(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 November 2024 (14.11.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/231497 A1

(51) International Patent Classification:
*B65D 21/02* (2006.01) *B65G 1/04* (2006.01)

(21) International Application Number:
PCT/EP2024/062836

(22) International Filing Date:
08 May 2024 (08.05.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20230541 09 May 2023 (09.05.2023) NO

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,

(54) Title: A SET OF STORAGE CONTAINERS

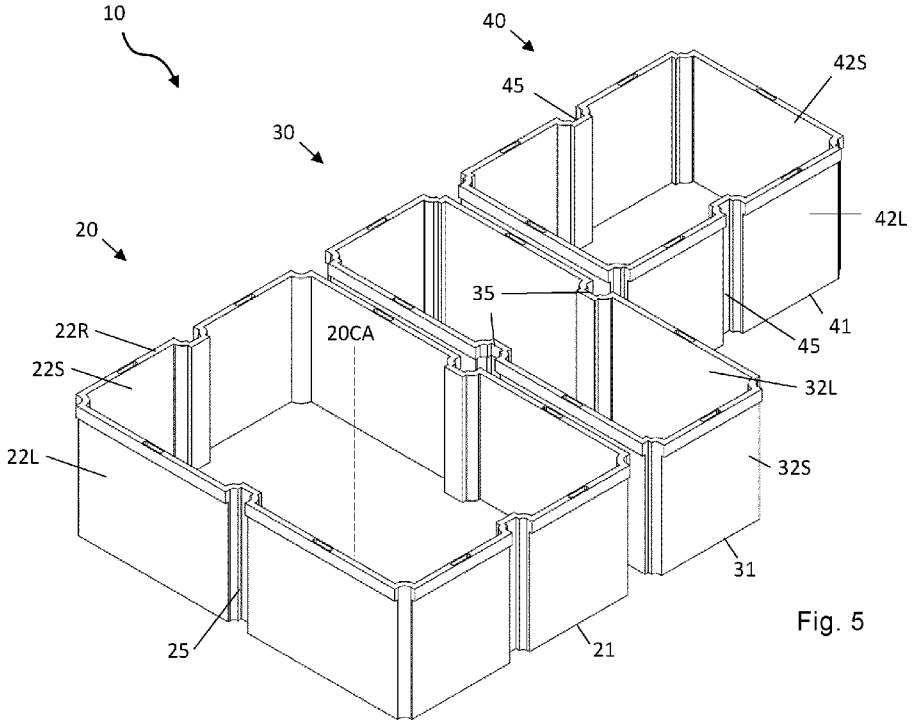


Fig. 5

(57) Abstract: The present disclosure relates to a set of storage containers for an automated storage and retrieval system The set of storage containers comprises storage containers having respective rectangular bases, two long sides and two short sides protruding up from the rectangular base. The set comprises a first storage container comprising a long side connection interface provided in a top of its long sides and two further storage containers, each comprising a short side connection interface provided in a top of its two short sides. The short side connection interfaces (of the two further storage containers) are functionally identical to the long side connection interface of the first storage container o, when the long sides of the two further storage containers are located adjacent to each other, to a short side connection interface of the first storage container provided in the top of its short sides.

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*[Continued on next page]*

TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Published:**

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

# A SET OF STORAGE CONTAINERS

## TECHNICAL FIELD

**[0001]** The present disclosure relates to a set of storage containers for an automated storage and retrieval system. The present disclosure also relates to an automated storage and retrieval system with such a set of storage containers.

## BACKGROUND

**[0002]** 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.

**[0003]** The framework structure 100 comprises upright members 102 and a storage volume comprising storage columns 105 arranged in rows between the upright members 102. In these storage columns 105 storage containers 106, also known as bins, are stacked one on top of one another to form stacks 107. The members 102 may typically be made of metal, e.g. extruded aluminum profiles.

**[0004]** 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 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.

**[0005]** 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.

**[0006]** 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.

**[0007]** 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.

**[0008]** 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.

**[0009]** 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.

**[0010]** 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.

**[0011]** Fig. 3 shows an alternative configuration of a container handling vehicle 301 with a cantilever construction. Such a vehicle is described in detail in e.g. NO317366, the contents of which are also incorporated herein by reference.

**[0012]** 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 herein may mean 'horizontal'.

**[0013]** 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.

**[0014]** 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.

**[0015]** 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.

**[0016]** In the framework structure 100, a majority of the columns are storage columns 105, i.e. columns 105 where storage containers 106 are stored in stacks 107. In addition to storage columns 105, there are special-purpose columns within the framework structure. 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.

**[0017]** 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.

**[0018]** 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.

**[0019]** A conveyor system comprising conveyors is normally employed to transport the storage containers between the port columns 119,120 and the access station.

**[0020]** 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.

**[0021]** 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.

**[0022]** 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.

**[0023]** 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.

**[0024]** 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.

**[0025]** WO2015197709 describes an automated storage and retrieval system with load handling devices capable of carrying multiple storage containers of a single grid-spacing size or single storage containers of a multiple grid spacings.

**[0026]** WO 2019/101366 describes a container handling vehicle capable of lifting two or four storage containers of the same size simultaneously or individually.

**[0027]** WO 2018/060527 describes a robot capable of lifting four storage containers of the same size simultaneously.

**[0028]** WO 2017/178370 describes several smaller-sized storage containers that can be stacked above other smaller-sized storage containers in various ways.

**[0029]** WO2017211634 shows a gripper which can be operated to lift one or several smaller-sized storage containers from a group of smaller-sized storage containers adjacent to each other.

**[0030]** At least preferred embodiments of the present disclosure improve the efficiency of the above automated storage and retrieval system.

## SUMMARY OF THE PRESENT DISCLOSURE

**[0031]** 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.

**[0032]** The present disclosure relates to a set of storage containers for an automated storage and retrieval system, wherein the set of storage containers comprises:
- a first storage container having a rectangular base, two long sides and two short sides protruding up from the rectangular base and a long side connection interface provided in a top of its long sides;
- two further storage containers, each having a rectangular base, two long sides and two short sides protruding up from the rectangular base and a short side connection interface provided in a top of its two short sides;
characterized in that:
- the first storage container comprises a short side connection interface provided in the top of its short sides;
- the short side connection interfaces of the two further storage containers are functionally identical to the long side connection interface of the first storage container or to the short side connection interface of the first storage container when one of the long sides of a first one of the two further storage containers is located adjacent to one of the long sides of a second one of the two further storage containers.

**[0033]** As used herein, the term "functionally identical" is referring to that that the connection interfaces are identical in function as seen from the equipment being used to connect to the connection interfaces. Hence, when one of the long sides of the first one of the two further storage containers is located adjacent to one of the long sides of the second one of the two further storage containers, the equipment used to connect to the connection interface may connect to and disconnect from the short side connection interfaces in the same way as it may connect to and disconnect from the long side connection interface of the first storage container or to the short side connection interface of the first storage container.

**[0034]** The short side connection interfaces of the two further storage containers may be identical to the long side connection interface of the first storage container or to the short side connection interface of the first storage container when one of the long

sides of a first one of the two further storage containers are located adjacent to one of the long sides of a second one of the two further storage containers and when the first one of the two further storage containers is similar in size to, or identical in size to, the second one of the two further storage containers.

**[0035]** The short side connection interfaces and the long side connection interfaces may be provided in an upper surface of a rim at the top of the short sides and long sides of the storage containers. The short side connection interfaces and the long side connection interfaces may comprise a slot provided through this rim. The slot may have an elongated shape. The rim may extend in a direction parallel to the base of the storage container. The rim may extend in a direction parallel to the base of, and away from a center of the storage container. Equipment being used to connect to the connection interfaces may be inserted vertically from above into the slot, wherein the equipment subsequently moves horizontally to engage the underside of the rim. The equipment being used to connect to the connection interfaces may be inserted vertically into the slot and down to a position outside of the long sides and/or outside of the short sides. Hence, the equipment will not be inserted vertically into a storage compartment of the storage container. This storage compartment are defined by the upwardly facing surface of the base and the inwardly facing surfaces of the long sides and the short sides. The storage container has a top opening defined by the periphery of the short sides and the long sides. Items may be inserted into and retrieved from the storage compartment via this top opening.

**[0036]** The short side connection interfaces and the long side connection interfaces may be provided in an upper end of the short sides and long sides of the storage containers. The short side connection interfaces and the long side connection interfaces may comprise a slot provided the upper end of the short sides and the long sides. The slot may have an elongated shape. Equipment being used to connect to the connection interfaces may be inserted horizontally into the slot, wherein the equipment subsequently moves vertically to engage the sides above the slot. The equipment may be grippers of a gripping device of a container handling vehicle.

**[0037]** The two further storage containers may be two second storage containers, wherein the short side connection interfaces of the two second storage containers may be functionally identical to the short side connection interface of the first storage container when one of the long sides of a first one of the two second storage containers may be

located adjacent to one of the long sides of a second one of the two second storage containers.

**[0038]** The second storage container has a footprint area of 45 – 50% of the first storage container.

**[0039]** As used herein, the term "footprint area" is used to denote the area formed by a projection from above on the ground.

**[0040]** The long side of the first storage container may have a length, referred to as a length of the first storage container. The short side of the first storage container may have a length, referred to as a width of the first storage container.

**[0041]** The long side of the second storage container may have a length, referred to as a length of the second storage container. The short side of the second storage container may have a length, referred to as a width of the second container.

**[0042]** The length of the second storage container may be equal to the length of the first storage container. The width of the second storage container may be 45 – 50% of the width of the first storage container. The second storage container may be referred to as a half-size storage container when compared to the first storage container. The first storage container may be referred to as a full-sized or normal-sized storage container.

**[0043]** The two further storage container may be two third storage containers, wherein the short side connection interfaces of the two third storage containers may be functionally identical to the long side connection interface of the first storage container when one of the long sides of a first one of the two third storage containers may be located adjacent to one of the long sides of a second one of the two third storage containers.

**[0044]** The third storage container has a footprint area of 45 – 50% of the first storage container.

**[0045]** The long side of the third storage container may have a length, referred to as a length of the third storage container. The short side of the third storage container may have a length, referred to as a width of the third storage container.

**[0046]** The length of the third storage container may be equal to the width of the first storage container. The width of the third storage container may be being 45 – 50% of the length of the first storage container. The third storage container may therefore also be referred to as a half-size storage container.

**[0047]** The third storage container may comprise a long side connection interface provided in a top of its long sides; and
wherein the set of storage containers may comprise two fourth storage containers, each having a rectangular base, two long sides and two short sides protruding up from the rectangular base and a short side connection interface provided in a top of its short sides;
wherein the short side connection interfaces of the two fourth storage containers may be functionally identical to the long side connection interface of the third storage container when one of the long sides of a first one of the two fourth storage containers may be located adjacent to one of the long sides of a second one of the two fourth storage containers.

**[0048]** The fourth storage container has a footprint area of 20 - 25% of the first storage container. The fourth storage container has a footprint area of 45 - 50% of the second storage container. The fourth storage container has a footprint area of 45 - 50% of the third storage container.

**[0049]** The long side of the fourth storage container may have a length, referred to as a length of the fourth storage container. The short side of the fourth storage container may have a length, referred to as a width of the fourth storage container.

**[0050]** The length of the fourth storage container may be equal to the width of the third storage container. The width of the fourth storage container may be being 45 – 50% of the length of the third storage container. The fourth storage container may therefore also be referred to as a quarter-size storage container.

**[0051]** The second storage container may comprise a long side connection interface provided in a top of its long sides; and
wherein the fourth storage container may comprise a long side connection interface provided in a top of its long sides; and
wherein the long side connection interfaces of the second storage container may be functionally identical to the long side connection interfaces of the two fourth storage containers when one of the short sides of a first one of the two fourth storage containers may be located adjacent to one of the short sides of a second one of the two fourth storage containers.

**[0052]** The first storage container may comprise a vertical guiding recess in each long side. The first storage container may comprise a vertical guiding recess in each short side.

**[0053]** The second storage container may comprise a vertical guiding recess in each long side. The vertical guiding recess in one of the long sides of the second storage container may be aligned with the vertical guiding recess in one of the long sides of the first storage container when the first storage container and the second storage container are stacked above each other in a stack.

**[0054]** The third storage container may comprise a vertical guiding recess in each long side. The vertical guiding recess in one of the long sides of the third storage container may be aligned with the vertical guiding recess in one of the short sides of the first storage container when the first storage container and the third storage container are stacked above each other in a stack.

**[0055]** These vertical guiding recesses may be located in the center of the respective sides of the storage containers. Hence, the vertical guiding recesses may be referred to as mid-side channel profiles.

**[0056]** The second storage container, the third storage container and the fourth storage container comprises corner profiles being similar to or identical to parts of the mid-side channel profile.

**[0057]** The first storage container may comprise a center guide protruding up from a centre of the base, wherein the center guide may comprise a through guiding aperture.

**[0058]** A first type of container handling vehicle may handle one first storage container by engaging the short side connection interface of the first storage container and may at another time handle one or two second storage containers by engaging the short side connection interface of one or two second storage containers. One advantage of such a type of container handling vehicle is that grippers will not protrude down into a storage compartment of first storage container nor into a storage compartment of the second storage container.

**[0059]** A second type of container handling vehicle may handle one first storage container by engaging long side connection interface of the first storage container and may at another time handle one or two third storage containers by engaging the short side connection interface of one or two third storage containers. Again, one advantage of

such a type of container handling vehicle is that grippers will not protrude down into a storage compartment of the first storage container nor into a storage compartment of the third storage container.

**[0060]** The present disclosure also relates to an automated storage and retrieval system comprising a framework structure, wherein the framework structure comprises:
- upright members;
- a storage volume comprising storage columns provided between the upright members;
- a rail system provided on top of the upright members,
wherein the automated storage and retrieval system comprises a container handling vehicle arranged to operate on the rail system;
wherein the automated storage and retrieval system comprises:
- first storage containers stackable in stacks within the first storage columns, wherein the storage containers each has a rectangular base, two long sides and two short sides protruding up from the rectangular base and a long side connection interface provided in a top of its long sides;
- at least two further storage containers stackable in stacks within the first storage columns, wherein each of the at least two further storage containers has a rectangular base, two long sides and two short sides protruding up from the rectangular base and a short side connection interface provided in a top of its two short sides;
wherein the first storage container comprises a short side connection interface provided in the top of its short sides;
wherein the short side connection interfaces of the two further storage containers are functionally identical to the long side connection interface of the first storage container or to the short side connection interface of the first storage container when one of the long sides of a first one of the two further storage containers is located adjacent to one of the long sides of a second one of the two further storage containers.

**[0061]** The first storage container and the further storage containers may be stacked in the same stack.

**[0062]** The further storage container may be a further storage container as defined above.

**[0063]** The first storage container may comprise a vertical guiding recess in each long side and in each short side; wherein the further storage container may comprise a vertical guiding recess in each long side and wherein the upright members may be

forming vertical guides for guiding vertical movement of the first storage container and the further storage container inside the storage column via their vertical guiding recess.

**[0064]** The upright members may serve the purpose of supporting the rail system. The upright members may serve the purpose of forming vertical guides for the storage containers. The framework structure may comprise upright members and may comprise vertical guides being separate from the upright members. The upright members may be connected to the rail system at intersections between a first set of parallel rails arranged to guide movement of the container handling vehicles in a first direction across the top of the frame structure 100, and a second set of parallel rails arranged perpendicular to the first set of rails to guide movement of the container handling vehicles in a second direction which is perpendicular to the first direction X.

