

DESCRIPTION

Title of Invention

OVERHEAD TRANSPORT VEHICLE

5 Technical Field

[0001] One aspect of the present invention relates to an overhead transport vehicle.

Background Art

[0002] An overhead transport vehicle including: a body unit configured to travel along a track; and a lifting unit including a gripping unit configured to grip an article, the lifting unit configured to ascend and descend with respect to the body unit by winding and paying out a plurality of suspending members is known. For example, Patent Literature 1 discloses an overhead transport vehicle in which shock-absorbing elements that are elastically deformable in the vertical direction are disposed between a lifting unit and a gripping unit. With the overhead transport vehicle thus configured, vibrations generated when a traveling body travels or when the lifting unit ascends and descends can be prevented from being transmitted to an article.

20 Citation List

Patent Literature

[0003] [Patent Literature 1] Japanese Unexamined Patent Publication No. 2016-94263

Summary of Invention

25 Technical Problem

[0004] In the conventional overhead transport vehicle in which the

shock-absorbing elements are disposed, transmission of vibrations to an article when the traveling body travels or when the lifting unit ascends and descends can be reduced. However, for example, roll motion tends to occur in the lifting unit due to acceleration during travel or centrifugal force during travel on a curve. The roll motion thus occurring tilts the lifting unit thereby causing the article to sway, and causes the problem that, for example, the article is brought into contact with a cover of the overhead transport vehicle or accuracy of transferring the article deteriorates.

[0005] In view of this, an object of one aspect of the present invention is to provide an overhead transport vehicle that can suppress sway of an article while reducing vibrations transmitted to the article.

Solution to Problem

[0006] An overhead transport vehicle according to one aspect of the present invention is an overhead transport vehicle including: a body unit configured to travel along a track; and a lifting unit including a gripping unit configured to grip an article, the lifting unit configured to be raised and lowered with respect to the body unit by a plurality of suspending members. The lifting unit includes: a base portion to which the gripping unit is provided; and a plurality of shock-absorbing mechanisms, each including a support portion supporting the base portion so as to be vertically movable from below in a vertical direction via a vibration-isolating portion, and to each of which at least one suspending member is attached. The shock-absorbing mechanisms are connected by a link mechanism, and the link mechanism operates so as to ensure similarity of respective distances between the base portion and

the support portions in the shock-absorbing mechanisms connected to each other.

[0007] In the overhead transport vehicle thus configured, because the base portion is provided so as to be vertically movable with respect to each of the support portions with the vibration-isolating portions, vibrations generated when the body unit travels or when the lifting unit ascends and descends can be prevented from being transmitted to the article. Furthermore, in the overhead transport vehicle thus configured, because the link mechanism operates so as to ensure similarity of respective distances between the base portion and the support portions in the respective shock-absorbing mechanisms connected to each other, occurrence of roll motion in the base portion can be reduced. Thus, tilt of the base portion can be reduced, and sway of the article can be suppressed. Consequently, it is possible to reduce sway of the article while reducing vibrations transmitted to the article.

[0008] In the overhead transport vehicle according to the aspect of the present invention, the link mechanism may connect together two of the shock-absorbing mechanisms arranged in a direction orthogonal to both of a direction in which the body unit travels and the vertical direction.

[0009] In the overhead transport vehicle thus configured, roll motion in a width direction (the direction orthogonal to both of the direction in which the body unit travels and the vertical direction) that occurs, for example, during travel on a curve or when the article is transferred in a lateral direction can be reduced.

[0010] In the overhead transport vehicle according to the aspect of the

present invention, the link mechanism may connect together two of the shock-absorbing mechanisms arranged in a direction in which the body unit travels.

5 [0011] In the overhead transport vehicle thus configured, roll motion in a front-and-rear direction (the direction in which the body unit travels) that occurs, for example, due to acceleration or deceleration during travel can be reduced.

10 [0012] In the overhead transport vehicle according to the aspect of the present invention, the link mechanism may connect together two of the shock-absorbing mechanisms arranged in a direction orthogonal to both of a direction in which the body unit travels and the vertical direction, and also may connect together two of the shock-absorbing mechanisms arranged in the direction in which the body unit travels.

15 [0013] In the overhead transport vehicle thus configured, roll motion in the width direction that occurs when, for example, during travel on a curve or when the article is transferred in the lateral direction can be reduced, and also roll motion in the front-and-rear direction (the direction in which the body unit travels) that occurs, for example, due to acceleration or deceleration during travel can be reduced.
20 Furthermore, it is possible to absorb tilt of the base portion caused by at least one of change in position of the center of gravity of the article and tolerance thereof in a state in which the article is gripped or in a state in which the article is not gripped, and thus the base portion can be kept level.

