second traveling wheels 12a to rotate.

[0021] The first shuttle 11 is movable in the second direction Y while being

mounted in the second shuttle 12, and movable in the first direction X while being separated from the second shuttle 12. The first shuttle 11 moves between the second shuttle 12 and the first rails 20 while the second shuttle 12 is at a position in the second direction Y that corresponds to the first rails 20 (here, a pair of first rails 20) that form a travel path of the first shuttle 11, as shown in FIG. 1.

[0022] An article W to be stored in a storage section 91 is loaded from outside the storage facility 100 into the loading section 92, and an article W removed from a storage section 91 is unloaded from the unloading section 93 to outside the storage facility 100. The loading section 92 and the unloading section 93 in the example shown in FIG. 1 are provided at an end of the travel path of the second shuttle 12 on the first side Y1 in the second direction Y. The article transport vehicle 10 transports an article W to be stored in a storage section 91 from the loading section 92 to the storage section 91, and transports an article W to be removed from a storage section 91 from the storage section 91 to the unloading section 93. FIG. 2 illustrates the case where the article W is a pallet Wa with a load Wb placed thereon.

[0023] Each storage section 91 of this embodiment is formed with use of the first rails 20. Specifically, each first rail 20 has a placement surface 22 (here, a surface facing the upper side Z1) located on the upper side Z1 relative to the first traveling surface 21, in addition to the aforementioned first traveling surface 21, as shown in FIG. 3. The placement surface 22 extends continuously in the first direction X. A plurality of articles W are stored next to each other in the first direction X in the storage section 91 by being placed next to each other in the first direction X on the placement surfaces 22.

[0024] An article W is stored in a storage section 91 with two sides of the article W in the second direction Y being supported by a pair of first rails 20 (specifically, a pair of first rails 20 that form a travel path of the first shuttle 11; the same applies below), as shown in FIG. 1. Specifically, an article W is stored in a storage section 91 with two sides of the article W in the second direction Y being placed on the placement surface 22 of one first rail 20, of a pair of first rails 20, and the placement surface 22 of the other one first rail 20, of the pair of first rails 20. When the inner side (inward) in the second direction Y refers to the side closer to the center between a pair of first rails 20 in the second direction Y, and the outer side (outward) in the second direction Y refers to the opposite side, the placement surfaces 22 of the pair of first rails

20 are located outward in the second direction Y relative to the respective first traveling surfaces 21 of the same first rails 20, as shown in FIG. 3. Accordingly, a pair of first traveling surfaces 21 that form a travel path of the first shuttle 11 in one storage section 91 is located between the two placement surfaces 22 that form this storage section 91 in the second direction Y.

5 [0025] The first shuttle 11 includes a support surface 11b for supporting an article W from the lower side Z2, as shown in FIGS. 2 and 3. The support surface 11b can be raised and lowered, and the first shuttle 11 raises and lowers the support surface 11b with use of a driving force of a drive device (not shown),

10 such as an electric motor. The second shuttle 12 includes a transport conveyor 12b for supporting an article W from the lower side Z2 and transporting the article W in the first direction X, as shown in FIG. 3. The second shuttle 12 drives the transport conveyor 12b with use of a driving force of a drive device (not shown), such as an electric motor.

15 [0026] To store an article W in a storage section 91, the control device 40 operates the first shuttle 11 and the second shuttle 12 as follows, for example. The second shuttle 12 with the first shuttle 11 mounted thereon operates the transport conveyor 12b in the loading section 92, and receives an article W on the transport conveyor 12b from the loading section 92. After receiving the

20 article W from the loading section 92, the second shuttle 12 travels in the second direction Y to a position corresponding to a storage section 91 in which the article W is to be stored, and stops. The first shuttle 11 supporting the article W on the raised support surface 11b separates from the second shuttle 12, travels in the first direction X to a storage position at which the article W

25 is to be stored, and stops. The first shuttle 11 then lowers the support surface 11b and places the article W, which has been supported on the support surface 11b, onto the placement surfaces 22. The article W is thus stored at the storage position in the storage section 91.