**[0065]** The vertical guides may be located between the upright members.

**[0066]** The vertical guides may comprise a lower end secured to the floor on which the lower end of the upright members are secured. The vertical guides may comprise an upper end secured to the rail system.

**[0067]** At least some of the corners of the first storage container and the further storage container may be guided by the upright members during vertical movement of the first storage container and the further storage container inside the storage column. It should be noted that vertical guiding may be provided by the vertical guiding recesses and the vertical guides only.

**[0068]** The vertical guides may be configured to guide vertical movement of the fourth storage container via the corner profile of the fourth storage container.

**[0069]** The first storage container may comprise a center guide protruding up from a centre of the base, wherein the center guide may comprise a through guiding aperture and wherein the framework structure may comprise a vertical guide for guiding vertical movement of the first storage container inside the storage column via its center guide.

**[0070]** The vertical guide may be located in the centre of each storage column. Hence, the vertical guide may be referred to as a vertical centre guide.

**[0071]** The vertical center guide may be configured to guide vertical movement of the further storage container via one of their vertical guiding recesses.

**[0072]** The vertical center guide may be configured to guide vertical movement of the fourth storage container via the corner profile of the fourth storage container.

**[0073]** Further storage containers may be stored in separate stacks within the storage column.

**[0074]** During picking of a picking order, a storage container is moved from its storage column to an access station where the product is picked from the storage container. The storage container is then returned to one of the storage columns again. During the transportation of the storage container to and from the access station, the storage container is occupied, i.e. it is prevented from being sent to another access station for a different picking order. Hence, for picking efficiency, it may be advantageous if the same type of product is stored in separate storage containers, thereby allowing parallel picking orders related to the same product to be completed. However, having the same type of product stored in separate storage containers reduces the storage efficiency.

**[0075]** According to the above, products may be stored in separate, smaller storage containers for the purpose of improving picking efficiency. Such separate, smaller storage containers will not reduce storage efficiency in the same way as if same-sized storage containers are used.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0076]** Following drawings are appended to facilitate the understanding of the present disclosure. The drawings show embodiments of the present disclosure, which will now be described by way of example only, where:

**[0077]** Fig. 1 is a perspective view of a framework structure of a prior art automated storage and retrieval system.

**[0078]** Fig. 2 is a perspective view of a prior art container handling vehicle having an internally arranged cavity for carrying storage containers therein.

**[0079]** Fig. 3 is a perspective view of a prior art container handling vehicle having a cantilever for carrying storage containers underneath.

**[0080]** 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.

**[0081]** Fig. 5 is a perspective view of a set of storage containers with a first, second and third storage container.

**[0082]** Fig. 6 is a top view of the first, second and third storage container of fig. 5.

**[0083]** Fig. 7 is a top view of the first storage container and two second storage containers located side by side.

**[0084]** Fig. 8 is a top view of the first storage container and two third storage containers located side by side.

**[0085]** Fig. 9 is a perspective view of a part of a framework structure in which second storage containers are stacked in a storage column.

**[0086]** Fig. 10 is a top view of the framework structure of fig. 9.

**[0087]** Fig. 11 is a perspective view of a further embodiment of the framework structure of fig. 9.

**[0088]** Fig. 12 is a top view of the framework structure of fig. 11.

**[0089]** Fig. 13 is a perspective view of the framework structure of fig. 9 with a container handling vehicle in operation on the rail system.

**[0090]** Fig. 14 is a side view of fig. 13.

**[0091]** Fig. 15a is a top view of a further embodiment of a set of storage containers with a first, second, third and fourth storage container.

**[0092]** Fig. 15b is a top view of a third storage container together with two fourth storage containers.

**[0093]** Fig. 15c is a top view of a second storage container together with two fourth storage containers.

**[0094]** Fig. 16 is a perspective view of the first storage container of fig. 15.

**[0095]** Fig. 17 is a perspective view of the framework structure of fig. 15 and 16 in which a fourth storage container is stacked above a second storage container.

**[0096]** Fig. 18 is a top view of the framework structure of fig. 17.

**[0097]** Fig. 19 is a perspective view of the framework structure of fig. 17 with a container handling vehicle for lifting fourth storage containers in operation on a rail system of the framework structure.

**[0098]** Fig. 20a is a perspective view of the framework structure of fig. 18 and 19 together with gripper devices of the container handling vehicle for lifting fourth storage containers, where other parts of the container handling vehicle has been removed.

**[0099]** Fig. 20b is an enlarged view of circle A of fig. 20a.

**[0100]** Fig. 20c is an enlarged view of circle B of fig. 20a.

**[0101]** Fig. 20d is an enlarged view of circle C of fig. 20a.

**[0102]** Fig. 21 is a perspective view of a container handling vehicle for lifting first and second storage containers.

**[0103]** Fig. 22 is a top view of the container handling vehicle of fig. 21.

**[0104]** Fig. 23 is a side view of the container handling vehicle of fig. 21 and 22.

**[0105]** Fig. 24 is a perspective view of the gripping devices of the vehicle of fig. 21 being used to lift a first storage container.

**[0106]** Fig. 25 is a perspective view of a further embodiment of a container handling vehicle.

**[0107]** Fig. 26 is a top view of the container handling vehicle of fig. 25.

**[0108]** Fig. 27 is a side view of the container handling vehicle of fig. 25 and 26.

**[0109]** Fig. 28 is a perspective view of yet a further embodiment of a container handling vehicle.

**[0110]** Fig. 29 illustrates a top view of a fourth storage container stored in a framework structure of the embodiment shown in fig. 9.

**[0111]**Fig. 30 illustrates schematically an embodiment of a framework structure where the upright members are serving the additional purpose of forming vertical guides.

**[0112]** Fig. 31 illustrates a further embodiment of a set of storage containers, where storage containers in fig. 5 may be stored within this set of containers.

**[0113]** Fig. 32 and 33 illustrates how the gripper may engage the connection interface of the storage containers of fig. 31.

## DETAILED DESCRIPTION

**[0114]** In the following, embodiments of the present 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 present disclosure to the subject-matter depicted in the drawings.

**[0115]** All of the above embodiments are related to different aspects of an automated storage and retrieval system 1. As shown in fig. 1, such systems 1 may comprise a framework structure 100 comprising upright members 102 and a rail system arranged across the top of framework structure 100. Details of the various embodiments will be apparent from the description below.

*First embodiment of a framework structure*

**[0116]** In a first embodiment, 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.

**[0117]**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.

**[0118]** 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.

**[0119]** It is now referred to fig. 9. Here it is shown that an upper end of the upright members 102 connected to the rail system 108 at intersections between 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.

**[0120]** In addition, the framework structure 100 here comprises vertical guides 102A located between the upright members 102. Hence, some vertical guides 102a are located under rails 110, while other vertical guides 102a are located under rails 111. A

lower end of the vertical guides 102A are secured to the floor on which the lower end of the upright members 102 are secured.

**[0121]** As shown in fig. 9, a storage column 105 is shown. In this storage column 105, one stack 107 or two stacks 107A, 107B of storage containers can be stored. In the present embodiment, a set of storage containers having different sizes may be stacked within the storage column 105. This will be described further in detail below.

*First embodiment of a set of storage containers*

**[0122]** It is now referred to fig. 5 and fig. 6. Here, a set 10 of three different storage containers are shown. The storage containers are referred to as a first storage container 20, a second storage container 30 and a third storage container 40.

**[0123]** The first storage container 20 has a rectangular base 21, two long sides 22L and two short sides 22S protruding up from the rectangular base 21. The first storage container 20 has a storage compartment defined by the upwardly facing surface of the base and the inwardly facing surfaces of the long sides and the short sides. The storage container has a top opening defined by the periphery of the top of the short sides and the long sides. Items may be inserted into and retrieved from the storage compartment via this top opening. The top of the short sides and the long sides comprises a rim 22R extending in a direction parallel to the base 21 of the first storage container 20 and away from a vertical center axis 22CA of the first storage container 20.

**[0124]** In a top of the long sides 22L, a long side connection interface CI20L is provided. In a top of the short sides 22S, a short side connection interface CI20S is provided. The short side connection interfaces CI20S and the long side connection interfaces CI20L comprises slots provided through this rim. The slots may have an elongated shape. In fig. 5 and 6, it is shown that each short side connection interface CI20S comprises two slots and each long side connection interface CI20L comprises two slots.

**[0125]** In fig. 6, it is shown that the long side 22L of the first storage container 20 has a length, referred to as a length L20 of the first storage container 20. The short side 22S of the first storage container 20 has a length, referred to as a width W20 of the first storage container 20.

**[0126]** The first storage container 20 further comprise a vertical guiding recess 25 in each long side 22L and in each short side 22S. When the first storage container 20 is

moved up or down within the storage column 105, the vertical guiding recess 25 is engaged with the vertical guide members 102A, thereby ensuring that the storage container 20 is positioned correctly within the storage column 105. It should be noted that corners of the first storage containers 20 may engage the upright members 102 in order to ensure that the storage container 20 is positioned correctly within the storage column 105.

**[0127]** The second storage container 30 has a rectangular base 31, two long sides 32L and two short sides 32S protruding up from the rectangular base 31. Similar to the first storage container 20, also the second storage container 30 has a rim extending in a direction parallel to the base 31 away from a vertical center axis of the second storage container 30.

**[0128]** In a top of the long sides 32L, a long side connection interface CI30L is provided. In a top of the short sides 32S, a short side connection interface CI30S is provided. Again, similar to the first container 20, the short side connection interfaces CI30S and the long side connection interfaces CI30L comprises elongated slots provided through its rim. In fig. 5 and 6, it is shown that each short side connection interface CI30S comprises one slot and each long side connection interface CI30L comprises two slots.

**[0129]** In fig. 6, it is shown that the long side 32L of the second storage container 30 has a length, referred to as a length L30 of the second storage container 30. The short side 32S of the second storage container 30 has a length, referred to as a width W30 of the second container 30.

**[0130]** The length L30 of the second storage container 30 is equal to the length L20 of the first storage container 20. The width W30 of the second storage container 30 is between 45 – 50% of the width W20 of the first storage container 20. Hence, if the first storage container 20 is referred to as a full-size storage container, then the second storage container 30 may be referred to as a half-size storage container.

**[0131]** Similar to the first storage container 20, the second storage container 30 comprises a vertical guiding recess 35 in each long side 32L. It should further be noted that vertical corners of the second storage container 30 have a shape resembling half of the vertical guiding recess 35, allowing at least some of the corners of the second container 30 to engage the vertical guide members 102A.

**[0132]** The third storage container 40 has a rectangular base 41, two long sides 42L and two short sides 42S protruding up from the rectangular base 41. Similar to the first storage container 20, also the third storage container 40 has a rim extending in a direction parallel to the base 41 away from a vertical center axis of the third storage container 40.

**[0133]** In a top of the long sides 42L, a long side connection interface CI40L is provided. In a top of the short sides 42S, a short side connection interface CI40S is provided. Again, similar to the first container 20, the short side connection interfaces CI40S and the long side connection interfaces CI40L comprises elongated slots provided through its rim. In fig. 5 and 6, it is shown that each short side connection interface CI40S comprises one slot and each long side connection interface CI40L comprises two slots.

**[0134]** In fig. 6, it is shown that the long side 42L of the third storage container 40 has a length, referred to as a length L40 of the third storage container 40. The short side 42S of the third storage container 40 has a length, referred to as a width W40 of the third container 30.

**[0135]** The length L40 of the third storage container 40 is equal to the width L20 of the first storage container 20. The width W40 of the third storage container 40 is between 45 – 50% of the length L20 the first storage container 20. Hence, if the first storage container 20 is referred to as a full-size storage container, then, the third storage container 40 may be referred to as a half-size storage container. Hence, there are two types of half-size storage containers.

**[0136]** As a consequence of the above, the width W40 is between 45 – 50% of the length L30, and the width W30 is between 45 – 50% of the length L40.

**[0137]** Similar to the first storage container 20, the third storage container 40 comprises a vertical guiding recess 45 in each long side 42L. It should further be noted that vertical corners of the third storage container 40 have a shape resembling half of the vertical guiding recess 45, allowing at least some of the corners of the third container 40 to engage the vertical guide members 102A.

**[0138]** It is now referred to fig. 7. Here it is shown a first storage container 20 at a distance from two second storage containers 30. The second storage containers 30 are arranged so that one of the long sides 32L of a first one of the two second storage containers 30 is located adjacent to one of the long sides 32L of a second one of the two

second storage containers 30. The long sides 32L of the two second storage containers 30 are in parallel with each other. One of the short sides 32S of the first one of the two second storage containers 30 is aligned with one of the short sides 32S of the second one of the two storage containers 30, and the other one of the short sides 32S of the first one of the two second storage containers 30 is aligned with the other one of the short sides 32S of the second one of the two storage containers 30. When comparing the first storage container 20 with the two second storage containers 30 of fig. 7, it is apparent that the short side connection interfaces CI30S of the two second storage containers 30 together are functionally identical to the short side connection interface CI20S of the first storage container 20.

**[0139]** Hence, as will be described further in detail below, a container handling vehicle 600 (fig. 21) with two gripping devices indicated as dashed rectangles 610A, 610B in fig. 7 may connect to and disconnect from the short side connection interfaces CI30S of the two storage containers 30 in the same way as it may connect to and disconnect from the short side connection interface CI20S of the first storage container 20.

**[0140]** It is now referred to fig. 8. Here it is shown a first storage container 20 at a distance from two third storage containers 40. The third storage containers 40 are arranged so that one of the long sides 42L of a first one of the two third storage containers 40 is located adjacent to one of the long sides 42L of a second one of the two third storage containers 40. The long sides 42L of the two third storage containers 40 are in parallel with each other. One of the short sides 42S of the first one of the two third storage containers 40 is aligned with one of the short sides 42S of the second one of the two storage containers 40, and the other one of the short sides 42S of the first one of the two third storage containers 40 is aligned with the other one of the short sides 42S of the second one of the two storage containers 40. When comparing the first storage container 20 with the two third storage containers 40 of fig. 8, it is apparent that the short side connection interfaces CI40S of the two third storage containers 40 together are functionally identical to the long side connection interface CI20L of the first storage container 20.

**[0141]** Hence, as will be described further in detail below, a container handling vehicle 600 similar to, but not identical to, the one shown in fig. 21, having two gripping devices indicated as dashed rectangles 610A, 610B in fig. 8 may connect to and disconnect from the short side connection interfaces CI40S of the two storage containers

40 in the same way as it may connect to and disconnect from the long side connection interface CI20L of the first storage container 20.

*First embodiment of container handling vehicle*

**[0142]** It is now referred to fig. 21, 22, 23. Here, a first embodiment of a container handling vehicle 600 is shown. The container handling vehicle 600 comprise a vehicle body 601. In fig. 21, the vehicle body 601 comprises a main body section 601MB and a cantilever body section 601CB protruding from a side of the main body section 601MB.

**[0143]** The container handling vehicle 600 comprises a first gripping device 610A, a second gripping device 610B, a first lifting device 620A for moving the first gripping device 610A vertically relative to the vehicle body 601; and a second lifting device 620B for moving the second gripping device 610B vertically relative to the vehicle body 601.

**[0144]** The first gripper device 610A and the second gripper device 610B may each comprise a lifting frame 604d which is connected to the respective lifting device 620A, 620B via lifting bands 604a. Each lifting frame 604d may comprise guide pins 604c for correctly positioning of the lifting frame 604d relative to the storage containers. Each lifting frame 604d comprises grippers 604b for engaging the connection interface of the storage containers.

