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(71) Applicant: **AUTOSTORE TECHNOLOGY AS** [NO/NO]; Stokkastrandvegen 85, 5578 Nedre Vats (NO).

(72) Inventor: **JUN, David**; c/o AutoStore Technology AS, Stokkastrandvegen 85, 5578 Nedre Vats (NO).

(74) Agent: **COUSENS, Nico** et al.; Kilburn & Strode LLP, Lacon London, 84 Theobalds Road, London WC1X 8NL (GB).

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(54) **Title:** VERTICAL ROLLER CONVEYOR

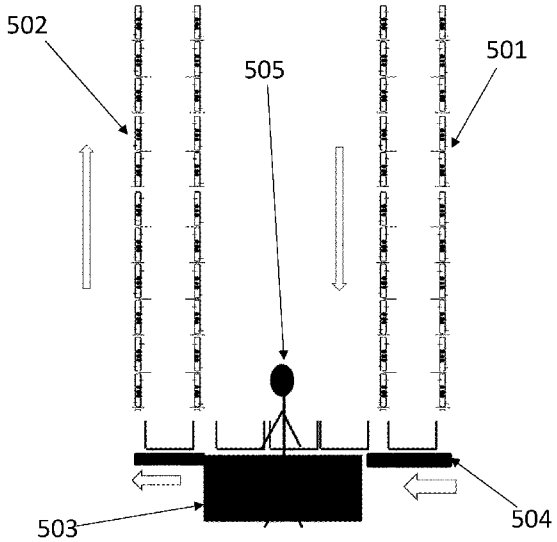

Fig. 5

(57) **Abstract:** A storage and retrieval system comprising a framework structure (100) which includes a rail system (108) comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction (X) across the top of the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction (Y) which is perpendicular to the first direction (X), the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members (102) defining storage columns (105) for storing containers (106) within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle (301, 401) configured to operate on the rail system, at least two automated lifts (501, 502) for delivering containers to and from a station (503), wherein a first lift is for delivering containers to the station that have been delivered from the

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framework structure by a container handling vehicle and a second lift is for delivering containers from the station to the framework structure of the storage and retrieval system using a container handling vehicle, that wherein the lift is comprised of levels placed on top of each other, wherein each level has a container holder (603) for securing the container to a level, and rollers (601) for transporting the container either up one level or down one level of the lifts, and container supports (602) for ensuring that the container does not go beyond the intended level.

VERTICAL ROLLER CONVEYOR

FIELD

The present disclosure relates to an automated storage and retrieval system for storage and retrieval of containers, in particular to a buffer system and method for using a buffer system, and more particularly a buffer system and method for using a buffer system to control the flow of containers to and from a picking port.

BACKGROUND AND PRIOR ART

Fig. 1 discloses a prior art automated storage and retrieval system 1 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 another to form stacks 107. The members 102 may typically be made of metal, e.g. extruded aluminum profiles.

The framework structure 100 of the automated storage and retrieval system 1 comprises a rail system 108 arranged across the top of framework structure 100, on which 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-supporting.

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, 201c, 301b,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 lifting device for vertical transportation of storage containers 106, e.g. raising a storage container 106 from, and lowering a storage container 106 into, a storage column 105. The lifting device comprises one or more gripping / engaging devices which are adapted to engage a storage container 106, and which gripping / engaging devices can be lowered from the vehicle 201,301,401 so that the position of the gripping / engaging devices 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*. Parts of the gripping device of the container handling vehicles 301,401 are shown in Figs. 3 and 4 indicated with reference number 304,404. The gripping device of the container handling device 201 is located within the vehicle body 201a in Fig. 2 and is thus not shown.

Conventionally, and also for the purpose of this application, *Z*=1 identifies the uppermost layer available for storage containers below the rails 110,111, 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,401a 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 incorporated herein by reference.

The cavity container handling vehicle 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 therein 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 110,111 may comprise two parallel tracks. In other rail systems 108, each rail in one direction (e.g. an X direction) may comprise one track and each rail in the other, perpendicular direction (e.g. a Y direction) may comprise two tracks. Each rail 110,111 may also comprise two track members that are fastened together, each track member providing one of a pair of tracks provided by each rail.

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.

In the framework structure 100, a majority 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. The transportation from the port to the access station may require movement along various different directions, by means such as delivery vehicles, trolleys or other transportation lines. 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 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 (not shown), 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 automated storage and retrieval 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 automated storage and retrieval system 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 problem can be that the delivery of containers to the station can cause a buildup of containers on the grid waiting to deliver their containers to the stations. This slows down the grid and causes unnecessary time where the container handling vehicles are not operating at full potential. A reason for this problem is that the people picking at the station picks at various speeds and the container handling vehicles therefore have to wait until the lift transporting the container to the station is free.

There is therefore a need for a system wherein the container handling vehicles do not have to spend time waiting to deliver their cargo at the station, and where there can be a little slack in the system where the container handling vehicles can deliver when they have time without having to wait or hold up the station.

SUMMARY

This summary is provided to introduce in simplified form a selection of concepts that are further described herein. The summary is not intended to identify key or essential features of the invention.

The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention.

In one aspect the disclosure concerns a buffer system for a station of a storage and retrieval system, wherein the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction which is perpendicular to the first direction, the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, and at least two lifts for delivering containers to and from the station, wherein a first lift of the at least two lifts is for delivering containers to the station that have been delivered to the first lift from the framework structure by a container handling vehicle and a second lift of the at least two lifts is for delivering containers from the station to a container handling vehicle for delivery to the framework structure, wherein each lift is comprised of a plurality of levels positioned sequentially in the direction of travel of the lift, wherein each level has a container holder for securing the container within a level, and rollers for transporting the container either up one level or down one level, and a container support for ensuring that the container does not go beyond the intended level (e.g. configured to prevent the container from going beyond an intended level or target level).

Optionally, the container support is configured such that a bottom surface of the container rests on the container support when the container is at rest at a level in one of the lifts.

Optionally, the container support is configured to be retracted when the container is to be moved from one level to another.

Optionally, the container holder is configured to be pushed into receiving slots of the container when the container is to be moved from one level to the other.

