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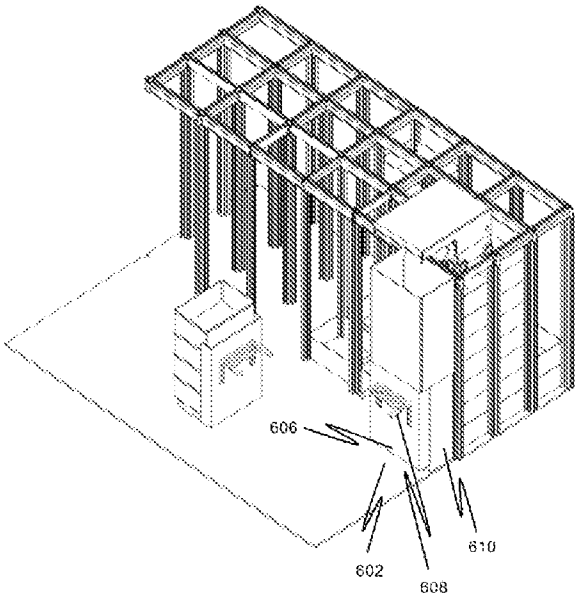
(71)	Applicant	Autostore Technology AS, Stokkastrandvegen 85, 5578 NEDRE VATS, Norge
(72)	Inventor	Erik Strømme, Borgenveien 136, 1388 BORGEN, Norge Juan Pablo Ramirez Perez, Kirchweg 4, 8071 HAUSMANNSTÄTTEN, Østerrike Jørgen Djuve Heggebø, Gulliveien 18, 1405 LANGHUS, Norge
(74)	Agent or Attorney	ONSAGERS AS, Postboks 1813 Vika, 0123 OSLO, Norge

(54) Title **AN ASSEMBLY FOR TRANSPORTING A PLURALITY OF GOODS HOLDERS TO/FROM A GRID-BASED STORAGE AND RETRIEVAL SYSTEM**

(57) Abstract

The invention relates to an assembly for transporting a plurality of goods holders (106) to/from a grid-based storage and retrieval system (1), said grid-based storage and retrieval system (1) comprising a framework structure (100) defining a storage volume for storing goods holders (106). The assembly comprises a guiding structure (602) configured to be affixed to an upper section of the framework structure, the guiding structure for guiding vertically moving goods holders (106) in an upright position. The assembly further comprises a transporter (604) for transporting a stack of goods holders (106), said transporter comprising a base (605) for supporting goods holders, wherein said transporter is configured to be positioned such that the base is positioned below the guiding structure such that goods holders (106) may be transferred between the storage volume and the transporter via said guiding structure. The assembly also comprises a protective structure (606) at least partially laterally enclosing the transporter when the base is positioned below said guiding structure. The invention further relates to a method for transporting a plurality of goods holders (106) to/from a grid-based storage and retrieval system (1).



AN ASSEMBLY FOR TRANSPORTING A PLURALITY OF GOODS HOLDERS TO/FROM A GRID-BASED STORAGE AND RETRIEVAL SYSTEM

The present invention primarily relates to an assembly for transporting a plurality of goods holders to/from a grid-based storage and retrieval system.

BACKGROUND AND PRIOR ART

Fig. 1 discloses a prior art automated storage and retrieval system 1 with a framework structure 100 and Figs. 2, 3a-3b 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 container 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 rail system 108 a plurality of container handling vehicles 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 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 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 301, 401 through access openings 112 in the rail system 108. The container handling vehicles 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 lateral movement of the container handling vehicles 201, 301,

401 in the *X* direction and in the *Y* direction, respectively. In Figs. 2-3b, 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 304, 404 (visible in Figs. 3a-3b) having a lifting frame part 304a, 404a 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 304, 404 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* (visible for instance in Fig. 1) 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. 3a and 3b indicated with reference number. The gripping device of the container handling device 201 is located within the vehicle body 201a in Fig. 2.

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=18, 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 3b and as described in e.g. WO2015/193278A1 and WO2019/206487A1, the contents of which are incorporated herein by reference.

Fig. 3a 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. 3b and as 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; in other rail systems 108, each rail in one direction may comprise one track and each rail in the other perpendicular direction may comprise two tracks. The rail system may also comprise a double track rail in one of the X or Y direction and a single track rail in the other of the X or Y direction. A double track rail may comprise two rail members, each with a track, which are fastened together.

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 a 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 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, once accessed, returned into the framework structure 100. 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 heights, 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 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 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 (shown in Fig. 1) which typically is computerized and which typically comprises a database for keeping track of the storage containers 106.

When introducing storage containers into the system 1, it is common that these are, prior to introduction, presented in stacks placed next to the system. However, the containers are introduced into the system 1 one-by-one. To this purpose, a destacker is normally employed to fragment a stack of containers to individual containers apt

for being introduced into the system. In addition to requiring operator presence, the destacker takes up valuable floor space. Analogously, a stacker is frequently employed in order to group a number of extracted storage containers to a stack thus preparing the containers for further transport.

WO2016/166294A1 discloses an object handling system having certain similarities with the system shown in Fig. 1. The system comprises a workspace with several vertically extending storage spaces, each comprising a plurality of stacked storage containers. The system further comprises wheeled robotic load handling devices operating on rails arranged in a grid pattern above the work space. The robotic devices can move in a horizontal direction and, when suitably positioned relative a selected storage space, i.e. immediately above a stack of containers, use lifting means to engage and lift a top container from the stack such that the engaged container is removed from the work space. A corresponding operation is performed in the opposite scenario, i.e. when a storage container needs to be introduced into a selected storage space of the work space. In one embodiment of WO2016/166294A1, a number of storage containers are extracted from the storage space(s) for subsequent transport to an alternative location. To that purpose, a wheeled structure shown in Fig. 5a of WO2016/166294A1 that transports stacked storage containers between the storage space(s) and the transport vehicle is employed. One major challenge associated with the system of WO2016/166294A1 is to ensure efficient and flexible management of storage containers being introduced to/extracted from the work space.

In view of the above it is desirable to provide a solution that solves or at least mitigates one or more of the aforementioned problems belonging to the prior art.

SUMMARY 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.

First aspect of the invention relates to an assembly for transporting a plurality of goods holders to/from a grid-based storage and retrieval system in accordance with claim 1.

Invention in accordance with the above enables flexible management of goods holders without employing advanced machinery other than remotely operated vehicles. This ensures a simple and economically efficient operation. The goods holder management typically takes place at a micro fulfilment center (MFC). Here, an MFC is a small-scale warehouse facility typically placed close to the consumer to improve delivery times.

Moreover, the solution in accordance with claim 1 enables two-way transfer of goods holders to/from the storage volume without constructional changes to the storage and retrieval system. In addition, the guiding/protective structures are easily retrofitted to existing systems.

Further benefits are reduced need for operator intervention and a reduced system footprint.

Another aspect of the invention relates to a method for transporting a plurality of goods holders to/from a grid-based storage and retrieval system in accordance with claim 35. For the sake of brevity, advantages discussed above in connection with the receptacle for moving a plurality of goods holders, may even be associated with the corresponding method and are not further discussed. Here, it is to be construed that the sequence of method steps of method claims may be effectuated in any given order.

In one aspect, the unit for moving a plurality of goods holders of the present invention is for use in the context of the framework structure 100 comprising upright members 102.

In another aspect, the unit for moving a plurality of goods holders of the present invention is for use in the context of a storage volume comprising storage columns 105 for storing stacks of goods holders 106. These storage columns 105 are arranged in rows between the upright members 102.

In another aspect, the unit for moving a plurality of goods holders 106 of the present invention is for use in the context of a rail system 108 arranged across the top of the framework structure 100. Here, a plurality of remotely operated vehicles travels on the rail system 108 and raises goods holders 106 from, and lowers goods holders 106 into, the storage columns 105, and also to transport the goods holders 106 above the storage columns 105. During this transport, the remotely operated vehicles move laterally, i.e. in a plane which is parallel to a horizontal plane.

In one aspect, the unit for moving a plurality of goods holders of the present invention is for use in the context of a SDG-based rail system 108. Here, SDG stands for Single/Double Grid. This design provides a single rail track along one axis and a double rail track along the other axis. Utilizing a single rail in one direction requires the meeting robots to have a cell between them.

In one aspect, the unit for moving a plurality of goods holders of the present invention is for use in the context of a DDG-based rail system 108. Here, DDG stands for Double/Double Grid. This design provides a double rail track in all directions allowing robots to pass each other in all directions.

For the purposes of this application, the term "container handling vehicle" used in "Background and Prior Art"-section of the application and the term "remotely operated vehicle" used in the rest of the application text are synonymous and define an autonomous wheeled vehicle operating on a rail system arranged across the top of the framework structure being part of an automated storage and retrieval system.

Analogously, the terms "storage container" and "storage bin" used in "Background and Prior Art"-section of the application and the term "goods holder" used in the rest of the application text are synonymous and define a vessel for storing items. In a related context, the goods holder of the present application can be any one of a bin, a tote, a pallet, a tray or similar. Different types of goods holders may be used in the same automated storage and retrieval system.

Moreover, the term "lifting frame part" used in "Background and Prior Art"-section of the application and the term "gripper assembly" used in in the rest of the application text both define a device for vertical transportation of storage containers, e.g. raising a storage container from, and lowering a storage container into, a storage column.

The relative terms "upper", "lower", "below", "above", "higher" etc. shall be understood in their normal sense and as seen in a Cartesian coordinate system. When mentioned in relation to a rail system, "upper" or "above" shall be understood as a position close to the surface rail system (relative to another component), contrary to the terms "lower" or "below" which shall be understood as a position further away from the rail system (relative another component).

BRIEF DESCRIPTION OF THE DRAWINGS

Following drawings are appended to facilitate the understanding of the invention. The drawings show embodiments of the invention, 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 a centrally arranged cavity for carrying storage containers therein.

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

Fig. 3b 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. 4a is a perspective view showing parts of an assembly for transporting a plurality of goods holders in accordance with one embodiment of the present invention where a protective structure is in a closed state.

Fig. 4b shows parts of an assembly of Fig. 4a where a protective structure is in an open state.

Fig. 5 is a perspective view showing parts of an assembly for transporting a plurality of goods holders in accordance with another embodiment of the present invention. Fig. 5 also shows a transporter for transporting a stack of goods holders integrated with a protective structure.

Figs. 6a-6b are perspective views showing a safety hatch in accordance with one embodiment of the present invention, the safety hatch being pivotable between a horizontal and a vertical position.

Figs. 6c-6d are perspective views showing a safety hatch in accordance with another embodiment of the present invention, the safety hatch being translatable between a first and a second horizontal position.

Fig. 7a is a top view of the transporter with goods holder alignment means in accordance with one embodiment of the present invention. Fig. 7b is a close-up of the goods holder alignment means shown in Fig. 7a.

Fig. 7c is a side view of the transporter with goods holder alignment means in accordance with another embodiment of the present invention. Fig. 7d is a perspective side view of the transporter with goods holder alignment means shown in Fig. 7c.

Figs. 8a-8c are perspective views sequentially showing how the transporter is aligned and locked in accordance with one embodiment of the present invention.

