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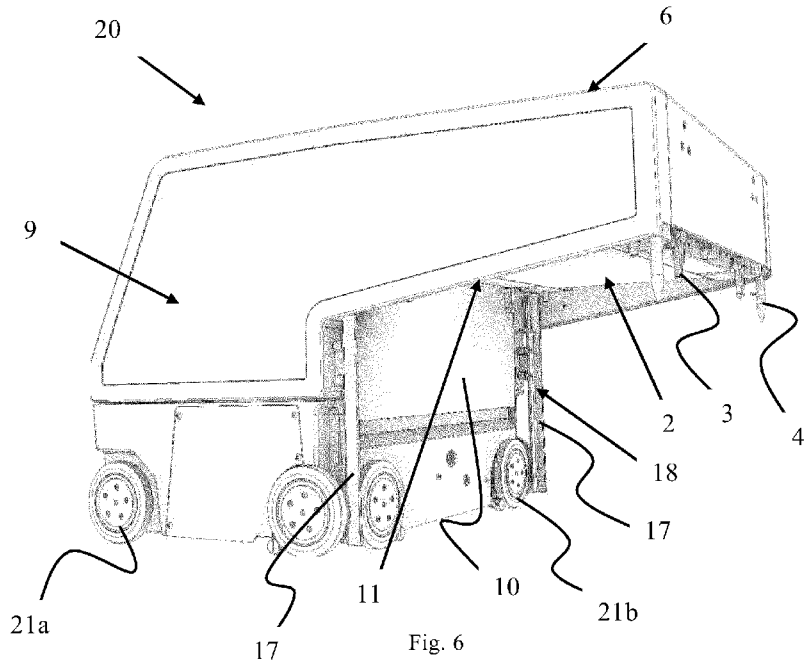

Fig. 6

(57) Abstract: A container handling vehicle (20) for lifting a storage container (106) from an underlying framework structure (100), the container handling vehicle comprising: a vehicle body (9); and a container lifting assembly (2,5,8) for lifting the storage container. The container lifting assembly comprises: a lifting frame (2) for releasable connection to a storage container (106); a lifting shaft assembly (8); and a plurality of lifting bands (5). The lifting bands (5) are connected to the lifting frame (2) and the lifting shaft assembly (8) such that the lifting frame (2) may be raised or lowered by operating the lifting shaft assembly. The vehicle body (9) further comprises: a sidewall (10); and a cantilevered section (6) from which the lifting frame (2) depends. The cantilevered section (6) extends laterally from an upper end (11) of the sidewall (10). The container handling vehicle further comprises a lifting frame guide assembly, the lifting frame guide assembly comprising a vertical guide surface (19) arranged at each of two opposite sides of the sidewall (10). The vertical

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guide surfaces (19) are arranged to interact with two opposite sides of the lifting frame (2) when the lifting frame is adjacent to the sidewall such that horizontal movement of the lifting frame relative to the vehicle body is restricted.

Container handling vehicle and storage system

Field

The present disclosure relates to a container handling vehicle and a storage system comprising the container handling vehicle.

Background

Fig. 1 discloses a prior art automated storage and retrieval system 1 (i.e. a storage system), with a framework structure 100 and Figs. 2, 3 and 4 disclose three different prior art container handling vehicles 201,301,401 suitable for operating on such a system 1.

The framework structure 100 comprises upright members 102 and a storage volume comprising storage columns 105 arranged in rows between the upright members 102. In these storage columns 105, storage containers 106 - also known as bins - are stacked one on top of one another to form stacks 107. The members 102 may typically be made of metal, e.g. extruded aluminium profiles.

The framework structure 100 of the automated storage and retrieval system 1 comprises a rail system 108 (i.e. a rail grid) arranged across the top of framework structure 100, on which rail system 108 a plurality of container handling vehicles 201,301,401 may be operated to raise storage containers 106 from, and lower storage containers 106 into, the storage columns 105, and also to transport the storage containers 106 above the storage columns 105. The rail system 108 comprises a first set of parallel rails 110 arranged to guide movement of the container handling vehicles 201,301,401 in a first direction *X* across the top of the frame structure 100, and a second set of parallel rails 111 arranged perpendicular to the first set of rails 110 to guide movement of the container handling vehicles 201,301,401 in a second direction *Y* which is perpendicular to the first direction *X*. Containers 106 stored in the columns 105 are accessed by the container handling vehicles 201,301,401 through access openings 112 in the rail system 108. The container handling vehicles 201,301,401 can move laterally above the storage columns 105, i.e. in a plane which is parallel to the horizontal *X*-*Y* plane.

The upright members 102 of the framework structure 100 may be used to guide the storage containers during raising of the containers out from and lowering of the containers into the columns 105. The stacks 107 of containers 106 are typically self-supportive.

Each prior art container handling vehicle 201,301,401 comprises a vehicle body 201a,301a,401a and first and second sets of wheels 201b,201c,301b,301c,401b,401c which enable the lateral movement of the container handling vehicles 201,301,401 in the *X* direction and in the *Y* direction, respectively. In Figs. 2, 3 and 4 two wheels in each set are fully visible. The first set of wheels 201b,301b,401b is arranged to engage with two adjacent rails of the first set 110 of rails, and the second set of wheels 201c,301c,401c is arranged to engage with two adjacent rails of the second set 111 of rails. At least one of the sets of wheels 201b,301b,201c,301c,401b,401c can be lifted and lowered, so that the first set of wheels 201b,301b,401b and/or the second set of wheels 201c,301c,401c can be engaged with the respective set of rails 110, 111 at any one time.

Each prior art container handling vehicle 201,301,401 also comprises a lift device 404, see fig. 4, for vertical transportation of storage containers 106 (i.e. a container lift device), e.g. raising a storage container 106 from, and lowering a storage container 106 into, a storage column 105. The lift device 404 features a lifting frame 2 comprising container connectors 3, adapted to engage connecting recesses 13 at an upper rim of the sidewalls 14 of a storage container 106, see fig. 5, and guiding pins 4. The guiding pins 4 are arranged to interact with guiding pin recesses 7 at the corners of the storage container and ensure a correct alignment of the lifting frame 2 and container connectors 3 relative to the storage container. The guiding pins 4 will also assist in guiding the lifting frame 2 relative to the upright members of the storage column 105. The lifting frame 2 can be lowered from the vehicle 201,301,401 so that the position of the lifting frame 2 with respect to the vehicle 201,301,401 can be adjusted in a third direction *Z* which is orthogonal the first direction *X* and the second direction *Y*. The lifting device of the container handling vehicle 201 is located within the vehicle body 201a in Fig. 2.

To raise or lower the lifting frame 2 (and optionally a connected storage container 106), the lifting frame 2 is suspended from a band drive assembly by lifting bands 5. In the band drive assembly, the lifting bands are commonly spooled on/off at least one rotating lifting shaft or reel arranged in the container handling vehicle. Various designs of band drive assemblies are described in for instance WO 2015/193278 A1, WO 2017/129384 A1 and WO 2019/206438 A1.

Conventionally, and also for the purpose of this application, *Z*=1 identifies the uppermost layer for storing storage containers below the rail system 108, i.e. the layer immediately below the rail system 108, *Z*=2 the second layer below the rail system 108, *Z*=3 the third layer etc. In the exemplary prior art disclosed in Fig. 1, *Z*=8 identifies the lowermost, bottom layer of storage containers. Similarly, *X*=1…*n* and *Y*=1…*n* identifies the position of each storage column 105 in the horizontal plane. Consequently, as an example, and using the Cartesian coordinate system *X*, *Y*, *Z* indicated in Fig. 1, the storage container identified as 106' in Fig. 1 can be said to occupy storage position *X*=17, *Y*=1, *Z*=6. The container handling vehicles 201,301,401 can be said to travel in layer *Z*=0, and each storage column 105 can be identified by its *X* and *Y* coordinates. Thus, the storage containers shown in Fig. 1 extending above the rail system 108 are also said to be arranged in layer *Z*=0.

The storage volume of the framework structure 100 has often been referred to as a grid 104, where the possible storage positions within this grid are referred to as storage cells. Each storage column may be identified by a position in an *X*- and *Y*-direction, while each storage cell may be identified by a container number in the *X*-, *Y*- and *Z*-direction.

Each prior art container handling vehicle 201,301,401 comprises a storage compartment or space for receiving and stowing a storage container 106 when transporting the storage container 106 across the rail system 108. The storage space may comprise a cavity arranged internally within the vehicle body 201a as shown in Figs. 2 and 4 and as described in e.g. WO2015/193278A1 and WO2019/206487A1, the contents of which are incorporated herein by reference.

Fig. 3 shows an alternative configuration of a container handling vehicle 301 with a cantilever construction. Such a vehicle is described in detail in e.g. NO317366, the contents of which are also incorporated herein by reference.

The cavity container handling vehicles 201 shown in Fig. 2 may have a footprint that covers an area with dimensions in the X and Y directions which is generally equal to the lateral extent of a storage column 105, e.g. as is described in WO2015/193278A1, the contents of which are incorporated herein by reference. The term 'lateral' used herein may mean 'horizontal'.

Alternatively, the cavity container handling vehicles 401 may have a footprint which is larger than the lateral area defined by a storage column 105 as shown in Fig. 1 and 4, e.g. as is disclosed in WO2014/090684A1 or WO2019/206487A1.

The rail system 108 typically comprises rails with grooves in which the wheels of the vehicles run. Alternatively, the rails may comprise upwardly protruding elements, where the wheels of the vehicles comprise flanges to prevent derailing. These grooves and upwardly protruding elements are collectively known as tracks. Each rail may comprise one track, or each rail may comprise two parallel tracks.

WO2018/146304A1, the contents of which are incorporated herein by reference, illustrates a typical configuration of rail system 108 comprising rails and parallel tracks in both *X* and *Y* directions forming a rail grid.

In the framework structure 100, most of the columns 105 are storage columns 105, i.e. columns 105 where storage containers 106 are stored in stacks 107. However, some columns 105 may have other purposes. In Fig. 1, columns 119 and 120 are such special-purpose columns used by the container handling vehicles 201,301,401 to drop off and/or pick up storage containers 106 so that they can be transported to an access station (not shown) where the storage containers 106 can be accessed from outside of the framework structure 100 or transferred out of or into the framework structure 100. Within the art, such a location is normally referred to as a ‘port’ and the column in which the port is located may be referred to as a ‘port column’ 119,120. The transportation to the access station may be in any direction, that is horizontal, tilted and/or vertical. For example, the storage containers 106 may be placed in a random or dedicated column 105 within the framework structure 100, then picked up by any container handling vehicle and transported to a port column 119,120 for further transportation to an access station. Note that the term ‘tilted’ means transportation of storage containers 106 having a general transportation orientation somewhere between horizontal and vertical.