Optionally, the container holder is configured to lift or lower the container towards the next level in the lift.

Optionally, the rollers are configured to transport the container into a resting position in the next level of the lift.

Optionally, the rollers are pushed into the sides of the container.

Optionally, the rollers are configured to be positioned on opposite sides of a container

Optionally, the rollers can be moved into engagement with the side of the container by a hydraulic, pneumatic, or electric motor pushing on the rollers.

Optionally, the or each roller can be wheels with a rubber coating.

Optionally, the rollers are driven to rotate by an electric motor.

Optionally, the container support can be retracted or pushed outwardly by a hydraulic, pneumatic, or electric cylinder.

Optionally, the container holder of each level is mounted on a vertical belt or chain in the form of a loop.

The present disclosure also relates to a method for using the above-described buffer system for a station of a storage and retrieval system. For example, the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction which is perpendicular to the first direction, the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, wherein the method includes, a) placing a container onto a container support in a lift, b) gripping the container with one or more container holder, c) retracting the container support, d) extending a container support at the next level to which the lift will travel, e) moving the container holder to move the container towards the next level, f) moving the rollers into engagement with the container, g) rotating the rollers, to bring the container onto the extended container support, h) retracting the rollers, i) repeating steps b-h until the container is at the lowest most level, j) transporting the container from the descending lift to the picking station using a conveyor belt, k) picking the designated items from the container, l) transporting the container from the picking station to the ascending lift, m) engaging the rollers in order to transport the container to the next step in the ascending lift by pushing rubber rollers to the sides of the container, n) engaging the holder with the container, o) rotating the rubber rollers to bring the container up so that the container holders of the next level can grip the container, p) rotating the belt with the container holder in order to transport the container to the next level, q) extending the container

supports of the next level and placing the container on the container supports, r) disengaging the container holder, and s) repeating steps o-r until the container is at the topmost level.

Optionally, when one container is transported out of the station to the second lift of the buffer system, another container is transported into the station by the first lift of the buffer system.

The present disclosure also encompasses a port comprising columns of a storage and retrieval system which are occupied with the above described buffer system and linked together with the station as a unit. The port may be configured to fit into an existing storage and retrieval system as a retrofit.

This solution allows the picker at the station to control the speed of the picking and the buffer system allows the container handling vehicles to load the buffer system like a magazine, which allows the container handling vehicles to operate on the grid with as little time spent as possible waiting for delivering or picking up the containers from the station. The container handling vehicles can deliver the containers from the storage and retrieval system when it is placed in the buffer system and not when the lift is ready, because by being able to load the lifts with multiple containers like a magazine, this gives the container handling vehicles more freedom when delivering their containers.

BRIEF DESCRIPTION OF THE DRAWINGS

The following drawings are appended to facilitate the understanding of the disclosure. The drawings show embodiments of the disclosure, which will now be described by way of example only, where:

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 an internally arranged cavity for carrying storage containers therein.

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

Fig. 4 is a perspective view, seen from below, of a prior art container handling vehicle having an internally arranged cavity for carrying storage containers therein.

Fig. 5 is a front view of the buffer system with a descending lift and an ascending lift and a picking station.

Fig. 6 is a front view of a level in one of the lifts.

Fig. 7 is a view of one side of one level of one lift.

Fig. 8a-f is a front view of two levels in a lift showing the sequence of bringing a container down one level in the lift.

DETAILED DESCRIPTION

In the following, embodiments of the disclosure will be discussed in more detail with reference to the appended drawings. It should be understood, however, that the drawings are not intended to limit the disclosure to the subject-matter depicted in the drawings.

The framework structure 100 of the automated storage and retrieval system 1 is constructed in a similar manner to the prior art framework structure 100 described above in connection with Figs. 1-3. That is, the framework structure 100 comprises a number of upright members 102, and comprises a first, upper rail system 108 extending in the X direction and Y direction.

The framework structure 100 further comprises storage compartments in the form of storage columns 105 provided between the members 102 wherein storage containers 106 are stackable in stacks 107 within the storage columns 105.

The framework structure 100 can be of any size. In particular it is understood that the framework structure can be considerably wider and/or longer and/or deeper than disclosed in Fig. 1. For example, the framework structure 100 may have a horizontal extent of more than 700x700 columns and a storage depth of more than twelve containers.

One embodiment of the automated storage and retrieval system according to the disclosure will now be discussed in more detail with reference to Figs. 5-8.

Fig. 5 is a front view of the buffer system with a descending lift and an ascending lift and a picking station.

In fig. 5 we can see that the buffer system is comprised of a first lift 501 bringing containers from the storage and retrieval system to the station 503 and a second lift 502 bringing the containers from the station 503 to the storage and retrieval system.

A first container is transported from the framework structure of the storage and retrieval system using a container handling vehicle.

The first container is placed into the first lift 501 of the buffer system and transported from the grid level of the storage and retrieval system and down to the level of the station 503 by the first lift 501. When it is at the level of the station 503 the container is transported to the station 503 using e.g. a conveyor belt. When it is at the station 503 the operator picks the required items from the container and when finished the container is sent back to the buffer system. The second lift 502 transports the container from the level of the station 503 to the grid level of the storage and retrieval system.

When the first container is transported from the station 503 to the second lift 502, a second container is transported from the first lift 501 to the station 503.

Both the first 501 and the second lift 502 have the capability to store more than one container. The buffer system acts like a magazine where it is possible to store the containers as they are waiting to be picked or to be placed back into the storage and retrieval system. Each lift in the storage system has the capability to store a plurality of containers. The number of containers that can be placed in the buffer system depends on the difference in height between the top of the grid and the level of the station 503. Assuming that the station 503 is placed on the floor level, the number of containers in each lift might be more than five or more that ten.

Fig. 6 is a front view of a level in one of the lifts. Each lift 501, 502 is comprised of a plurality of levels positioned sequentially in the direction of travel of the lift, wherein each level has a container holder for securing the container within a level, and rollers for transporting the container either up one level or down one level, and a container support for ensuring that the container does not go beyond the intended level.