**[0145]** The lifting devices 620A, 620B comprises drums 621A, 621B onto which the lifting bands 604a may be reeled up during lifting of the lifting plate or out from which the lifting bands 604a may be reeled out during lowering of the lifting plate. The lifting devices 620A, 620B may comprise motors for rotating the drums 621A, 621B.

**[0146]** The first lifting device 620A is moving the first gripping device 610A in a vertical direction below the cantilever body section 601CB while the second lifting device 620B is moving the second gripping device 610B in a vertical direction below the cantilever body section 601CB adjacent to the first lifting device 620A.

**[0147]** The container handling vehicle 600 comprises a vehicle control system 650 (indicated by a dashed rectangle) for controlling the lifting devices and the gripping devices. The vehicle control system 650 may be provided in communication with a control system 500 of the automated storage and retrieval system 1. The vehicle control system 650 may be configured to control other parts of the container handling vehicle 600, such as wheels etc. The gripper devices and/or the lifting devices may comprise

sensors for sensing the location of the gripper plate or other parts of the gripper device relative to a storage container, relative to the vehicle etc.

**[0148]** The container handling vehicle 600 may comprise a first set of wheels 602 for moving the container handling vehicle 600 in a first direction and a second set of wheels 603 for moving the container handling vehicle 600 in a second direction perpendicular to the first direction. The wheels are secured to the main body section 601MB. The cantilever body section 601CB may be located at a height above the wheels in order to carry storage containers while moving horizontally, i.e. without the storage containers obstructing or preventing movement of the container handling vehicle. In fig. 21, a cantilever direction CL is indicated as the direction the cantilever body section 601CB is protruding from the main body section 601MB. A separation line SL between the two gripping devices is here perpendicular to the cantilever direction CL. It should be noted that other propulsions means may be used instead of wheels, such as belts etc.

**[0149]** In the present embodiment, the first gripping device 610A and the second gripping device 610B are configured to cooperatively engage a connection interface CI20S of the first storage container 20. This is the situation shown to the left of fig. 7. This is referred to as a first mode of operation. This is also shown in fig. 24, where the first and second gripping devices 610A, 610B are cooperatively engaging the connection interface CI20S of a first storage container 20 and lifting it up from or down onto a stack of other first storage containers 20.

**[0150]** In a second mode of operation, the first gripping device 610A is configured to engage the short side connection interface CI30S of one second storage container 30, and the second gripping device 610B is configured to engage the short side connection interface CI30S of another second storage container 30. It should be noted that in the second mode of operation, the first gripping device 610A and the second gripping device 610B are operated independently of each other. Similarly, the first lifting device 620A and the second lifting device 620B are operated independently of each other. Hence, they can lift one second storage container each, or only one of them can lift a storage container. As shown in fig. 21, the first gripping device 610A is engaged with a second storage container 30 and the lifting device 620A has lowered the storage container to a positing below the wheels, while the second gripper device 610B is not engaged with a storage container and is in an elevated position above another second storage container 30.

**[0151]** In fig. 13 and fig. 14, it is shown how second storage containers 30 are stacked in two stacks 107 within one storage column. Note that here, the framework structure 100 only has two guiding members 102A. Hence, the second storage containers 30 are guided via their corners along the guiding members 102A and the upright members 102. The second storage containers 30 here does not have a guiding recess 35.

*Second embodiment of the container handling vehicle*

**[0152]** A second embodiment of a container handling vehicle (only indicated in fig. 8) is identical to the above first embodiment, with one exception. The only difference is the first and second gripper (and hence possibly a different distance between the bands 604). In this embodiment, the first and second gripper 610A, 610B are configured to cooperatively engage the first storage container 20 as described above and shown to the left in fig. 8 in a first mode of operation. In a second mode of operation, the first and second gripper 610A, 610B are independently configured to engage one or two third storage containers 40, as described above and shown to the right in fig. 8. In such an embodiment, the cantilever direction CL may be parallel to the separation line SL between the two gripping devices.

*Third embodiment of the container handling vehicle*

**[0153]** It is now referred to fig. 25, 26, 27 and 28. Here, the vehicle body 601 comprises a first body section 601A, a second body section 601B provided at a horizontal distance from the first body section 601A and a third body section 601C connected between the first body section 601A and the second body section 601B. Here, the first lifting device 620A is moving the first gripping device 610A in a vertical direction below the third body section 601C while the second lifting device 620B is moving the second gripping device 610B in a vertical direction below the third body section 601C adjacent to the first lifting device 620A. As in the first embodiment, also this container handling vehicle has a first mode of operation and a second mode of operation. This type of vehicle may engage one first storage container or one or two second storage containers. The same type of vehicle may engage one first storage container or one or two third storage containers (similar to the second embodiment described above).

**[0154]** The third body section 601C may be located at a height above the wheels being sufficient to carry the storage containers while moving horizontally, i.e. without the storage containers obstructing or preventing movement of the container handling vehicle.

**[0155]** The third embodiment of the container handling vehicle 600 further comprises a rotation device 608 for rotating the first lifting device 620A and the second lifting device 620B together relative to the vehicle body 601. The rotation is shown in fig. 28. The containers may be rotated 90° or 180°. The rotation device 608 may be connected between the third body section 601C and the first and second.

**[0156]** It may be possible to provide the vehicle of the first and second embodiment with a similar rotation device connected between the cantilever body section 601CB and the first and second lifting devices 620A, 620B.

*Second embodiment of a set of storage containers*

**[0157]** A second set 10 of storage containers will now be described with reference to fig. 15a. The set 10 is similar to the set 10 shown in fig. 5 and 6, and only differences will be described herein.

**[0158]** The second set 10 of storage containers comprises a fourth storage container 50 in addition to the first, second and third storage containers. The fourth storage container 50 comprises a rectangular base 51, two long sides 52L and two short sides 52S protruding up from the rectangular base 51 and a short side connection interface CI50S provided in a top of its short sides 52S.

**[0159]** The fourth storage container 50 has a footprint area of 20 - 25% of the first storage container 20. The fourth storage container 50 has a footprint area of 45 - 50% of the second storage container 30. The fourth storage container 50 has a footprint area of 45 - 50% of the third storage container 40.

**[0160]** The long side 52L of the fourth storage container 50 may have a length, referred to as a length L50 of the fourth storage container 50. The short side 52S of the fourth storage container 50 may have a length, referred to as a width W50 of the fourth storage container 50.

**[0161]** The length L50 of the fourth storage container 50 may be equal to the width W40 of the third storage container 40. The width W50 of the fourth storage container 50 may be being 45 – 50% of the length L40 of the third storage container 40. The fourth storage container 50 may therefore be referred to as a quarter-size storage container.

**[0162]** It is now referred to fig. 15b. Here it is shown that the third storage container 40 comprises a long side connection interface CI40L provided in a top of its

long sides 42L. The short side connection interfaces CI50S of two fourth storage containers 50 are functionally identical to the long side connection interface CI40L of the third storage container 40 when one of the long sides 52L of a first one of the two fourth storage containers 50 is located adjacent to one of the long sides 52L of a second one of the two fourth storage containers 50.

**[0163]** It is now referred to fig. 15c. Here, it is shown that the second storage container 30 comprises a long side connection interface CI30L provided in a top of its long sides 32L. The fourth storage container 50 comprises a long side connection interface CI50L provided in a top of its long sides 52L. The long side connection interfaces CI30L of the second storage container 30 is functionally identical to the long side connection interfaces CI50L of the two fourth storage containers 50 when one of the short sides 52S of a first one of the two fourth storage containers 50 is located adjacent to one of the short sides 52S of a second one of the two fourth storage containers 50.

**[0164]** It is now referred to fig. 15a and fig. 15d. In the second set 10 of storage containers, the first storage container 20 comprises a center guide 29 protruding up from a centre of the base 21. The center guide 29 comprises a through guiding aperture 29b.

*Framework structure for second set of storage containers*

**[0165]** It is now referred to fig. 11, fig. 12, fig. 17 and fig. 18. Here it is shown one storage column 105 of a framework structure 100 with upright members 102, guiding members 102A and the rail system 108. Here, the storage column 105 is defined by four upright members 102, one in each corner of the storage column, and four guiding members 102A, one guiding member between each two of the upright members 102.

**[0166]** In addition, the framework structure 100 comprises a vertical guide 102B located in the centre of each storage column 105. The vertical guide 102B is guiding first storage containers via its center guide 29. The vertical guide 102B is guiding second storage containers 30 via one of its vertical guiding recesses 35 (the other vertical guiding recess being guided by one of the vertical guides 102A) as shown in fig. 11 and 12. The vertical guide 102B is guiding third storage containers 40 via one of its vertical guiding recesses 45, similar to the second storage containers 30. The vertical guide 102B is guiding fourth storage containers 50 via one of its corners or corner profiles (the other three corners being guided by the vertical guides 102A) as shown in fig. 17 and 18.

*Container handling vehicle for second set of storage containers*

**[0167]** It is now referred to fig. 19 and 20. Here it is shown a container handling vehicle 600 of a similar type as the one described above with reference to fig. 21. In fig. 19 and 20, the container handling vehicle 600 has four gripping devices 610A, 610B, 610C, 610D and four lifting devices 620A, 620B, 620C, 620D, one lifting device for each gripping device.

**[0168]** The first, second, third and fourth gripping devices 610A, 610B, 610C, 610D are configured to individually engage the short side connection interface CI50S of one of the fourth storage containers 50. Hence, the vehicle may engage one, two, three or four fourth storage containers 50 individually or simultaneously.

**[0169]** Similar to the above vehicles, all four gripping devices and lifting devices may cooperatively engage one first storage container 20 via its short side connection interface CI20S. As shown in fig. 19 and 20a, the second gripping device 610B is lifting one fourth storage container 50, while the other gripping devices are not engaging any storage containers.

**[0170]** The first and third gripping devices 610A, 610C are configured to cooperatively engage the connection interface CI40B of a first one of the third storage containers 40. Similarly, the second and fourth gripping devices 610B, 610D are configured to cooperatively engage the long side connection interface CI40L of a second one of the third storage containers 40.

**[0171]**It is now referred to fig. 20b, 20c, 20d. Here it is shown that the gripper devices have recesses 604e shaped according to the vertical guides 102A and the central vertical guide 102B to allow the gripper devices to be lowered into the storage compartment.

*The automated storage and retrieval system*

**[0172]** Above, different embodiments of sets of containers, framework structures and container handling vehicles are described. These can be used in different embodiments of automated storage and retrieval systems. Some embodiments may use only two types of storage containers, for example the first and the second storage containers, or the first and the third storage containers. In this case, one type of container handling vehicle is sufficient for lifting both of these storage containers. other embodiments may use the first, second and third storage containers. In this case, two

types of container handling vehicles of the type shown in fig. 21 are necessary (one for the first and second container, the other one for the first and third container).

**[0173]** In yet some embodiments, the first, second, third and fourth storage containers are used. It should be noted that all containers can be stacked above each other in a stack, under the assumption that the layer below a new stack is not partially empty.

*Alternative embodiments*

**[0174]** As a final comment to the first embodiment, it should be noted that the guiding recesses 25, 35, 45 are not essential features. In such a case, the first storage container 20 may be of similar size as the prior art storage container 106. If the system 1 only has first storage containers and third storage containers, the short side connection interface CI20S is not essential, and then the first storage container 20 may be identical to the prior art storage container 106. Hence, it is possible to expand the function of an existing system 1 by adding two or four guide members 102A and/or a central guide member 102B.

**[0175]** It is now referred to fig. 29. Here it is shown a storage column 105 with one fourth storage container 50. It is possible to use the fourth storage container 50 in a storage column with four guide members 102A, but without the central guide member 102B.

**[0176]** In fig. 30, it is illustrated schematically an embodiment where the four guide members 102A are also serving the purpose of supporting the rail system 108. Hence, there are no upright members 102.

**[0177]** It is now referred to fig. 31. Here, the short side connection interfaces CI20S, CI30S, CI40S and the long side connection interfaces CI20L, CI30L, CI40L may be provided in an upper end of the short sides and long sides of the storage containers. The short side connection interfaces and the long side connection interfaces may comprise a slot provided the upper end of the short sides and the long sides. The slot may have an elongated shape. In fig. 32 and 33 it is illustrated how a gripper may pivot into the slots of the connection interface in order to engage the storage container.

**[0178]** In the preceding description, various aspects of the set of contains, the framework structure, the container handling vehicle and the automated storage and retrieval system according to the present 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

| | |
|---|---|
| 1 | automated storage and retrieval system |
| 10 | set of storage containers |
| 20 | first storage container |
| 21 | base of first storage container |
| 22 | sides of first storage container |
| 25 | vertical guiding recess |
| 29 | center guide of first storage container |
| 29b | guiding aperture |
| 30 | second storage container |
| 31 | base of second storage container |
| 32 | sides of second storage container |
| 35 | vertical guiding recess of second storage container |
| 40 | third storage container |
| 41 | base of third storage container |
| 42 | sides of third storage container |
| 45 | vertical guiding recess of third storage container |
| 50 | fourth storage container |
| 51 | base of fourth storage container |
| 52 | sides of fourth storage container |
| 100 | Framework structure |
| 102 | Upright members of framework structure |
| 102A | vertical guide |
| 102B | vertical center guide |
| 104 | Storage grid |
| 105 | Storage column |
| 106 | Storage container |
| 106' | Particular position of storage container |
| 107 | Stack |
| 107a | separate stacks |

| | |
|---|---|
| 107b | separate stacks |
| 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 |
| 600 | container handling vehicle |
| 601 | vehicle body |
| 601A | first body section |
| 601B | second body section |
| 601C | third body section |
| 601CB | cantilever body section |
| 601MB | main body section |
| 602 | wheels |
| 603 | wheels |
| 604a | Lifting band |

| | |
|---|---|
| 604b | Gripper |
| 604c | Guide pin |
| 604d | Lifting frame |
| 608 | rotation device |
| 610A | first gripping device |
| 610B | second gripping device |
| 610C | third gripping device |
| 610D | fourth gripping device |
| 620A | first lifting device |
| 620B | second lifting device |
| 620C | third lifting device |
| 620D | fourth lifting device |

| | |
|---|---|
| CI20L | long side connection interface |
| CI20S | short side connection interface |
| CI30L | long side connection interface |
| CI30S | short side connection interface |
| CI40L | long side connection interface |
| CI40S | short side connection interface |
| CI50S | short side connection interface |

| | |
|---|---|
| L20 | length/length of long side |
| L30 | length/length of long side |
| L40 | length/length of long side |
| L50 | length/length of long side |
| W20 | width/length of short side |
| W30 | width/length of short side |
| W40 | width/length of short side |
| W50 | width/length of short side |
| X | First direction |
| Y | Second direction |
| Z | Third direction |

## CLAIMS

1. A set (10) of storage containers for an automated storage and retrieval system (1), wherein the set (10) of storage containers comprises:
- a first storage container (20) having a rectangular base (21), two long sides (22L) and two short sides (22S) protruding up from the rectangular base (21) and a long side connection interface (CI20L) provided in a top of its long sides (22L);
- two further storage containers (30, 40), each having a rectangular base (31, 41), two long sides (32L, 42L) and two short sides (32S, 42S) protruding up from the rectangular base (31, 41) and a short side connection interface (CI30S, CI40S) provided in a top of its two short sides (32S, 42S);
wherein:
- the first storage container (20) comprises a short side connection interface (CI20S) provided in the top of its short sides (22S);
- the short side connection interfaces (CI30S, CI40S) of the two further storage containers (30, 40) are functionally identical to the long side connection interface (CI20L) of the first storage container (20) or to the short side connection interface (CI20S) of the first storage container (20) when one of the long sides (32L, 42L) of a first one of the two further storage containers (30, 40) is located adjacent to one of the long sides (32L, 42L) of a second one of the two further storage containers (30, 40).