In Fig. 1, the first port column 119 may for example be a dedicated drop-off port column where the container handling vehicles 201,301,401 can drop off storage containers 106 to be transported to an access or a transfer station, and the second port column 120 may be a dedicated pick-up port column where the container handling vehicles 201,301,401 can pick up storage containers 106 that have been transported from an access or a transfer station.

The access station may typically be a picking or a stocking station where product items are removed from or positioned into the storage containers 106. In a picking or a stocking station, the storage containers 106 are normally not removed from the

automated storage and retrieval system 1 but are returned into the framework structure 100 again once accessed. A port can also be used for transferring storage containers to another storage facility (e.g. to another framework structure or to another automated storage and retrieval system), to a transport vehicle (e.g. a train or a lorry), or to a production facility.

A conveyor system comprising conveyors is normally employed to transport the storage containers between the port columns 119,120 and the access station.

If the port columns 119,120 and the access station are located at different levels, the conveyor system may comprise a lift device with a vertical component for transporting the storage containers 106 vertically between the port column 119,120 and the access station.

The conveyor system may be arranged to transfer storage containers 106 between different framework structures, e.g. as is described in WO2014/075937A1, the contents of which are incorporated herein by reference.

When a storage container 106 stored in one of the storage columns 105 disclosed in Fig. 1 is to be accessed, one of the container handling vehicles 201,301,401 is instructed to retrieve the target storage container 106 from its position and transport it to the drop-off port column 119. This operation involves moving the container handling vehicle 201,301,401 to a location above the storage column 105 in which the target storage container 106 is positioned, retrieving the storage container 106 from the storage column 105 using the container handling vehicle's 201,301,401 lifting device 404, and transporting the storage container 106 to the drop-off port column 119. If the target storage container 106 is located deep within a stack 107, i.e. with one or a plurality of other storage containers 106 positioned above the target storage container 106, the operation also involves temporarily moving the above-positioned storage containers prior to lifting the target storage container 106 from the storage column 105. This step, which is sometimes referred to as "digging" within the art, may be performed with the same container handling vehicle that is subsequently used for transporting the target storage container to the drop-off port column 119, or with one or a plurality of other cooperating container handling vehicles. Alternatively, or in addition, the automated storage and retrieval system 1 may have container handling vehicles 201,301,401 specifically dedicated to the task of temporarily removing storage containers 106 from a storage column 105. Once the target storage container 106 has been removed from the storage column 105, the temporarily removed storage containers 106 can be repositioned into the original storage column 105. However, the removed storage containers 106 may alternatively be relocated to other storage columns 105.

When a storage container 106 is to be stored in one of the columns 105, one of the container handling vehicles 201,301,401 is instructed to pick up the storage container 106 from the pick-up port column 120 and transport it to a location above the storage column 105 where it is to be stored. After any storage containers 106 positioned at or above the target position within the stack 107 have been removed, the container handling vehicle 201,301,401 positions the storage container 106 at the desired

position. The removed storage containers 106 may then be lowered back into the storage column 105 or relocated to other storage columns 105.

For monitoring and controlling the storage system 1, e.g. monitoring and controlling the location of respective storage containers 106 within the framework structure 100, the content of each storage container 106, and the movement of the container handling vehicles 201,301,401 so that a desired storage container 106 can be delivered to the desired location at the desired time without the container handling vehicles 201,301,401 colliding with each other, the storage 1 comprises a control system 500 which typically is computerized and which typically comprises a database for keeping track of the storage containers 106.

A disadvantage of, for example, the prior art container handling vehicle 301 shown in fig. 3 is that horizontal movement of the lifting frame 2 is not prevented until the lifting frame is fully raised and in contact with an underside of the cantilevered section 6 from which the lifting frame 2 depends. When fully raised, the lifting frame 2 interacts with the cantilever section 6 to restrain horizontal movement between the lifting frame 2 and the cantilever section 6. To avoid potential errors caused by horizontal movement in the lifting frame 2, the container handling vehicle 301 in fig. 3 should not move upon the rail system 108 until the lifting frame is fully raised. The time delay of having the container handling vehicle 301 standing still until the lifting frame is fully raised is minor when viewed on an individual basis. However, a storage system will commonly have a plurality of container handling vehicles, wherein each vehicle performs many lifting operations and actions of one must often be completed before another vehicle can perform its actions. Consequently, a slight time delay for each operation will add up and contribute to a less than optimal efficiency of the storage system.

An object of the present disclosure is therefore to provide an improved container handling vehicle, for example wherein some of the disadvantages of the prior art vehicles featuring a cantilevered section are avoided or alleviated.

Summary

This overview introduces concepts that are described in more detail in the detailed description. It should not be used to identify essential features of the claimed subject matter, nor to limit the scope of the claimed subject matter.

The presently claimed invention is defined by the attached claims.

According to a first aspect, there is provided a container handling vehicle for lifting a storage container from an underlying framework structure, the container handling vehicle comprising: a vehicle body; and a container lifting assembly for lifting the storage container, wherein the container lifting assembly comprises: a lifting frame for releasable connection to a storage container; a lifting shaft assembly; and a plurality of lifting bands, wherein the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly, and wherein the vehicle body further comprises: a sidewall; and a cantilevered section from which the lifting frame depends, wherein the cantilevered section extends laterally from an upper end of the sidewall, and wherein: the container handling vehicle further comprises a lifting frame guide assembly, the lifting frame guide

assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; and the vertical guide surfaces are arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall such that horizontal movement of the lifting frame relative to the vehicle body is restricted.

Optionally, the vertical guide surfaces and a width of the lifting bands extend in substantially the same horizontal direction.

Optionally, each of the vertical guide surfaces is configured to provide a corresponding vertically extending corner section.

Optionally, the lifting frame comprises at least two vertical guide pins, and each of the vertically extending corner sections is configured to accommodate one of the guide pins when the lifting frame is adjacent to the sidewall.

Optionally, the vertical guide surfaces are provided by vertically extending guide profiles arranged at each of the two opposite sides of the sidewall, each of the vertically extending guide profiles providing one of the vertical guide surfaces.

Optionally, each of the vertically extending guide profiles is configured to provide a or the vertically extending corner section featuring one of the guide surfaces, each of the corner sections being configured to accommodate a respective corner of the lifting frame and arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall.

Optionally, each of the vertically extending corner sections extends from a lower position on the sidewall towards the cantilevered section, such that the lifting frame is configured to be guided by the vertically extending corner sections during movement of the lifting frame in a vertical direction between the lower position and an upper position in which the lifting frame docks with the cantilevered section.

Optionally, the container handling vehicle comprises: a first set of wheels; and a second set of wheels, wherein at least one of the sets of wheels is displaceable in a vertical direction between a first position and a second position, and wherein: the first set of wheels is arranged on opposite sides of the vehicle body and is configured for moving the vehicle along a first direction on a rail system of the underlying framework structure when the at least one of the sets of wheels is in the first position; and the second set of wheels is arranged on other opposite sides of the vehicle body and is configured for moving the vehicle along a second direction on the rail system when the at least one of the sets of wheels is in the second position.

According to a second aspect, there is provided a storage system comprising: at least one container handling vehicle of the first aspect; and a or the framework structure, wherein the framework structure comprises a plurality of storage columns, each storage column arranged to store a plurality of storage containers on top of one another in a substantially vertical stack, and wherein the vehicle is operated on a or the rail system at an upper level of the framework structure and is arranged to: retrieve storage containers

from the storage columns; store storage containers in the storage columns; and transport the storage containers horizontally across the rail system.

According to a third aspect, there is provided a method of operating a container handling vehicle in a storage system, the storage system comprising: a framework structure, wherein the framework structure comprises a plurality of storage columns, each storage column arranged to store a plurality of storage containers on top of one another in a substantially vertical stack; and at least one container handling vehicle, wherein the container handling vehicle is operated on a rail system at an upper level of the framework structure and is arranged to: retrieve storage containers from the storage columns; store storage containers in the storage columns; and transport the storage containers horizontally across the rail system, wherein the container handling vehicle comprises: a vehicle body; and a container lifting assembly for lifting the storage container, wherein the container lifting assembly comprises: a lifting frame for releasable connection to a storage container; a lifting shaft assembly; and a plurality of lifting bands, wherein the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly, and wherein the vehicle body further comprises: a sidewall; and a cantilevered section from which the lifting frame depends, wherein the cantilevered section extends laterally from an upper end of the sidewall, and wherein: the container handling vehicle further comprises a lifting frame guide assembly, the lifting frame guide assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; the vertical guide surfaces are arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall such that horizontal movement of the lifting frame relative to the vehicle body is restricted; and the method comprises the steps of: lowering a storage container into a storage column by use of the container lifting assembly; releasing the storage container from the lifting frame; raising the lifting frame until the vertical guide surfaces interact with the lifting frame; and moving the container handling vehicle horizontally across the rail system when a lowermost level of the lifting frame is above an uppermost level of the rail system and before the lifting frame has reached an upper position.

According to a first example, there is provided a container handling vehicle for lifting a storage container from an underlying framework structure, the vehicle comprises a container lifting assembly for lifting the storage container and a vehicle body; the container lifting assembly comprises a lifting frame for releasable connection to a storage container, a lifting shaft assembly and a plurality of lifting bands, the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly; and the vehicle body comprises a sidewall and a cantilevered section from which the lifting frame depends, the cantilevered section extends laterally from an upper end of the sidewall; wherein the container handling vehicle features a lifting frame guide assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; and the vertical guide surfaces are arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall (i.e. the vertical guide surfaces are arranged on opposite sides of the lifting frame when the lifting frame

is adjacent to the sidewall), such that horizontal movement of the lifting frame relative to the vehicle body is restricted.

The lifting bands have a width and a thickness. Optionally, the ratio between width and thickness may be at least 10.

In an example of the vehicle according to the first example, the vertical guide surfaces and a width of the lifting bands may extend in the same horizontal direction. In other words, the vertical guide surfaces and vertical lengths of the lifting bands, i.e. the vertical length of the lifting bands extending between the lifting frame and the lifting shaft assembly, may be arranged in parallel vertical planes.

In an example of the vehicle according to the first example, each of the vertical guide surfaces may be configured to provide a corresponding vertically extending corner section. Each of the corner sections may be configured to accommodate a respective corner of the lifting frame and be arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall.

In an example of the vehicle according to the first example, the vertical guide surfaces may be provided by vertically extending guide profiles arranged at each of two opposite sides of the sidewall, each of the vertically extending guide profiles providing one of the vertical guide surfaces.