Each level is comprised of two sides facing each other. Further each side has at least one container holder. The container holders are attached to a looped band or similar that rotates the container holder

In this embodiment it is shown how each level may be comprised of two belts 601 running from the top of the level and to the bottom of the level. The belts 601 of either level are spaced apart in order to accommodate a container between them. The belts 601 are hence placed on opposing sides of the containers.

Either of the belts 601 can be in the form of a belt 601 looped around an electric motor in one end and a roller in the other end. Alternatively, there can be an electric motor in either end. The electric motor can turn the belt around. As mentioned earlier one level is comprised of two belts 601. Typically, the belts 601 are counter rotating.

Further the movement of the belts 601 is typically synchronized. This means that either belt 601 moves the same amount of rotations of the electric motor. Hence the movement of all the electric motors in one level is synchronized for safer transportation of the containers to and from the level.

The belts 601 on either side of the level that transports the containers from the grid of the storage and retrieval system and to the station 503, hence downwards, rotate towards each other at the top and away from each other at the bottom. The belts 601 on either side of the level that transports the containers from the station 503 and towards the grid of the storage and retrieval system rotate away from each other at the top and towards each other at the bottom.

The container holder is configured to be pushed into receiving slots of the container when the container is to be moved from one level to the other. The container holder is configured to lift or lower the container towards the next level in the lift.

Further each level of the lift is comprised of rollers. The rollers can be motorized wheels or rubber rollers which hold containers in place when they are to be transported from one level of the lift to the other. The rollers transport the containers by being pushed onto the sides of the containers in order to get grip. The rollers rotate in order to transport the container either upwards or downwards. The rollers are motorized. These motorized rollers can be spring loaded in order to be able to follow the contours of the sides of the containers as they are transported through the level.

The rollers are configured to transport the container into a resting position in the next level of the lift. The rollers are pushed into the sides of the container.

The rollers are configured to be positioned on opposite sides of a container

The rollers can be moved into engagement with the side of the container by a hydraulic, pneumatic, or electric motor pushing on the rollers.

Each roller can comprise a wheel with a rubber coating.

The rollers are driven to rotate by an electric motor.

Each level of the lift is further comprised of a container support. The container support is in the form of a shelf that is positioned underneath each looped belt on either side of the level. The container support can be moved in and out horizontally in order to be able to transport the container from one level to the next. The container support is in order to allow the container to rest in place at one level of the lift and to ensure that the container does not go beyond the intended level of the

lift. If the container was to travel further than intended then the central computer system will not know the exact location of the container. This can result in problems leading to the storage and retrieval system needing to be shut down.

The container support is configured such that a bottom surface of the container rests on the container support when the container is at rest at a level in one of the lifts.

The container support is configured to be retracted when the container is to be moved from one level to another.

The container support can be retracted or pushed outwardly by a hydraulic, pneumatic, or electric cylinder.

Fig. 7 is a view of one side of one level of one lift. This image is an example of an embodiment of the present disclosure. Here it can be seen that each side of the lift can be comprised of a plurality of bands, each having their own container holder. In between these bands there is a set of rollers. Between each level there is a container support.

Fig. 8a-f are a front view of two levels in a lift showing the sequence of bringing a container down one level in the lift.

The method for using a buffer system for a station (503) of a storage and retrieval system includes a container handling vehicle placing a container onto a container support in a descending lift. Further the container is gripped with one or more container holders. Then the container support of the level the container is positioned is retracted. Then the container support is extended at the next level to which the lift will travel. Then the method is further comprised of moving the container holder to move the container towards the next level. After that the rollers are moved into engagement with the container. Then the rollers are rotated in order to bring the container onto the extended container support. When the container is positioned on the extended container support the rollers are retracted. These steps are repeated until the container is at the bottom most level.

When the container is at the bottom most level the container is transported from the descending lift to the picking station using e.g. a conveyor belt.

When the container is at the picking station the designated item is picked from the container. After that, the container is transported from the picking station to the ascending lift.

In order to bring the container up one level of the ascending lift the rollers are engaged by pushing rubber rollers to the sides of the container. The rollers are rotated in order to bring the container up so that the container holders of the next level can grip the container. Then the belts of the next level are rotated with the container holder in order to transport the container to the next level. When the container is in the next level the container support is extended placing the container on the container supports. At last the container holders are disengaged.

These steps are repeated until the container is at the topmost level.

When one container is transported out of the station 503 to the second lift 502 of the buffer system, another container is transported into the station 503 by the first lift 501 of the buffer system.

The operation of the lift can be controlled by an operator either pushing a button or a pedal in order to give a signal when a new container is to be transported into the picking station.

Further a central computer system can control when a new container is to be transported into the picking station.

Also disclosed are the following numbered items:

1. A buffer system for a station (503) of a storage and retrieval system, wherein the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction (X) across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction (Y) which is perpendicular to the first direction (X), the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, and at least two lifts for delivering containers to and from the station (503), wherein a first lift (501) is for delivering containers to the station (503) that have been delivered to the first lift from the framework structure by a container handling vehicle and a second lift (502) is for delivering containers from the station to a container handling vehicle for delivery to the framework structure, wherein each lift (501, 502) is comprised of a plurality of levels

positioned sequentially in the direction of travel of the lift, wherein each level has a container holder for securing the container within a level, and rollers for transporting the container either up one level or down one level, and a container support for ensuring that the container does not go beyond the intended level.

2. System according to item 1 wherein the container support is configured such that a bottom surface of the container rests on the container support when the container is at rest at a level in one of the lifts.

3. System according to any of the preceding items wherein the container support is configured to be retracted when the container is to be moved from one level to another.

4. System according to any of the preceding items wherein the container holder is configured to be pushed into receiving slots of the container when the container is to be moved from one level to the other.

5. System according to any of the preceding items wherein the container holder is configured to lift or lower the container towards the next level in the lift.

6. System according to any of the preceding items wherein the rollers are configured to transport the container into a resting position in the next level of the lift.

7. System according to any of the preceding items wherein the rollers are pushed into the sides of the container.

8. System according to any of the preceding items wherein the rollers are configured to be positioned on opposite sides of a container

9. System according to any of the preceding items wherein the rollers can be moved into engagement with the side of the container by a hydraulic, pneumatic, or electric motor pushing on the rollers.