2. The set (10) of storage containers according to claim 1, wherein the two further storage containers (30, 40) are two second storage containers (30), wherein the short side connection interfaces (CI30S) of the two second storage containers (30) are functionally identical to the short side connection interface (CI20S) of the first storage container (20) when one of the long sides (32L) of a first one of the two second storage containers (30) is located adjacent to one of the long sides (32L) of a second one of the two second storage containers (30).

3. The set (10) of storage containers according to claim 2, wherein the second storage container (30) has a footprint area of 45 – 50% of the first storage container (20).

4. The set (10) of storage containers according to claim 2 or 3, wherein the two further storage container (30, 40) are two third storage containers (40), wherein the short side connection interfaces (CI40S) of the two third storage containers (40) are functionally identical to the long side connection interface (CI20L) of the first storage container (20) when one of the long sides (42L) of a first one of the two third storage

containers (40) is located adjacent to one of the long sides (42L) of a second one of the two third storage containers (40).

5. The set (10) of storage containers according to claim 4, wherein the third storage container (40) has a footprint area of 45 – 50% of the first storage container (20).

6. The set (10) of storage containers according to claim 5, wherein the third storage container (40) comprises a long side connection interface (CI40L) provided in a top of its long sides (42L); and
wherein the set of storage containers comprises two fourth storage containers (50), each having a rectangular base (51), two long sides (52L) and two short sides (52S) protruding up from the rectangular base (51) and a short side connection interface (CI50S) provided in a top of its short sides (52S);
wherein the short side connection interfaces (CI50S) of the two fourth storage containers (50) are functionally identical to the long side connection interface (CI40L) of the third storage container (40) when one of the long sides (52L) of a first one of the two fourth storage containers (50) is located adjacent to one of the long sides (52L) of a second one of the two fourth storage containers (50).

7. The set (10) of storage containers according to claim 5 or 6, wherein the second storage container (30) comprises a long side connection interface (CI30L) provided in a top of its long sides (32L); and
wherein the fourth storage container (50) comprises a long side connection interface (CI50L) provided in a top of its long sides (52L); and
wherein the long side connection interfaces (CI30L) of the second storage container (30) is functionally identical to the long side connection interfaces (CI50L) of the two fourth storage containers (50) when one of the short sides (52S) of a first one of the two fourth storage containers (50) is located adjacent to one of the short sides (52S) of a second one of the two fourth storage containers (50).

8. The set (10) of storage containers according to any one of the above claims, wherein the first storage container (20) comprises a center guide (29) protruding up from a centre of the base (21), wherein the center guide (29) comprises a through guiding aperture (29b).

9. An automated storage and retrieval system (1) comprising a framework structure (100), wherein the framework structure (100) comprises:
- upright members (102; 102A);

- a storage volume comprising storage columns (105) provided between the upright members (102; 102A);
- a rail system (108) provided on top of the upright members (102; 102A),
wherein the automated storage and retrieval system (1) comprises a container handling vehicle (600) arranged to operate on the rail system (108);
wherein the automated storage and retrieval system (1) comprises:
- first storage containers (20) stackable in stacks (107) within the first storage columns (105), wherein the storage containers (20) each has a rectangular base (21), two long sides (22L) and two short sides (22S) protruding up from the rectangular base (21) and a long side connection interface (CI20L) provided in a top of its long sides (22L);
- at least two further storage containers (30, 40) stackable in stacks (107) within the first storage columns (105), wherein each of the at least two further storage containers (30, 40) has a rectangular base (31, 41), two long sides (32L, 42L) and two short sides (32S, 42S) protruding up from the rectangular base (31, 41) and a short side connection interface (CI30S, CI40S) provided in a top of its two short sides (32S, 42S);
wherein the first storage container (20) comprises a short side connection interface (CI20S) provided in the top of its short sides (22S);
wherein the short side connection interfaces (CI30S, CI40S) of the two further storage containers (30, 40) are functionally identical to the long side connection interface (CI20L) of the first storage container (20) or to the short side connection interface (CI20S) of the first storage container (20) when one of the long sides (32L, 42L) of a first one of the two further storage containers (30, 40) is located adjacent to one of the long sides (32L, 42L) of a second one of the two further storage containers (30, 40).

10. The automated storage and retrieval system (1) according to claim 9, wherein the further storage container (30, 40) is a further storage container as defined in any one of claims 2 – 8.

11. The automated storage and retrieval system (1) according to claim 9 or 10, wherein the first storage container (20) comprises a vertical guiding recess (25) in each long side (22L) and in each short side (22S); wherein the further storage container (30, 40) may comprise a vertical guiding recess (35, 45) in each long side (32L, 42L) and wherein the upright members (102; 102A) are forming vertical guides for guiding vertical movement of the first storage container (20) and the further storage container (30, 40) inside the storage column (105) via their vertical guiding recess (25, 35, 45).

12. The automated storage and retrieval system (1) according to any one of claims 9 - 11, wherein the first storage container (20) comprises a center guide (29) protruding up from a centre of the base (21), wherein the center guide (29) comprises a through guiding aperture (29b) and wherein the framework structure (100) comprises a vertical guide (102B) for guiding vertical movement of the first storage container (20) inside the storage column (105) via its center guide (29).

13. The automated storage and retrieval system (1) according to claim 11, wherein the vertical center guide (102B) is configured to guide vertical movement of the further storage container (30, 40) via one of their vertical guiding recesses (35, 45).

14. The automated storage and retrieval system (1) according to any one of claims 9 – 13, wherein further storage containers (30, 40) are stored in separate stacks (107a, 107b) within the storage column (105).

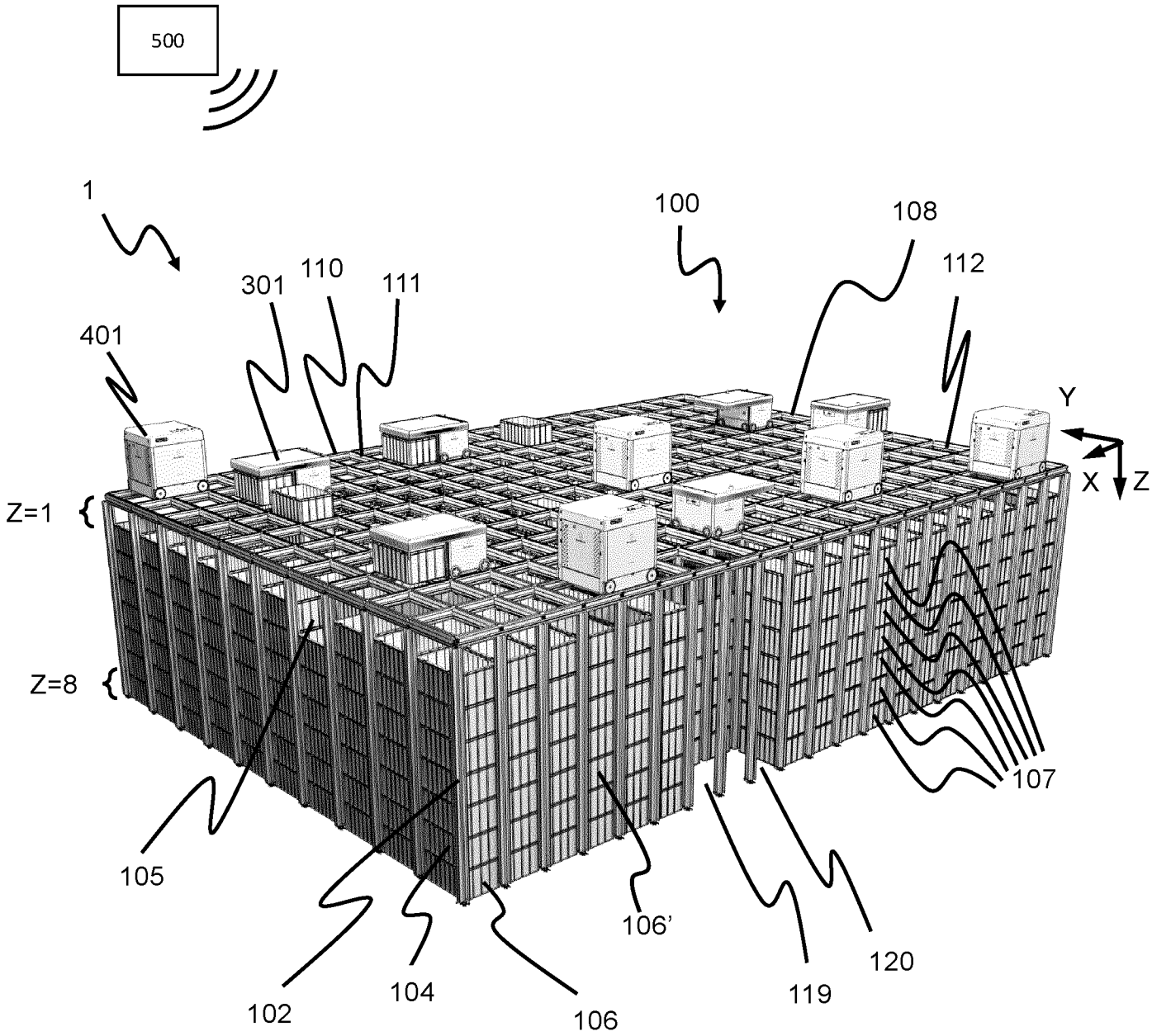


Fig. 1
(Prior Art)

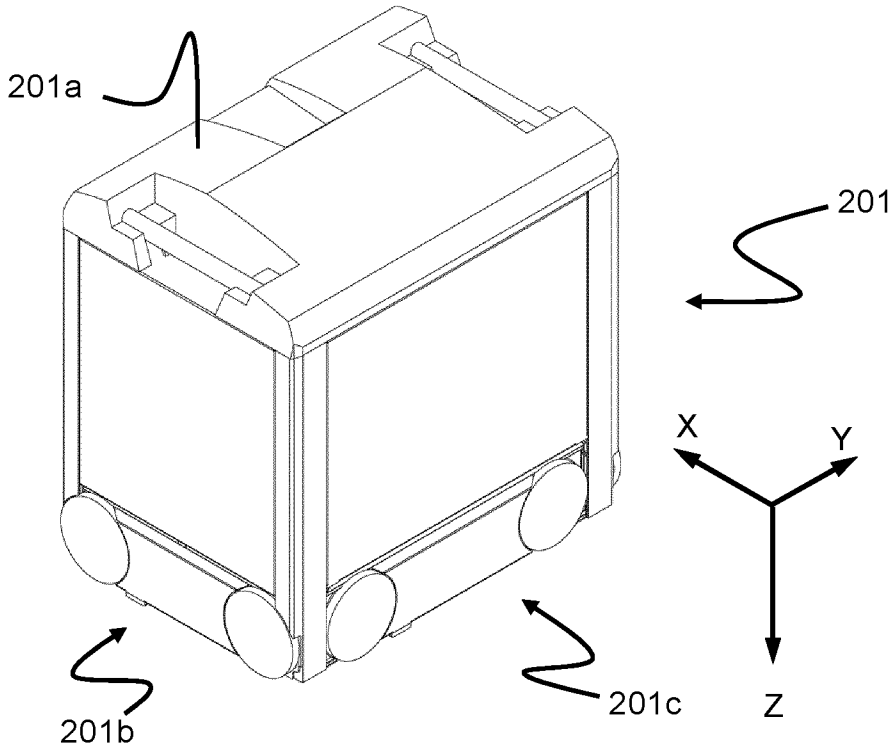


Fig. 2
(Prior Art)

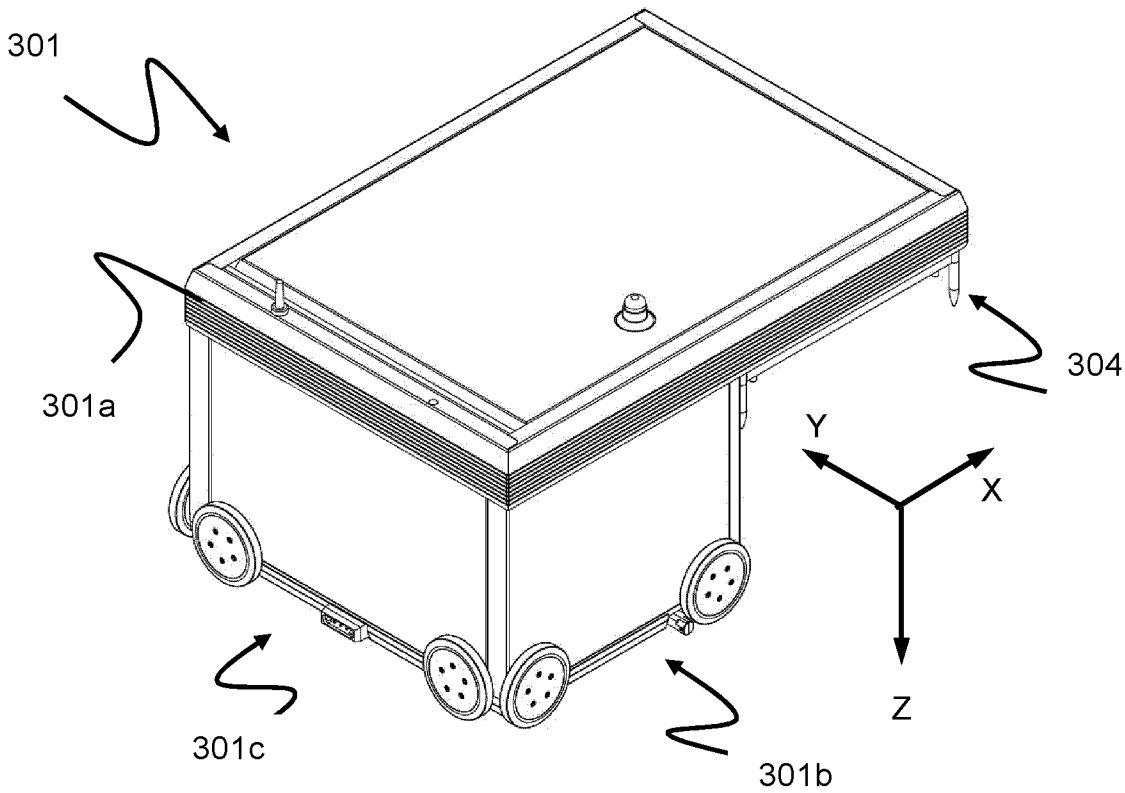


Fig. 3
(Prior Art)