[0027] To remove an article W from a storage section 91, the control device 40

30 operates the first shuttle 11 and the second shuttle 12 as follows, for example. The second shuttle 12 with the first shuttle 11 mounted thereon travels in the second direction Y to a position corresponding to the storage section 91 in which the article W to be removed is stored, and stops. The first shuttle 11 with the lowered support surface 11b separates from the second shuttle 12, travels in

35 the first direction X to a storage position at which the article W to be removed is stored, and stops. The first shuttle 11 raises the support surface 11b at the

storage position, supports the article W placed on the placement surfaces 22 with use of the support surface 11b, then travels in the first direction X to the position at which the first shuttle 11 is mounted on the second shuttle 12, and stops. The article W that has been stored at the storage position in the storage section 91 is thus removed from the storage section 91. The article W removed from the storage section 91 is supported by the transport conveyor 12b as a result of the first shuttle 11 lowering the support surface 11b on the second shuttle 12. The second shuttle 12 travels in the second direction Y to the position corresponding to the unloading section 93 and stops, then operates the transport conveyor 12b, and delivers the article W from the transport conveyor 12b to the unloading section 93.

[0028] Each of the storage layers 90 at a plurality of levels has an operator passage 82 (corridor) through which an operator can move in the second direction Y, as shown in FIG. 2. The operator passage 82 is located at a position overlapping the travel path of the second shuttle 12 as viewed in the up-down direction Z. In this embodiment, the operator passage 82 at each level has a dimension in the up-down direction Z that allows an operator (e.g. an operator of an average height) to walk therethrough.

[0029] The lowermost operator passage 82 in the example shown in FIG. 2 is formed by a floor surface, and the operator passages 82 at the other levels L are each formed by a passage-forming member 80. Each passage-forming member 80 is located at a height corresponding to the second rail 30 (here, a pair of second rails 30) at a corresponding level, except for the lowermost level. Each passage-forming member 80 has a plate shape (including a shape of a plate having an open hole) that allows the operator to stand thereon, and a space on the upper side Z1 relative to the passage-forming member 80 serves as the operator passage 82. The operator transfers from a footing 81 (see FIG. 1) to a passage-forming member 80 and thus enters the operator passage 82 formed by this passage-forming member 80.

[0030] If a malfunction has occurred in any of the storage sections 91, the operator can pass through the operator passage 82 at the same level L as a malfunctioning storage section 91A (see FIG. 4), which is a storage section 91 where the malfunction has occurred, and move to this malfunctioning storage section 91A in order to perform work to handle the malfunction in the malfunctioning storage section 91A. Examples of malfunctions that can occur in the storage sections 91 include a failure of the first shuttle 11 in the storage

sections 91 and an article W being stored in an inappropriate state (e.g. direction) in the storage sections 91. The work performed to handle a malfunction is work performed to solve a malfunction, such as work performed on a failed first shuttle 11 or work performed on an article W stored in an inappropriate state. Each storage section 91 of this embodiment does not have a plate-shaped member on which the operator can stand, unlike the passage-forming member 80. The operator boards a work carrier that travels on the first rails 20 (here, a pair of first rails 20) and moves in the first direction X in the storage section 91.

10 [0031] Next, control executed by the control device 40 in response to a malfunction occurring in any of the storage sections 91 will be described. Note that various technical features of the control device 40 described below can also be applied to a method for controlling the first shuttle 11 and the second shuttle 12 (e.g. a method including steps shown in FIG. 6) and a program for

15 controlling the first shuttle 11 and the second shuttle 12. The present specification discloses not only this type of method and program but also a recording medium (a computer-readable recording medium such as an optical disk or a flash memory) with this type of program recorded therein. For example, the program for controlling the first shuttle 11 and the second shuttle

20 12 is provided by the recording medium with the program recorded therein or via a communication network, and the provided program is stored in a storage device that can be referenced by the control device 40 (computer).

[0032] For example, the control device 40 determines whether or not a malfunction has occurred in any of the storage sections 91, based on detection

25 information from sensors (image sensors etc.) provided in the storage sections 91, or based on a signal transmitted from the first shuttle 11 or the second shuttle 12. For example, the first shuttle 11 that is present in one storage section 91 transmits, to the control device 40, a signal indicating that a malfunction has occurred in this storage section 91 in response to detecting a

30 failure of a device (e.g. a drive device such as an electric motor) included in the first shuttle 11. Also, for example, the first shuttle 11 or the second shuttle 12 transmits, to the control device 40, a signal indicating that a malfunction has occurred in a storage section 91 in response to detecting that work to load or unload an article W into or from this storage section 91 has not finished in

35 a scheduled cycle. In this embodiment, the control device 40 and the first shuttle 11 communicate (here, wirelessly) with each other via the second

shuttle 12, as shown in FIG. 5. Unlike this configuration, the control device 40 and the first shuttle 11 may alternatively communicate directly with each other (i.e. without via the second shuttle 12).