10. System according to any of the preceding items wherein the or each roller can be wheels with a rubber coating.

11. System according to any of the preceding items wherein the rollers are driven to rotate by an electric motor.

12. System according to any of the preceding items wherein the container support can be retracted or pushed outwardly by a hydraulic, pneumatic, or electric cylinder.

13. System according to item 1 wherein the container holder of each level is mounted on a vertical belt (600) or chain in the form of a loop.

14. A storage and retrieval system comprising a framework structure, a container handling vehicle, a station (503) and a buffer system as claimed in any preceding claim for delivering containers to and from the station (503).

15. Method for using a buffer system for a station (503) of a storage and retrieval system, wherein the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction (X) across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction (Y) which is perpendicular to the first direction (X), the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, wherein the method includes:

a. placing a container onto a container support in a lift,

b. gripping the container with one or more container holder

c. retracting the container support,

d. extending a container support at the next level to which the lift will travel,

e. moving the container holder to move the container towards the next level,

f. moving the rollers into engagement with the container,

g. rotating the rollers, to bring the container onto the extended container support,

h. retracting the rollers,

i. repeating the steps b-h until the container is at the lowest most level,

j. transporting the container from the descending lift to the picking station using a conveyor belt,

k. picking the designated items from the container,

l. transporting the container from the picking station to the ascending lift,

m. engaging the rollers in order to transport the container to the next step in the ascending lift by pushing rubber rollers to the sides of the container,

n. engaging the holder with the container,

o. rotating the rubber rollers to bring the container up so that the container holders of the next level can grip the container,

p. rotating the belt(s) with the container holder in order to transport the container to the next level,

q. extending the container supports of the next level and placing the container on the container supports.

r. disengaging the container holder

s. repeat steps o-r until the container is at the topmost level.

16. Method according to item 15, wherein when one container is transported out of the station (503) to the second lift (502) of the buffer system, another container is transported into the station (503) by the first lift (501) of the buffer system.

17. Method according to item 15 or 16, wherein the operation of the lift is controlled by an operator either pushing a button or a pedal in order to give a signal when a new container is to be transported into the picking station.

18. Method according to item15 or 16, wherein a central computer system controls when a new container is to be transported into the picking station.

In the preceding description, various aspects of the delivery vehicle and the automated storage and retrieval system according to the disclosure have been described with reference to the illustrative embodiment. For purposes of explanation, specific numbers, systems, and configurations were set forth in order to provide a thorough understanding of the system and its workings. However, this description is not intended to be construed in a limiting sense. Various modifications and variations of the illustrative embodiment, as well as other embodiments of the system, which

are apparent to persons skilled in the art to which the disclosed subject matter pertains, are deemed to lie within the scope of the present disclosure.

LIST OF REFERENCE NUMBERS

Prior art (figs 1-4):

1	Prior art automated storage and retrieval system
100	Framework structure
102	Upright 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*)
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 set of wheels in first direction (*X*)
201c	Drive means / wheel arrangement / second set of wheels in second direction (*Y*)
301	Prior art cantilever container handling vehicle
301a	Vehicle body of the container handling vehicle 301
301b	Drive means / first set of wheels in first direction (*X*)
301c	Drive means / second set of wheels in second direction (*Y*)
304	Gripping device
401	Prior art container handling vehicle
401a	Vehicle body of the container handling vehicle 401
401b	Drive means / first set of wheels in first direction (*X*)
401c	Drive means / second set of wheels in second direction (*Y*)
404	Gripping device
404a	Lifting band
404b	Gripper
404c	Guide pin
404d	Lifting frame
500	Control system
501	Vertical lift transporting containers down
502	Vertical lift transporting container up

503	Picking port
504	Conveyor belt.
505	Operator
600	Opposing sides of a lift
601	Rollers
602	Container support
603	Container holder
X	First direction
Y	Second direction
Z	Third direction

CLAIMS

1. A buffer system for a station of a storage and retrieval system,
wherein the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction which is perpendicular to the first direction, the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure,
wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, and first and second lifts for delivering containers to and from the station, wherein the first lift is configured to deliver containers to the station that have been delivered to the first lift from the framework structure by a container handling vehicle and the second lift is configured to deliver containers from the station to a container handling vehicle for delivery to the framework structure,
wherein each lift is comprised of a plurality of levels positioned sequentially in the direction of travel of the lift, wherein each level has a container holder configured to secure a container within a level, and rollers configured to transport the container either up one level or down one level, and a container support configured to prevent the container from going beyond an intended level.

2. System according to claim 1 wherein the container support is configured such that a bottom surface of the container rests on the container support when the container is at rest at a level in one of the lifts.

3. System according to any of the preceding claims wherein the container support is configured to be retracted when the container is to be moved from one level to another.

4. System according to any of the preceding claims wherein each container holder is configured to be pushed into receiving slots of the container when the container is to be moved from one level to the other.

5. System according to any of the preceding claims wherein each container holder is configured to lift or lower the container towards the next level in the lift.

6. System according to any of the preceding claims wherein the rollers are configured to transport the container into a resting position in the next level of the lift.

7. System according to any of the preceding claims wherein the rollers are pushed into the sides of the container.

8. System according to any of the preceding claims wherein the rollers are configured to be positioned on opposite sides of a container.

9. System according to any of the preceding claims wherein the rollers can be moved into engagement with the side of the container by a hydraulic, pneumatic, or electric motor pushing on the rollers.

10. System according to any of the preceding claims wherein the or each roller comprises a wheel with a rubber coating.

11. System according to any of the preceding claims wherein the rollers are configured to be driven to rotate by an electric motor.

12. System according to any of the preceding claims wherein the container support can be retracted or pushed outwardly by a hydraulic, pneumatic, or electric cylinder.

13. System according to claim 1 wherein the container holder of each level is mounted on a vertical belt or chain in the form of a loop.

14. A storage and retrieval system comprising a framework structure, a container handling vehicle, a station and a buffer system as claimed in any preceding claim for delivering containers to and from the station.