In an example of the vehicle according to the first example, each of the vertically extending guide profiles may be configured to provide a vertically extending corner section featuring one of the guide surfaces, each of the corner sections being configured to accommodate a respective corner of the lifting frame and arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall.

In an example of the vehicle according to the first example, the vertically extending corner sections may be configured to interact with two opposite corners of the lifting frame, the opposite corners being adjacent to the sidewall.

In an example of the vehicle according to the first example, each vertical guide profile may comprise a vertically extending corner section. In other words, each of the vertical guide profiles may have an L-shaped horizontal cross-section.

In an example of the vehicle according to the first example, the lifting frame may comprise vertical guide pins, and each of the vertically extending corner sections may be configured to accommodate one of the guide pins when the lifting frame is adjacent to the sidewall.

In an example of the vehicle according to the first example, each of the vertically extending corner sections may extend from a lower position on the sidewall towards the cantilevered section, such that the lifting frame may be guided during movement in a vertical direction between a lower position adjacent to the sidewall and an upper position in which the lifting frame docks with the cantilevered section.

In an example, the vehicle according to the first example may comprise: a first set of wheels arranged on opposite sides of the vehicle body, for moving the vehicle along a first direction on a rail system of the underlying framework structure; a second set of wheels arranged on other opposite sides of the vehicle body, for moving the vehicle along a second direction on the rail system, the second direction being perpendicular to the first direction; and at least one of the sets of wheels being displaceable in a vertical direction between a first position, wherein the first set of wheels allows movement of the vehicle along the first direction, and a second position, wherein the second set of wheels allows movement of the vehicle along the second direction.

In an example of the container handling vehicle, the vertical guide surfaces and the lifting frame may be arranged to interact with each other when the lifting frame is adjacent the sidewall, such that horizontal movement of the lifting frame relative to the vehicle body is restricted or prevented.

The lifting bands may provide a lifting band end connected at one of four corner sections of the lifting frame. In an example, the container handling vehicle may comprise four lifting bands. In other words, the lifting bands may be connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered relative to the cantilevered section by operating the lifting shaft assembly. In other words, the lifting frame is suspended, or depends, from an underside of the cantilevered section.

According to a second example, there is provided a storage system comprising a framework structure and at least one container-handling vehicle according to the first example, wherein the framework structure comprises multiple storage columns, in which storage containers may be stored on top of one another in vertical stacks, and the container handling vehicle is operated on a rail system at a top level of the framework structure for retrieving storage containers from, and storing storage containers in, the storage columns, and for transporting the storage containers horizontally across the rail system.

According to a third example, there is provided a method of operating a container handling vehicle in a storage system, the storage system comprising a framework structure and at least one container-handling vehicle, wherein the framework structure comprises multiple storage columns, in which storage containers may be stored on top of one another in vertical stacks, and the container handling vehicle is operated on a rail system at an upper level of the framework structure for retrieving storage containers from, and storing storage containers in, the storage columns, and for transporting the storage containers horizontally across the rail system, the container handling vehicle comprises a container lifting assembly for lifting the storage container and a vehicle body; the container lifting assembly comprises a lifting frame for releasable connection to a storage container, a lifting shaft assembly and a plurality of lifting bands, the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly; and the vehicle body comprises a sidewall and a cantilevered section from which the lifting frame depends, the cantilevered section extends laterally from an upper end of the sidewall; wherein the container handling vehicle features a lifting frame guide assembly

comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; the vertical guide surfaces arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall, such that horizontal movement of the lifting frame relative to the vehicle body is restricted; wherein the method comprises the steps of: lowering a storage container into a storage column by use of the container lifting assembly; releasing the storage container from the lifting frame; raising the lifting frame until the vertical guide surfaces interact with the lifting frame; and moving the container handling vehicle horizontally across the rail system when a lowermost level of the lifting frame is above an uppermost level of the rail system and before the lifting frame has reached an upper position.

According to a fourth example, there is provided a method of preventing horizontal movement of a lifting frame of a container handling vehicle, the container handling vehicle comprises a container lifting assembly for lifting the storage container and a vehicle body; the container lifting assembly comprises a lifting frame for releasable connection to a storage container, a lifting shaft assembly and a plurality of lifting bands, the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly; and the vehicle body comprises a sidewall and a cantilevered section from which the lifting frame depends, the cantilevered section extends laterally from an upper end of the sidewall; wherein the container handling vehicle features a lifting frame guide assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; the vertical guide surfaces arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall, such that horizontal movement of the lifting frame relative to the vehicle body is restricted; wherein the method comprises the steps of: raising the lifting frame from a level below the container handling vehicle to a first position in which interaction between the lifting frame and the vertical guide surfaces is initiated; and raising the lifting frame from the first position to a second position in which the lifting frame and the vertical guide surfaces interact with each other and horizontal movement of the lifting frame relative to the vehicle body is restricted or prevented.

In an example, the container handling vehicle may comprise wheels for moving the vehicle along any of a first direction and a second direction on a rail system of the underlying framework structure, the first direction being perpendicular to the second direction.

In the third and fourth examples, the container handling vehicle may be according to any of the examples of the first example.

The term “sidewall” is intended to mean a side section of the vehicle body. The side section may comprise a cover plate but may also be a framework structure. The side section may be substantially vertical.

The term “horizontal movement” is intended to comprise both lateral and rotational horizontal movement.

Optional features of one aspect (and/or example) may be optional features of another aspect (and/or example), as will occur to the skilled person.

Brief description of the drawings

Further details, aspects and examples of the invention will be described, by way of example only, with reference to the drawings. In the drawings, like reference numbers are used to identify like or functionally similar elements. Elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale.

Examples of the present invention are described in more detail by reference to the following drawings:

Fig. 1 is a perspective view of a framework structure of a prior art automated storage and retrieval system.

Fig. 2 is a perspective view of a prior art container handling vehicle having a centrally arranged cavity for carrying storage containers therein.

Fig. 3 is a perspective view of a prior art container handling vehicle having a cantilevered section for carrying storage containers underneath.

Fig. 4 is a perspective view of a prior art container handling vehicle, wherein a container lifting assembly is shown.

Fig. 5 is a perspective view of a storage container as used in the storage system in fig. 1.

Fig. 6 is a perspective side view of an exemplary container handling vehicle according to the present disclosure.

Figs. 7 to 9 are side views of the container handling vehicle in fig. 6.

Fig. 10 is a perspective view from below of the container handling vehicle in fig. 6.

Fig. 11 is an enlarged view of details in fig. 10.

Fig. 12 is a perspective side view of the container handling vehicle in fig. 6, wherein parts of the bodywork are not shown for ease of understanding.

Fig. 13 is an enlarged view of details shown in fig. 12.

Detailed description

In the following detailed description, examples of the present invention will be discussed in more detail with reference to the appended drawings. However, the drawings are not intended to limit the present invention to the subject-matter depicted in the drawings.

An overview of the present subject matter will first be provided. In summary, a container handling vehicle suitable for lifting a storage container from an underlying framework structure is provided which, advantageously, prevents horizontal movement of a lifting frame and thus, if present, a storage container being lifted by the lifting frame. More specifically, the container handling vehicle prevents horizontal movement of the lifting frame of the container handling vehicle during the period (that is, distance) before the lifting frame is fully raised and in contact with a cantilevered section of the container

handling (at which point horizontal movement is generally prevented by interaction of the lifting frame with the cantilever section, as previously described). Such horizontal movement is prevented at least in part by the provision of a lifting frame guide assembly which includes vertical guide surfaces. The vertical guide surfaces are arranged at opposite sides of the container handling vehicle, and more specifically on two opposite sides of a side wall of a body of the container handling vehicle. In use, the vertical guide surfaces interact with the lifting frame such that horizontal movement of the lifting frame – and thus any storage container being lifted – is restricted. Advantageously, this means that the container handling vehicle may move upon the rail system upon which it sits before the lifting frame is fully raised into the cantilevered section. This could be advantageous both when no storage container is being lifted (for example, after delivery of a storage container) and when a storage container is being lifted. In both cases, the container handling vehicle can move on the rail system before the lifting frame is fully raised, and thus can move sooner. For example, the container handling vehicle may move as soon as the storage container being lifted is above the rail system, or – if no storage container is being presently lifted – as soon as the lifting frame is lifted above the rail system. Accordingly, the container handling vehicle can move sooner and need not lift the lifting frame entirely into the cantilever section. Overall, time and energy are thus saved because the container handling vehicle can perform its operations faster and with reduced movement of the lifting device. A more efficient device, system comprising the device, and methods of using the device and system are thus provided.

A more detailed description of the present subject matter will now be provided in reference to the appended drawings.

According to an example of the present invention, a remotely operated container handling vehicle is provided for use in an automated storage system featuring storage columns 105 for accommodating a stack of storage containers and a rail system 108, as discussed for the prior art storage system disclosed in fig. 1.

An example of a container handling vehicle according to the present invention is shown in figs. 6-13. The vehicle is for picking up storage containers 106 in an automated storage system 1, e.g. as shown in fig. 1, by use of a container lifting assembly 2,5,8a,8b. The container lifting assembly features, for example, a lifting frame 2 for releasable connection to a storage container 106, a lifting shaft assembly 8a,8b (shown in fig. 12) and four lifting bands 5. The lifting bands 5 are connected to the lifting frame 2 and the lifting shaft assembly 8a,8b such that the lifting frame 2 may be raised or lowered by operating the lifting shaft assembly 8a,8b.

The container handling vehicle has a vehicle body 9 comprising a sidewall 10 and a cantilevered section 6. The lifting frame 2 is suspended from the cantilevered section 6 which extends laterally from an upper end 11 of the sidewall 10. The lifting frame features contact sensors 12 arranged on a top side of the lifting frame 2 (shown in figs. 12 and 13). The contact sensors 12 interact with a part of the cantilever section 6 when the lifting frame is fully raised. When fully raised, horizontal movement between the lifting frame 2 and the cantilever section 6 is restrained.

The lifting bands 5 suspending the lifting frame 2 are tape-shaped. The width W of the lifting bands is commonly in the range of 1-5 cm, i.e. substantially larger than their thickness. The thickness of the lifting bands is usually about 0.15 mm. When suspending the lifting frame below the cantilever section 6, the shape of the lifting bands 5 provides an inherent restriction of horizontal movement of the lifting frame in the direction of their width W. Movement of the lifting frame in the thickness direction, i.e. a direction perpendicular to the direction in which the lifting band width W extends, is not substantially restricted.

As discussed above, errors may be caused by horizontal movement in the lifting frame 2 and the prior art cantilevered container handling vehicle 301 in fig. 3 should not move upon the rail system 108 until the lifting frame 2 is fully raised.