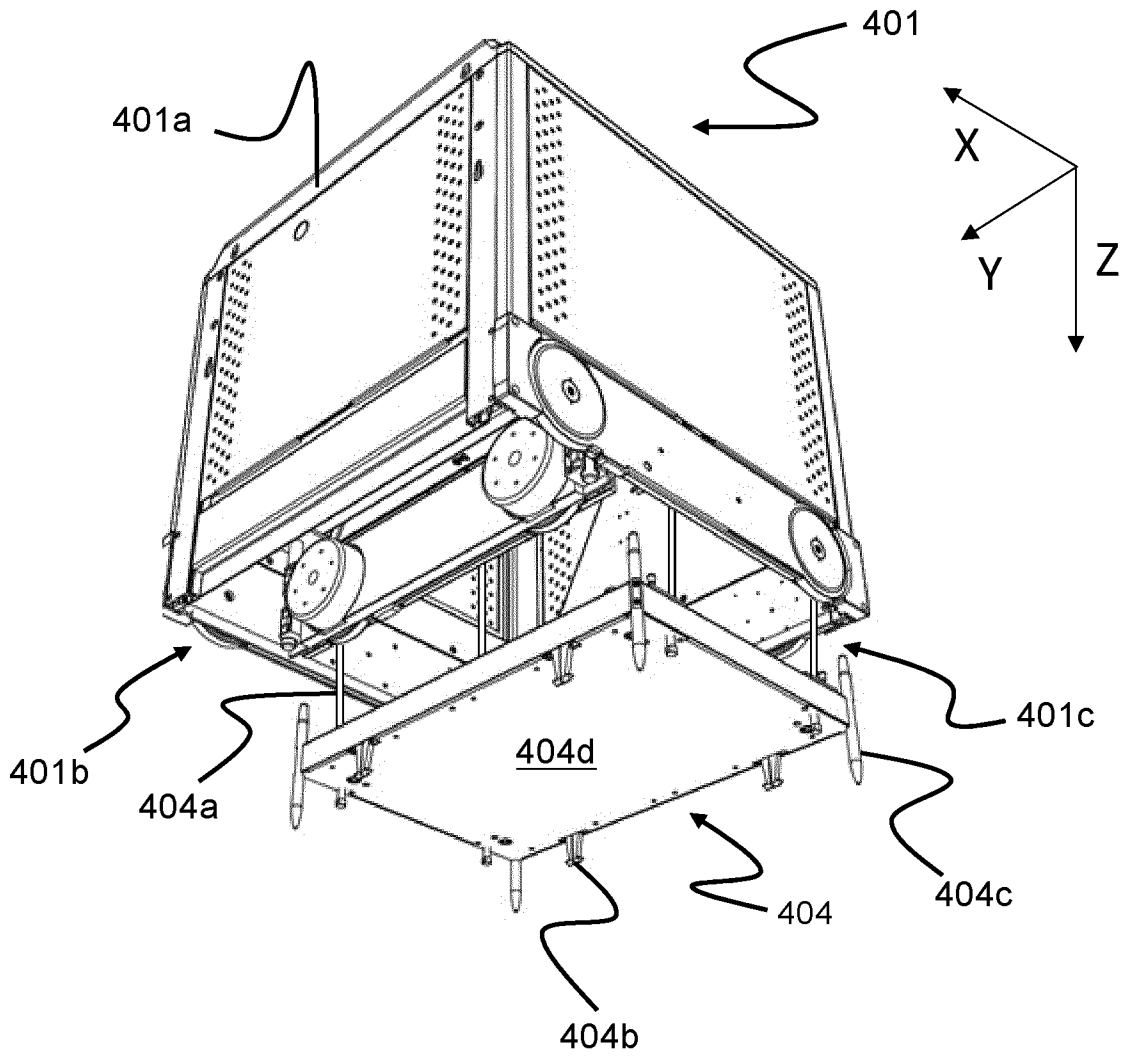


Fig. 4
(Prior Art)

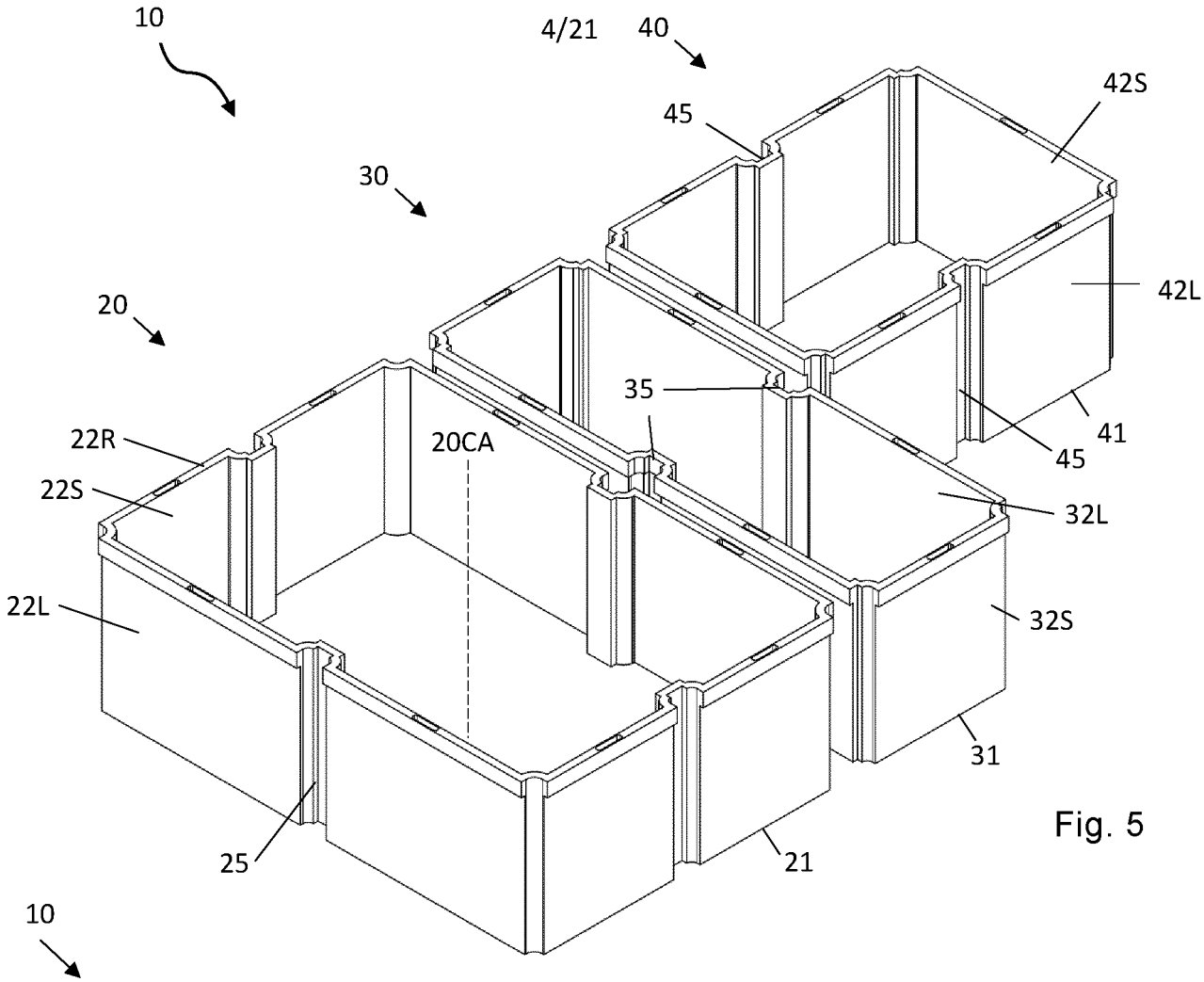
10
4/21
40
42S
45
30
42L
20
35
41
22R
20CA
45
22S
32L
22L
32S
31
25
21

Fig. 5

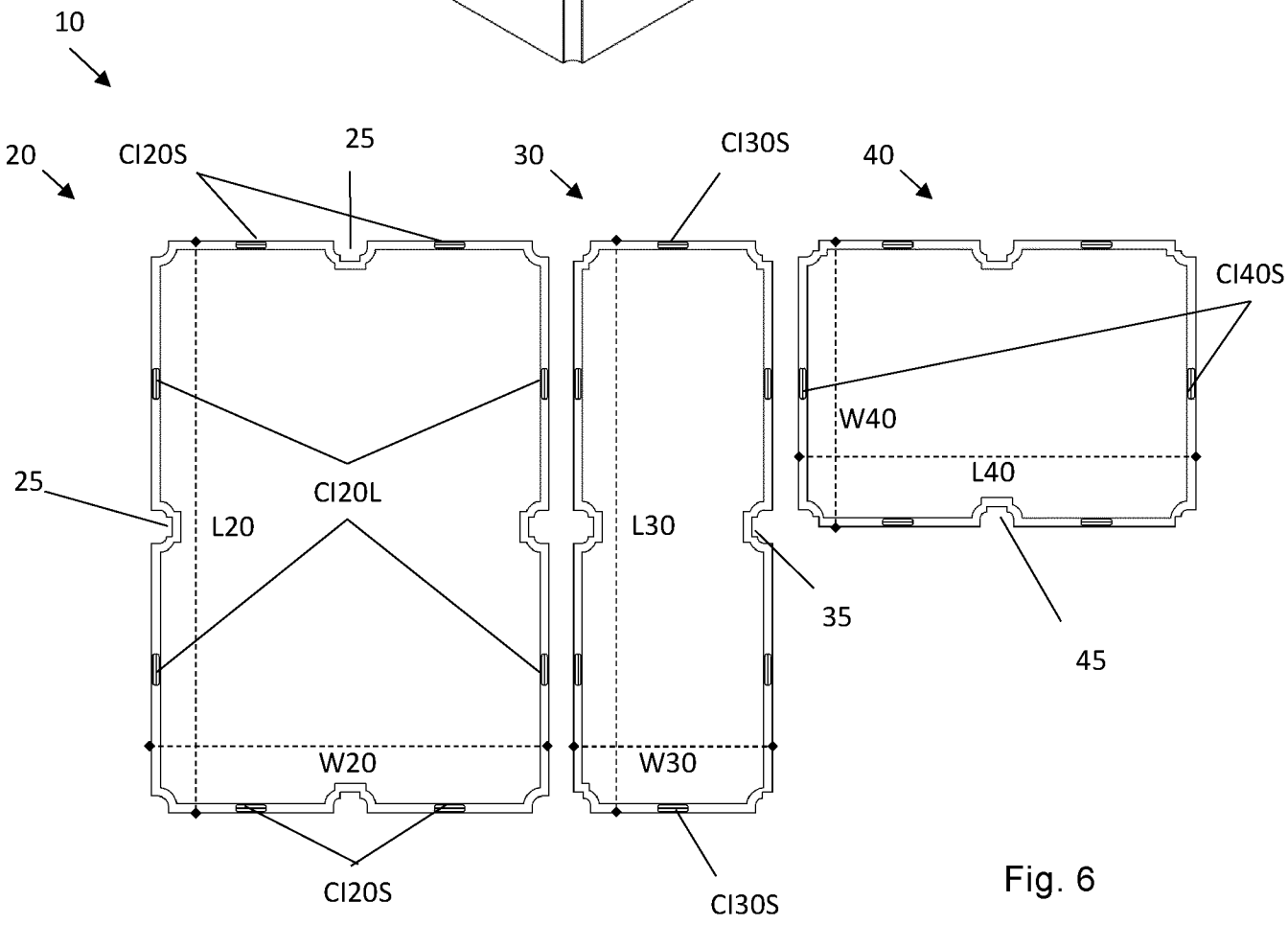
10
20
CI20S
25
30
CI30S
40
CI40S
W40
L40
25
CI20L
L20
L30
35
45
W20
W30
CI20S
CI30S

Fig. 6

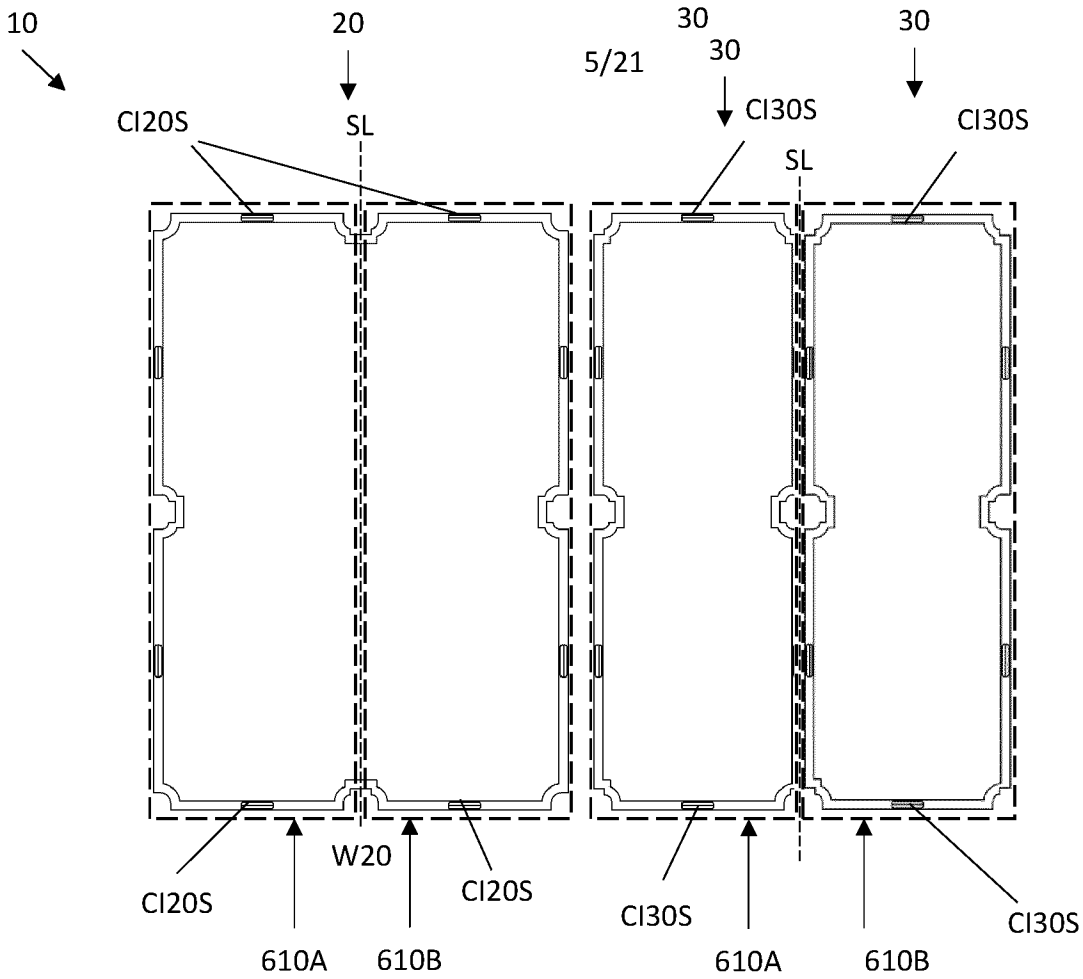
10
20
30
30
30
5/21
CI20S
SL
CI30S
SL
CI30S
W20
CI20S
CI20S
CI30S
CI30S
610A
610B
610A
610B