25 [0014] In the overhead transport vehicle according to the aspect of the present invention, the lifting unit may be suspended by four suspending

members from the body unit, one shock-absorbing mechanism of the shock-absorbing mechanisms may further include a swingable portion swingably provided to the corresponding support portion, and two suspending members of the four suspending members may be attached to the swingable portion.

[0015] In the overhead transport vehicle thus configured, the lifting unit is suspended by the four suspending members, but is in a state of being suspended substantially at three locations by two joints between the lifting unit and two suspending members that are not attached to the swingable portion and one swingable portion swingably connected in the lifting unit. Thus, an effect similar to that in the case of being suspended by three suspending members can be obtained, whereby the lifting unit can be more stably suspended. Furthermore, even if one suspending member has been cut for some reason, the suspended state can be maintained, and thus the safety level can be increased more than in the case of being actually suspended by three suspending members.

Advantageous Effects of Invention

[0016] According to the aspect of the present invention, it is possible to reduce tilt of the lifting unit (gripping unit) while reducing vibrations transmitted to the article.

Brief Description of Drawings

[0017] FIG. 1 is a front view illustrating an overhead transport vehicle according to one embodiment.

FIG. 2 is a side view of the overhead transport vehicle in FIG. 1 when viewed from front.

FIG. 3 is a side view of first shock-absorbing mechanisms when

viewed from right.

FIG. 4 is a side view of a second shock-absorbing mechanism when viewed from left.

FIG. 5 is a perspective view of a link mechanism.

5 FIG. 6 is a perspective view of the link mechanism disposed on the back side of a base portion.

FIG. 7 is a perspective view of the link mechanism disposed on the back side of the base portion.

Description of Embodiments

10 [0018] One embodiment will now be described in detail with reference to the drawings. In the description of the drawings, like elements are designated by like reference signs, and duplicated explanation is omitted.

15 [0019] FIG. 1 is a front view illustrating an overhead transport vehicle according to the embodiment, and FIG. 2 is a side view of the overhead transport vehicle in FIG. 1 when viewed from front. In FIG. 1 and FIG. 2, illustration of a link mechanism 70 is omitted. This overhead transport vehicle 1 depicted in FIG. 1 travels along a traveling rail 2 provided at a position higher than a floor, e.g., at a ceiling of a clean room. The overhead transport vehicle 1 conveys a front opening unified pod (FOUP) (article) 90 as an article between a storage facility and a predetermined load port, for example. The FOUP 90 accommodates a plurality of semiconductor wafers, reticles, or the like. The FOUP 90 has a flange 95 configured to be held by the overhead transport vehicle 1.

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[0020] In the following description, the left-and-right direction (X-axis

direction) in FIG. 1 is defined as the front-and-rear direction of the overhead transport vehicle 1 for convenience in description. The up-and-down direction in FIG. 1 is defined as the up-and-down (vertical) direction (Z-axis direction) of the overhead transport vehicle 1. The direction into the page of FIG. 1 is defined as the left-and-right direction or the width direction (Y-axis direction) of the overhead transport vehicle 1. The X-axis, the Y-axis, and the Z-axis are orthogonal to each other.

[0021] As depicted in FIG. 1, the overhead transport vehicle 1 includes a traveling drive unit 3, a horizontal drive unit (body unit) 5, a rotary drive unit (body unit) 6, a lifting drive unit (body unit) 7, a lifting device (lifting unit) 10, a holding device (gripping unit) 11, first shock-absorbing mechanisms 50 (see FIG. 5), a second shock-absorbing mechanism 40 (see FIG. 5), and the link mechanism 70 (see FIG. 5).

In the overhead transport vehicle 1, a pair of covers 8 and 8 is provided in the front-and-rear direction so as to cover the horizontal drive unit 5, the rotary drive unit 6, the lifting drive unit 7, the lifting device 10, and the holding device 11. The pair of covers 8 and 8 forms a space for accommodating a FOUP 90 below the holding device 11 in a state in which the lifting device 10 has ascended to its ascending end. Fall-preventing mechanisms 8A prevent a FOUP 90 held by the holding device 11 from falling in the state in which the lifting device 10 has ascended to the ascending end. Sway suppression mechanisms 8B suppress sway of the FOUP 90 held by the holding device 11 in the front-and-rear direction (traveling direction) and the left-and-right direction of the overhead transport vehicle 1 during travel.

[0022] The traveling drive unit 3 moves the overhead transport vehicle 1 along the traveling rail 2. The traveling drive unit 3 is disposed inside the traveling rail 2. The traveling drive unit 3 drives a roller (not depicted) configured to travel on the traveling rail 2. To the under
5 part of the traveling drive unit 3, the horizontal drive unit 5 is disposed with a shaft 3A interposed therebetween. The horizontal drive unit 5 moves the rotary drive unit 6, the lifting drive unit 7, and the lifting device 10 in a direction (left-and-right direction) orthogonal to the extending direction of the traveling rail 2 in a horizontal plane. The
10 rotary drive unit 6 rotates the lifting drive unit 7 and the lifting device 10 in a horizontal plane. The lifting drive unit 7 raises and lowers the lifting device 10 by winding and paying out four belts (suspending members) 9. As the belts 9 in the lifting drive unit 7, appropriate suspending members such as wires and ropes may be used.