As shown in figs. 10 and 11, to restrict horizontal movement of the lifting frame 2 during movement of the inventive container handling vehicle, the vehicle comprises a lifting frame guide assembly having a vertical guide surface 19 arranged at each of two opposite sides of the sidewall 10. The vertical guide surfaces 19 are arranged to interact with two opposite sides of the lifting frame 2 when the lifting frame is adjacent to the sidewall 10, such that horizontal movement of the lifting frame 2 relative to the vehicle body 9 is restricted. In addition to their vertical extent, the guide surfaces 19 also extend in substantially the same horizontal direction as the width W of the lifting bands, such that horizontal movement of the lifting frame is restricted in a direction being perpendicular to the width W of the lifting bands 5.

As shown in fig. 9, the vertical guide surfaces 19 are provided by vertically extending guide profiles 17 arranged at each of two opposite sides of the sidewall 10, each of the vertically extending guide profiles 17 provides a vertically extending corner section 18 featuring one of the vertical guide surfaces 19. Each of the corner sections is configured to accommodate a respective corner and guide pin 4 of the lifting frame 2 and arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall 10.

When positioned within a storage column 105, horizontal movement of the lifting frame 2 is restricted by the inner periphery of the storage column 105. When the lifting frame 2 emerges from the storage column 105, horizontal restraint of the lifting frame 2 is provided by the vertical guide surfaces 19.

By having the lifting frame guide assembly 17,18,19, the lifting frame 2 can be raised from a lower position close to the rail system 108 where it emerges from the lateral constraints of the storage column 105, to a higher position adjacent the sidewall 9 while horizontal movement of the lifting frame 2 is restricted or prevented. The lowermost level of the lifting frame 2 when in the lower position is above an uppermost level of a rail system 108 upon which the container handling vehicle is arranged, see fig. 7. In the upper position, the lifting frame is fully raised towards the cantilevered section 6.

In summary, provision of the lifting frame guide assembly 17,18,19 results in an improved container handling vehicle. Various specific advantages will now be discussed.

Due to the lifting frame guide assembly 17,18,19, the container handling vehicle according to the present example may start to move upon the rail system 108 as soon as the lifting frame is in the lower position, e.g. after storing a storage container 106 in a storage column 105. When the lifting frame 2 is not connected to a storage container 106, the lifting frame may be kept in the lower position while the container handling vehicle 20 moves upon the rail system 108. In this manner time and energy is also saved by not requiring the lifting frame 2 to be lifted between the cantilever section 6 and the lower position when a storage container is to be retrieved. The lifting frame guide assembly will also ensure that the container handling vehicle 20 can move upon the rail system 108 as soon as a storage container connected to the lifting frame 2 is lifted above the rail system 108. The latter feature is advantageous when the container handling vehicle is used in a storage system comprising storage containers of different heights, since a storage container being lower than the maximum storage container height may be lifted clear of the rail system before the lifting frame is at its upper position in contact with the cantilever section.

In view of for example the prior art cantilevered container handling vehicle 301, as shown in fig. 3, the container handling vehicle 20 of the present example is more efficient in that less time is required to perform multiple container lifting/storage operations. In comparison, the prior art container vehicle 301 is not allowed to move upon a rail system 108 until its lifting frame 3 is fully raised into contact with the cantilevered section.

To allow movement of the container handling vehicle 20 upon the rail system 108, the vehicle features a first set of wheels 21a arranged to allow movement of the vehicle along a first direction of the rail system 108 as shown in fig. 1, e.g. along rails extending in a first direction X, and a second set of wheels 21b arranged to allow movement of the vehicle in a second direction, e.g. along rails extending in a second direction Y.

Further, the disclosure comprises the subject matter described in the clauses listed below.

Clause 1. A container handling vehicle for lifting a storage container from an underlying framework structure, the vehicle comprises a container lifting assembly for lifting the storage container and a vehicle body; the container lifting assembly comprises a lifting frame for releasable connection to a storage container, a lifting shaft assembly and a plurality of lifting bands, the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly; and the vehicle body comprises a sidewall and a cantilevered section from which the lifting frame depends, the cantilevered section extends laterally from an upper end of the sidewall; wherein the container handling vehicle features a lifting frame guide assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; and the vertical guide surfaces are arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall, such that horizontal movement of the lifting frame relative to the vehicle body is restricted.

Clause 2. A vehicle according to clause 1, wherein the vertical guide surfaces and a width of the lifting bands extend in the same horizontal direction.

Clause 3. A vehicle according to clause 1 or clause 2, wherein each of the vertical guide surfaces are configured to provide a corresponding vertically extending corner section.

Clause 4. A vehicle according to any of the preceding clauses, wherein the vertical guide surfaces are provided by vertically extending guide profiles arranged at each of two opposite sides of the sidewall, each of the vertically extending guide profiles providing one of the vertical guide surfaces.

Clause 5. A vehicle according to clause 4, wherein each of the vertically extending guide profiles is configured to provide a vertically extending corner section featuring one of the guide surfaces, each of the corner sections being configured to accommodate a respective corner of the lifting frame and arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall.

Clause 6. A vehicle according to clause 3, wherein the lifting frame comprises a vertical guide pin at each corner of the lifting frame, and each of the vertically extending corner sections is configured to accommodate one of the guide pins when the lifting frame is adjacent to the sidewall.

Clause 7. A vehicle according to any of clauses 3 to 6, wherein each of the vertically extending corner sections extends from a lower position on the sidewall towards the cantilevered section, such that the lifting frame may be guided during movement in a vertical direction between a lower position adjacent to the sidewall and an upper position in which the lifting frame docks with the cantilevered section.

Clause 8. A vehicle according to any of the preceding clauses, comprising: (a) a first set of wheels arranged on opposite sides of the vehicle body, for moving the vehicle along a first direction on a rail system of the underlying framework structure; (b) a second set of wheels arranged on other opposite sides of the vehicle body, for moving the vehicle along a second direction on the rail system, the second direction being perpendicular to the first direction; and (c) at least one of the sets of wheels being displaceable in a vertical direction between a first position, wherein the first set of wheels allows movement of the vehicle along the first direction, and a second position, wherein the second set of wheels allows movement of the vehicle along the second direction.

Clause 8a. The vehicle of any preceding clauses, wherein each vertical guide surface is arranged to interact with a respective one of the two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall.

Clause 9. A storage system comprising a framework structure and at least one container-handling vehicle according to any of the preceding clauses, wherein the framework structure comprises multiple storage columns, in which storage containers may be stored on top of one another in vertical stacks, and the container handling vehicle is operated on a rail system at a top level of the framework structure for

retrieving storage containers from, and storing storage containers in, the storage columns, and for transporting the storage containers horizontally across the rail system.

Clause 10. A method of operating a container handling vehicle in a storage system, the storage system comprising a framework structure and at least one container-handling vehicle, wherein the framework structure comprises multiple storage columns, in which storage containers may be stored on top of one another in vertical stacks, and the container handling vehicle is operated on a rail system at an upper level of the framework structure for retrieving storage containers from, and storing storage containers in, the storage columns, and for transporting the storage containers horizontally across the rail system, the container handling vehicle comprises a container lifting assembly for lifting the storage container and a vehicle body; the container lifting assembly comprises a lifting frame for releasable connection to a storage container, a lifting shaft assembly and a plurality of lifting bands, the lifting bands are connected to the lifting frame and the lifting shaft assembly such that the lifting frame may be raised or lowered by operating the lifting shaft assembly; and the vehicle body comprises a sidewall and a cantilevered section from which the lifting frame depends, the cantilevered section extends laterally from an upper end of the sidewall; wherein the container handling vehicle features a lifting frame guide assembly comprising a vertical guide surface arranged at each of two opposite sides of the sidewall; the vertical guide surfaces arranged to interact with two opposite sides of the lifting frame when the lifting frame is adjacent to the sidewall, such that horizontal movement of the lifting frame relative to the vehicle body is restricted; wherein the method comprises the steps of: (a) lowering a storage container into a storage column by use of the container lifting assembly; (b) releasing the storage container from the lifting frame; (c) raising the lifting frame until the vertical guide surfaces interact with the lifting frame; and (d) moving the container handling vehicle horizontally across the rail system when a lowermost level of the lifting frame is above an uppermost level of the rail system and before the lifting frame has reached an upper position.

List of reference numbers

1	Prior art automated storage and retrieval system
2	Lifting frame
3	Container connector, container gripper
4	Guiding pin
5	Lifting bands
6	Cantilever section
7	Guiding pin recess
8a	Rotatable lifting shaft, lifting shaft assembly
8b	Shaft featuring lifting band sheaves, lifting shaft assembly
9	Vehicle body
10	Sidewall
11	Upper end (of sidewall)
12	Contact sensor
13	Connecting recess in upper rim of storage container
14	Sidewall of storage container
15	Lower bottom surface of lifting frame
16	Upper rim of storage container
17	Vertical guide profile
18	Vertically extending corner section
19	Vertical guide surface
20	Container handling vehicle according to the present example
21a,21b	First and second set of wheels
100	Framework structure
102	Upright members of framework structure
103	Horizontal members of framework structure
104	Storage grid
105	Storage column
106	Storage container
106’	Particular position of storage container
107	Stack
108	Rail system
110	Parallel rails in first direction (*X*)
110a	First rail in first direction (X)
110b	Second rail in first direction (X)
111	Parallel rail in second direction (*Y*)
111a	First rail of second direction (Y)
111b	Second rail of second direction (Y)
112	Access opening
119	First port column
120	Second port column
201	Prior art container handling vehicle
201a	Vehicle body of the container handling vehicle 201
201b	Drive means / wheel arrangement, first direction (*X*)
201c	Drive means / wheel arrangement, second direction (*Y*)
301	Prior art cantilever container handling vehicle
301a	Vehicle body of the container handling vehicle 301

301b	Drive means in first direction (*X*)
301c	Drive means in second direction (*Y*)
401	Prior art container handling vehicle
401a	Vehicle body of the container handling vehicle 401
401b	Drive means in first direction (*X*)
401c	Drive means in second direction (*Y*)
Y	Second direction
Z	Third direction

Claims

1. A container handling vehicle (20) for lifting a storage container (106) from an underlying framework structure (100), the container handling vehicle comprising:

a vehicle body (9); and

a container lifting assembly (2,5,8) for lifting the storage container, wherein the container lifting assembly comprises:

a lifting frame (2) for releasable connection to a storage container (106);

a lifting shaft assembly (8); and

a plurality of lifting bands (5), wherein the lifting bands (5) are connected to the lifting frame (2) and the lifting shaft assembly (8) such that the lifting frame (2) may be raised or lowered by operating the lifting shaft assembly,

and wherein the vehicle body (9) further comprises:

a sidewall (10); and

a cantilevered section (6) from which the lifting frame (2) depends, wherein the cantilevered section (6) extends laterally from an upper end (11) of the sidewall (10), and wherein:

the container handling vehicle further comprises a lifting frame guide assembly, the lifting frame guide assembly comprising a vertical guide surface (19) arranged at each of two opposite sides of the sidewall (10); and

the vertical guide surfaces (19) are arranged to interact with two opposite sides of the lifting frame (2) when the lifting frame is adjacent to the sidewall such that horizontal movement of the lifting frame relative to the vehicle body is restricted.