[0033] The control device 40 executes first control and second control in response to a malfunction occurring in any of the storage sections 91. Here, a malfunctioning storage section 91A refers to a storage section 91 in which a malfunction has occurred, a malfunctioning storage layer 90A refers to a storage layer 90 in which the malfunctioning storage section 91A is present, an upper adjacent storage layer 90B refers to a storage layer 90 adjacent, on the upper side Z1, to the malfunctioning storage layer 90A, and an immediately above storage section 91B refers to a storage section 91 located immediately above the malfunctioning storage section 91A in the upper adjacent storage layer 90B, as shown in FIG. 4. A lower adjacent storage layer 90C refers to a storage layer 90 adjacent, on the lower side Z2, to the malfunctioning storage layer 90A, and an immediately below storage section 91C refers to a storage section 91 located immediately below the malfunctioning storage section 91A in the lower adjacent storage layer 90C. Note that the storage layers 90 in FIG. 4 are simplified by omitting articles W, for example. In FIG. 4, a symbol “o” denotes an allowable movement of the first shuttle 11 or the second shuttle 12, and a symbol “x” denotes a prohibited movement of the first shuttle 11 or the second shuttle 12.

[0034] The first control is control to stop traveling of both the first shuttle 11 and the second shuttle 12 in the malfunctioning storage layer 90A, and the second control is control to prohibit the first shuttle 11 from entering the immediately above storage section 91B. The first shuttle 11 is basically prohibited from traveling in the storage section 91 (here, the immediately above storage section 91B) in response to the first shuttle 11 being prohibited from entering this storage section 91. As a result of the control device 40 executing the above first control and second control in response to a malfunction occurring in any of the storage sections 91, transport of articles W is stopped over the entire malfunctioning storage layer 90, and loading and unloading of articles W into and from the immediately above storage section 91B is stopped in the upper adjacent storage layer 90B (see FIG. 4).

[0035] The control device 40 executes the second control while allowing the second shuttle 12 to travel in the upper adjacent storage layer 90B and the first shuttle 11 to enter storage sections 91 that are not subjected to the second

control in the upper adjacent storage layer 90B. The control device 40 allows the first shuttle 11 to travel in the storage sections 91 that are not subjected to the second control, thereby allowing the first shuttle 11 to enter these storage sections 91. Accordingly, even if a malfunction has occurred in any of the storage sections 91, articles W can be loaded into and unloaded from storage sections 91 that are not subjected to the second control in the upper adjacent storage layer 90B, with use of the first shuttle 11 and the second shuttle 12. In this embodiment, the aforementioned passage-forming member 80 is placed between each operator passage 82 and the travel path of the second shuttle 12 that is formed on the upper side Z1 of the operator passage 82 (see FIG. 2). This makes it easy to appropriately ensure safety of the operator who moves in the operator passage 82 in the malfunctioning storage layer 90A while allowing the second shuttle 12 to travel in the upper adjacent storage layer 90B.

[0036] In the second control, the first shuttle 11 is prohibited from entering at least the immediately above storage section 91B, of the plurality of storage sections 91 in the upper adjacent storage layer 90B. If, in the second control, the first shuttle 11 is only prohibited from entering the immediately above storage section 91B, of the plurality of storage sections 91 in the upper adjacent storage layer 90B, the immediately above storage section 91B is the only storage section 91 subjected to the second control. Meanwhile, if, in the second control, the first shuttle 11 is also prohibited from entering the storage sections 91 other than the immediately above storage section 91B, of the plurality of storage sections 91 in the upper adjacent storage layer 90B, a plurality of storage sections 91 including the immediately above storage section 91B are the storage sections 91 subjected to the second control. For example, in the second control, the control device 40 may also prohibit the first shuttle 11 from entering storage sections 91 adjacent to the immediately above storage section 91B on two sides in the second direction Y in the upper adjacent storage layer 90B. In this case, a total of three storage sections 91, namely the immediately above storage section 91B and the storage sections 91 adjacent to the immediately above storage section 91B on two sides in the second direction Y are the storage sections 91 subjected to the second control.