Fig. 7

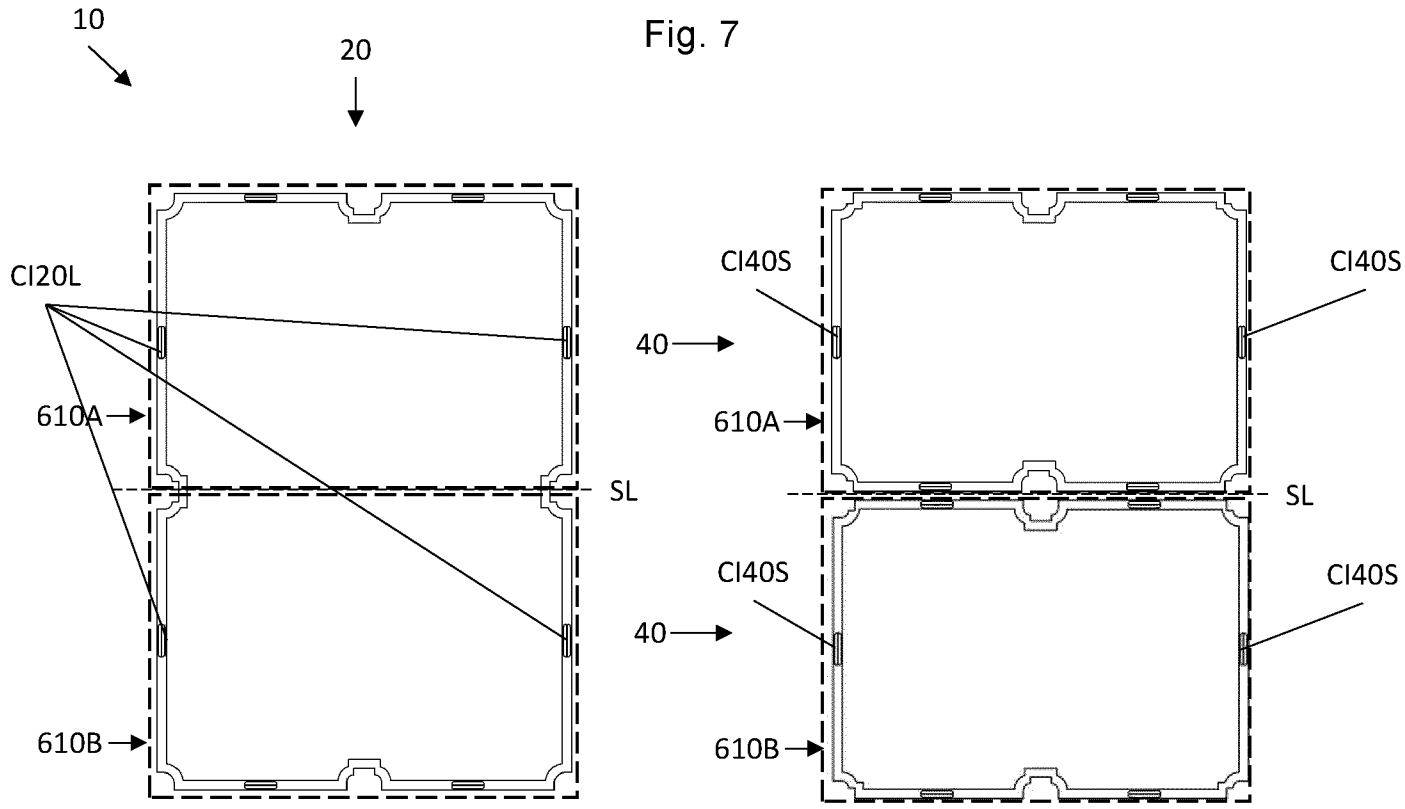
10
20
CI20L
610A
SL
610B
CI40S
CI40S
40
610A
SL
CI40S
CI40S
40
610B