[0023] As depicted in FIG. 1 and FIG. 2, the lifting device 10 in the
15 present embodiment is provided so as to be able to be raised and lowered by the lifting drive unit 7, and functions as a lifting platform in the overhead transport vehicle 1. The lifting device 10 includes the first shock-absorbing mechanisms 50 and the second shock-absorbing
20 mechanism 40 as a plurality of shock-absorbing mechanisms to which four belts 9 are attached, a base portion 10A to which the holding device 11 is provided, and a cover portion 10B covering the base portion 10A. The holding device 11 holds a FOUP 90. The holding device 11 includes a pair of L-shaped arms 12 and 12, hands 13 and 13 fixed to
25 the respective arms 12 and 12, and an opening/closing mechanism 15 configured to open and close the pair of arms 12 and 12.

[0024] The pair of arms 12 and 12 is provided to the opening/closing mechanism 15. The opening/closing mechanism 15 moves the pair of arms 12 and 12 in a direction coming closer to each other and in a direction separating apart from each other. By operation of the opening/closing mechanism 15, the pair of arms 12 and 12 is moved forward and backward in the front-and-rear direction. By this operation, the pair of hands 13 and 13 fixed to the arms 12 and 12 is opened and closed. In the present embodiment, the height position of the holding device 11 (lifting device 10) is adjusted such that the holding surface of each hand 13 is positioned lower than the height of the lower surface of the flange 95 when the pair of hands 13 and 13 is in an open state. In this state, when the pair of hands 13 and 13 is brought into a closed state, the holding surfaces of the hands 13 and 13 are moved forward below the lower surface of the flange 95, and the lifting device 10 is raised in this state, whereby the flange 95 is held (gripped) by the pair of hands 13 and 13, and the FOUP 90 is supported.

[0025] FIG. 3 is a side view illustrating a schematic configuration of the first shock-absorbing mechanisms, and FIG. 4 is a side view illustrating a schematic configuration of the second shock-absorbing mechanism. In FIG. 3, illustration of a part (second support member 54B) of a first body member 54 described later and the link mechanism 70 connected to the first shock-absorbing mechanisms 50 is omitted for convenience in description. In FIG. 4 also, illustration of a part (fourth support member 46B) of a fourth body member 46 described later and the link mechanism 70 connected to the second shock-absorbing mechanism 40 is omitted for convenience in description. As depicted in FIG. 3 and

FIG. 4, the first shock-absorbing mechanisms 50 and the second shock-absorbing mechanism 40 are mechanisms coupling the belts 9 to the lifting device 10 (see FIG. 1), and are mechanisms configured to prevent vibrations, generated when the traveling drive unit 3 travels or when the lifting device 10 ascends and descends, from being transmitted to the FOUP 90.

[0026] As depicted in FIG. 2, the first shock-absorbing mechanisms 50 are provided on the right side of the lifting device 10 in the left-and-right direction. The first shock-absorbing mechanisms 50 are disposed at two locations in the front-and-rear direction as depicted in FIG. 3. Each first shock-absorbing mechanism 50 includes a connecting member 51, a swingable member 53, the first body member (support portion) 54, a second body member 56, first shaft portions 57 and 57, and first spring members (vibration-isolating portions) 58 and 58.

[0027] The connecting member 51 is a member attached to the corresponding belt 9. The swingable member 53 is a member connected to the connecting member 51. The swingable member 53 is rotatably connected to the connecting member 51 via a first pin member 52. The first body member 54 is a substantially U-shaped member the upper end of which is open, and the bottom portion thereof is formed to be flat in the horizontal direction. Upper ends of the first body member 54 are connected to both ends of the swingable member 53 by a bolt 55. The first body member 54 includes a first support member 54A (see FIG. 5 and FIG. 6) and a second support member 54B (see FIG. 5 and FIG. 6). The first support member 54A supports the first spring

members 58 and 58 from below. The second support member 54B is a member orthogonal to the first support member 54A.

[0028] The second body member 56 is a member coupling together substantially central portions of the swingable member 53 and the first body member 54 in the front-and-rear direction. The first shaft portions 57 and 57 in a pair are rod-like members extending upward from the first body member 54, and are disposed so as to sandwich the second body member 56 in the front-and-rear direction. The first spring members 58 and 58 in a pair are compression coil springs having a predetermined spring constant, and through which the pair of first shaft portions 57 and 57 is each disposed. On the upper ends of the pair of first spring members 58 and 58, the base portion 10A is disposed so as to be in contact therewith. Each first spring member 58 presses the base portion 10A upward toward a side opposite to a gripping direction of the FOUP 90 (lower side in the vertical direction). The first spring member 58 as a vibration-isolating portion plays a role in reducing vibrations transmitted between members that are in contact with each other.