15. Method for using a buffer system for a station of a storage and retrieval system,
wherein the storage and retrieval system comprises a framework structure which includes a rail system comprising a first set of parallel rails arranged to guide movement of a container handling vehicle in a first direction across the framework structure, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicle in a second direction which is perpendicular to the first

direction, the first and second sets of parallel rails dividing the rail system into a plurality of grid cells, the framework structure comprising upright members defining storage columns for storing containers within the framework structure, wherein the storage and retrieval system comprises at least one container handling vehicle configured to operate on the rail system, wherein the method includes:

a. placing a container onto a container support in a lift,

b. gripping the container with one or more container holders,

c. retracting the container support,

d. extending a container support at the next level to which the lift will travel,

e. moving the container holder to move the container towards the next level,

f. moving the rollers into engagement with the container,

g. rotating the rollers, to bring the container onto the extended container support,

h. retracting the rollers,

i. repeating steps b-h until the container is at a lowest level,

j. transporting the container from the descending lift to the picking station using a conveyor belt,

k. picking items from the container,

l. transporting the container from the picking station to the ascending lift,

m. engaging the rollers in order to transport the container to the next step in the ascending lift by pushing rubber rollers to the sides of the container,

n. engaging the holder with the container,

o. rotating the rubber rollers to bring the container up so that the container holders of the next level can grip the container,

p. rotating the belt(s) with the container holder in order to transport the container to the next level,

q. extending the container supports of the next level and placing the container on the container supports,

r. disengaging the container holder, and

s. repeating steps o-r until the container is at a topmost level.

16. Method according to claim 15, wherein when a first container is transported out of the station to the second lift of the buffer system, and a second container is transported into the station by the first lift of the buffer system.

17. Method according to claim 15 or 16, wherein an operator either pushes a button or a pedal in order to give a signal when a new container is to be transported into the picking station, to control operation of the lift.

18. Method according to claim 15 or 16, wherein a central computer system controls when a new container is to be transported into the picking station.

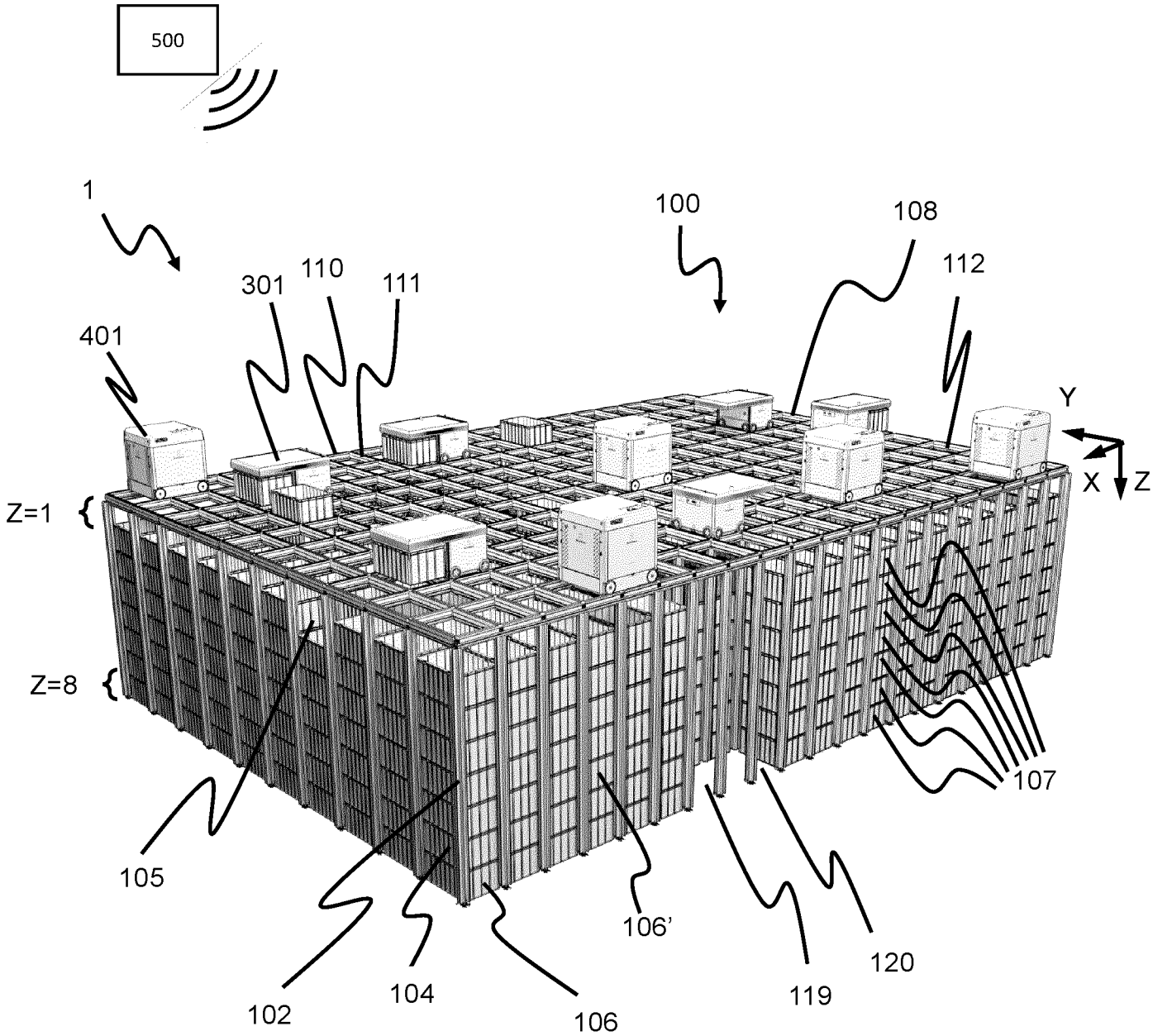

Fig. 1
(Prior Art)