Fig. 8

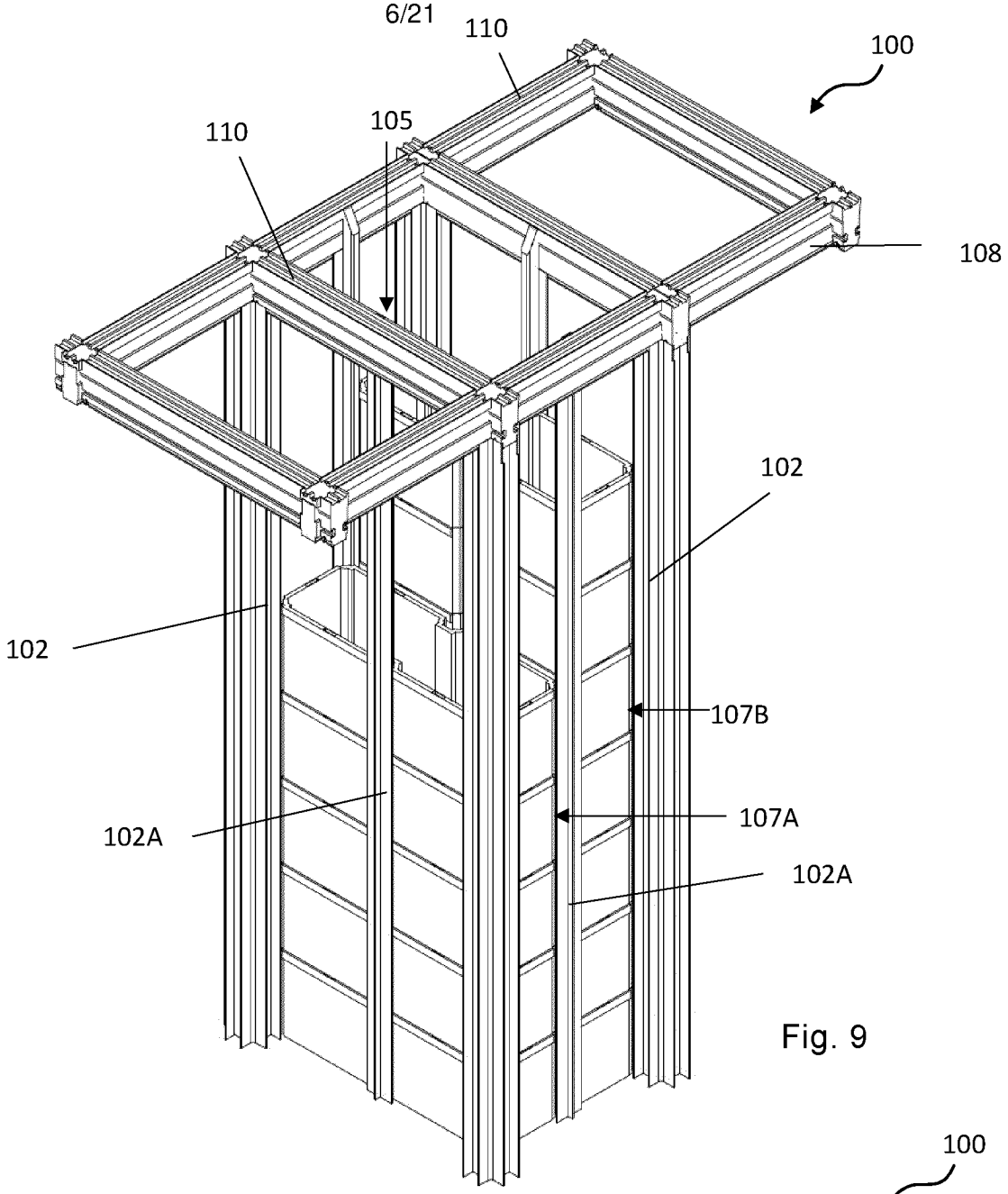


Fig. 9

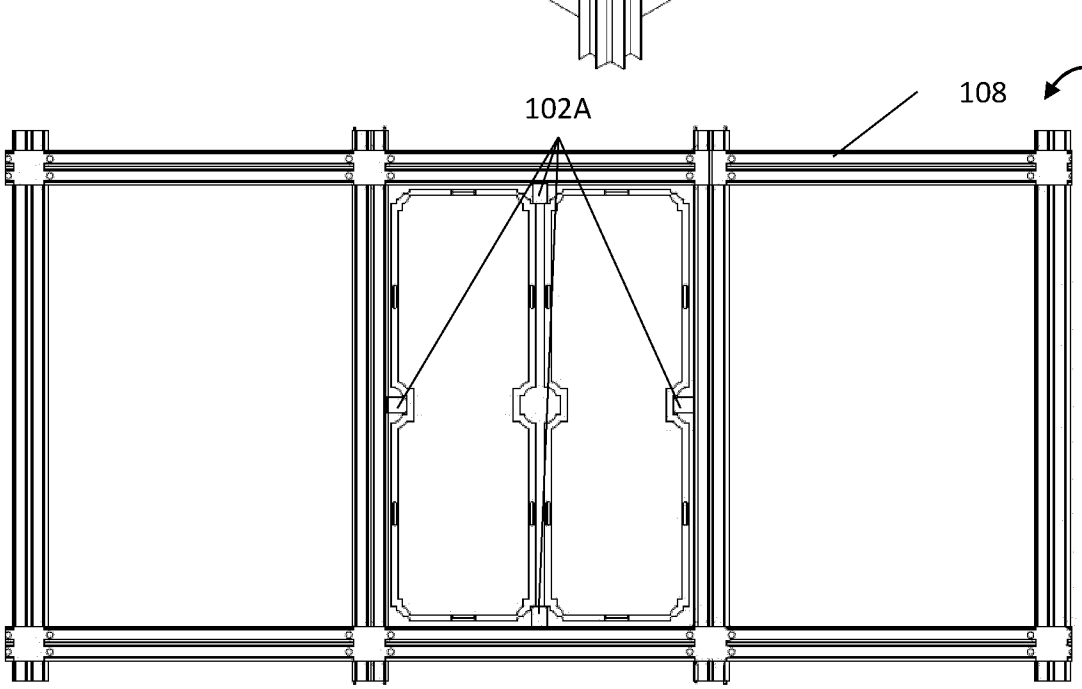


Fig. 10

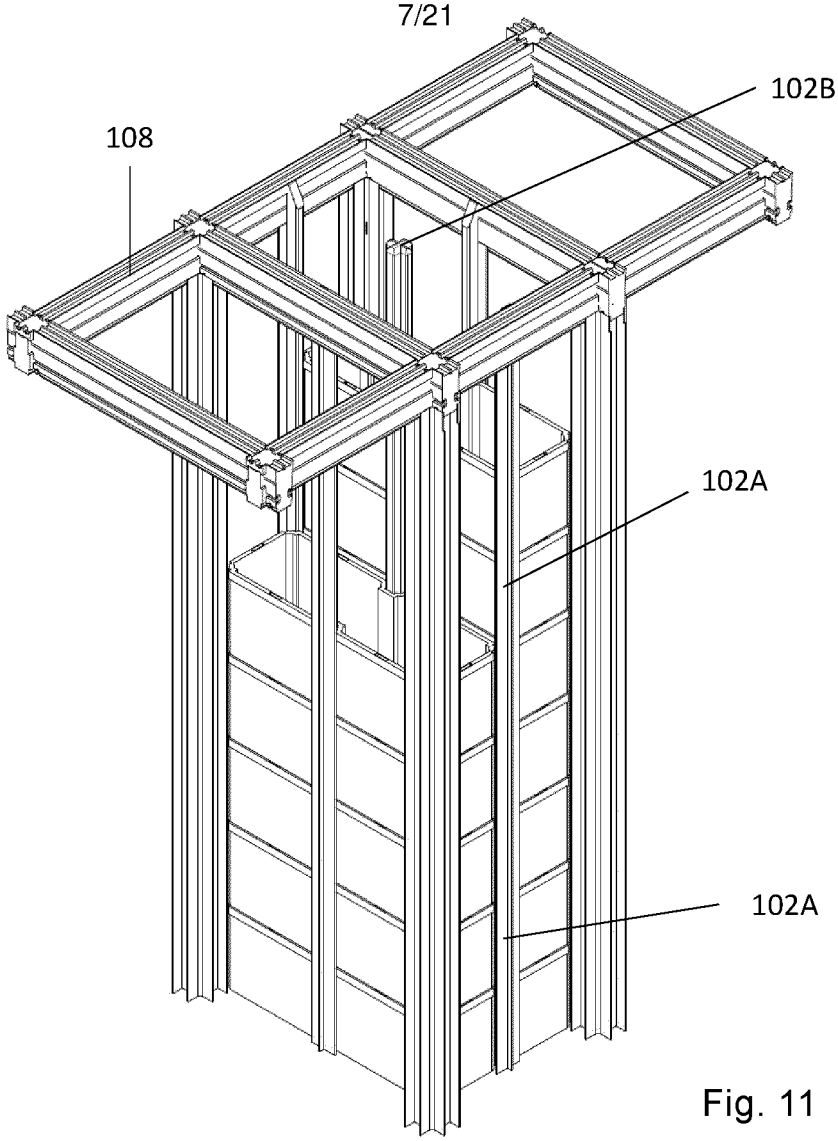


Fig. 11

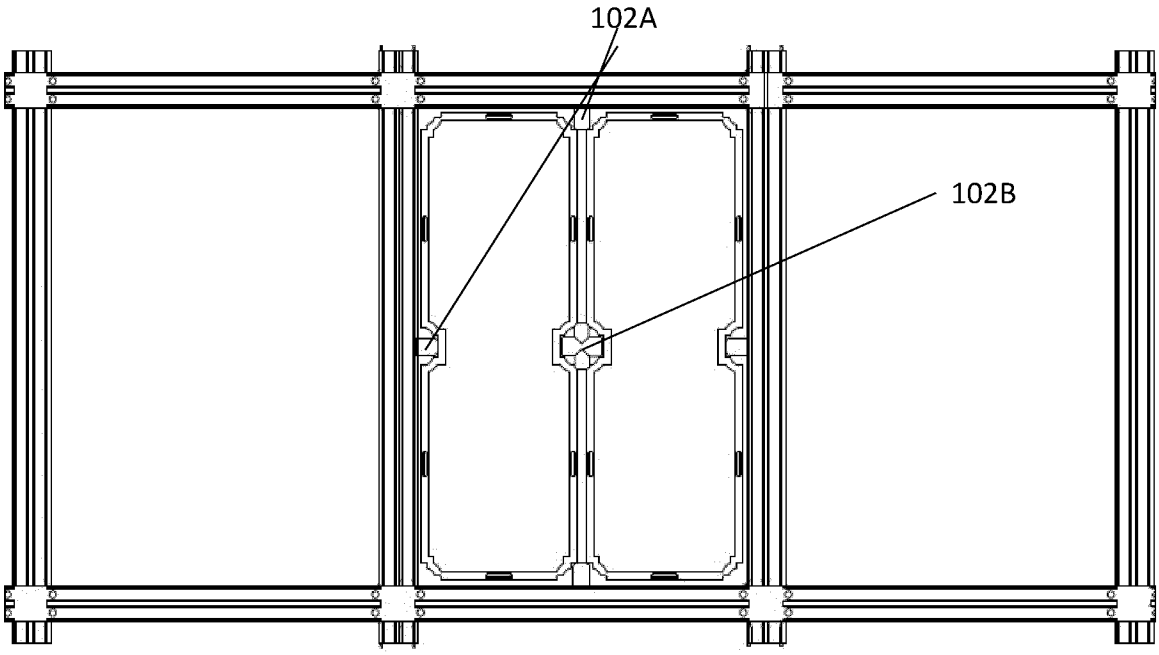


Fig. 12

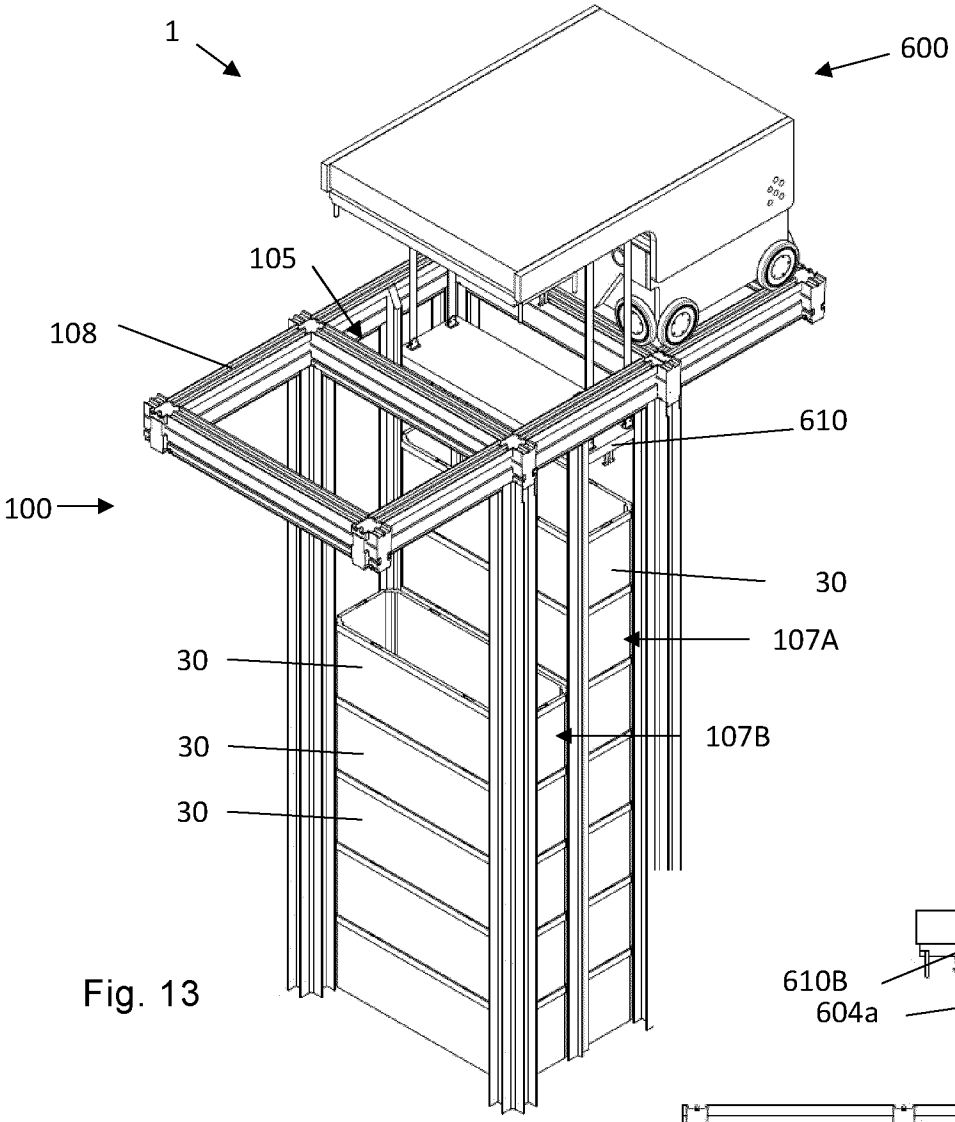
1
600
105
108
610
100
30
107A
30
107B
30
30

Fig. 13

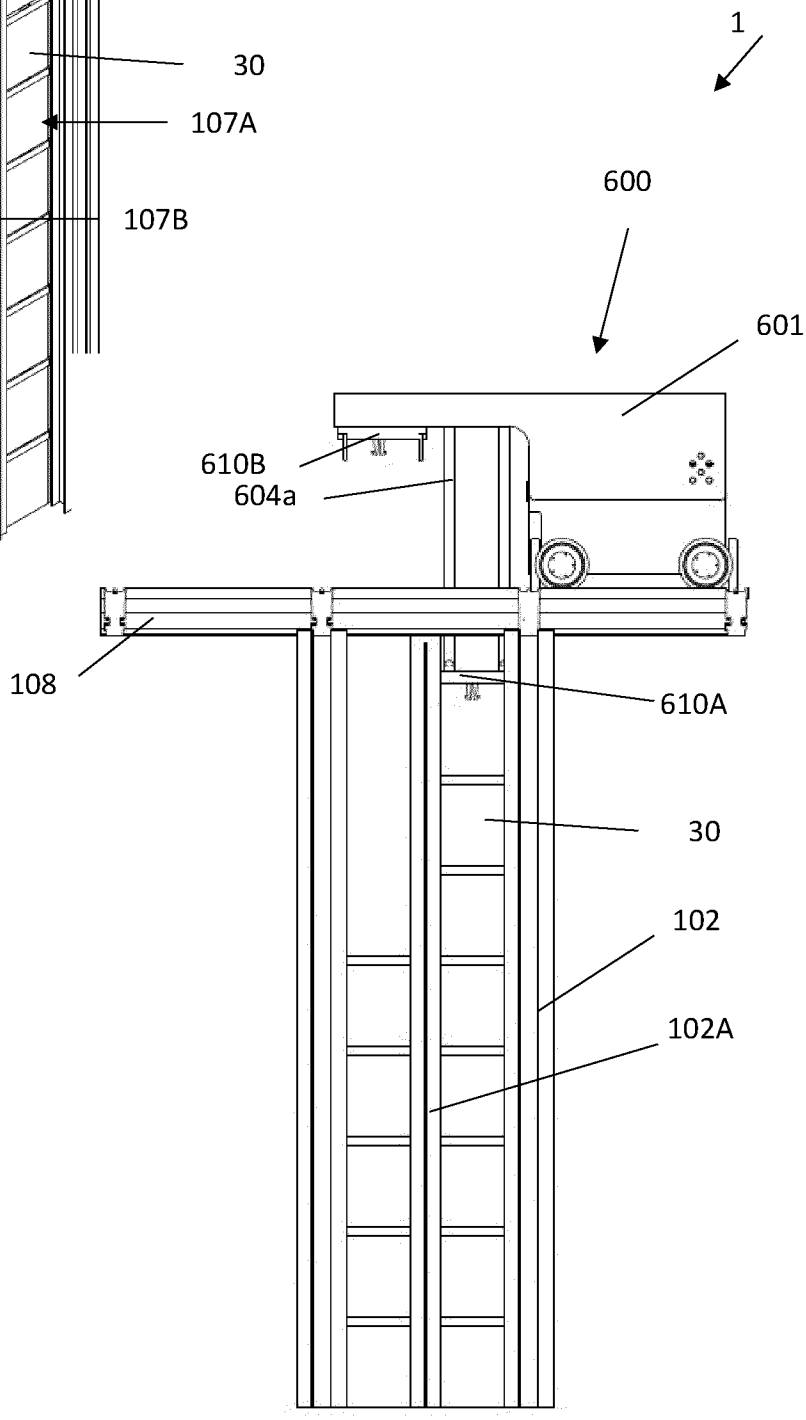
1
600
601
610B
604a
108
610A
30
102
102A