[0029] As depicted in FIG. 2, the second shock-absorbing mechanism 40 is provided on the left side of the lifting device 10 in the left-and-right direction. The second shock-absorbing mechanism 40 is disposed near a central portion thereof in the front-and-rear direction as depicted in FIG. 4. The second shock-absorbing mechanism 40 includes connecting members 41 and 41, a swingable member (swingable portion) 43, a third body member 45, the fourth body member (support portion) 46, second shaft portions 47 and 47, and

second spring members (vibration-isolating portions) 48 and 48.

[0030] The connecting members 41 and 41 are members to which the belts 9 and 9 are attached. The swingable member 43 is a member coupling the connecting members 41 and 41 in a pair to the third body member 45. The pair of connecting members 41 and 41 and the swingable member 43 are connected so as to be rotatable in both directions, and are connected together via a pair of third pin members 42 and 42. The swingable member 43 and the third body member 45 are connected together via a fourth pin member 44. The fourth body member 46 is a plate member connected to the lower end of the third body member 45 and extending in the horizontal direction. The fourth body member 46 has a third support member 46A (see FIG. 5 and FIG. 6) and a fourth support member 46B (see FIG. 5 and FIG. 6). The third support member 46A supports the second spring members 48 and 48 from below. The fourth support member 46B is a member orthogonal to the third support member 46A.

[0031] The second shaft portions 47 and 47 in a pair are rod-like members extending upward from the fourth body member 46, and are disposed so as to sandwich the third body member 45 in the front-and-rear direction. The second spring members 48 and 48 in a pair are compression coil springs having a predetermined spring constant, and through which the pair of second shaft portions 47 and 47 is each disposed. On the upper ends of the pair of second shaft portions 47 and 47, the base portion 10A is disposed so as to be in contact therewith. Each second spring member 48 presses the base portion 10A upward toward the side opposite to the gripping direction

of the FOUP 90 (lower side in the vertical direction). The second spring member 48 as a vibration-isolating portion plays a role in reducing vibrations transmitted between members that are in contact with each other.

5 [0032] As depicted in FIG. 5 to FIG. 7, the link mechanism 70 connects together the two first shock-absorbing mechanisms 50 and the second shock-absorbing mechanism 40 that are arranged in the left-and-right direction (width direction) orthogonal to both of the front-and-rear direction (traveling direction) and the up-and-down direction (vertical direction), and also connects together the two first shock-absorbing mechanisms 50 and 50 arranged in the front-and-rear direction. The link mechanism 70 operates so as to bring, closer to each other, the distances between the base portion 10A and the first body member 54 in each first shock-absorbing mechanism 50 and the distance between the base portion 10A and the fourth body member 46 in the second shock-absorbing mechanism 40. The link mechanism 70 also operates so as to bring, closer to each other, the distance between the base portion 10A and the first body member 54 in the first shock-absorbing mechanism 50 disposed on the left side and the distance between the base portion 10A and the first body member 54 in the first shock-absorbing mechanism 50 disposed on the right side. The following describes details of the link mechanism 70.

20 [0033] The link mechanism 70 includes first shafts 71, second shafts 72, third shafts 73, fourth shafts 74, first bushings 81, first blocks 82, second blocks 83, second bushings 84, third bushings 85, fixing portions 86, and a coupling portion 88.

[0034] The first shafts 71 are supported by the first bushings 81 fixed to the fourth support member 46B in the second shock-absorbing mechanism 40, and extend in the front-and-rear direction. Each first shaft 71 is disposed through a through hole 81A of the corresponding first bushing 81, and is provided so as to be rotatable with respect to the first bushing 81 and slidable in the axial direction. Material of the first bushing 81 is appropriately selected such that the first shaft 71 has a certain rotatability and a certain slidability. The two first shafts 71 arranged in the front-and-rear direction are disposed substantially in a straight line in the front-and-rear direction. The respective first shafts 71 are disposed, in the front-and-rear direction, in line with the second shaft portions 47 and 47 (see FIG. 4) each disposed through the pair of second spring members 48 and 48.