Fig. 9a is a perspective side view showing a goods holder support actuator comprising a frame and means for engaging. Fig. 9b is a perspective side view showing a goods holder support actuator shown in Fig. 9b where means are engaging a rotatable axel thus enabling pivoting of the goods holder support.

Figs. 10a-10b are perspective views of the transporter showing operation of a goods holder support actuator comprising a lever.

DETAILED DESCRIPTION OF THE INVENTION

In the following, embodiments of the invention will be discussed in more detail, by way of example only and with reference to the appended drawings. It should be

understood, however, that the drawings are not intended to limit the invention to the subject-matter depicted in the drawings.

The framework structure 100 of the automated storage and retrieval system 1 is constructed in accordance with the prior art framework structure 100 described above in connection with Figs. 1-3b, i.e. a number of upright members 102, wherein the framework structure 100 also comprises a first, upper rail system 108 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 where 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.

Various embodiments of the present invention will now be discussed in more detail with reference to Figs. 4-10b.

Fig. 4a is a perspective view showing parts of an assembly for transporting a plurality of goods holders in accordance with one embodiment of the present invention where a protective structure is in a closed state.

The grid-based storage and retrieval system 1 of Fig. 4a comprises a framework structure comprising vertically extending members 102 and a grid 108 of horizontal rails provided at upper ends of said vertical members 102. The framework structure defines a storage volume for storing goods holders 106. A remotely operated vehicle 506 for handling goods holders 106 operates on top of the grid 108. The shown system 1 is a micro fulfilment center (MFC). Here, an MFC is a small-scale warehouse facility placed close to the consumer to improve delivery times.

As stated above, it is also shown the assembly for transporting a plurality of goods holders 106 to/from the grid-based storage and retrieval system 1. The assembly comprises a guiding structure 602 affixed to an upper section of the framework structure, said guiding structure for guiding vertically moving goods holders 106 in an upright position.

The assembly also comprises a transporter 604 for transporting a stack of goods holders 106. The transporter comprises a base 605 for supporting goods holders. Such a transporter is shown in Fig. 4a at a distance from the storage volume. As shown in Fig. 4b, the transporter is positioned so that the base is positioned below

the guiding structure such that goods holders may be transferred between the storage volume and the transporter via said guiding structure.

A protective structure 606 that laterally encloses the transporter when the base is positioned below said guiding structure is also shown. In Fig. 4a, the protective structure is in a closed state whereas in Fig. 4b the protective structure is in an open state such that the enclosed transporter may be seen. For the sake of brevity, the parts discussed above in connection with Fig. 4a are not further discussed in connection with Fig. 4b.

The assembly in accordance with the above enables flexible management of goods holders without employing advanced machinery other than remotely operated vehicles. This ensures a simple and economically efficient operation and also reduced system footprint. Moreover, it is hereby enabled two-way transfer of goods holders to/from the storage volume without constructional changes to the storage and retrieval system 1. In addition, the guiding/protective structures of the assembly are easily retrofitted to existing systems.

With reference to Figs. 4a-4b, the protective structure 606 is a door and opening of said door allows access to the transporter positioned such that the base is below the guiding structure. The protective structure further comprises two oppositely arranged side retention members, here embodied as panels. In an alternative embodiment, these retention members may be part of the guiding structure. The transporter of the assembly may have wheels and braking means, typically disc-based brakes, could be mounted on these wheels.

As seen in Figs. 4a-4b, goods holders 106 are inserted/extracted in/from the transporter 604 by means of the remotely operated vehicle 506 of the cantilever type. In this context, the guiding structure 602 is affixed adjacent to a peripheral section of the framework structure and aligned with two adjacent parallel rails 110.

Still with reference to Figs. 4a-4b, the guiding structure is a tubular structure 602 for allowing vertical passage therethrough of goods holders 106. In the shown embodiment, the tubular structure is sized so as to allow vertical passage of a single goods holder 106 at a time in an upright position. Correspondingly, the shown transporter is for transporting a single stack of goods holders 106. In one embodiment (not shown), an inner face of the tubular structure and/or an inner face of the previously mentioned protective structure comprise means for guiding the goods holder being transferred between the storage volume and the transporter.

The guiding structure shown in Figs. 4a-4b is tubular. In an alternative embodiment (not shown), the guiding structure consists of at least one pair of diagonally

arranged vertically extending members, wherein guiding portions of the members face the goods holder 106 vertically passing through a space limited by the guiding portions, and each guiding portion has L-shaped cross-section.

Fig. 5 is a perspective view showing parts of an assembly for transporting a plurality of goods holders in accordance with another embodiment of the present invention. Fig. 5 also shows a transporter 602 for transporting a stack of goods holders. In Fig. 5, a protective structure 606 is a retention member structurally integrated with the transporter. The retention member extends upwardly from the base 605 of the transporter. Furthermore, a handle 608 is arranged at a side of the retention member 606 facing away from the goods holders being transported. In the embodiment shown in Fig. 5, the protective structure comprises two oppositely arranged side retention members 610, here embodied as panels. For the sake of brevity, the parts discussed above in connection with Figs. 4a-4b are not further discussed in connection with Fig. 5.

Figs. 6a-6b are perspective views showing a safety hatch 612 in accordance with one embodiment of the present invention, the safety hatch being pivotable between a horizontal and a vertical position. The movable safety hatch is for preventing inadvertent downward movement of the goods holders from the storage volume. When deployed, said safety hatch also denies access to the transporter 604 to unauthorized personnel. The vertically extending members 102 of the framework structure are also shown. With reference to Figs. 6a-6b, the movable hatch is operated by being pivoted between a first, horizontal, closed position (Fig. 6b) in which the downward movement of the goods holders is obstructed and a second, vertical, open position (Fig. 6a). A transporter 604 moving towards the framework structure is also shown in Fig. 6b and below the guiding structure (not shown) in Fig. 6a. In consequence, the safety hatch is in closed position.

Figs. 6c-6d are perspective views showing a safety hatch 612 in accordance with another embodiment of the present invention, the safety hatch being translatable between a first and a second horizontal position. The vertically extending members 102 of the framework structure are also shown. Here, the movable safety hatch is operated by being translated between a first, horizontal, closed position (Fig. 6d) in which the downward movement of the goods holders is obstructed and a second, horizontal, open position (Fig. 6c).

Fig. 7a is a top view of the transporter with goods holder alignment means in accordance with one embodiment of the present invention. In Fig. 7a, the goods holder alignment means are arranged in the base (covered by the goods holder 106). These means are upwardly projecting pins 615 arranged in one or more corners of the base. Fig. 7b is a close-up of an upwardly projecting pin 615 encircled in Fig. 7a. A portion of the goods holder 106 is also visible in Fig. 7b. For the sake of

brevity, the parts discussed above in connection with Fig. 7a are not further discussed in connection with Fig. 7b.

Fig. 7c is a side view of the transporter 604 with goods holder alignment means 615 in accordance with another embodiment of the present invention. In Fig. 7c, the alignment means are arranged in the base. Still with reference to Fig. 7c, said means is a plurality of flanges 617 extending upwardly from the periphery at one or more sides of the base 605. Moreover, said flanges are joined to the base at a right angle, and are approximately mid-height bent outward to form a lip. Fig. 7d is a perspective view of the transporter with flanges 617 shown in Fig. 7c. For the sake of brevity, the parts discussed above in connection with Fig. 7c are not further discussed in connection with Fig. 7d.

Figs. 8a-8c are perspective views sequentially showing how the transporter 602 is aligned and locked in accordance with one embodiment of the present invention.

Fig. 8a shows means for aligning a base 605 of a transporter 602 with respect to a framework structure (here represented as a framework plate 620 fixed between two vertical members (not shown) of the framework structure). A goods holder 106 is positioned on the base. Fig. 8a shows the transporter 602 similar to the one discussed in connection with Figs. 4a-4b, said transporter comprising a bore hole 622 and the framework structure comprising a guiding finger 624 configured to mate with the bore hole to form the means for aligning the transporter. The bore hole 622 extends in an axial direction of a cylindrically shaped rod 626 affixed to the base of the transporter. To facilitate mating process, at least one of the guiding finger 624 and the cylindrically shaped rod 626 may be tapered. The shown guiding finger has circular cross-section, but other variants, such as elliptical or quadrangular cross-section, are conceivable. Moreover, the guiding finger may be provided with a radially protruding stop for abutting against edge of the cylindrically shaped rod. Shown means have a pair of guiding fingers and corresponding bore holes, but a solution involving a single finger/hole-set is equally conceivable.

In Fig. 8b, the guiding finger 624 is mated with the bore hole 622 and the transporter 602 is aligned with the framework structure. For the sake of brevity, the parts discussed above in connection with Fig. 8a are not further discussed in connection with Fig. 8b.

In Fig. 8c, the aligned transporter (with respect to the framework structure) is locked using means for locking. The means for locking the transporter comprises a movable pin 628 for mating with a radially extending through hole 630 arranged in the guiding finger 622 and the cylindrically shaped rod 626. For the sake of brevity, the parts discussed above in connection with Figs. 8a-8b are not further discussed in connection with Fig. 8c.

Fig. 9a is a perspective side view showing a goods holder support actuator 640 comprising a frame 642 and means for engaging 644. More precisely, it is shown a rectangular frame to be affixed to upright members (not shown in Fig. 9a). Said means for engaging 644 are for engagement with a rotatable axle for controlling a position of the goods holder support. A transporter 602 comprising such rotatable axle and goods holder supports is shown in Fig. 9b and discussed in greater detail in connection with Figs. 10a-10b. Fig. 9b is a perspective side view showing a rectangular frame 642 and means for engaging 644 shown in Fig. 9a where said means are engaging said rotatable axel thus enabling pivoting of the goods holder support. For the sake of brevity, the parts discussed above in connection with Fig. 9a are not further discussed in connection with Fig. 9b.

Figs. 10a-10b are perspective views of a wheeled transporter 602 showing operation of a goods holder support actuator comprising a manual lever 646 and its interaction with a goods holder support pair 648. The shown transporter comprises a goods holder support pair 648 configured to be pivoted between a first, closed position in which said support can obstruct passage of the goods holder 106 moving vertically towards or away from the base of the transporter and a second, open position in which the vertically moving goods holder 106 can vertically move towards or away from the base 605 of the transporter.

In Fig. 10a, uppermost goods holder support pair 648 is in a XY-plane (closed position) and uppermost levers 646 are also in a XY-plane. Lowermost goods holder support pair (not visible) is also in a XY-plane (closed position) and lowermost levers 646 are in a XY-plane. In consequence, it is possible to position (by means of a remotely operated vehicle) a goods holder on the uppermost goods holder support pair.

In Fig. 10b, uppermost goods holder supports 648 are mutually parallel (open position) and uppermost levers 646 are also mutually parallel. Lowermost goods holder support pair (not visible) and lowermost levers 646 are still in a XY-plane (closed position). In consequence, it is possible to position (by means of a remotely operated vehicle) a goods holder on the lowermost goods holder support pair.

With reference to Figs 10a-10b, pivoting of each goods holder support 648 is controlled by a rotatable axle 650 mentioned in connection with Fig. 9b and mounted to the transporter 602, said rotatable axle being fixedly coupled to corresponding goods holder support.