[0037] Note that if the first shuttle 11 is present in a storage section 91 to be subjected to the second control at a point in time when a malfunction occurs in any of the storage sections 91, the control device 40 may start the second control after causing the first shuttle 11 to retreat from the storage section 91

to be subjected to the second control. This configuration is preferable in the case where one first shuttle 11 is provided in each of the storage layers 90 at a plurality of levels, for example.

[0038] The control device 40 of this embodiment also executes third control in response to a malfunction occurring in any of the storage sections 91. The third control is control to prohibit the first shuttle 11 from entering the immediately below storage section 91C. The control device 40 executes the above third control in response to a malfunction occurring in any of the storage sections 91, thereby stopping loading and unloading of articles W into and from the immediately below storage section 91C in the lower adjacent storage layer 90C (see FIG. 4).

[0039] The control device 40 executes the third control while allowing the second shuttle 12 to travel in the lower adjacent storage layer 90C and the first shuttle 11 to enter storage sections 91 that are not subjected to the third control in the lower adjacent storage layer 90C. The control device 40 allows the first shuttle 11 to travel in the storage sections 91 that are not subjected to the third control, thereby allowing the first shuttle 11 to enter these storage sections 91. Accordingly, even if a malfunction has occurred in any of the storage sections 91, articles W can be loaded into and unloaded from storage sections 91 that are not subjected to the third control in the lower adjacent storage layer 90C, with use of the first shuttle 11 and the second shuttle 12.

[0040] In the third control, the first shuttle 11 is prohibited from entering at least the immediately below storage section 91C, of the plurality of storage sections 91 provided in the lower adjacent storage layer 90C. If, in the third control, the first shuttle 11 is only prohibited from entering the immediately below storage section 91C, of the plurality of storage sections 91 in the lower adjacent storage layer 90C, the immediately below storage section 91C is the only storage section 91 subjected to the third control. Meanwhile, if, in the third control, the first shuttle 11 is also prohibited from entering storage sections 91 other than the immediately below storage section 91C, of the plurality of storage sections 91 in the lower adjacent storage layer 90C, a plurality of storage sections 91 including the immediately below storage section 91C are the storage sections 91 subjected to the third control. For example, the control device 40 may also prohibit, in the third control, the first shuttle 11 from entering storage sections 91 adjacent to the immediately below storage section 91C on two sides in the second direction Y in the lower adjacent storage

layer 90C. In this case, a total of three storage sections 91, namely the immediately below storage section 91C and the storage sections 91 adjacent to the immediately below storage section 91C on two sides in the second direction Y are the storage sections 91 subjected to the third control.

5 [0041] Note that if the first shuttle 11 is present in a storage section 91 to be subjected to the third control at a point in time when a malfunction occurs in any of the storage sections 91, the control device 40 may start the third control after causing the first shuttle 11 to retreat from the storage section 91 to be subjected to the third control. This configuration is preferable in the case
10 where one first shuttle 11 is provided in each of the storage layers 90 at a plurality of levels, for example.

[0042] The control device 40 of this embodiment starts the first control in response to a malfunction occurring in any of the storage sections 91, and thereafter starts the second control (the second control and the third control in
15 this embodiment) in response to detection of movement of the operator for entering the malfunctioning storage layer 90A. Specifically, if a malfunction has occurred in any of the storage sections 91 (step #01: Yes), the control device 40 starts the first control (step #02), as shown in FIG. 6. Thereafter, if movement of the operator for entering the malfunctioning storage layer 90A
20 has been detected (step #03: Yes), the control device 40 starts the second control (the second control and the third control in this embodiment) (step #04).

[0043] In this embodiment, a detection device 41 for detecting movement of the operator for entering a storage layer 90 (e.g. enter from the footing 81 shown in FIG. 1) is provided in each of the storage layers 90 at a plurality of
25 levels, as shown in FIG. 5. The control device 40 determines whether or not the operator has moved to enter the malfunctioning storage layer 90A, based on detection information from the detection device 41 provided in the malfunctioning storage layer 90A. Movement of the operator for entering the storage layer 90 is a concept that includes both movement of the operator to
30 the storage layer 90 and preliminary movement of the operator before moving to the storage layer 90. For example, the preliminary movement refers to the operator's movement to open a door at an entrance of the storage layer 90 (opening the door, operating a switch for opening the door, etc.).