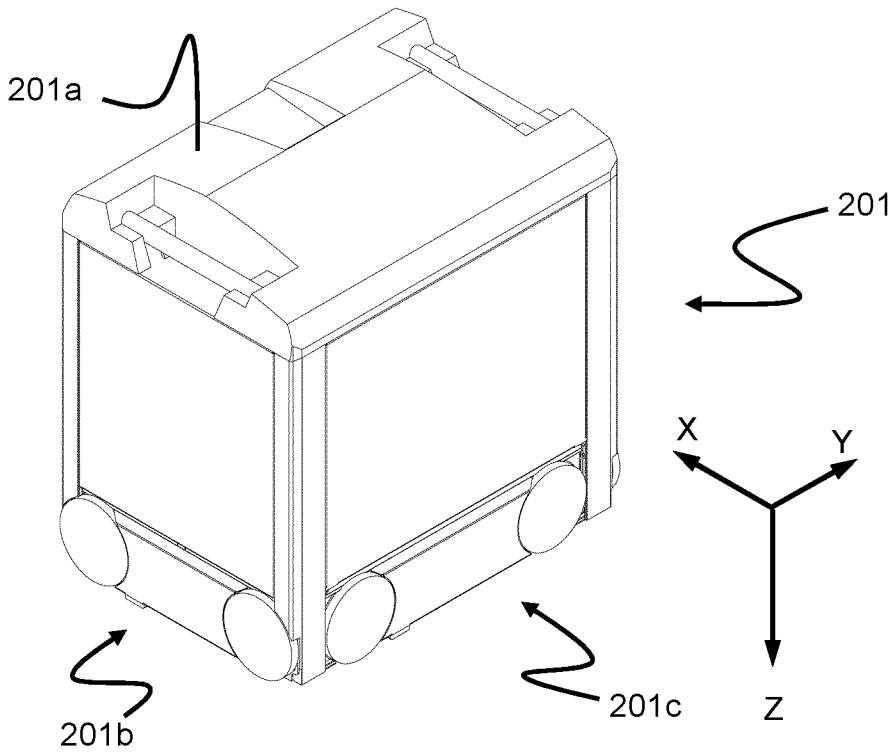

Fig. 2
(Prior Art)

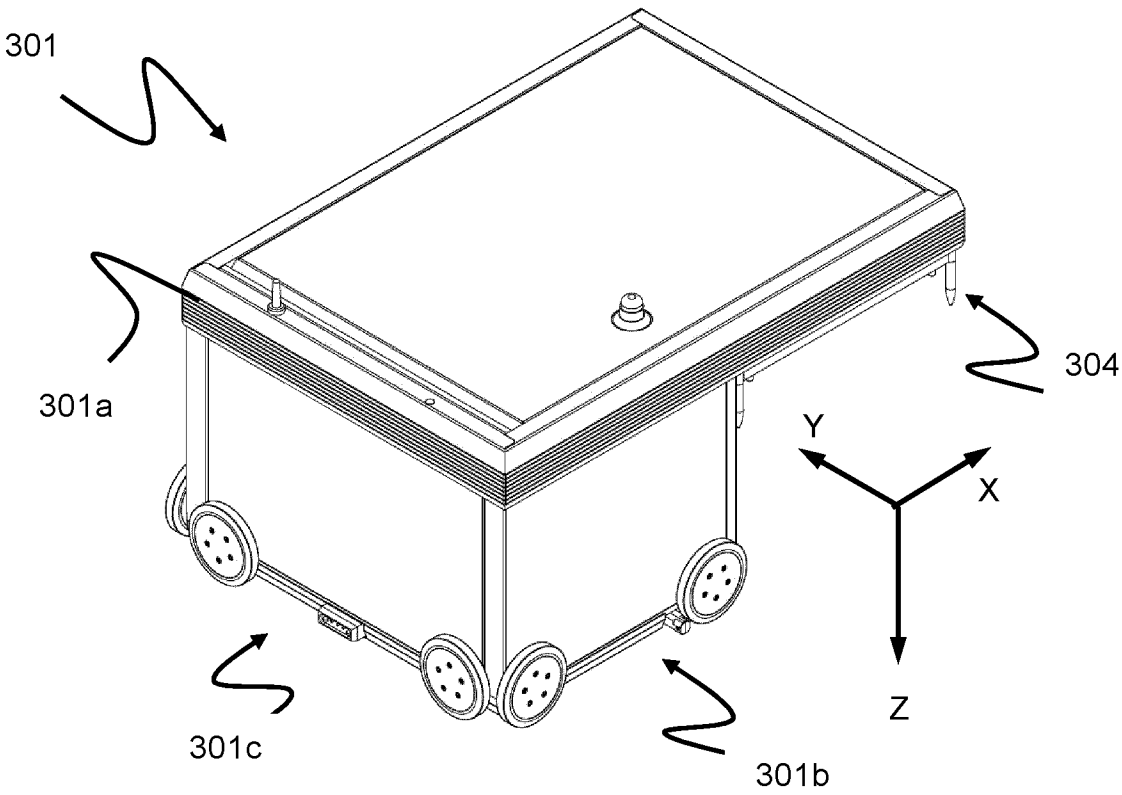

Fig. 3
(Prior Art)