In the preceding description, various aspects of the assembly for transporting a plurality of goods holders to/from a grid-based storage and retrieval system according to the invention have been described with reference to the illustrative embodiments. 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 invention.

LIST OF REFERENCE NUMBERS

1	Storage and retrieval system
100	Framework structure
102	Upright members of framework structure
104	Storage grid
105	Storage column
106	Storage container/Goods holder
106'	Particular position of storage container
107	Stack of storage containers
108	Rail system
110	Parallel rails in first direction (*X*)
111	Parallel rails in second direction (Y)
112	Access opening
119	First port column
201	Container handling vehicle belonging to prior art
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	Cantilever-based container handling vehicle belonging to prior art
301a	Vehicle body of the container handling vehicle 301
301b	Drive means in first direction (*X*)
301c	Drive means in second direction (*Y*)
401	Container handling vehicle belonging to prior art
401a	Vehicle body of the container handling vehicle 401
401b	Drive means in first direction (*X*)
401c	Drive means in second direction (*Y*)
500	Control system
506	Remotely operated vehicle
X	First direction
Y	Second direction
Z	Third direction
602	Guiding structure
604	Transporter
605	Base
606	Protective structure/Retention member
608	Handle
610	Side retention members
612	Hatch
615	Upward projecting pin

617	Flange
620	Framework plate
622	Bore hole
624	Guiding finger
626	Rod
628	Movable pin
630	Through hole
640	Actuator
642	Rectangular frame
644	Means for engaging
646	Lever
648	Goods holder support
650	Rotatable axel

CLAIMS

1. An assembly for transporting a plurality of goods holders (106) to/from a grid-based storage and retrieval system (1), said grid-based storage and retrieval system (1) comprising a framework structure (100) defining a storage volume for storing goods holders (106), said assembly comprising:

- a guiding structure (602) configured to be affixed to an upper section of the framework structure (100), the guiding structure for guiding vertically moving goods holders (106) in an upright position,

- a transporter (604) for transporting a stack of goods holders (106), said transporter comprising a base (605) for supporting goods holders, wherein said transporter is configured to be positioned such that the base is positioned below the guiding structure such that goods holders (106) may be transferred between the storage volume and the transporter via said guiding structure,

- a protective structure (606) at least partially laterally enclosing the transporter when the base is positioned below said guiding structure.

2. An assembly in accordance with claim 1, wherein the protective structure (606) comprises a door configured so that opening of said door allows access to the transporter (604) when positioned such that the base (605) is below the guiding structure.

3. An assembly in accordance with claim 1, wherein the protective structure (606) comprises a retention member being part of the transporter, said retention member (606) extending upwardly from the base (605).

4. An assembly in accordance with claim 3, wherein a handle (608) is arranged at a side of the retention member (606) facing away from the goods holders when supported by the base (605).

5. An assembly in accordance with any of the preceding claims, wherein the protective structure comprises two oppositely arranged side retention members (610).

6. An assembly in accordance with any of the preceding claims, wherein the transporter (604) has wheels.

7. An assembly in accordance with any of the preceding claims, wherein goods holder alignment means are arranged in the base (605).

8. An assembly in accordance with claim 7, wherein the goods holder alignment means comprise upwardly projecting pins (615) arranged in one or more corners of the base (605).

9. An assembly in accordance with claim 7, wherein the goods holder alignment means comprise flanges (617) extending upwardly from the periphery at one or more sides of the base (605).

10. An assembly in accordance with claim 9, wherein said flanges (617) are joined to the base (605) at a right angle, and wherein said flanges are bent outward to form a lip.

11. An assembly in accordance with any of the preceding claims, wherein the guiding structure (602) is configured to be affixed adjacent to a peripheral section of the framework structure.

12. An assembly in accordance with any of the preceding claims, wherein the guiding structure (602) consists of at least one pair of diagonally arranged vertically extending members, wherein guiding portions of the members face the goods holder vertically passing through a space limited by the guiding portions, and each guiding portion has L-shaped cross-section.

13. An assembly in accordance with any of the claims 1-11, wherein the guiding structure is a tubular structure (602) for allowing vertical passage therethrough of goods holders (106).

14. An assembly in accordance with claim 13, wherein the tubular structure (602) is sized so as to allow vertical passage of a single goods holder (106) at a time in an upright position.

15. An assembly in accordance with any of the preceding claims, wherein the transporter (604) is for transporting a single stack of goods holders (106).

16. An assembly in accordance with any of the claims 13-15, wherein an inner face of the tubular structure (602) and/or an inner face of the protective structure (606) comprises means for guiding the goods holder being transferred between the storage volume and the transporter.

17. An assembly in accordance with any of the preceding claims, wherein the transporter (604) comprises means for aligning the base (605) of the transporter with respect to the framework structure (100).

18. An assembly in accordance with claim 17, wherein one of the transporter (604) and the framework structure (620) comprises a bore hole (622) and the other one of the transporter (604) and the framework structure (620) comprises a guiding finger (624) configured to mate with the bore hole (622) to form the means for aligning the transporter.

19. An assembly in accordance with claim 18, wherein the bore hole (622) extends in an axial direction of a cylindrically shaped rod (626) affixed to the base (605) of the transporter.

20. An assembly in accordance with claim 19, wherein at least one of the guiding finger (624) and the cylindrically shaped rod (626) is tapered.

21. An assembly in accordance with any of the claims 18-20, wherein the guiding finger (624) has quadrangular cross-section.

22. An assembly in accordance with any of the claims 18-21, wherein the guiding finger (624) is provided with a radially protruding stop for abutting against edge of the cylindrically shaped rod (626).

23. An assembly in accordance with any of the claims 17-22, wherein the transporter (604) comprises means for locking the transporter with respect to the framework structure.

24. An assembly in accordance with claim 23, wherein the means for locking the transporter comprises a movable pin (628) for mating with a radially extending through hole (630) arranged in the guiding finger (624) and/or the cylindrically shaped rod (626).

25. An assembly in accordance with any of the preceding claims, wherein the transporter (604) comprises braking means.

26. An assembly in accordance with any of the preceding claims, wherein the assembly further comprises a movable hatch (612) associated with the guiding or tubular structure (602), said hatch for preventing inadvertent downward movement of the goods holders (106) from the storage volume.

27. An assembly in accordance with claim 26, wherein the movable hatch (612) is configured to be opened or closed by being pivoted between a first, horizontal, closed position in which the downward movement of the goods holders is obstructed and a second, vertical, open position.

28. An assembly in accordance with claim 26, wherein the movable hatch (612) is configured to be opened or closed by being translated between a first, horizontal, closed position in which the downward movement of the goods holders is obstructed and a second, horizontal, open position.

29. An assembly in accordance with any of the preceding claims, wherein the transporter (604) comprises a goods holder support pair (648) configured to be pivoted between a first, closed position in which said support can obstruct passage of the goods holder (106) moving vertically towards or away from the base of the transporter and a second, open position in which the vertically moving goods holder (106) can vertically move towards or away from the base of the transporter.

30. An assembly in accordance with claim 29, wherein pivoting of the goods holder support (648) is controlled by a rotatable axle (650) mounted to the transporter, said rotatable axle being fixedly coupled to said goods holder support.

31. An assembly in accordance with claim 30, wherein the transporter (604) comprises a goods holder support actuator (640) comprising a lever (646), wherein actuation of said lever results in rotation of the rotatable axle (650) and pivoting of the goods holder support (648).

32. A grid-based storage and retrieval system (1), said grid-based storage and retrieval system (1) comprising a framework structure (100) comprising vertically extending members (102) and a grid of horizontal rails (110, 111) provided at upper ends of said vertical members (102), wherein remotely operated vehicles for handling goods holders (106) operate on top of the grid, the framework structure (100) defining a storage volume for storing goods holders (106), the grid-based storage and retrieval system (1) comprising an assembly in accordance with any of the claims 1-31.

33. A grid-based storage and retrieval system (1) in accordance with claim 32, wherein the guiding/tubular structure (602) is aligned with two adjacent parallel rails (110), and wherein the remotely operated vehicle (506) is of the cantilever type.

34. A grid-based storage and retrieval system (1) in accordance with claim 33 when dependent on claim 31, wherein the goods holder support actuator (640) comprises a rectangular frame affixed to upright members (102), said goods holder support actuator (640) further comprising means for engaging (644) said rotatable axle (650) such that actuation of said means for engaging results in rotation of the rotatable axel and pivoting of the goods holder support (648).

35. A method for transporting a plurality of goods holders (106) to/from a grid-based storage and retrieval system (1), said grid-based storage and retrieval system (1) comprising a framework structure (100) defining a storage volume for storing goods holders (106), said method comprising:

- positioning a transporter (604) for transporting a stack of goods holders (106) such that a base (605) of the transporter is positioned below a guiding structure (602),

- vertically passing at least one goods holder (106) by the guiding structure affixed to an upper section of the framework structure,

- providing a protective structure (606) at least partially laterally enclosing the transporter when the base (605) is positioned below the guiding structure such that goods holders (106) may be transferred between the storage volume and the transporter via said guiding structure.

36. A method in accordance with claim 35, wherein the method comprises:

- using the remotely operated vehicle (506) to transfer the goods holders (106) between the storage volume and the transporter via said guiding structure.

37. A method in accordance with claim 35 or 36, wherein the method comprises:

- displacing the protective structure in order to access the transporter.

38. A method in accordance with any of the claims 35-37, wherein the method comprises:

- aligning the transporter (604) with respect to the framework structure (620) by mating a guiding finger (624) with a bore hole (622).

39. A method in accordance with claim 38, wherein the method comprises:

- locking the transporter (604) with respect to the framework structure (620) by mating a movable pin (628) with a radially extending through hole (630) arranged in the guiding finger.

40. A method in accordance with any of the claims 35-39, wherein the method comprises:

- providing a hatch (612) associated with the guiding structure,

- moving the hatch (612) from a first position to a second position so as to prevent inadvertent downward movement of the extracted goods holders.