[0044] As described above, the control device 40 of this embodiment executes
35 the first control, the second control, and the third control in response to a malfunction occurring in any of the storage sections 91. However, the control

device 40 may also execute control other than the first control, the second control, and the third control (e.g. at least either fourth control or fifth control, which will be described below) in response to a malfunction occurring in any of the storage sections 91. The fourth control is control to prohibit the first shuttle 11 from entering a storage section 91 immediately above the immediately above storage section 91B, in a storage layer 90 adjacent, on the upper side Z1, to the upper adjacent storage layer 90B. The fifth control is control to prohibit the first shuttle 11 from entering a storage section 91 immediately below the immediately below storage section 91C, in a storage layer 90 adjacent, on the lower side Z2, to the lower adjacent storage layer 90C.

Other Embodiments

[0045] (1) The above embodiment has described an example of a configuration where the control device 40 starts the first control in response to a malfunction occurring in any of the storage sections 91, and thereafter starts the second control (the second control and the third control in the above embodiment) in response to detection of movement of the operator for entering the malfunctioning storage layer 90A. However, the present disclosure is not limited to this type of configuration. For example, the control device 40 may alternatively start the second control (or the second control and the third control; the same applies to the following) after a set time has elapsed since the first control started, or may start the first control and the second control at the same time. Alternatively, the control device 40 may start the first control in response to detection of movement of the operator for entering the malfunctioning storage layer 90A after a malfunction occurred in any of the storage sections 91, and start the second control at the same time or after a set time has elapsed.

[0046] (2) The above embodiment has described an example of a configuration where the control device 40 executes the third control, in addition to the first control and the second control, in response to a malfunction occurring in any of the storage sections 91. However, the present disclosure is not limited to this type of configuration, and may alternatively employ a configuration where the control device 40 does not execute the third control (e.g. executes only the first control and the second control) in response to a malfunction occurring in any of the storage sections 91.

[0047] (3) The above embodiment has described an example of a configuration

where each first rail 20 has a placement surface 22 on which articles W are placeable in the storage sections 91. However, the present disclosure is not limited to this type of configuration, and may alternatively employ a configuration where any other member (e.g. a member exclusively for the placement surface 22) supported by the columns 1 has the placement surface 22.

[0048] (4) Note that the configuration disclosed in the above embodiment can also be applied in combination with configurations disclosed in other embodiments (including combinations of the embodiments described as other embodiments) unless inconsistency occurs. Regarding other configurations as well, the embodiment disclosed herein is merely an example in all respects. Accordingly, various modifications can be made as appropriate without departing from the gist of the present disclosure.

15 Summary of Above Embodiment

[0049] A summary of the above-described storage facility will be described below.

[0050] A storage facility has storage layers at a plurality of levels that are next to each other in an up-down direction, each of the storage layers including a plurality of rows of storage sections in each of which articles are storable next to each other in a first direction, which is a specific direction along a horizontal plane, the plurality of rows being next to each other in a second direction intersecting the first direction as viewed in the up-down direction. The storage facility comprises: a first shuttle configured to travel in the first direction and transport the articles in the storage sections; a second shuttle on which the first shuttle is mountable, the second shuttle being configured to travel in the second direction outside the storage sections; and a control device configured to control traveling of the first shuttle and the second shuttle, wherein each of the storage layers includes first rails on which the first shuttle travels, the first rails corresponding to the plurality of rows of storage sections, and second rails on which the second shuttle travels, the control device executes first control and second control in response to a malfunction occurring in at least one of the storage sections, the first control is control to stop traveling of both the first shuttle and the second shuttle in a malfunctioning storage layer, which is one of the storage layers that includes a malfunctioning storage section, which is one of the storage sections and in which the

malfunction has occurred, and the second control is control to prohibit the first shuttle from entering an immediately above storage section, which is one of the storage sections that is immediately above the malfunctioning storage section, in an upper adjacent storage layer, which is one of the storage layers that is adjacent, on an upper side, to the malfunctioning storage layer.