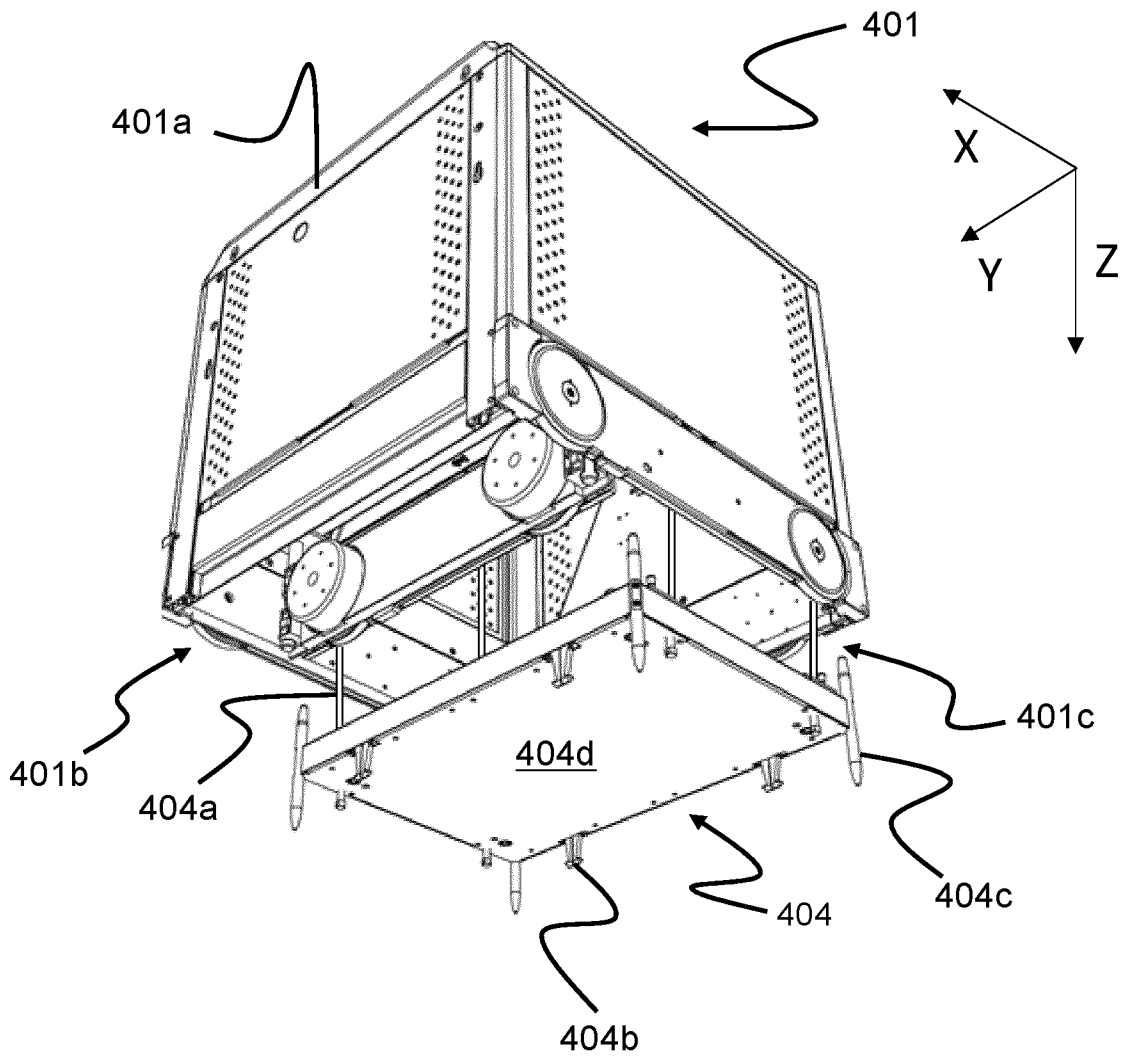

Fig. 4
(Prior Art)