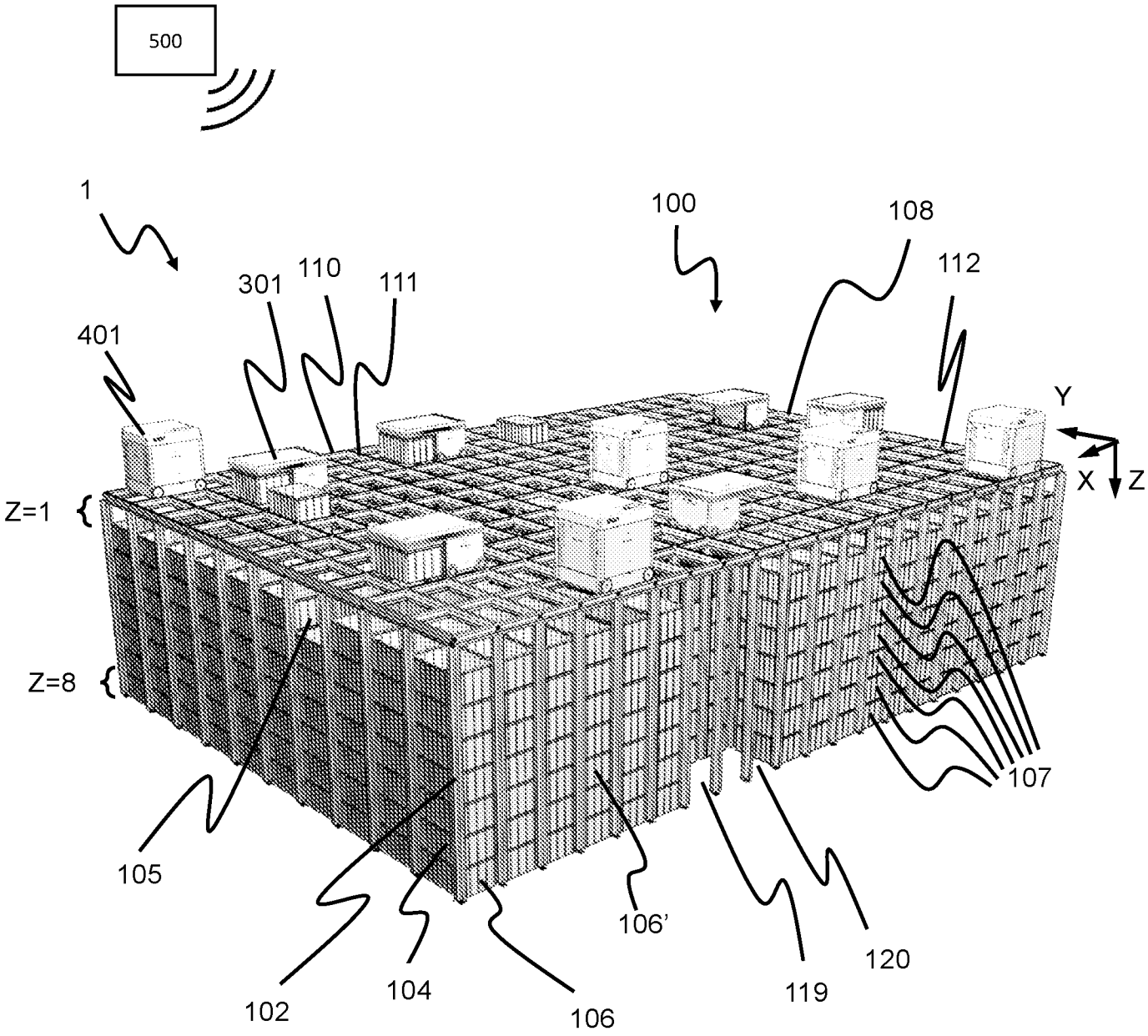


Fig. 1
(Prior Art)

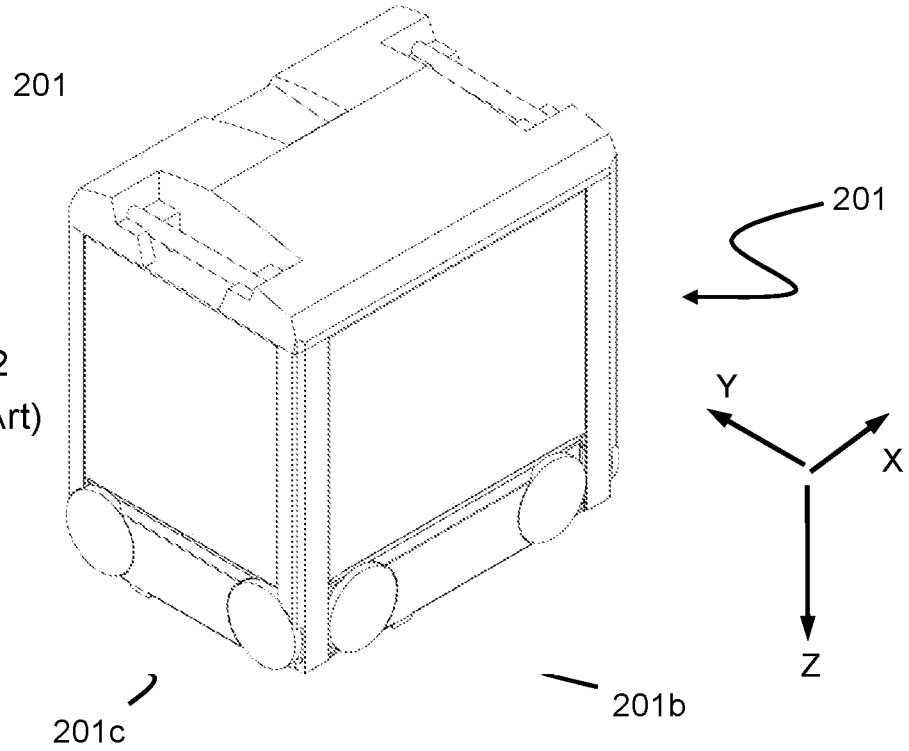


Fig. 2
(Prior Art)

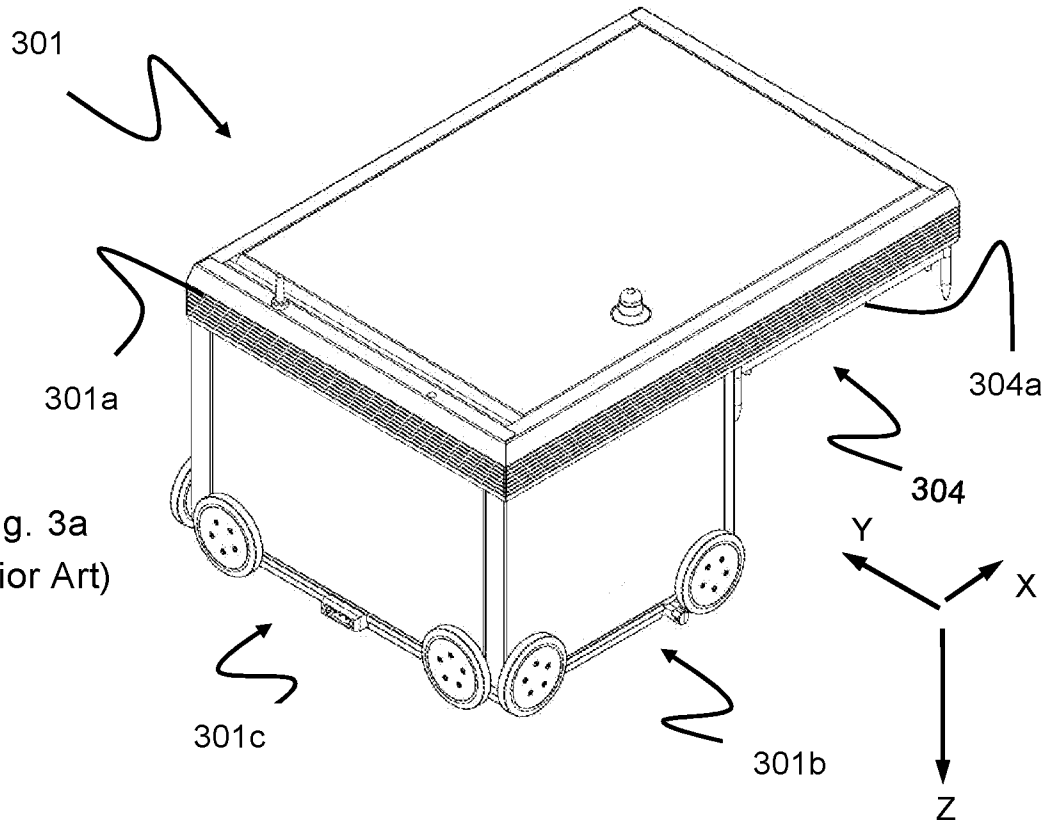


Fig. 3a
(Prior Art)

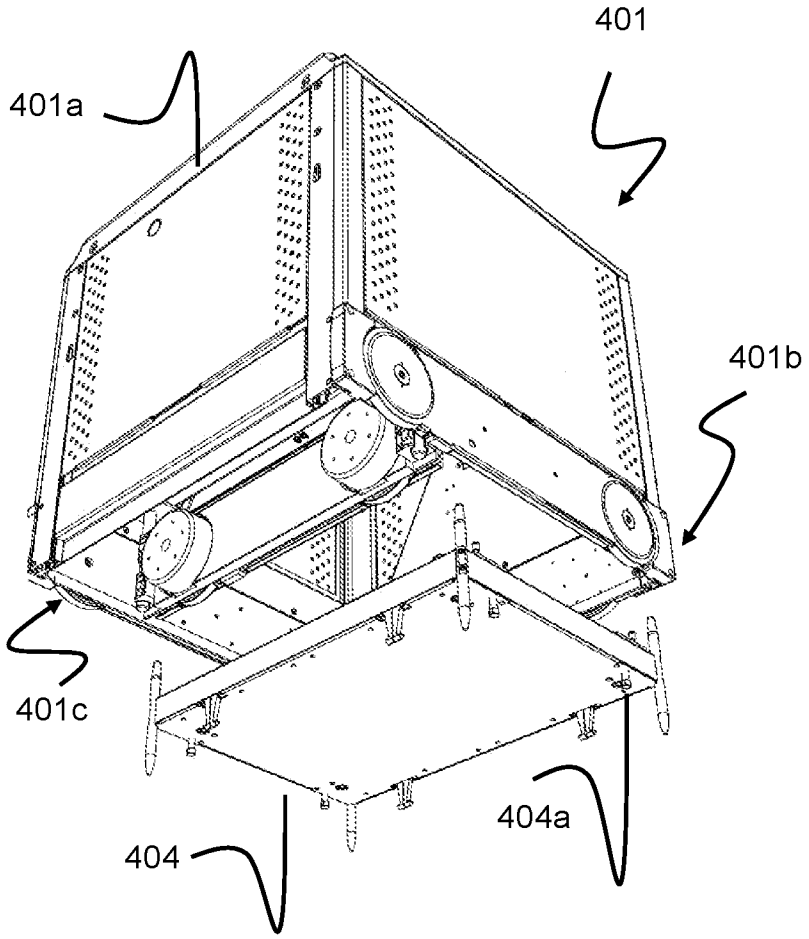


Fig. 3b
(Prior Art)