5 [0051] According to this configuration, the control device executes the first control in response to a malfunction occurring in any of the storage sections, and stops traveling of both the first shuttle and the second shuttle in the storage layer (malfunctioning storage layer) that includes the storage section

10 (malfunctioning storage section) where the malfunction has occurred. Accordingly, it is possible to appropriately ensure safety of the operator who moves to the malfunctioning storage section in the malfunctioning storage layer and performs work to handle the malfunction in the malfunctioning storage section. Further, according to this configuration, the control device

15 executes the second control, in addition to the first control, in response to a malfunction occurring in any of the storage sections, and prohibits the first shuttle from entering the storage section (immediately above storage section) immediately above the malfunctioning storage section, in the storage layer (upper adjacent storage layer) adjacent, on the upper side, to the

20 malfunctioning storage layer. Thus prohibiting the first shuttle from entering the immediately above storage section located relatively close to the malfunctioning storage section in the upper adjacent storage layer prevents contact between the operator who performs work to handle the malfunction in the malfunctioning storage section and the first shuttle present in the upper

25 adjacent storage layer, and appropriately ensures security of the operator. Meanwhile, not prohibiting the first shuttle from entering storage sections in a region relatively separated from the malfunctioning storage section in the upper adjacent storage layer limits the region where transportation of the articles is stopped in the upper adjacent storage layer to a part of the upper

30 adjacent storage layer, and prevents a decrease in the working efficiency of the storage facility caused by executing the second control.

[0052] As described above, this configuration can more effectively prevent a decrease in the working efficiency of the storage facility in case of a malfunction occurring in any storage section.

35 [0053] Here, it is preferable that, in the second control, the control device further prohibits the first shuttle from entering the storage sections adjacent,

on two sides in the second direction, to the immediately above storage section in the upper adjacent storage layer.

[0054] According to this configuration, even if the storage sections adjacent, on two sides in the second direction, to the immediately above storage section in the upper adjacent storage layer are located relatively close to the malfunctioning storage section, it is possible to prevent contact between the operator who performs work to handle the malfunction in the malfunctioning storage section and the first shuttle present in the upper adjacent storage layer and appropriately ensure security of the operator.

[0055] It is preferable that the control device executes the second control while allowing the second shuttle to travel in the upper adjacent storage layer and allowing the first shuttle to enter the storage sections that are not subjected to the second control in the upper adjacent storage layer.

[0056] According to this configuration, articles can be loaded into and unloaded from storage sections that are not subjected to the second control in the upper adjacent storage layer with use of the first shuttle and the second shuttle even while the second control is being executed. Accordingly, the second control can be executed while preventing a decrease in the working efficiency of the storage facility.

[0057] It is preferable that the control device also executes third control in response to a malfunction occurring in at least one of the storage sections, and the third control is control to prohibit the first shuttle from entering an immediately below storage section, which is one of the storage sections that is immediately below the malfunctioning storage section, in a lower adjacent storage layer, which is one of the storage layers that is adjacent, on a lower side, to the malfunctioning storage layer.

[0058] According to this configuration, the control device executes the third control, in addition to the first control and the second control, in response to a malfunction occurring in any of the storage sections, and prohibits the first shuttle from entering the storage section (immediately below storage section) immediately below the malfunctioning storage section, in the storage layer (lower adjacent storage layer) adjacent, on the lower side, to the malfunctioning storage layer. Thus prohibiting the first shuttle from entering the immediately below storage section relatively close to the malfunctioning storage section in the lower adjacent storage layer makes it easier to prevent a malfunction in the lower adjacent storage layer; for example, even if an object

(e.g. a tool) falls into the lower adjacent storage layer from the malfunctioning storage section while the operator is performing work to handle the malfunction, this object can be collected without the object coming into contact with the first shuttle present in the lower adjacent storage layer. Meanwhile,
5 not prohibiting the first shuttle from entering storage sections in a region relatively separated from the malfunctioning storage section in the lower adjacent storage layer limits the region where transportation of articles is stopped in the lower adjacent storage layer to a part of the lower adjacent storage layer, and prevents a decrease in the working efficiency of the storage
10 facility caused by executing the third control.

[0059] In a configuration where the control device also executes the third control in response to a malfunction occurring in any of the storage sections as described above, it is preferable that, in the third control, the control device further prohibits the first shuttle from entering the storage sections adjacent,
15 on two sides in the second direction, to the immediately below storage section in the lower adjacent storage layer.

[0060] According to this configuration, a malfunction can be more easily prevented from occurring in the lower adjacent storage layer even if the storage sections adjacent, on two sides in the second direction, to the immediately
20 below storage section in the lower adjacent storage layer are relatively close to the malfunctioning storage section.