[0035] The third shafts 73 are supported by the second bushings 84 fixed to the second support members 54B in the first shock-absorbing mechanisms 50, and extend in the front-and-rear direction. Each third shaft 73 is disposed through a through hole 84A of the corresponding second bushing 84, and is provided so as to be rotatable with respect to the second bushing 84 and slidable in the axial direction. The fourth shafts 74 are supported by the third bushings 85 fixed to the second support members 54B in the first shock-absorbing mechanisms 50, and extend in the front-and-rear direction. Each fourth shaft 74 is disposed through a through hole 85A of the corresponding third bushing 85, and is provided so as to be rotatable with respect to the third bushing 85 and slidable in the axial direction. Materials of the second bushing 84 and the third bushing 85 are appropriately selected in the same manner as

for the first bushing 81 such that the third shaft 73 and the fourth shaft 74 have certain rotatabilities and certain slidabilities.

[0036] Each third shaft 73 and the corresponding fourth shaft 74 are disposed in parallel to each other with the corresponding first shock-absorbing mechanism 50 interposed therebetween. More specifically, when a line in the front-and-rear direction that passes through the first shaft portions 57 and 57 each disposed through the pair of first spring members 58 and 58 is defined as an imaginary line, the third shaft 73 and the fourth shaft 74 are disposed so as to be symmetric with respect to this imaginary line. The two third shafts 73 and 73 arranged in the front-and-rear direction are disposed in a straight line in the front-and-rear direction, and are connected together by the coupling portion 88 described later in detail. The two fourth shafts 74 and 74 arranged in the front-and-rear direction are disposed in a straight line in the front-and-rear direction.

[0037] Each second shaft 72 is supported by the corresponding first block 82 and the corresponding second block 83 that are fixed to the bottom surface of the base portion 10A, and extends in the left-and-right direction. The second shaft 72 is disposed through a through hole 82A of the first block 82 and a through hole 83A of the second block 83, and is provided so as to be rotatable with respect to the first block 82 and the second block 83 and slidable in the axial direction.

[0038] One end of the second shaft 72 in the left-and-right direction is connected to the corresponding first shaft 71. Specifically, an end portion of the first shaft 71 is disposed through a through hole 72A formed in the second shaft 72. The other end of the second shaft 72 in

the left-and-right direction is connected to the corresponding third shaft 73. Specifically, an end portion of the third shaft 73 is disposed through a through hole 72B formed in the second shaft 72. The second shaft 72 is also connected to the corresponding fourth shaft 74 between the first block 82 and the second block 83 in the left-and-right direction. The second shaft 72 is connected to the fourth shaft 74 via the corresponding fixing portion 86 fixed to the bottom surface of the base portion 10A. The fixing portion 86 absorbs attachment tolerance between the fourth shaft 74 and the second shaft 72.

[0039] When the overhead transport vehicle 1 is viewed from right, the third shaft 73 connected to the first shock-absorbing mechanism 50 disposed on the front side and the third shaft 73 connected to the first shock-absorbing mechanism 50 disposed on the rear side are connected together by the coupling portion 88. The coupling portion 88 is disposed at a position that is substantially the center between the two second bushings 84 and 84 arranged in the front-and-rear direction. The coupling portion 88 has an inserted portion 88A having an inside diameter that is larger than the outside diameter of the third shaft 73 disposed on the front side. This third shaft 73 is fixed, for example, at one location in the inserted portion 88A with a support member such as resin. Thus, the third shaft 73 is provided so as to be movable in the up-and-down and left-and-right directions inside the inserted portion 88A.

[0040] Referring to FIG. 5 to FIG. 7, the following describes one example of operation of the link mechanism 70 coupling together the second shock-absorbing mechanism 40 and each first shock-absorbing

mechanism 50 that are arranged in the left-and-right direction. For example, it is assumed that, due to centrifugal force during travel, force is applied to the second spring members 48 and 48 of the second shock-absorbing mechanism 40 on the left side. When the force is applied to the second spring members 48 and 48 of the second shock-absorbing mechanism 40, the second spring members 48 and 48 are compressed, and the fourth body member 46 is accordingly moved upward (arrow D1). In other words, the distance between the fourth body member 46 and the base portion 10A decreases. When the fourth body member 46 is moved upward, an end portion of each first shaft 71 fixed to the fourth body member 46 via the corresponding first bushing 81, on the side closer to the first bushing 81, is moved upward (arrow D2) with respect to the end portion thereof on the side connected to the corresponding second shaft 72.

[0041] When the end portion of the first shaft 71 on the side closer to the first bushing 81 is moved upward, the second shaft 72 is rotated clockwise (arrow D3). When the second shaft 72 is rotated clockwise, an end portion of the third shaft 73 connected thereto, on the side closer to the coupling portion 88, is moved upward (arrow D4) with respect to the end portion thereof on the side connected to the second shaft 72. Furthermore, when the second shaft 72 is rotated clockwise, an end portion of the fourth shaft 74 connected thereto, on the side opposite to the side connected to the second shaft 72, is moved upward (arrow D4) with respect to the end portion thereof on the side connected to the second shaft 72. Accordingly, the first body member 54 that is fixed to the third shaft 73 via the corresponding second bushing 84 and is also

fixed to the fourth shaft 74 via the corresponding third bushing 85 is pushed upward (arrow D5). When the first body member 54 is pushed upward, the corresponding pair of first spring members 58 and 58 is compressed. In other words, the distance between the first body member 54 and the base portion 10A decreases.