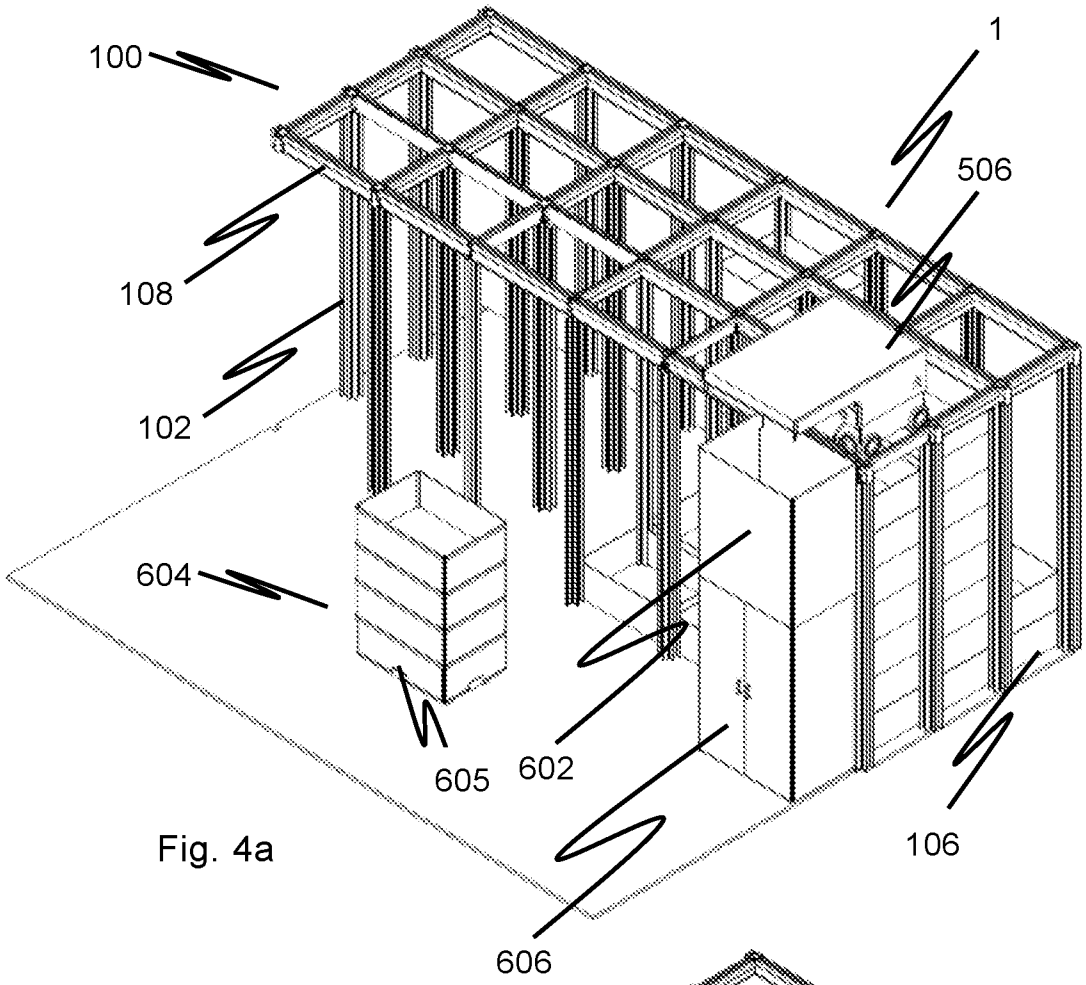


Fig. 4a

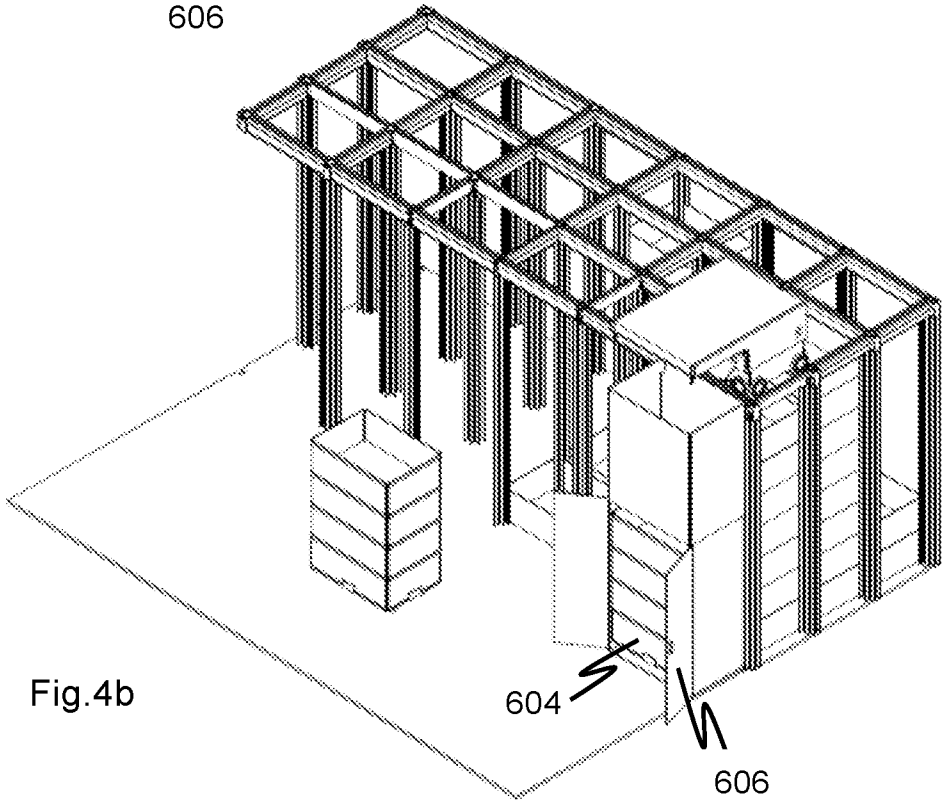


Fig.4b

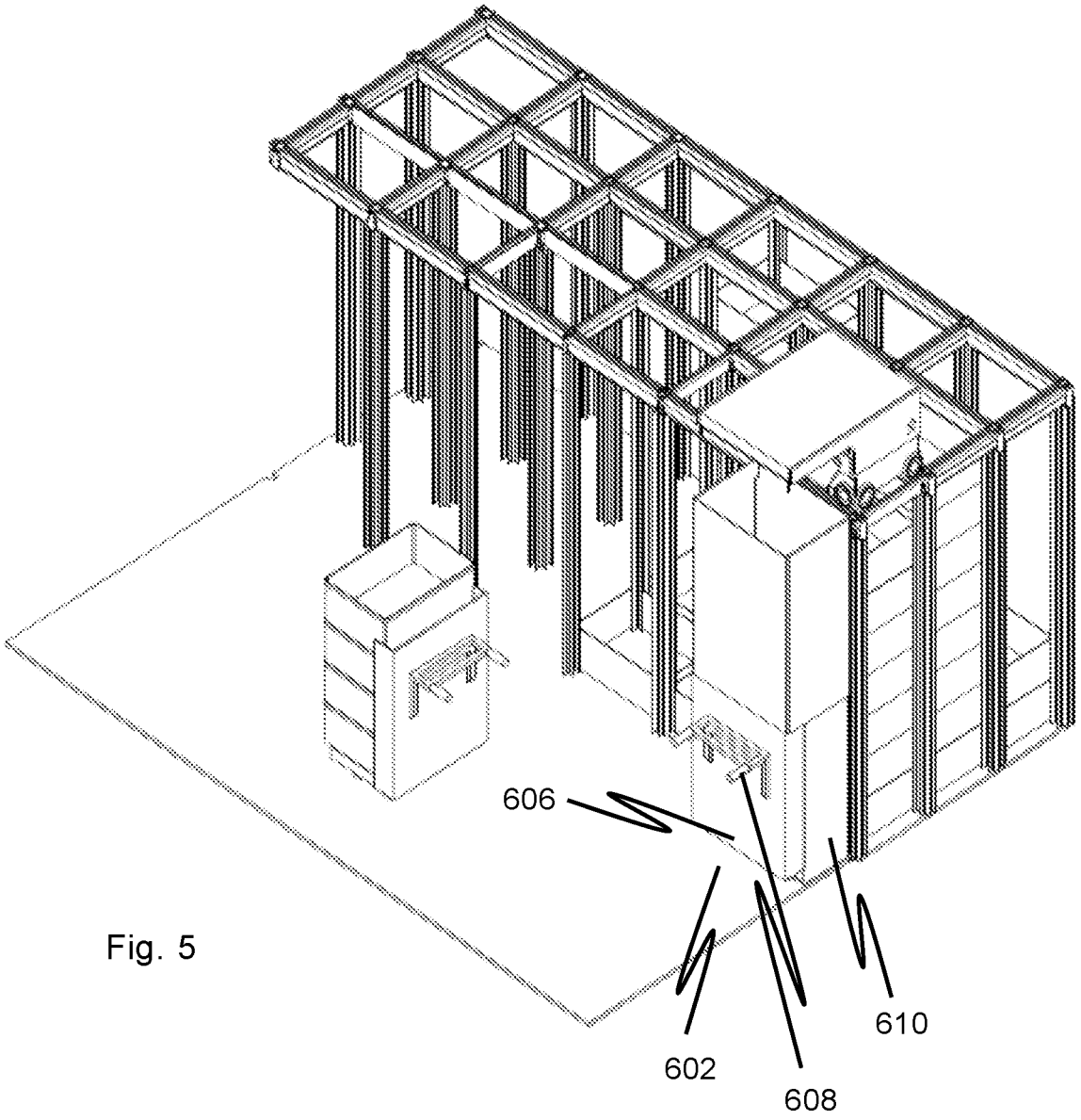


Fig. 5

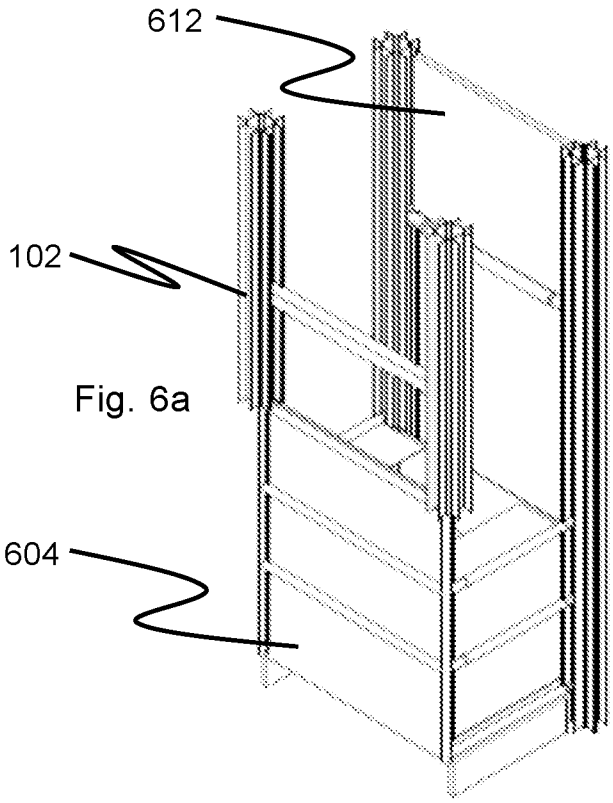