2. The container handling vehicle of claim 1, wherein the vertical guide surfaces (19) and a width (W) of the lifting bands extend in substantially the same horizontal direction.

3. The container handling vehicle of claim 1 or 2, wherein each of the vertical guide surfaces (19) is configured to provide a corresponding vertically extending corner section (18).

4. The container handling vehicle of claim 3, wherein the lifting frame (2) comprises at least two vertical guide pins (4), and each of the vertically extending corner sections (18) is configured to accommodate one of the guide pins (4) when the lifting frame is adjacent to the sidewall (10).

5. The container handling vehicle of claim 3 or claim 4, wherein each vertically extending corner section (18) has an L-shaped horizontal cross-section.

6. The container handling vehicle of any preceding claim, wherein the vertical guide surfaces are provided by vertically extending guide profiles (17) arranged at each of the two opposite sides of the sidewall (10), each of the vertically extending guide profiles (17) providing one of the vertical guide surfaces (19).

7. The container handling vehicle of claim 6, wherein each of the vertically extending guide profiles (17) is configured to provide a or the vertically extending corner section (18) featuring one of the guide surfaces (19), each of the corner sections being configured to accommodate a respective corner of the lifting frame (2) and arranged to interact with the lifting frame when the lifting frame is adjacent to the sidewall (10).

8. The container handling vehicle of any of claims 3 to 7, wherein each of the vertically extending corner sections extends from a lower position on the sidewall (10) towards the cantilevered section (6), such that the lifting frame (2) is configured to be guided by the vertically extending corner sections during movement of the lifting frame (2) in a vertical direction between the lower position and an upper position in which the lifting frame docks with the cantilevered section (6).

9. The container handling vehicle according to any preceding claim, comprising:
a first set of wheels (21a); and
a second set of wheels (21b), wherein at least one of the sets of wheels is displaceable in a vertical direction (Z) between a first position and a second position, and wherein:
the first set of wheels (21a) is arranged on opposite sides of the vehicle body (9) and is configured for moving the vehicle (20) along a first direction (X) on a rail system (108) of the underlying framework structure (100) when the at least one of the sets of wheels is in the first position; and
the second set of wheels (21b) is arranged on other opposite sides of the vehicle body (9) and is configured for moving the vehicle (20) along a second direction (Y) on the rail system (108) when the at least one of the sets of wheels is in the second position.

10. The container handling vehicle according to any preceding claim, wherein:
the lifting bands (5) have a or the width and a thickness; and
the ratio between the width and the thickness is at least 10.

11. The container handling vehicle according to any preceding claim, wherein the shape of the lifting bands (5) is such that, when the lifting frame (2) is suspended below the cantilevered section (6) by the lifting bands (5), the shape of the lifting bands (5) restricts horizontal movement of the lifting frame (2) in the direction of the width of the lifting bands (5).

12. The container handling vehicle according to any preceding claim, wherein the lifting frame (2) comprises contact sensors (12) arranged on a top side of the lifting frame (2), and wherein the contact sensors (12) interact with a part of the cantilevered section (6) when the lifting frame (2) is fully raised.

13. A storage system comprising:

at least one container handling vehicle (20) according to any preceding claim; and

a or the framework structure (100), wherein the framework structure (100) comprises a plurality of storage columns (105), each storage column (105) arranged to store a plurality of storage containers (106) on top of one another in a substantially vertical stack (107),

and wherein the vehicle is operated on a or the rail system (108) at an upper level of the framework structure and is arranged to:

retrieve storage containers (106) from the storage columns;

store storage containers in the storage columns; and

transport the storage containers horizontally across the rail system (108).

14. The storage system of claim 13, wherein:

when the lifting frame (2) is positioned within a storage column (105), horizontal movement of the lifting frame (2) is at least partially restricted by the inner periphery of the storage column (105); and

when the lifting frame (2) emerges from the storage column (105), horizontal movement of the lifting frame (2) is at least partially restricted by the vertical guide surfaces (19).

15. A method of operating a container handling vehicle in a storage system, the storage system comprising:

a framework structure (100), wherein the framework structure (100) comprises a plurality of storage columns (102), each storage column (105) arranged to store a plurality of storage containers (106) on top of one another in a substantially vertical stack (107); and

at least one container handling vehicle (20), wherein the container handling vehicle is operated on a rail system (108) at an upper level of the framework structure and is arranged to:

retrieve storage containers (106) from the storage columns;

store storage containers in the storage columns; and

transport the storage containers horizontally across the rail system (108),

wherein the container handling vehicle comprises:

a vehicle body (9); and

a container lifting assembly (2,5,8a,8b) for lifting the storage container, wherein the container lifting assembly comprises:

a lifting frame (2) for releasable connection to a storage container (106);

a lifting shaft assembly (8a,8b); and

a plurality of lifting bands (5), wherein the lifting bands (5) are connected to the lifting frame (2) and the lifting shaft assembly (8a,8b) such that the lifting frame (2) may be raised or lowered by operating the lifting shaft assembly,

and wherein the vehicle body (9) further comprises:

a sidewall (10); and

a cantilevered section (6) from which the lifting frame (2) depends, wherein the cantilevered section (6) extends laterally from an upper end (11) of the sidewall (10), and wherein:

the container handling vehicle further comprises a lifting frame guide assembly, the lifting frame guide assembly comprising a vertical guide surface (19) arranged at each of two opposite sides of the sidewall (10);

the vertical guide surfaces (19) are arranged to interact with two opposite sides of the lifting frame (2) when the lifting frame is adjacent to the sidewall such that horizontal movement of the lifting frame relative to the vehicle body is restricted; and

the method comprises the steps of:

lowering a storage container (106) into a storage column (105) by use of the container lifting assembly;

releasing the storage container (106) from the lifting frame (2);

raising the lifting frame (2) until the vertical guide surfaces (19) interact with the lifting frame (2); and

moving the container handling vehicle horizontally across the rail system (108) when a lowermost level of the lifting frame (2) is above an uppermost level of the rail system (108) and before the lifting frame (3) has reached an upper position.

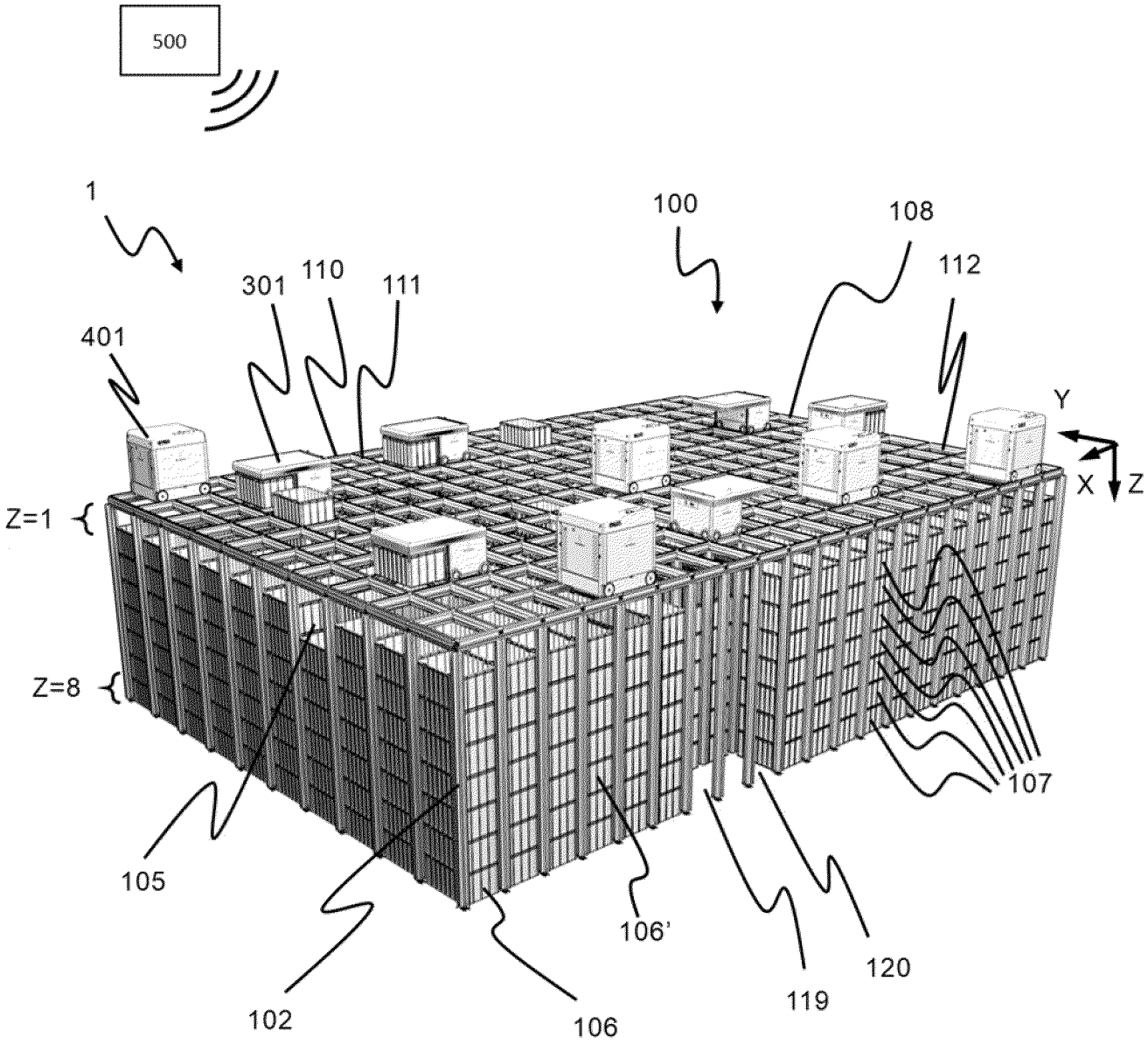

Fig. 1
(Prior Art)