[0042] In contrast, when the second spring members 48 and 48 are stretched and the fourth body member 46 is accordingly moved downward (direction opposite to the arrow D1), the end portion of the first shaft 71 on the side closer to the first bushing 81 is moved downward (direction opposite to the arrow D2) with respect to the end portion thereof on the side connected to the second shaft 72. When the end portion of the first shaft 71 on the side closer to the first bushing 81 is moved downward, the second shaft 72 is rotated counterclockwise (direction opposite to the arrow D3). When the second shaft 72 is rotated counterclockwise, the end portion of the third shaft 73 on the side closer to the coupling portion 88 is moved downward (direction opposite to the arrow D4) with respect to the end portion thereof on the side connected to the second shaft 72, and the end portion of the fourth shaft 74 on the side opposite to the side connected to the second shaft 72 is moved downward (direction opposite to the arrow D4) with respect to the end portion thereof on the side connected to the second shaft 72. Accordingly, the first body member 54 is pushed downward (direction opposite to the arrow D5), and the pair of first spring members 58 and 58 is stretched.

[0043] As described above, in the link mechanism 70 coupling together the second shock-absorbing mechanism 40 and each first

shock-absorbing mechanism 50 that are arranged in the left-and-right direction, when spring members of one of the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 are compressed or stretched, the corresponding second shaft 72 is rotated, in response to this compression or stretch, about the corresponding first block 82 and the corresponding second block 83 that are fixed to the bottom surface of the base portion 10A, whereby spring members of the other of the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 are compressed or stretched. In other words, when a difference arises between the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the corresponding first body member 54 in the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 that are connected to each other, the link mechanism 70 operates so as to bring, closer to each other, the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the first body member 54 in the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 that are connected to each other.

[0044] The link mechanism 70 includes the second shaft 72 configured to produce a stress (torsion stress) when a difference arises between the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the first body member 54 in the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 that are connected to each other. Reaction force against the stress produced in the second shaft 72 acts as

a force that brings, closer to each other, the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the first body member 54 in the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 that are connected to each other.

[0045] The following describes one example of operation of the link mechanism 70 coupling together the first shock-absorbing mechanisms 50 arranged in the front-and-rear direction. For example, it is assumed that, due to acceleration or deceleration during travel, force is applied to the first spring members 58 and 58 of the first shock-absorbing mechanism 50 on the rear side. When the force is applied to the first spring members 58 and 58 of the first shock-absorbing mechanism 50, the first spring members 58 and 58 are compressed, and the corresponding first body member 54 is accordingly moved upward (arrow D5). In other words, the distance between the first body member 54 and the base portion 10A decreases. When the first body member 54 is moved upward (arrow D5), an end portion of the third shaft 73 fixed to the first body member 54 via the corresponding second bushing 84, on the side closer to the coupling portion 88, is moved upward (arrow D6) with respect to the end portion thereof on the side connected to the corresponding second shaft 72.

[0046] When the coupling portion 88 is moved upward (arrow D6), an end portion of the other third shaft 73 connected to the coupling portion 88 (the third shaft 73 disposed on the left side in FIG. 5), on the side closer to the coupling portion 88, is also moved upward (arrow D6) with respect to the end portion thereof on the side connected to the

corresponding second shaft 72. Accordingly, the first body member 54 that is fixed to the third shaft 73 via the second bushing 84 of the first shock-absorbing mechanism 50 on the front side is pushed upward (arrow D7). When the first body member 54 is pushed upward, the corresponding pair of the first spring members 58 and 58 is compressed. In other words, the distance between the first body member 54 and the base portion 10A decreases.

[0047] In contrast, when the first spring members 58 and 58 of the first shock-absorbing mechanism 50 on the front side are stretched and the first body member 54 is accordingly moved downward (direction opposite to the arrow D5), the end portion of the corresponding third shaft 73 on the side closer to the coupling portion 88 is moved downward (direction opposite to the arrow D6) with respect to the end portion thereof on the side connected to the corresponding second shaft 72. When the coupling portion 88 is moved downward, an end portion of the other third shaft 73 connected to the coupling portion 88 on the side closer to the coupling portion 88 is also moved downward (direction opposite to the arrow D6) with respect to the end portion thereof on the side connected to the corresponding second shaft 72. Accordingly, the first body member 54 of the first shock-absorbing mechanism 50 on the front side is pushed downward (direction opposite to the arrow D7). When the first body member 54 is pushed downward, the corresponding pair of first spring members 58 and 58 is stretched.