Fig. 6a

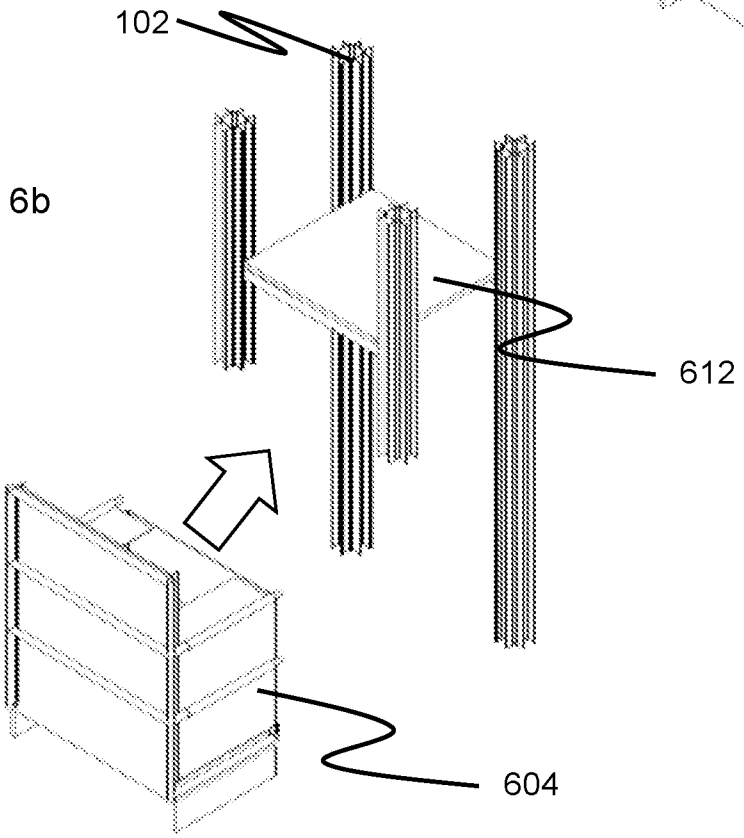


Fig. 6b

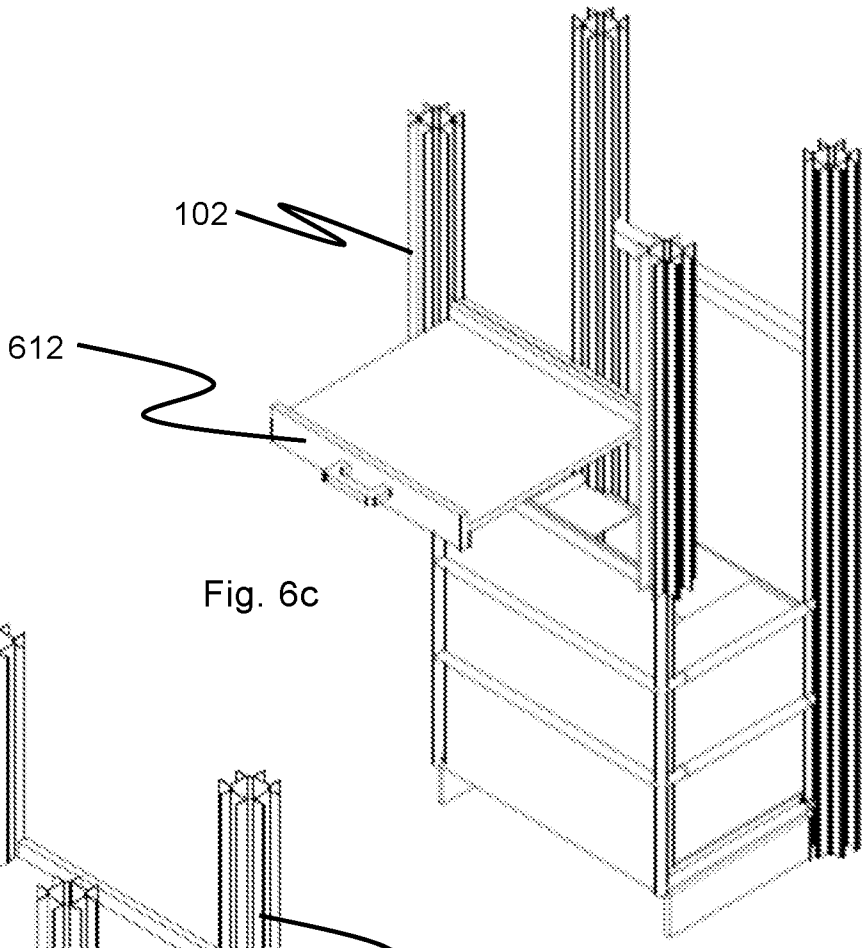


Fig. 6c

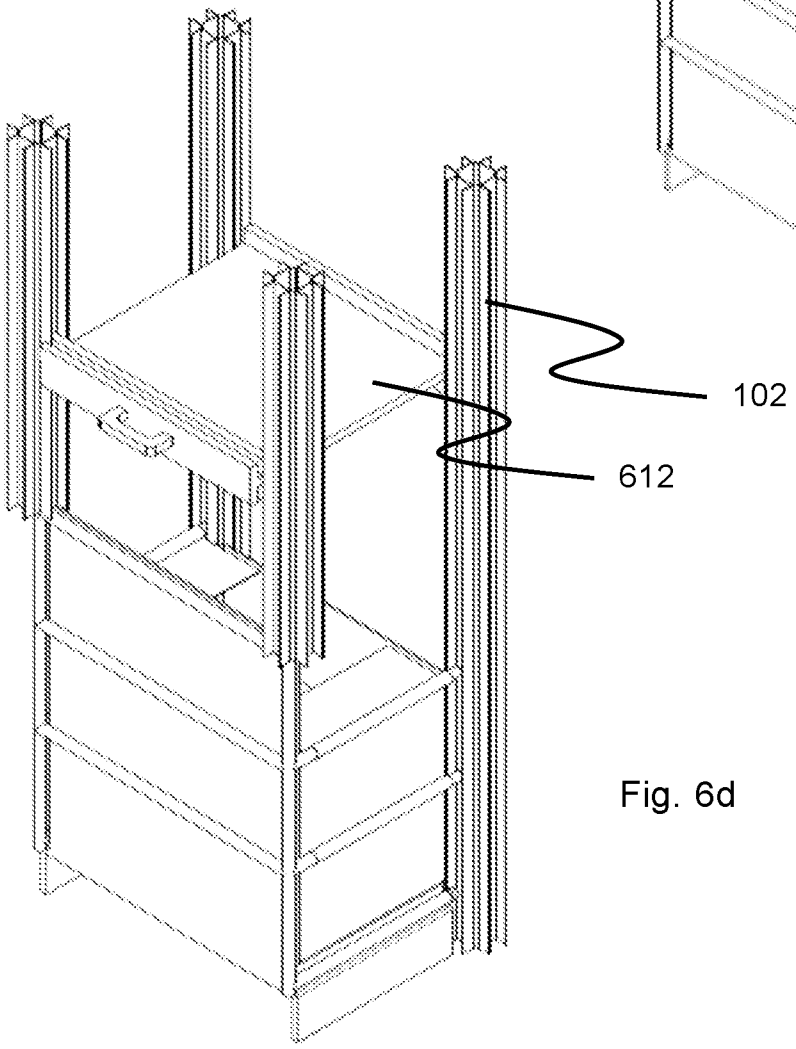


Fig. 6d

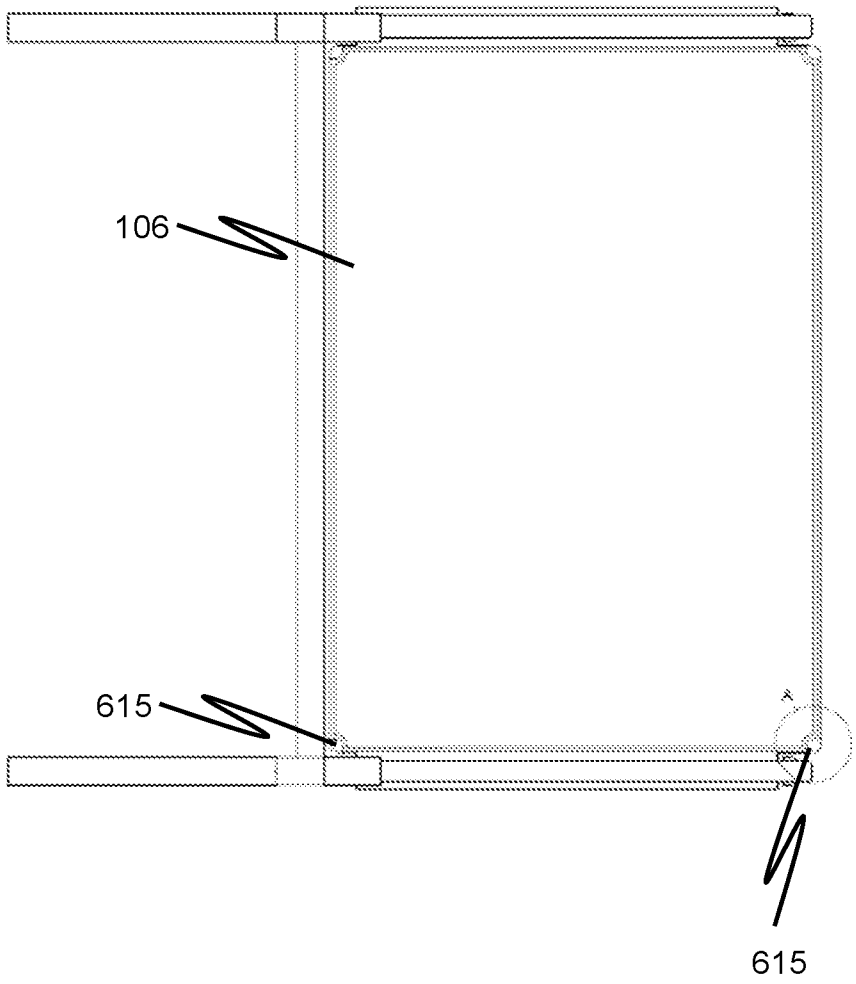