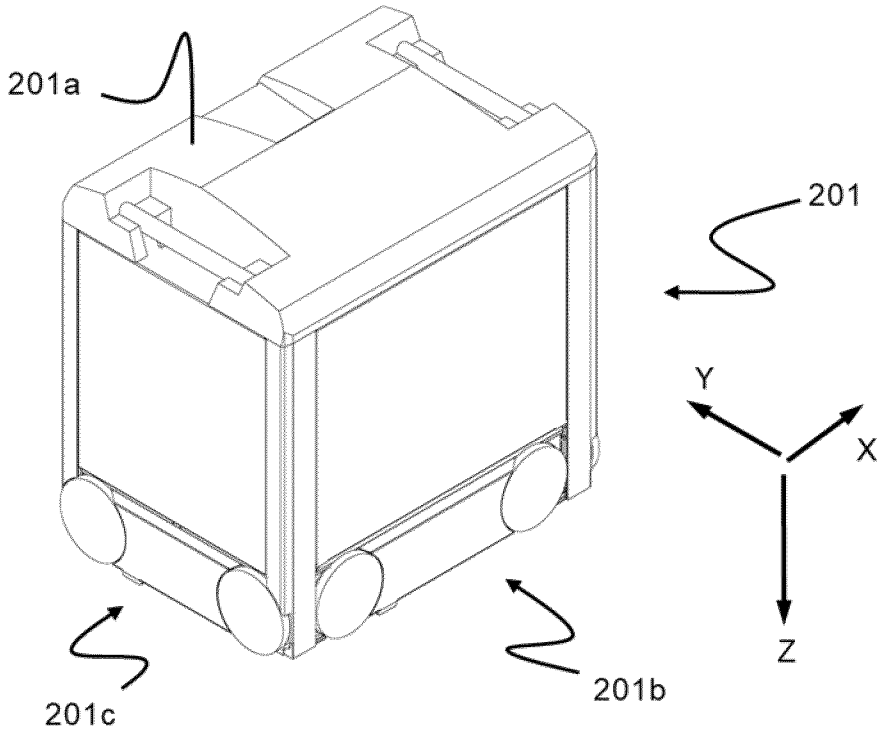

Fig. 2
(Prior Art)

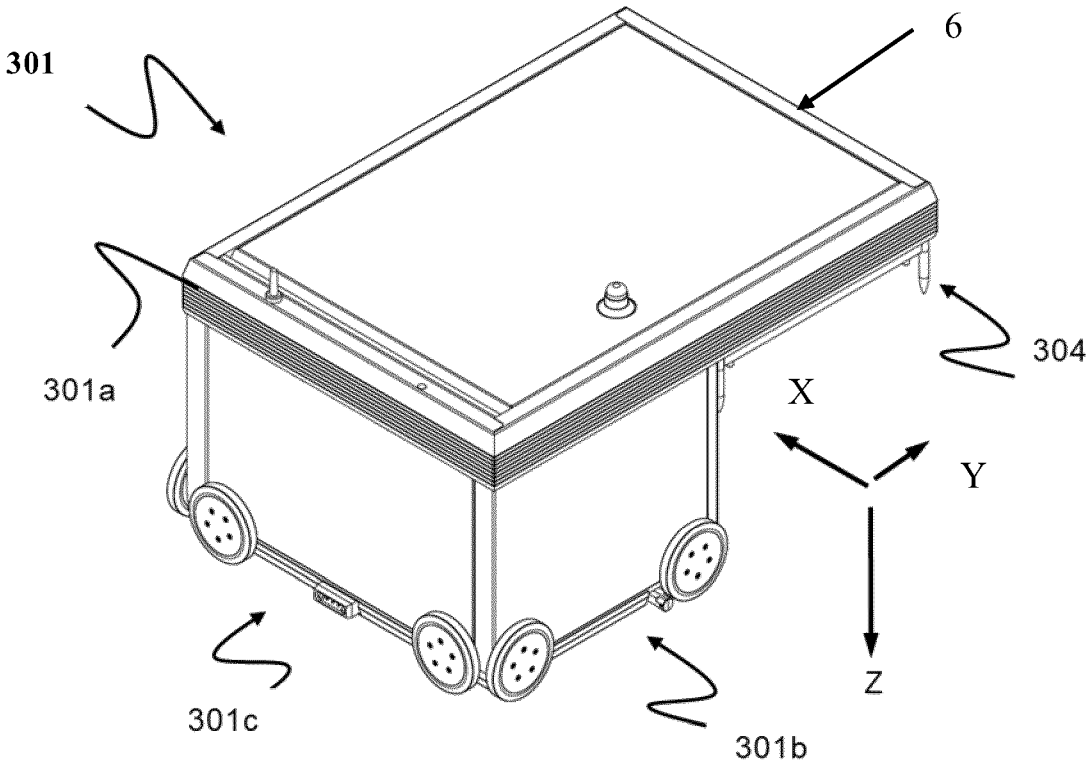

Fig. 3
(Prior Art)

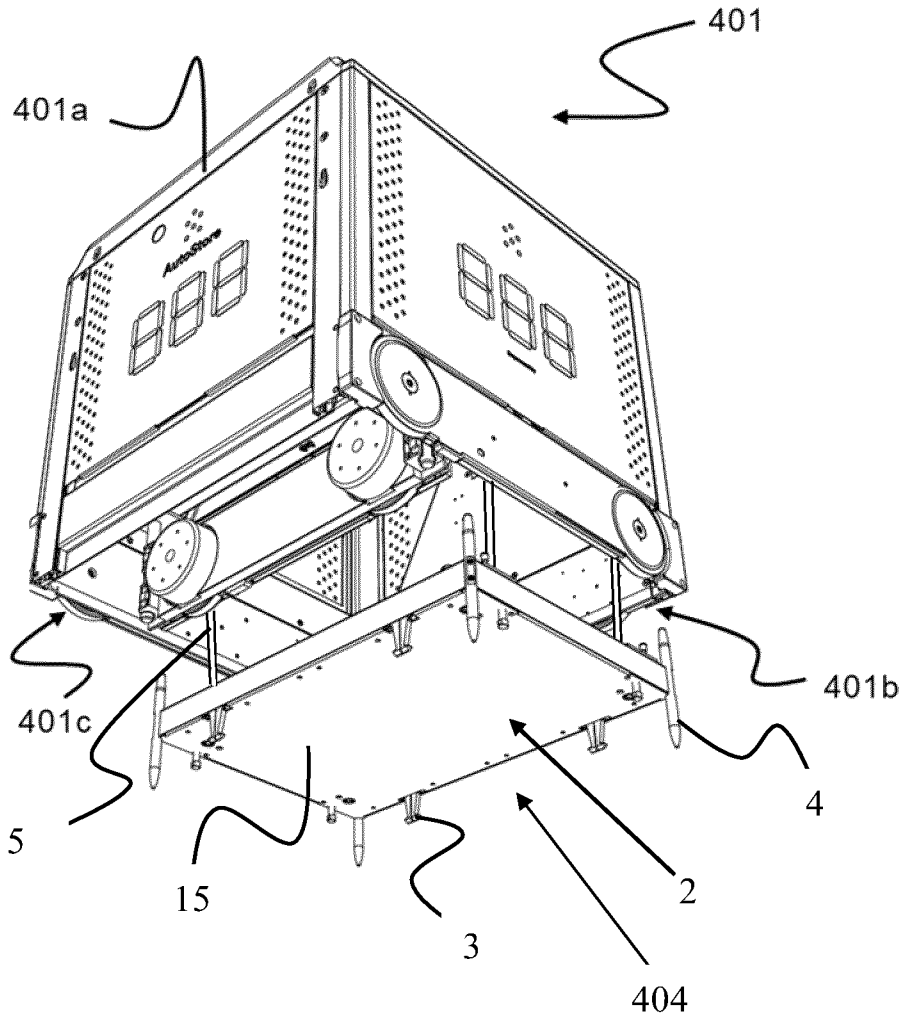

Fig. 4 (Prior Art)

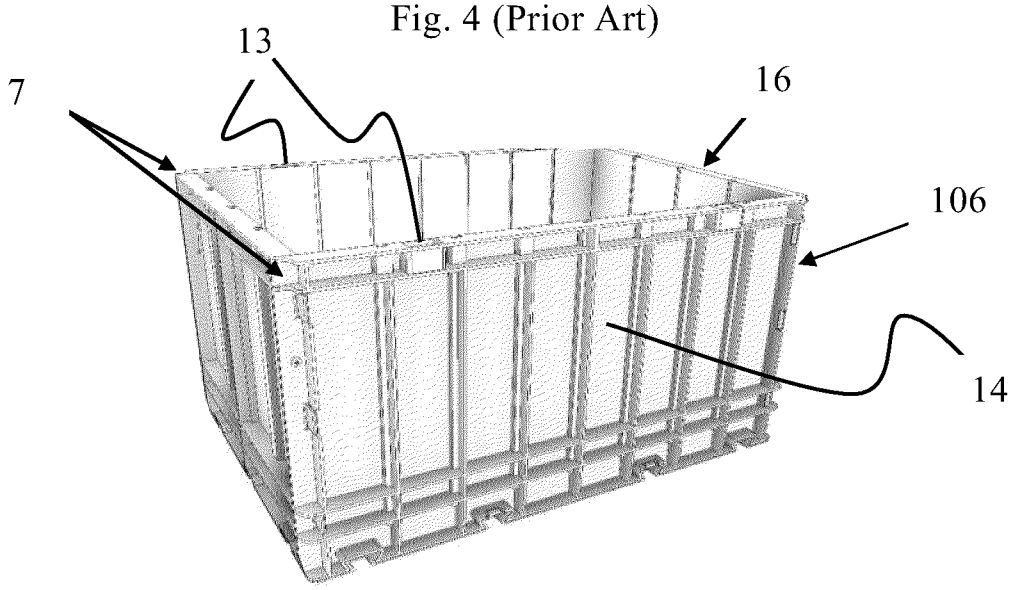

Fig. 5 (Prior Art)