[0048] As described above, in the link mechanism 70 coupling together the first shock-absorbing mechanisms 50 arranged in the front-and-rear

direction, when one of the first spring members 58 and 58 of one of the first shock-absorbing mechanisms 50 is compressed or stretched, in a manner supported by the coupling portion 88 and following the movement of the corresponding third shaft 73, the other third shaft 73 is moved, whereby the first spring members 58 and 58 of the other of the first shock-absorbing mechanisms 50 are compressed or stretched. In other words, the link mechanism 70 operates so as to ensure similarity of respective distances between the base portion 10A and the first body members 54 and 54 in the first shock-absorbing mechanisms 50 that are connected to each other.

[0049] The link mechanism 70 includes the third shafts 73 configured to produce a stress when a difference arises between the distances between the base portion 10A and the first body members 54 in the first shock-absorbing mechanisms 50 that are connected to each other. Reaction force against the stress produced in the third shafts 73 acts as a force that ensure similarity of respective distances between the base portion 10A and the first body members 54 in the first shock-absorbing mechanisms 50 that are connected to each other.

[0050] The following describes functional effects of the overhead transport vehicle 1 according to the embodiment described above. In the overhead transport vehicle 1 according to the embodiment, because the base portion 10A is provided so as to be movable in the up-and-down direction with respect to the first body members 54 and the fourth body member 46 with the first spring members 58 and the second spring members 48 interposed therebetween, vibrations generated when the traveling drive unit 3 travels or when the lifting

device 10 ascends and descends can be prevented from being transmitted to an article. Furthermore, in the overhead transport vehicle 1 according to the embodiment, when a difference arises, in the second shock-absorbing mechanism 40 and each first shock-absorbing mechanism 50 that are connected to each other, between the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the corresponding first body member 54, the link mechanism 70 brings, closer to each other, the distance between the base portion 10A and the fourth body member 46 and the distance between the base portion 10A and the first body member 54 in the second shock-absorbing mechanism 40 and the first shock-absorbing mechanism 50 that are connected to each other, whereby occurrence of roll motion in the base portion 10A can be reduced. Thus, tilt of the base portion 10A can be reduced, and sway of a FOUP 90 can be reduced. Consequently, it is possible to reduce sway of the FOUP 90 while reducing vibrations transmitted to the FOUP 90.

[0051] Because the link mechanism 70 connects together the two first shock-absorbing mechanisms 50 and the second shock-absorbing mechanism 40 that are arranged in the left-and-right direction (width direction) orthogonal to both of the front-and-rear direction in which the traveling drive unit 3 travels and the up-and-down direction, roll motion in the width direction that occurs during travel on a curve or when the FOUP 90 is transferred in the lateral direction can be suppressed. Furthermore, because the link mechanism 70 connects together the two first shock-absorbing mechanisms 50 arranged in the direction in which

the traveling drive unit 3 travels, roll motion in the front-and-rear direction that occurs due to acceleration or deceleration during travel can be reduced.

5 [0052] In the overhead transport vehicle 1 according to the embodiment, the lifting device 10 is suspended by the four belts 9, but is in a state of being suspended substantially at three locations by two connecting portions between the lifting device 10 and two belts 9 that are attached to the first shock-absorbing mechanisms 50 and the one
10 fourth pin member 44 swingably connected in the second shock-absorbing mechanism 40. Thus, an effect similar to that in the case of being suspended by three belts 9 can be obtained, whereby the lifting device 10 can be more stably suspended. Furthermore, even if one belt 9 has been cut for some reason, the suspended state can be maintained, and thus the safety level can be increased more than in the
15 case of being actually suspended by three belts 9.

[0053] In the foregoing, one embodiment has been described. However, one aspect of the present invention is not limited to the embodiment, and various modifications can be made without departing from the scope of the claims.

20 [0054] In the embodiment, an example has been described in which each first shock-absorbing mechanism 50 and the second shock-absorbing mechanism 40 that are arranged in the left-and-right direction are connected by the link mechanism 70, and the first shock-absorbing mechanisms 50 arranged in the front-and-rear direction
25 are also connected to each other by the link mechanism 70. However, the aspect of the present invention is not limited to this. For example,

the overhead transport vehicle may be configured such that only each first shock-absorbing mechanism 50 and the second shock-absorbing mechanism 40 that are arranged in the left-and-right direction may be connected by the link mechanism 70. Even in this case, roll motion that occurs in the width direction during travel on a curve or when the FOUP is transferred in the lateral direction can be reduced. Alternatively, the overhead transport vehicle may be configured such that only the first shock-absorbing mechanisms 50 arranged in the front-and-rear direction are connected to each other by the link mechanism 70. Even in this case, roll motion in the front-and-rear direction that occurs due to acceleration or deceleration during travel can be reduced.