Fig. 7a

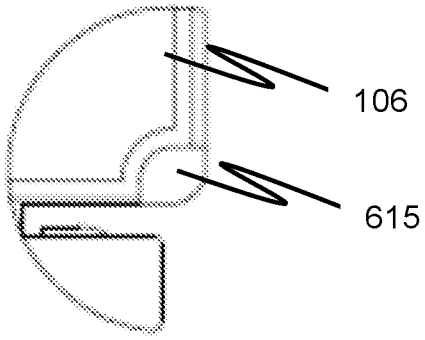


Fig. 7b

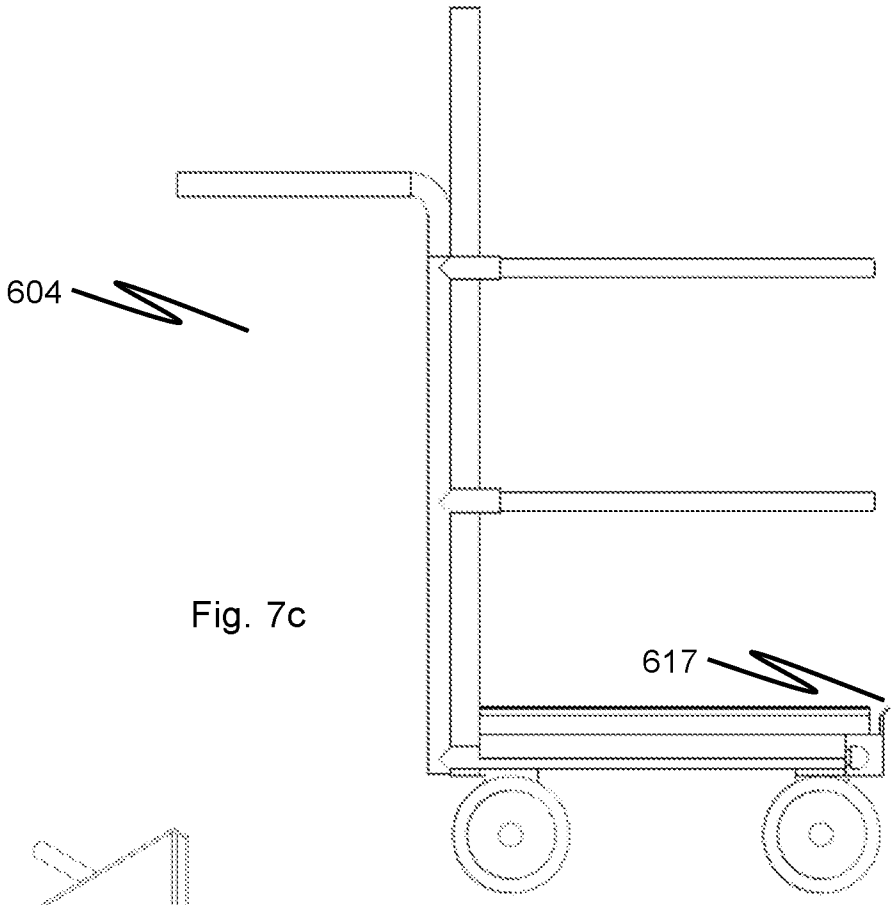


Fig. 7c

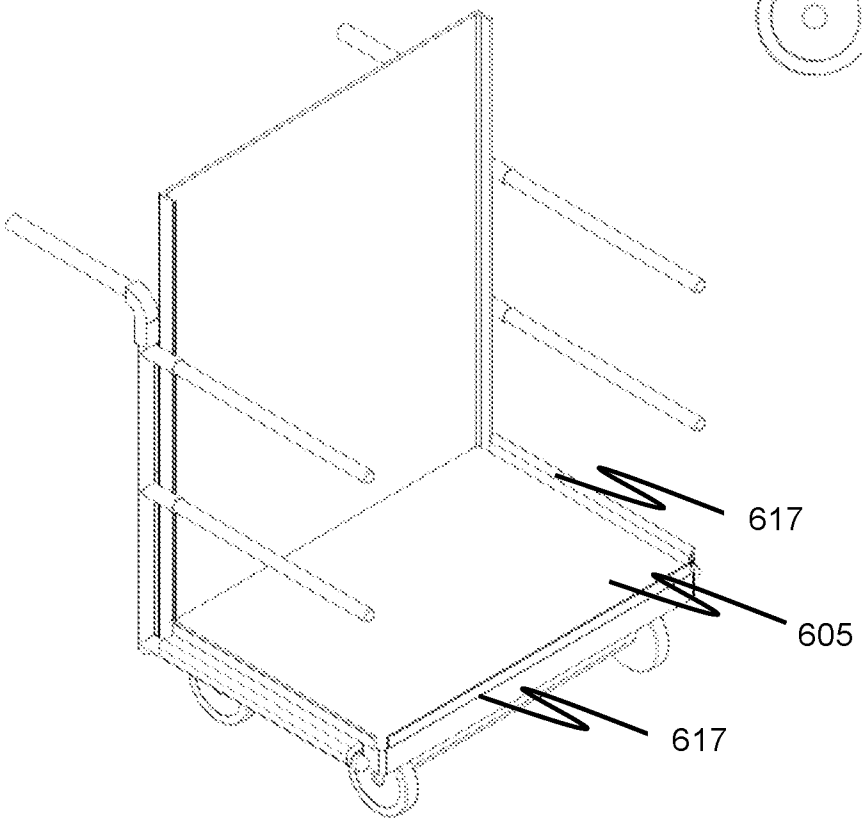
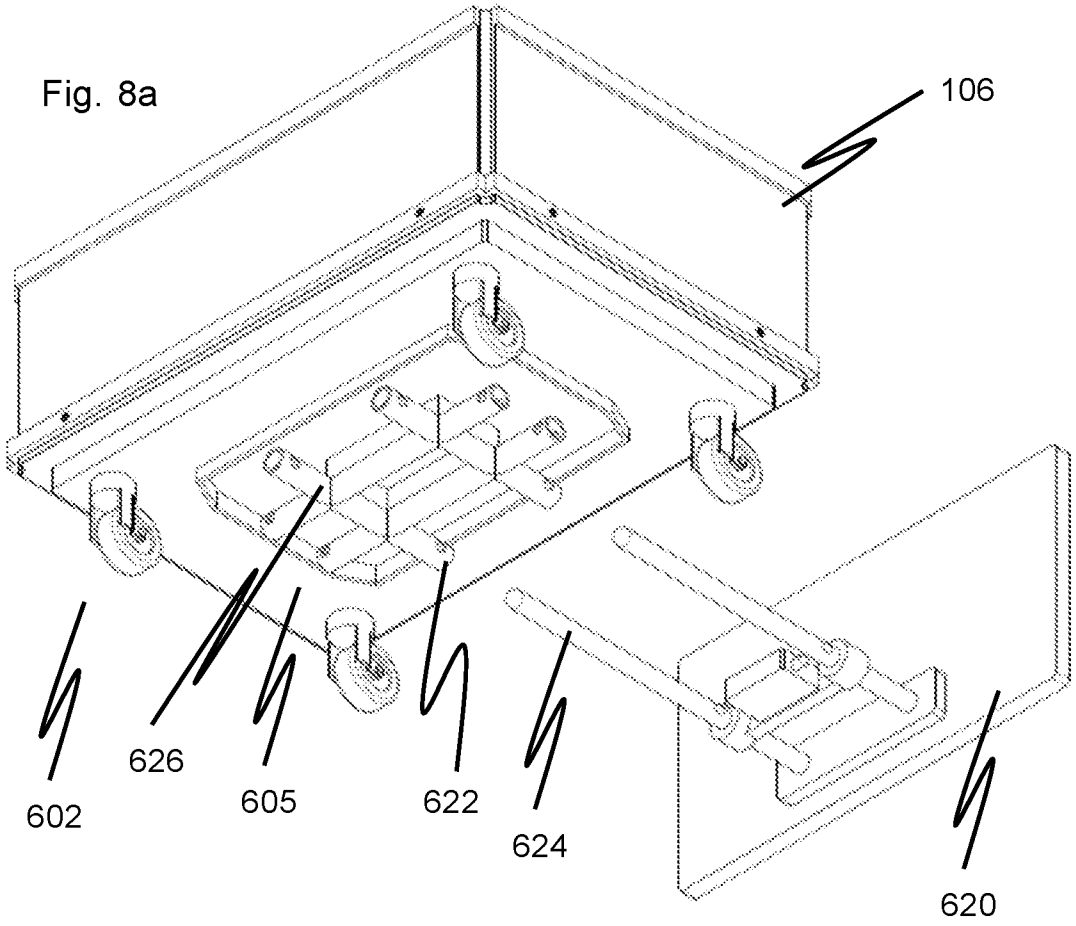