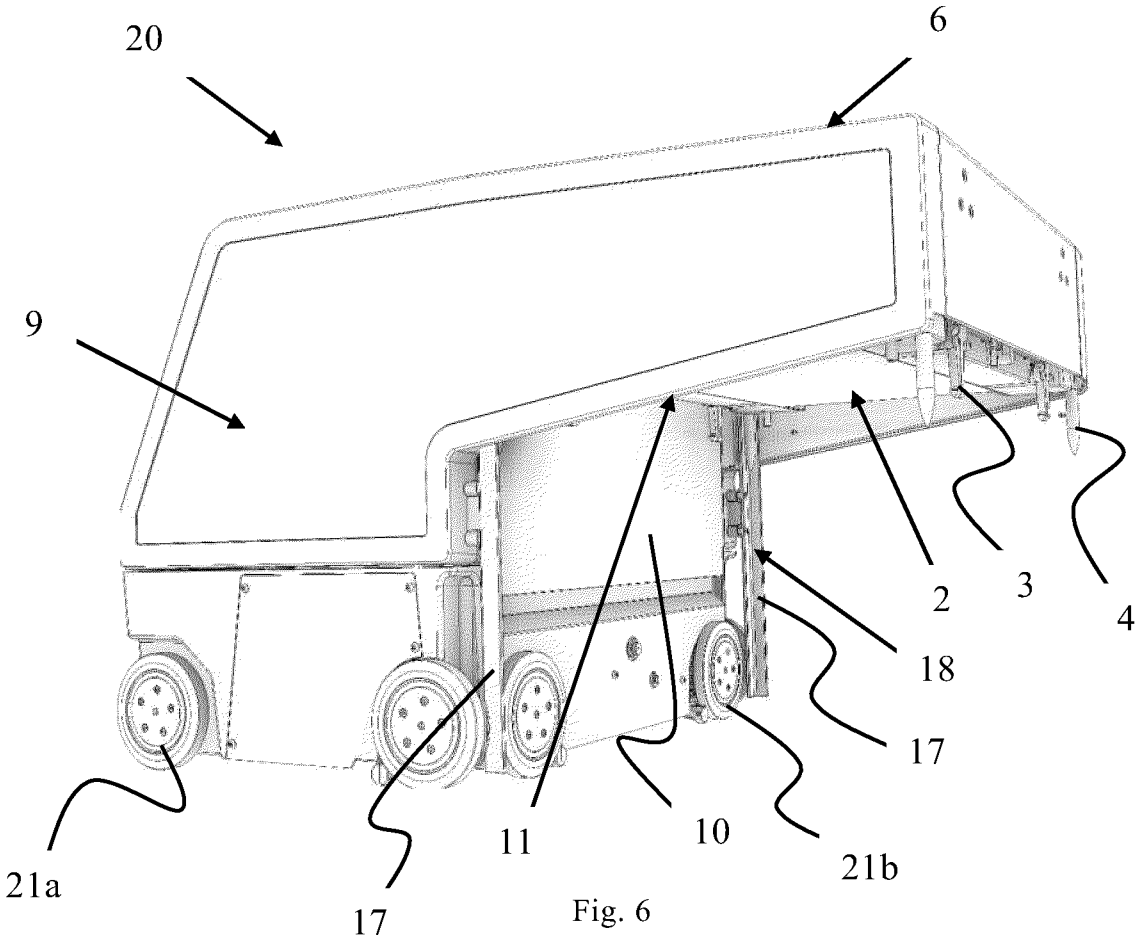

Fig. 6

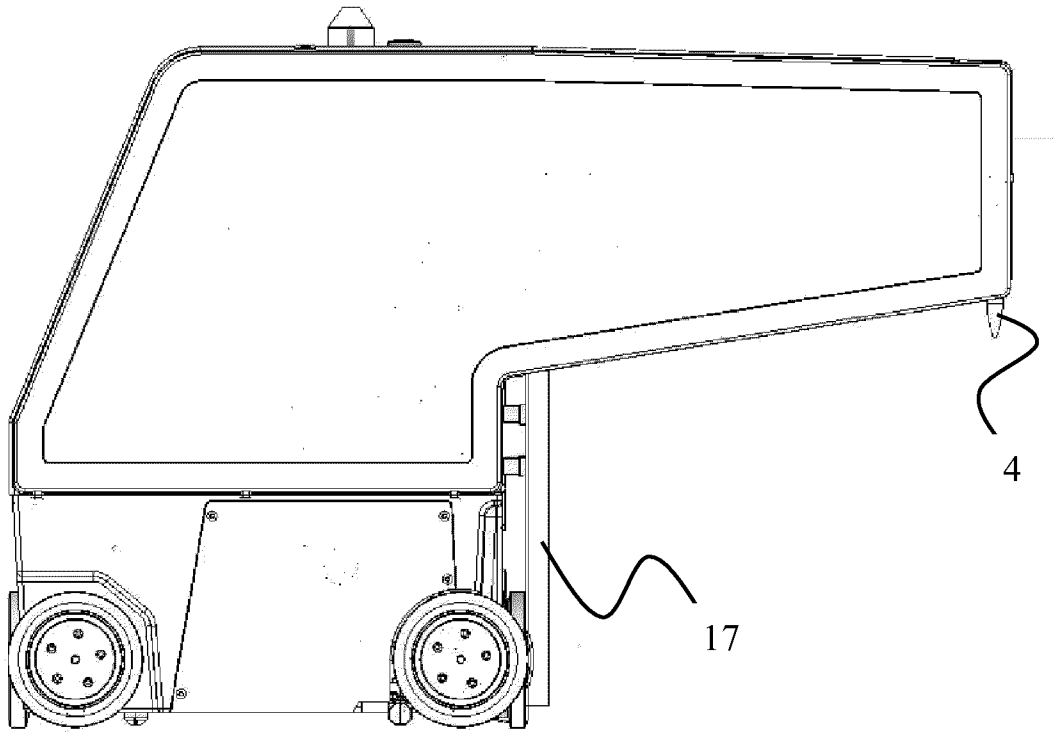

Fig. 7

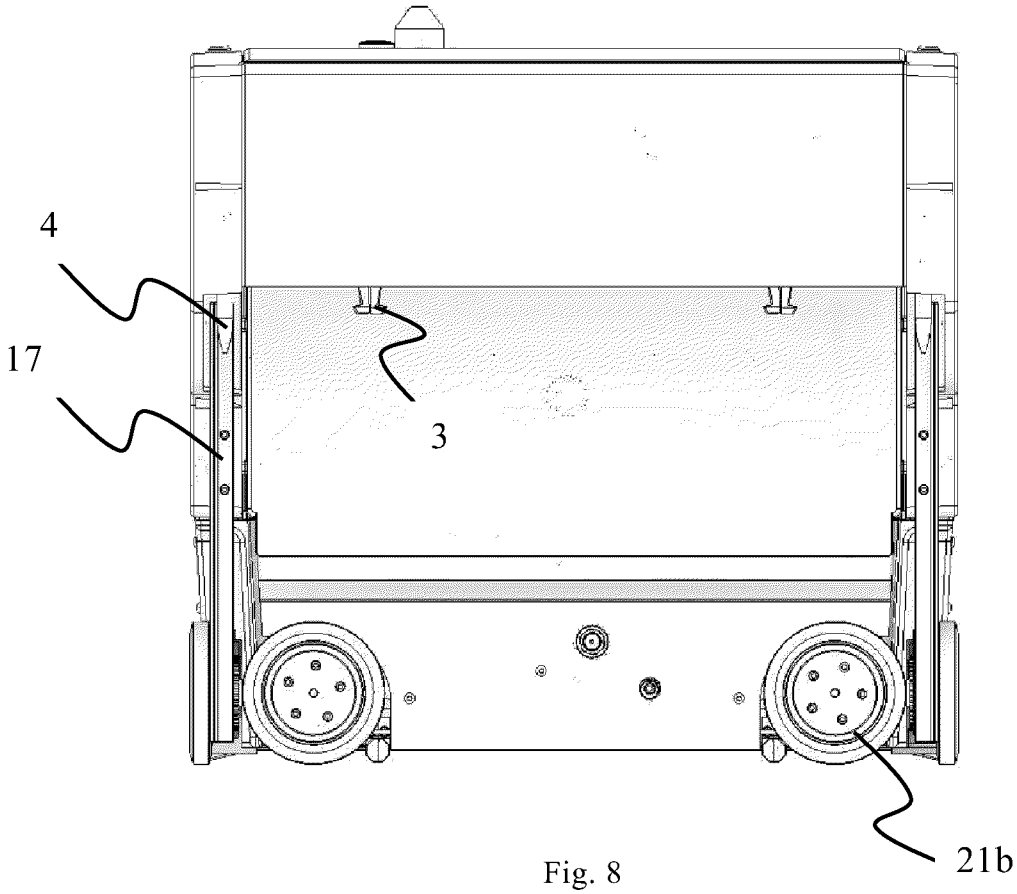

Fig. 8

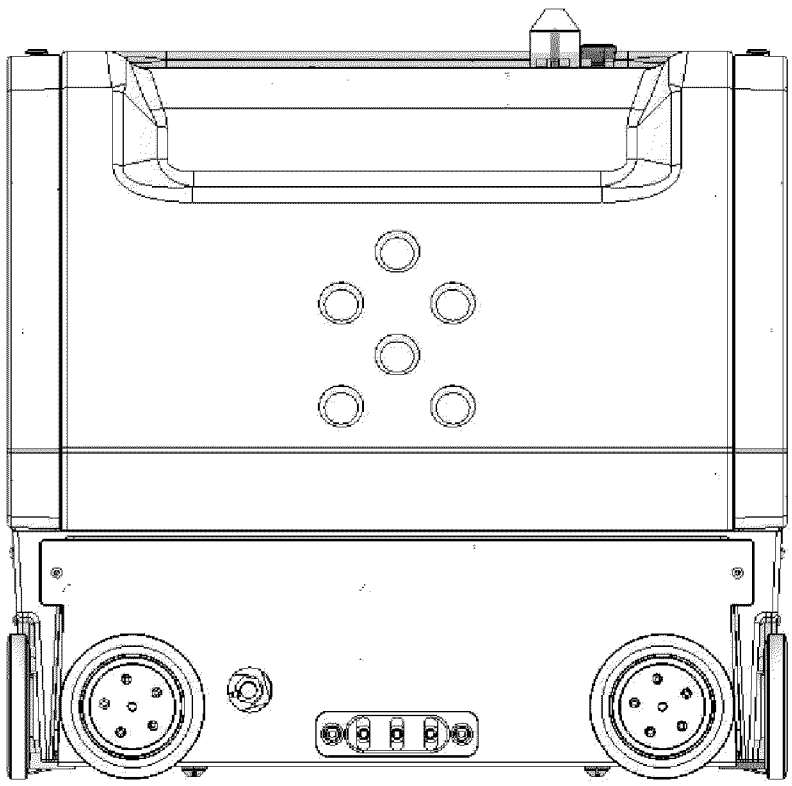

Fig. 9

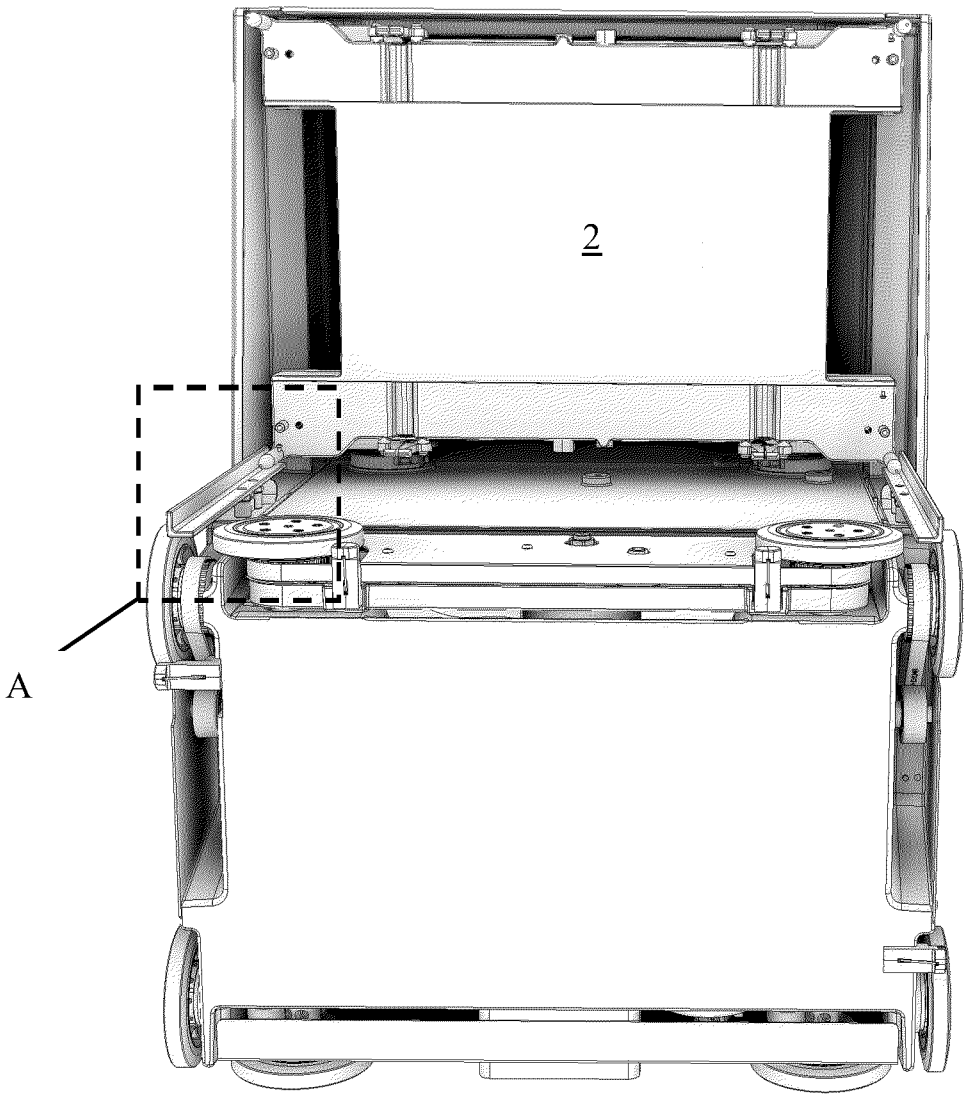

Fig. 10

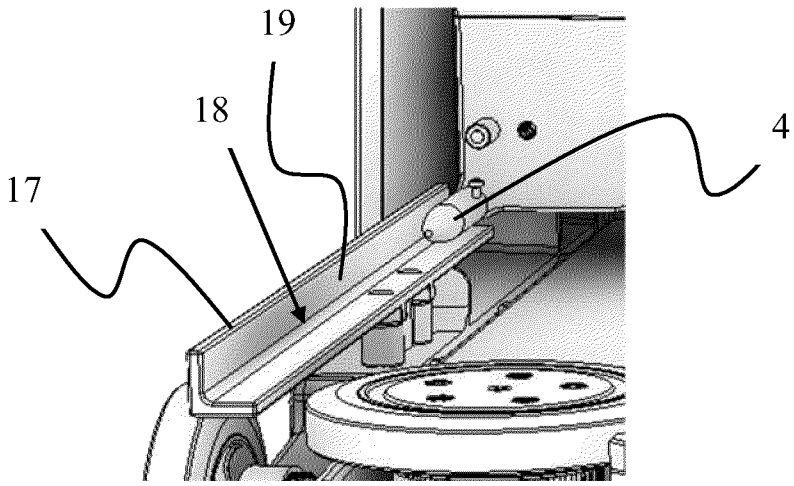

Fig. 11 (Detail A)

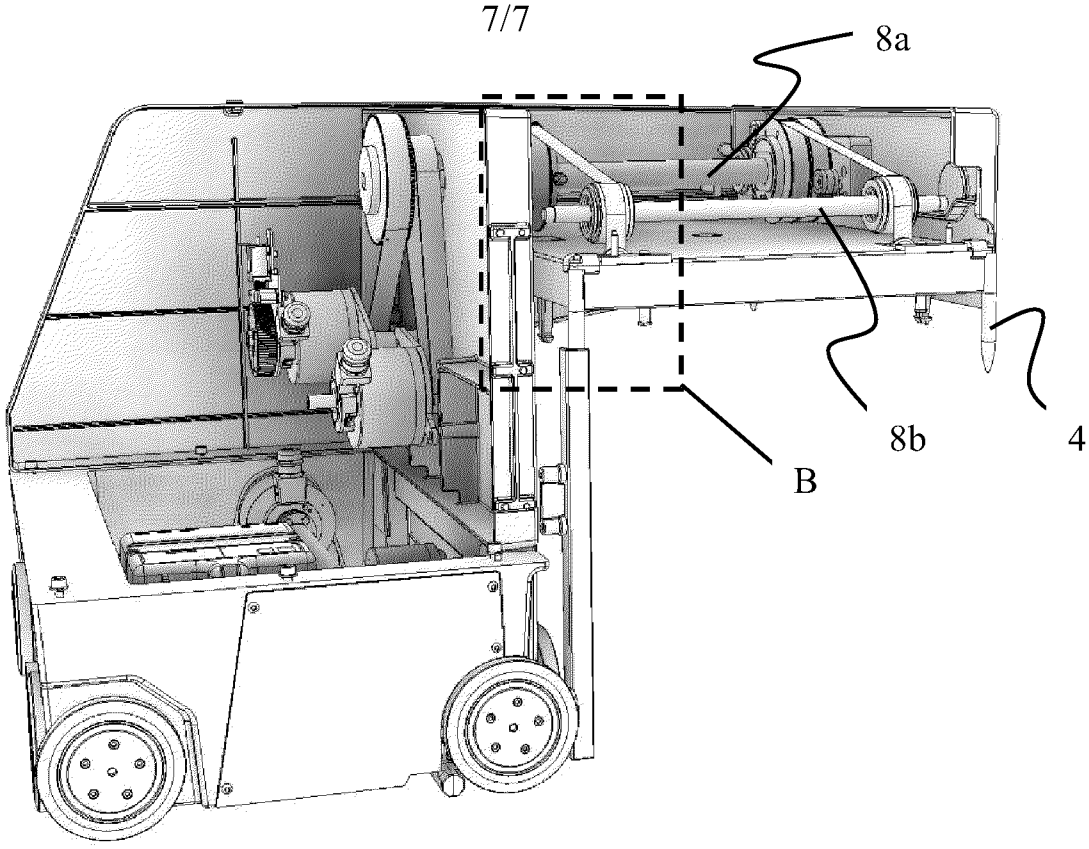

Fig. 12

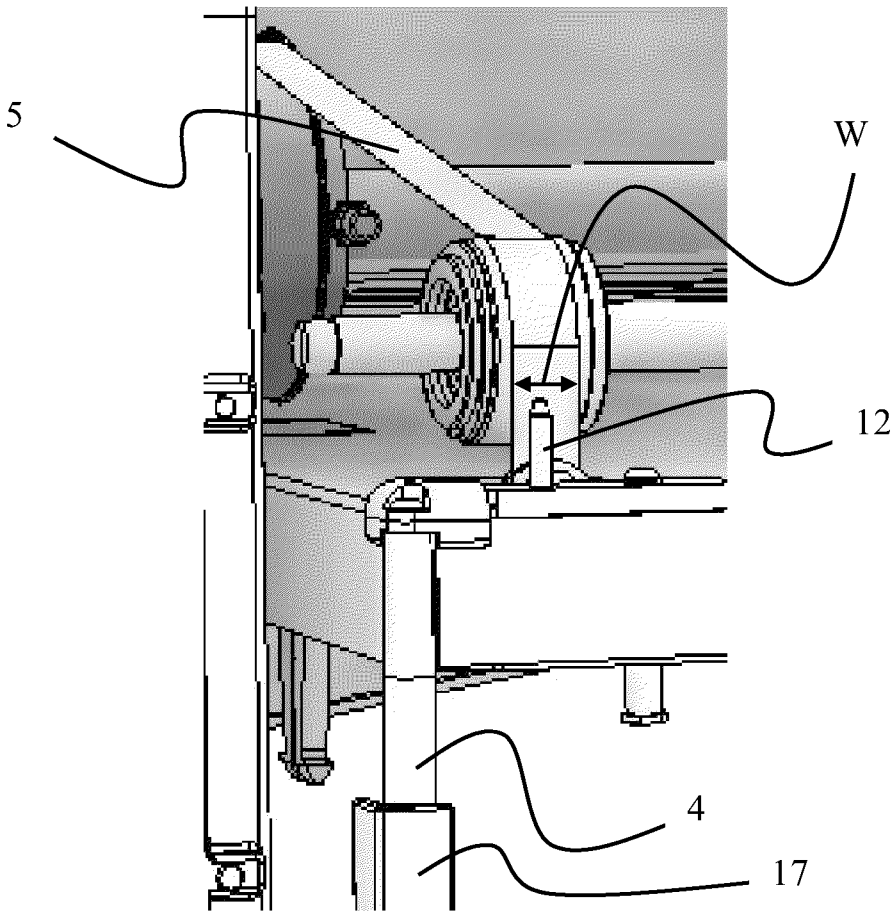

Fig. 13 (Detail B)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/064684

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65G1/04 B66C19/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65G B66F B66C H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2023/145633 A1 (AUSTRHEIM TROND [NO] ET AL) 11 May 2023 (2023-05-11) paragraph [0104] - paragraph [0124]; figures 5-16	1-15
A	WO 2019/101366 A1 (AUTOSTORE TECH AS [NO]) 31 May 2019 (2019-05-31) page 17, line 5 - line 25; figure 13	1-15
A	DE 10 2022 201404 B3 (GEBHARDT FOERDERTECH [DE]) 16 March 2023 (2023-03-16) paragraph [0051] - paragraph [0067]; figures 1-13	1-15
A	US 3 608 750 A (YOUNG ROBERT R ET AL) 28 September 1971 (1971-09-28) column 2 - column 11; figures 1-15	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/EP2024/064684

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