[0055] In the embodiment or the modifications above, an example has been described in which each first shock-absorbing mechanism 50 is fixed to two shafts of the corresponding third shaft 73 and the corresponding fourth shaft 74. However, a configuration may be used in which the first shock-absorbing mechanism 50 is fixed only to the third shaft 73. However, when a shaft that is a part of the link mechanism 70 fixed to each first body member 54 does not correspond to the direction in which the first spring members 58 and 58 are arranged (when the shaft does not lie on the above-described imaginary line) as in the present embodiment, horizontal balance can be more easily maintained with the configuration in which the first shock-absorbing mechanism 50 is fixed to the two shafts of the third shaft 73 and the fourth shaft 74. This enables sway of the FOUP 90 to be effectively reduced.

[0056] In the embodiment or the modifications above, an example has been described in which the first spring members 58 and the second spring members 48 as vibration-isolating portions are disposed substantially directly below the positions of portions suspended by the belts 9. However, the aspect of the present invention is not limited to this. A configuration may be used in which the positions of the portions suspended by the belts 9 and the positions of the vibration-isolating portions are displaced from each other.

[0057] Instead of or in addition to the first spring members 58 or the second spring members 48 in the embodiment or the modifications above, for example, gel elastic bodies formed of silicone resin or the like may be disposed. Even in this case, vibrations and shock can be absorbed similarly to the case when the first spring members 58 or the second spring members 48 are disposed.

[0058] In the embodiment or the modifications above, an example has been described in which the lifting device 10 is suspended by the four belts 9. However, a configuration may be used in which the lifting device is suspended by three belts 9. In this case, the belts 9 are attached at three locations to the connecting members 51 and 51 (see FIG. 3) and the fourth pin member 44 (see FIG. 4).

[0059] In the embodiment or the modifications above, an example has been described in which the base portion 10A is disposed so as to be movable in the up-and-down direction with respect to the first body members 54 or the fourth body member 46 as support portions by disposing each first shaft portion 57 as a shaft member through the corresponding first spring member 58 or by disposing each second shaft

portion 47 as a shaft member through the corresponding second spring member 48. However, the aspect of the present invention is not limited to this. For example, as a configuration for making the base portion movable in the up-and-down direction, a linear motion guide may be used.

Reference Signs List

[0060] 1... overhead transport vehicle, 2... traveling rail, 3... traveling drive unit, 5... horizontal drive unit, 6... rotary drive unit, 7... lifting drive unit, 9... belt, 10... lifting device, 10A... base portion, 11... holding device, 40... second shock-absorbing mechanism (shock-absorbing mechanism), 43... swingable member, 46... fourth body member (support portion), 46A... third support member, 46B... fourth support member, 48... second spring member (vibration-isolating portion), 50... first shock-absorbing mechanism (shock-absorbing mechanism), 54... first body member (support portion), 54A... first support member, 54B... second support member, 58... first spring member (vibration-isolating portion), 70... link mechanism

CLAIMS

1. An overhead transport vehicle comprising:
a body unit configured to travel along a track; and
a lifting unit including a gripping unit configured to grip an
5 article, the lifting unit being configured to be raised and lowered with
respect to the body unit by a plurality of suspending members, wherein
the lifting unit includes:
a base portion to which the gripping unit is provided;
and
10 a plurality of shock-absorbing mechanisms, each
including a support portion supporting the base portion, so as to be
vertically movable from below in a vertical direction via a
vibration-isolating portion, and to each of which at least one suspending
member is attached,
15 the shock-absorbing mechanisms are connected by a link
mechanism, and
the link mechanism operates so as to ensure similarity of
respective distances between the base portion and the support portions
in the shock-absorbing mechanisms connected to each other.
20
2. The overhead transport vehicle according to claim 1, wherein
the link mechanism connects together two of the shock-absorbing
mechanisms arranged in a direction orthogonal to both of a direction in
which the body unit travels and the vertical direction.
25
3. The overhead transport vehicle according to claim 1 or 2,

wherein the link mechanism connects together two of the shock-absorbing mechanisms arranged in a direction in which the body unit travels.

5 4. The overhead transport vehicle according to any one of claims 1 to 3, wherein the link mechanism connects together two of the shock-absorbing mechanisms arranged in a direction orthogonal to both of a direction in which the body unit travels and the vertical direction, and also connects together two of the shock-absorbing mechanisms
10 arranged in the direction in which the body unit travels.

 5. The overhead transport vehicle according to any one of claims 1 to 4, wherein
 the lifting unit is suspended by four suspending members from
15 the body unit,
 one shock-absorbing mechanism of the shock-absorbing mechanisms further includes a swingable portion swingably provided to the corresponding support portion, and
 two suspending members of the four suspending members are
20 attached to the swingable portion.