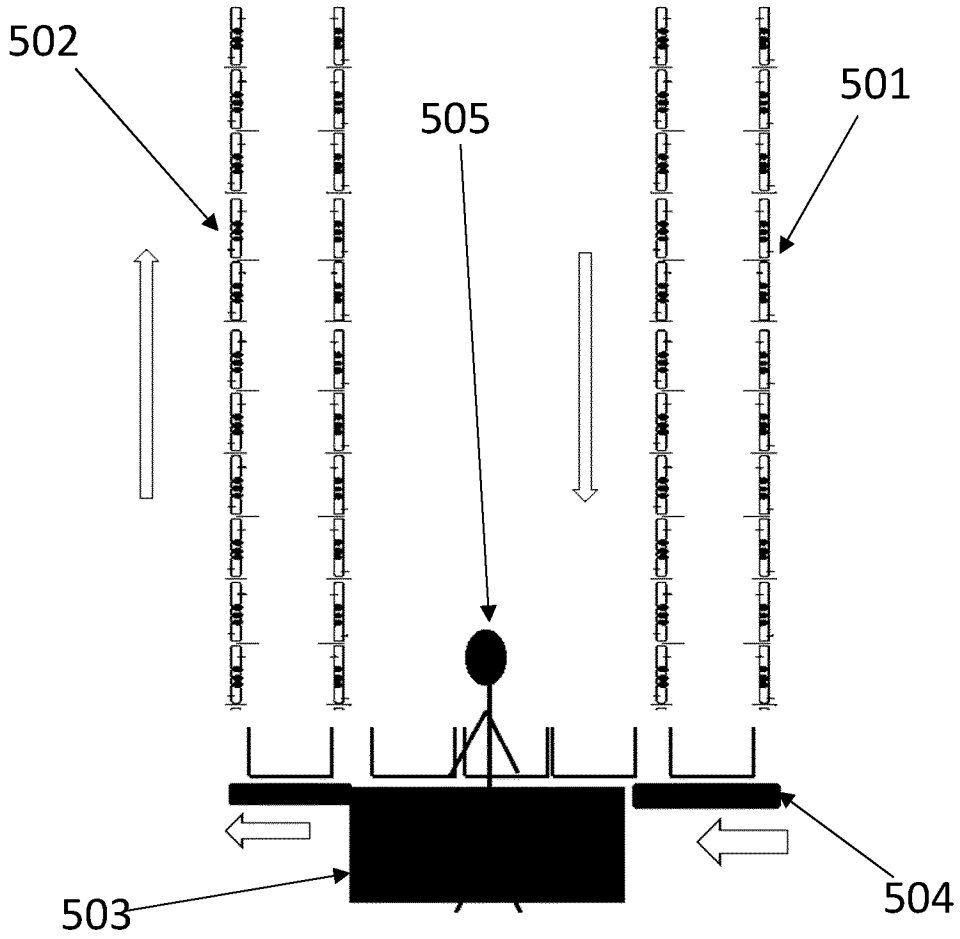

Fig. 5

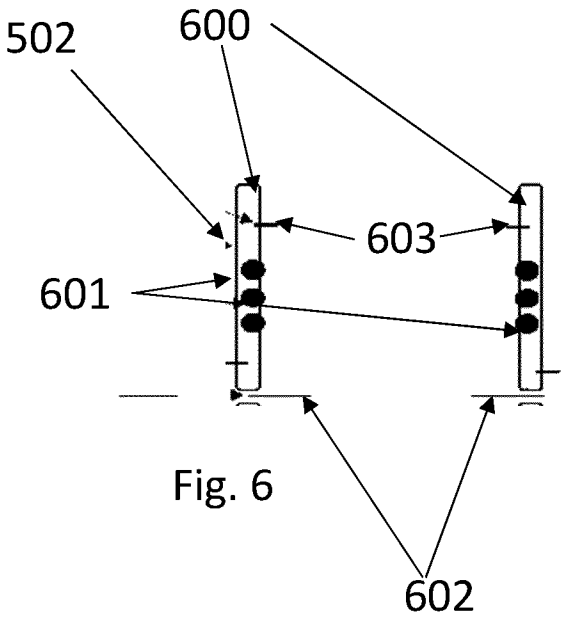

Fig. 6

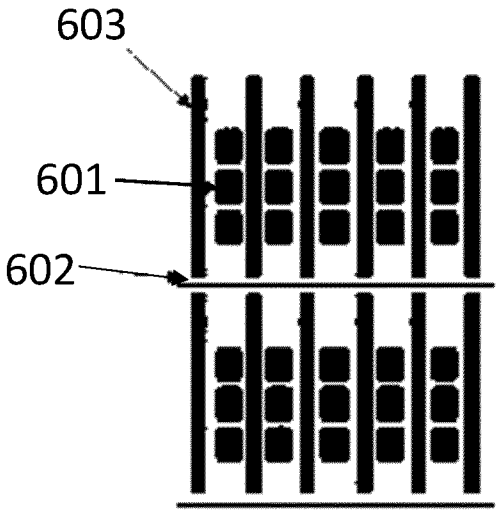

Fig. 7

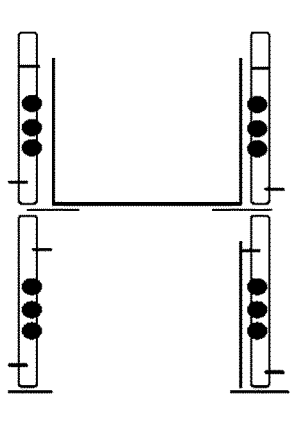

Fig. 8a

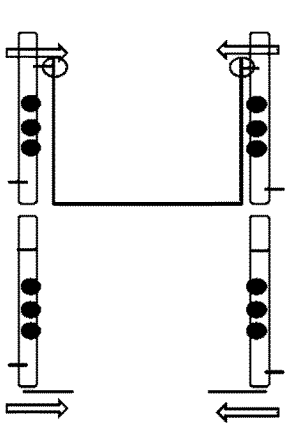

Fig. 8b

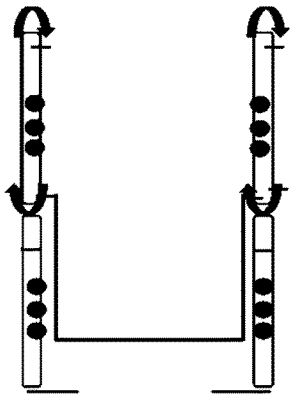

Fig. 8c

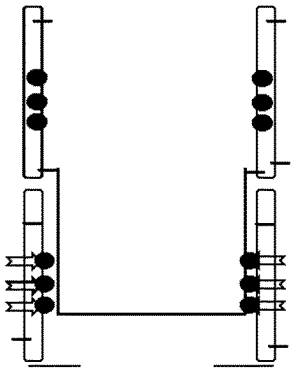

Fig. 8d

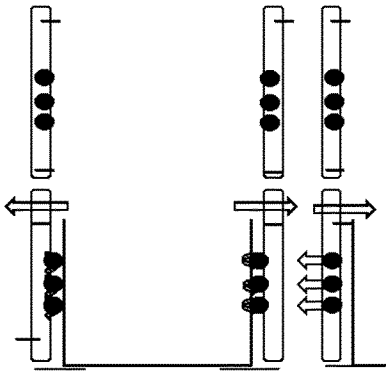

Fig. 8e

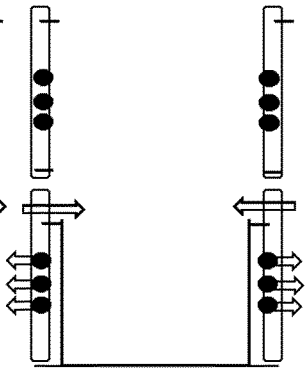

Fig. 8f

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/060608

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65G1/04
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

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 2016/145058 A1 (LINDBO LARS SVERKER TURE [GB]) 26 May 2016 (2016-05-26) paragraph [0036] - paragraph [0118]; figures 9-10	14-18
A	JP S52 20574 A (SANKI ENG CO LTD) 16 February 1977 (1977-02-16) abstract; figure 5	14-18
A	DE 10 2019 111709 B4 (DEMATIC GMBH [DE]) 1 April 2021 (2021-04-01) the whole document	14-18

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 July 2024	02/08/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Scheller, Johannes

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2024/060608

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-13
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 1-13

The formulation of claims 1-13 leave doubt which parts of the claims form part of the buffer system and which parts form part of the storage and retrieval system for which the buffer system is simply suitable for. Claim 1 and dependent claims 2-13 never specify which parts form the buffer system.

Consequently a large number of documents is potentially novelty destroying for the current claim 1 to such an extent that no meaningful search can be carried out. This also applies to claims 2-13 as these claims further specify features of the storage system which are not part of the claim.

The combination of claims 1 and 14 resolves this issue and consequently the search was restricted to claims 1-13 in combination with claim 14. The applicant was consulted according to PCT-EPO Guidelines B-VIII, 3.3 and agreed with the restriction on the 08-07-2024.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guidelines C-IV, 7.3), should the problems which led to the Article 17(2) PCT declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/060608

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016145058 A1	26-05-2016	EP 3003932 A1	13-04-2016
		EP 3988482 A1	27-04-2022
		ES 2961835 T3	14-03-2024
		GB 2518259 A	18-03-2015
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		PL 3003932 T3	26-02-2024
		US 2016145058 A1	26-05-2016
		US 2018086573 A1	29-03-2018
		WO 2014195901 A1	11-12-2014
JP S5220574 A	16-02-1977	NONE	
DE 102019111709 B4	01-04-2021	NONE	