[0061] In the storage facility having any of the above configurations, it is preferable that the control device starts the first control in response to a malfunction occurring in at least one of the storage sections, and thereafter
25 starts the second control in response to detection of movement of an operator for entering the malfunctioning storage layer.

[0062] According to this configuration, a start of the second control can be delayed until movement of the operator for entering the malfunctioning storage layer is detected, even if a malfunction has occurred in any of the
30 storage sections. Accordingly, regular transportation of articles, including loading and unloading articles into and from the immediately above storage section, can be continued in the upper adjacent storage layer before the aforementioned movement of the operator is detected. The second control is started in response to detection of the aforementioned movement of the
35 operator, and thereafter, it is possible to prohibit the first shuttle from entering the immediately above storage section and appropriately ensure safety of the

operator who performs work to handle the malfunction in the malfunctioning storage section.

[0063] The storage facility according to the present disclosure need only exhibit at least one of the above-described effects.

5

Description of Reference Signs

[0064] 11: First shuttle

12: Second shuttle

20: First rail

10 30: Second rail

40: Control device

90: Storage layer

90A: Malfunctioning storage layer

90B: Upper adjacent storage layer

15 90C: Lower adjacent storage layer

91: Storage section

91A: Malfunctioning storage section

91B: Immediately above storage section

91C: Immediately below storage section

20 100: Storage facility

W: Article

X: First direction

Y: Second direction

Z: Up-down direction

25 Z1: Upper side

Z2: Lower side

What Is Claimed Is:

1. A storage facility having storage layers at a plurality of levels that are next to each other in an up-down direction, each of the storage layers including
5 a plurality of rows of storage sections in each of which articles are storable next to each other in a first direction, which is a specific direction along a horizontal plane, the plurality of rows being next to each other in a second direction intersecting the first direction as viewed in the up-down direction,
the storage facility comprising:
10 a first shuttle configured to travel in the first direction and transport the articles in the storage sections;
a second shuttle on which the first shuttle is mountable, the second shuttle being configured to travel in the second direction outside the storage sections; and
15 a control device configured to control traveling of the first shuttle and the second shuttle,
wherein each of the storage layers includes first rails on which the first shuttle travels, the first rails corresponding to the plurality of rows of storage sections, and second rails on which the second shuttle travels,
20 the control device executes first control and second control in response to a malfunction occurring in at least one of the storage sections,
the first control is control to stop traveling of both the first shuttle and the second shuttle in a malfunctioning storage layer, which is one of the storage layers that includes a malfunctioning storage section, which is one of the
25 storage sections and in which the malfunction has occurred, and
the second control is control to prohibit the first shuttle from entering an immediately above storage section, which is one of the storage sections that is immediately above the malfunctioning storage section, in an upper adjacent storage layer, which is one of the storage layers that is adjacent, on an upper
30 side, to the malfunctioning storage layer.
2. The storage facility according to claim 1,
wherein, in the second control, the control device further prohibits the first shuttle from entering the storage sections adjacent, on two sides in the
35 second direction, to the immediately above storage section in the upper adjacent storage layer.

3. The storage facility according to claim 1 or 2,
wherein the control device executes the second control while allowing
the second shuttle to travel in the upper adjacent storage layer and allowing
5 the first shuttle to enter the storage sections that are not subjected to the
second control in the upper adjacent storage layer.
4. The storage facility according to any one of claims 1 to 3,
wherein the control device also executes third control in response to a
10 malfunction occurring in at least one of the storage sections, and
the third control is control to prohibit the first shuttle from entering an
immediately below storage section, which is one of the storage sections that is
immediately below the malfunctioning storage section, in a lower adjacent
storage layer, which is one of the storage layers that is adjacent, on a lower
15 side, to the malfunctioning storage layer.
5. The storage facility according to claim 4,
wherein, in the third control, the control device further prohibits the
first shuttle from entering the storage sections adjacent, on two sides in the
20 second direction, to the immediately below storage section in the lower
adjacent storage layer.
6. The storage facility according to any one of claims 1 to 5,
wherein the control device starts the first control in response to a
25 malfunction occurring in at least one of the storage sections, and thereafter
starts the second control in response to detection of movement of an operator
for entering the malfunctioning storage layer.