Fig. 7d

Fig. 8a



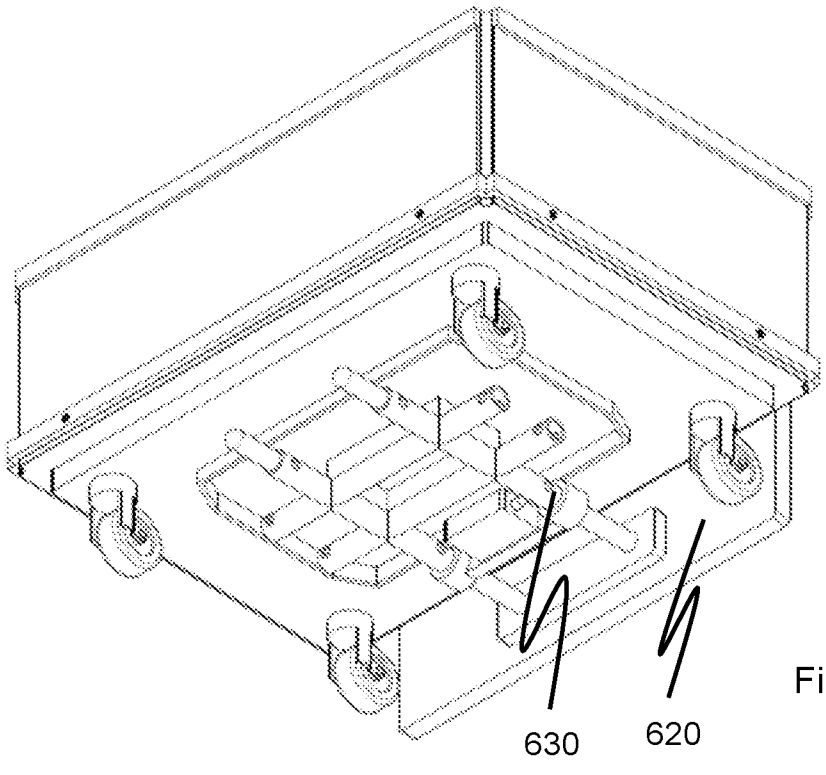


Fig. 8b

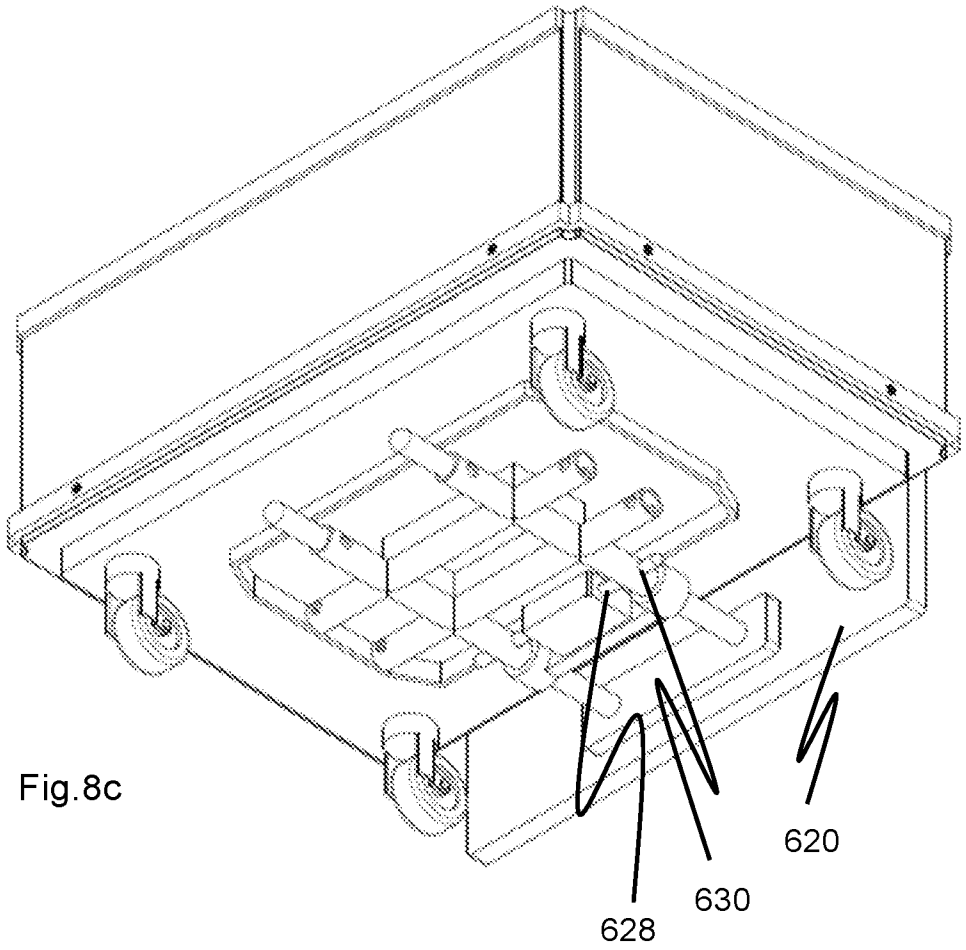


Fig.8c

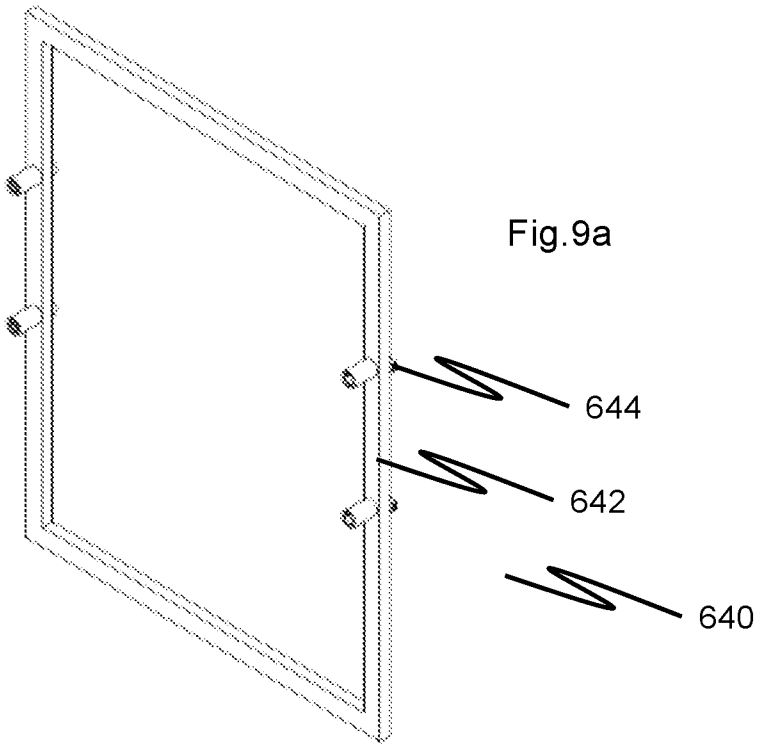


Fig.9a

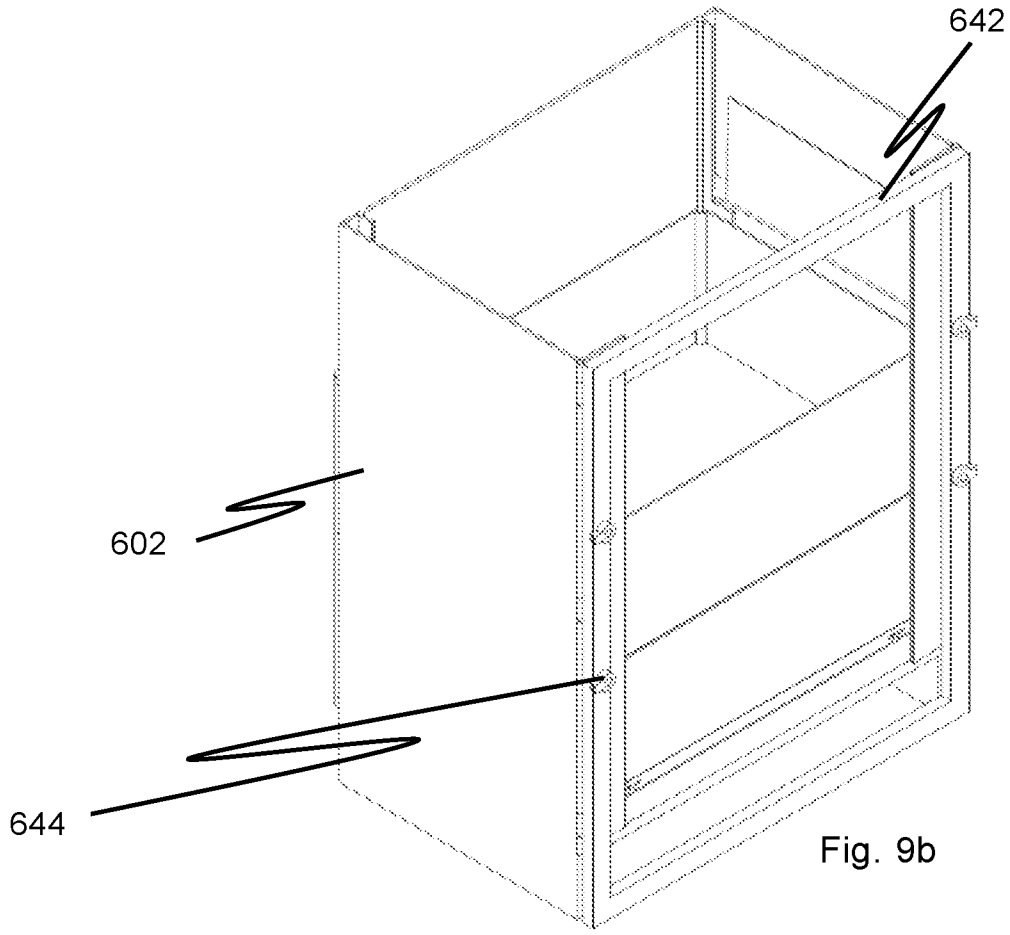


Fig. 9b

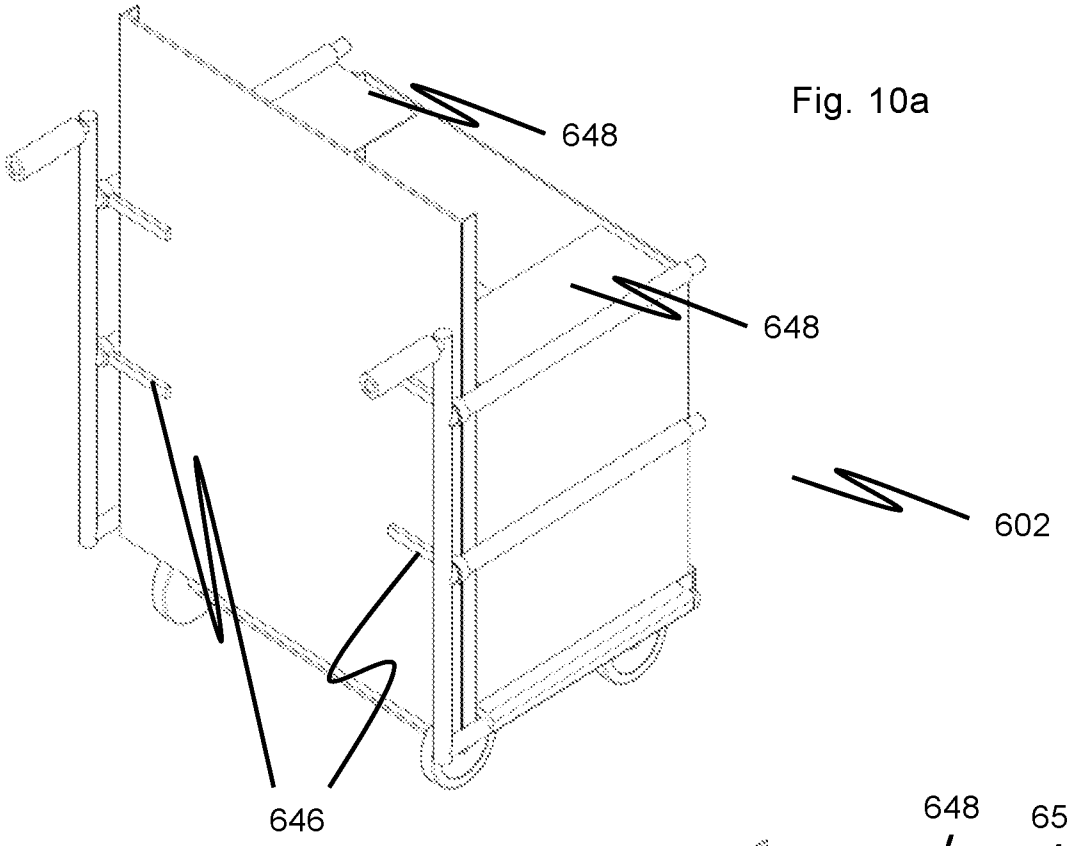


Fig. 10a

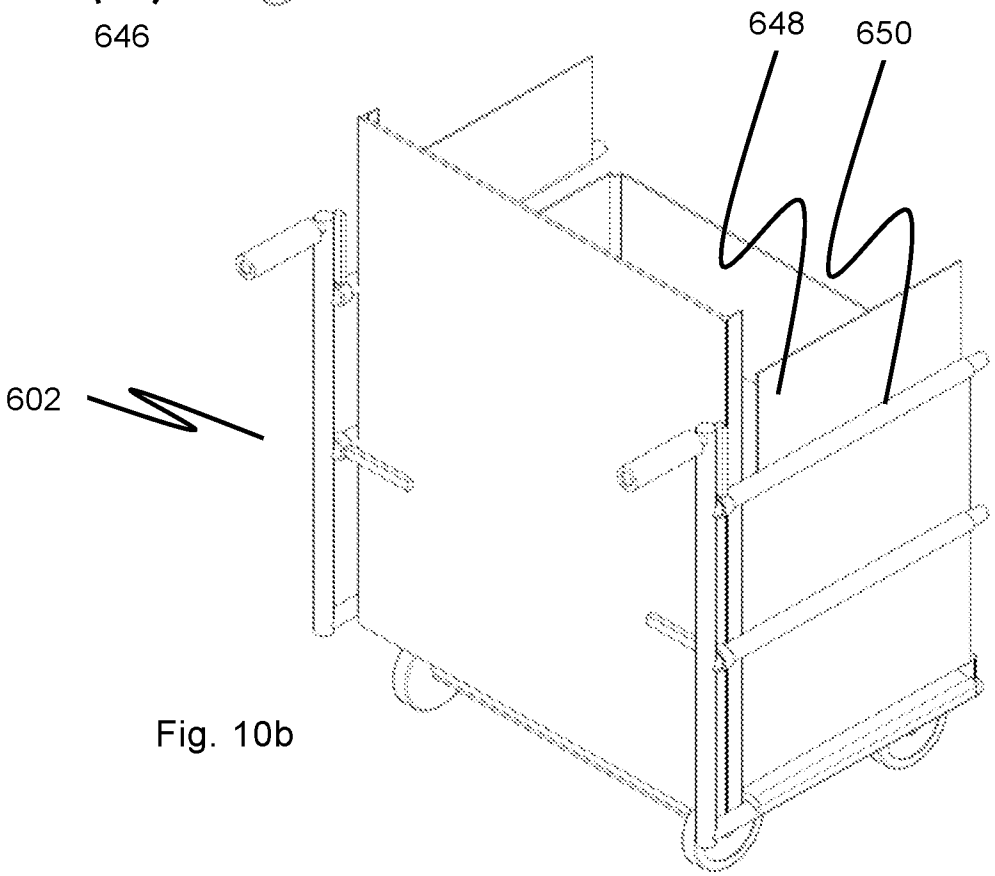


Fig. 10b