Fig. 14

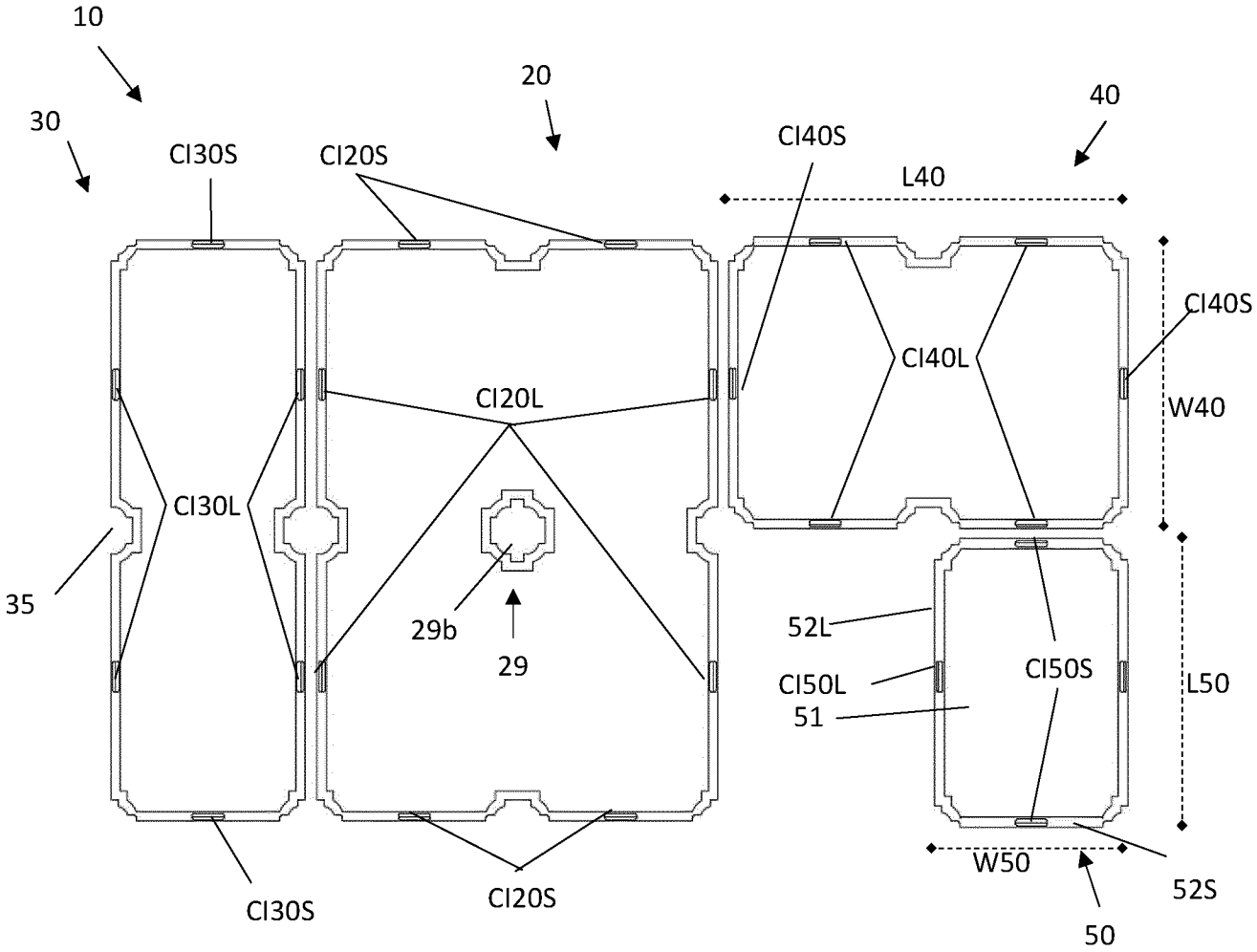


Fig. 15a

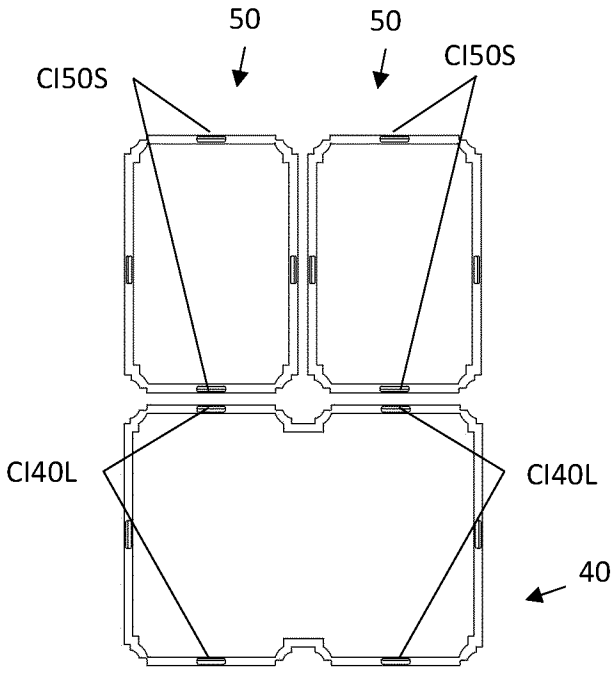


Fig. 15b

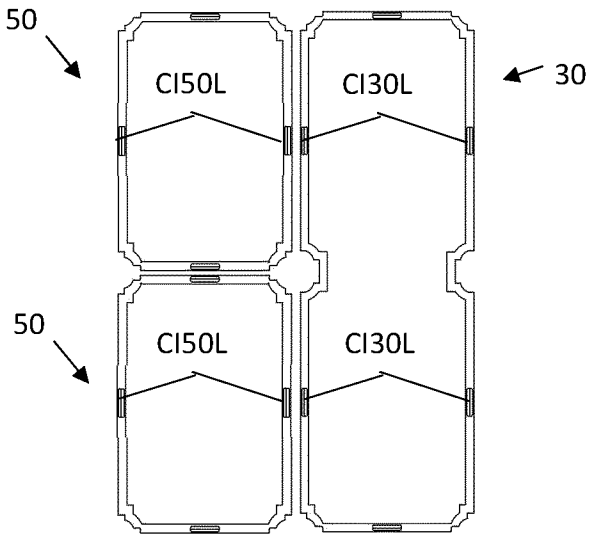


Fig. 15c

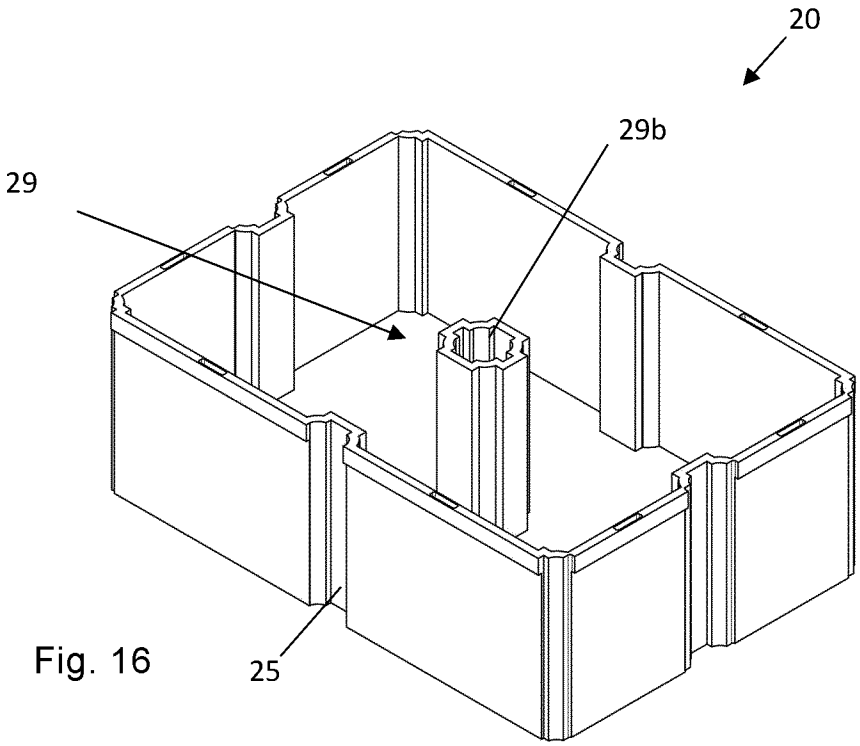


Fig. 16

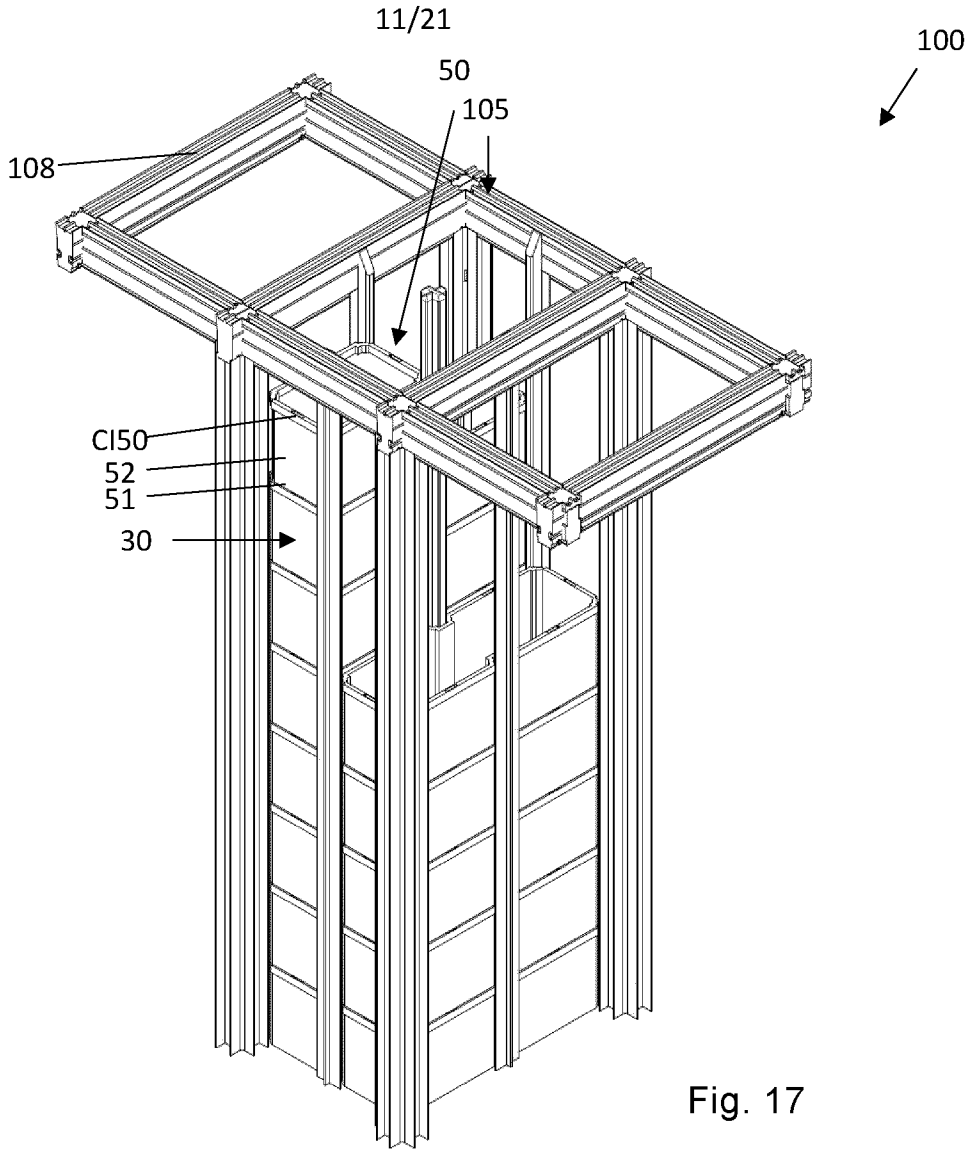


Fig. 17

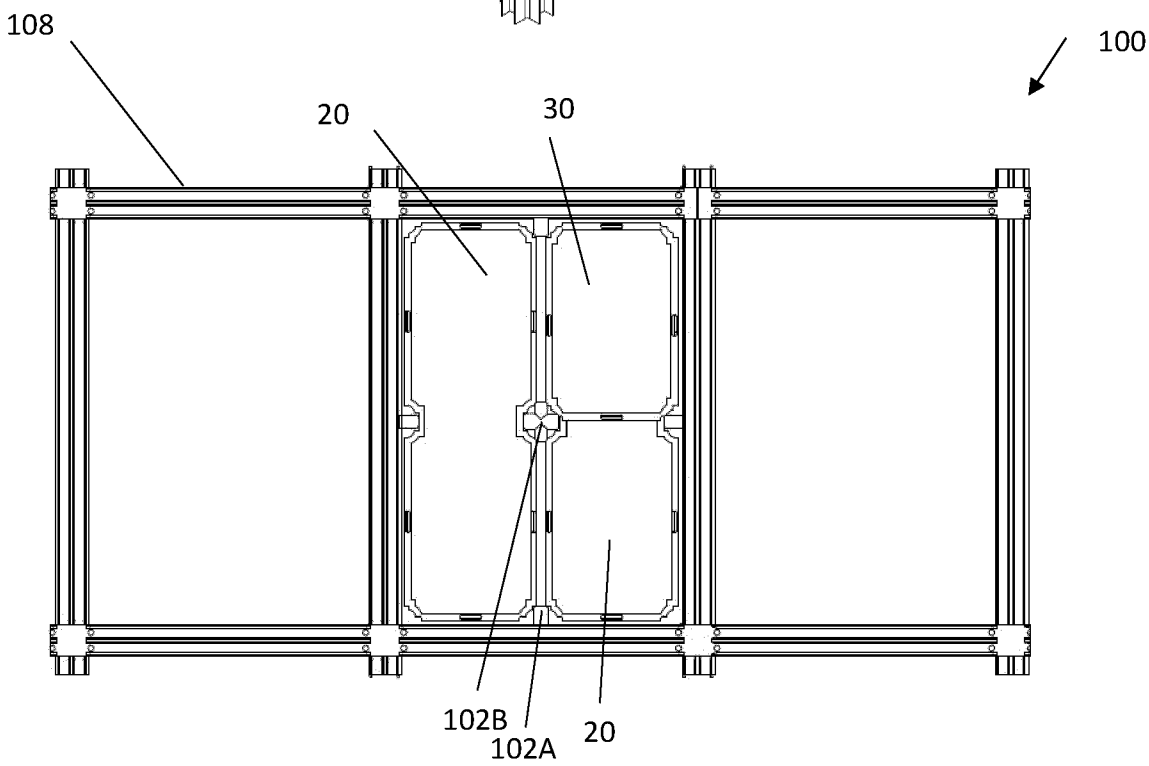


Fig. 18

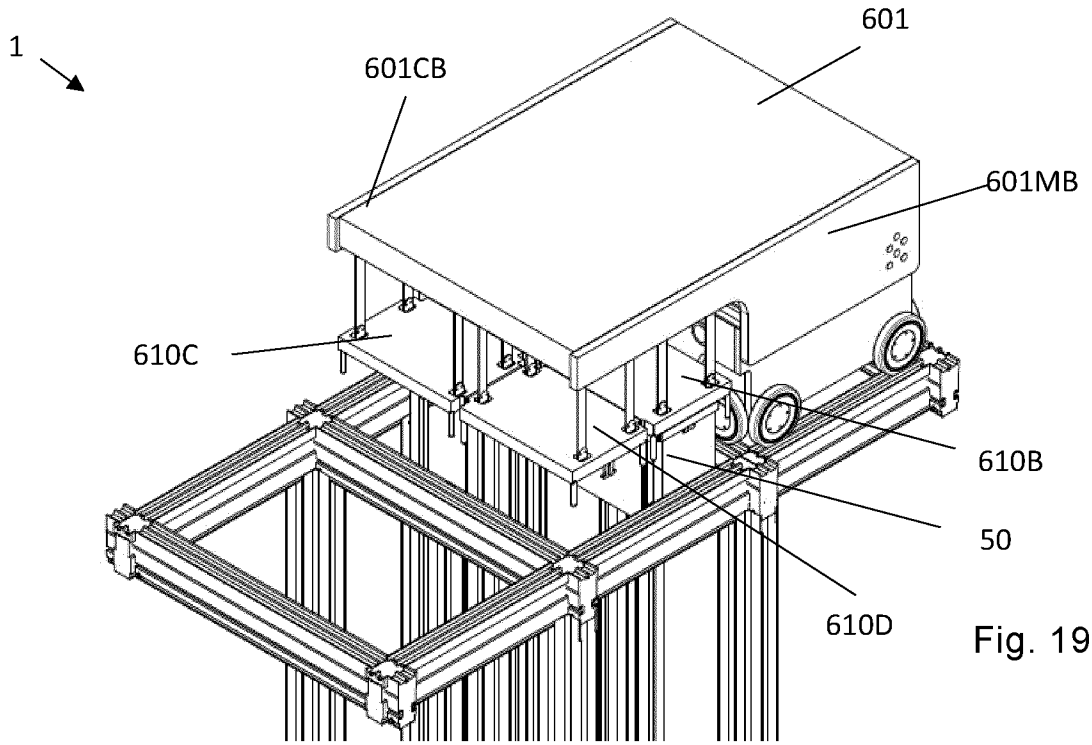


Fig. 19

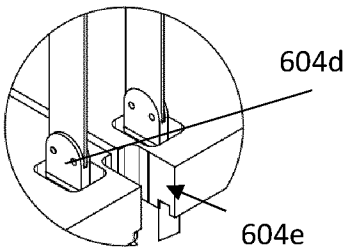


Fig. 20b

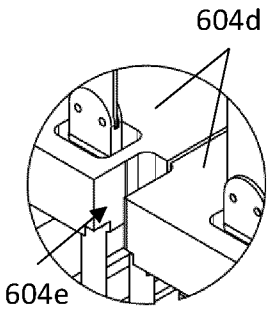


Fig. 20c

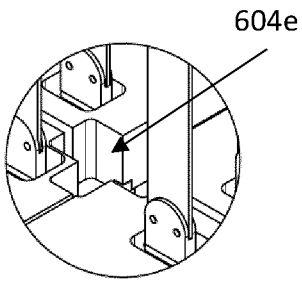


Fig. 20d

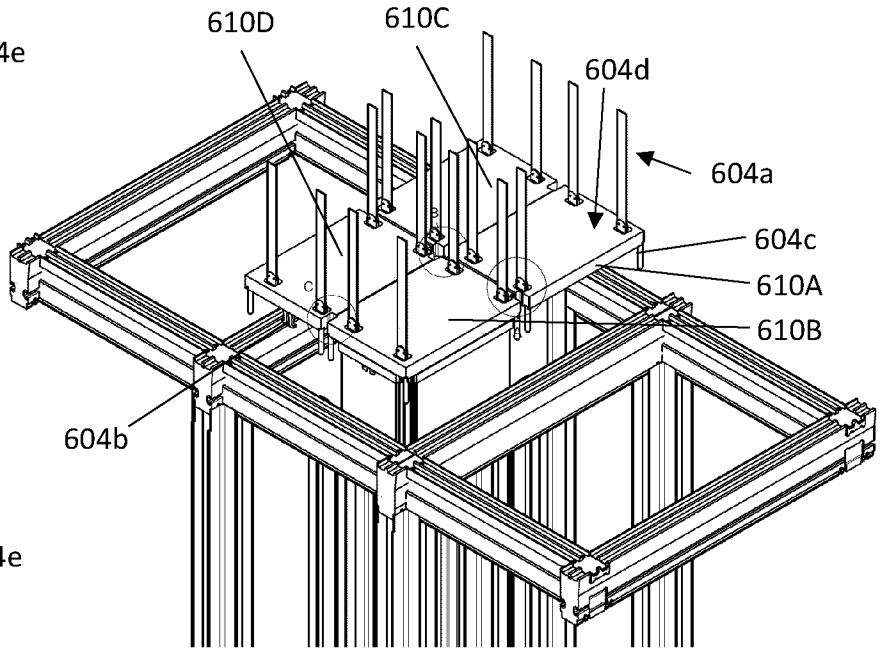


Fig. 20a

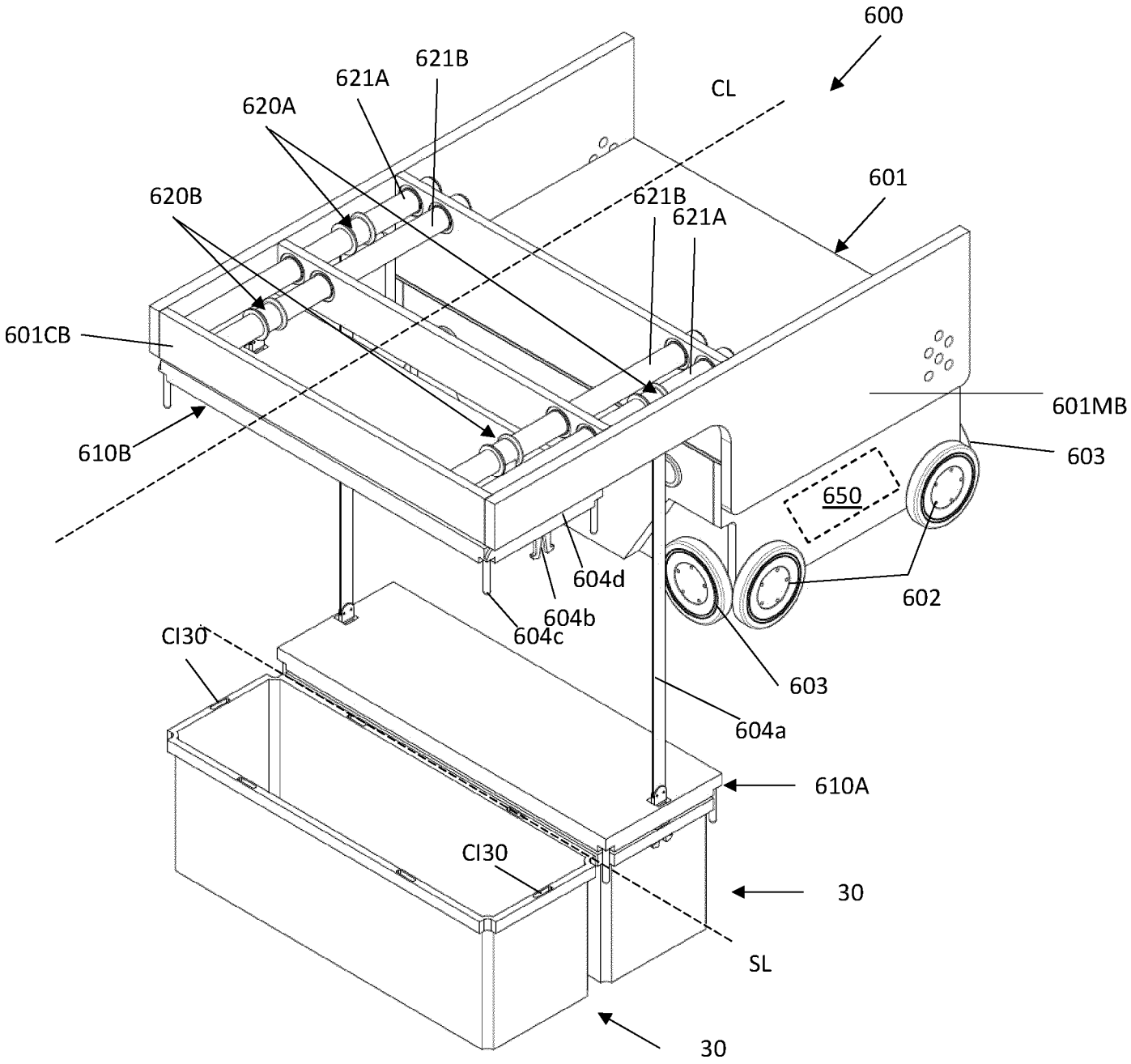
600
621B
621A
620A
CL
601
620B
621B
621A
601CB
601MB
610B
603
650
604d
602
604b
604c
CI30
603
604a
610A
CI30
30
SL
30

Fig. 21

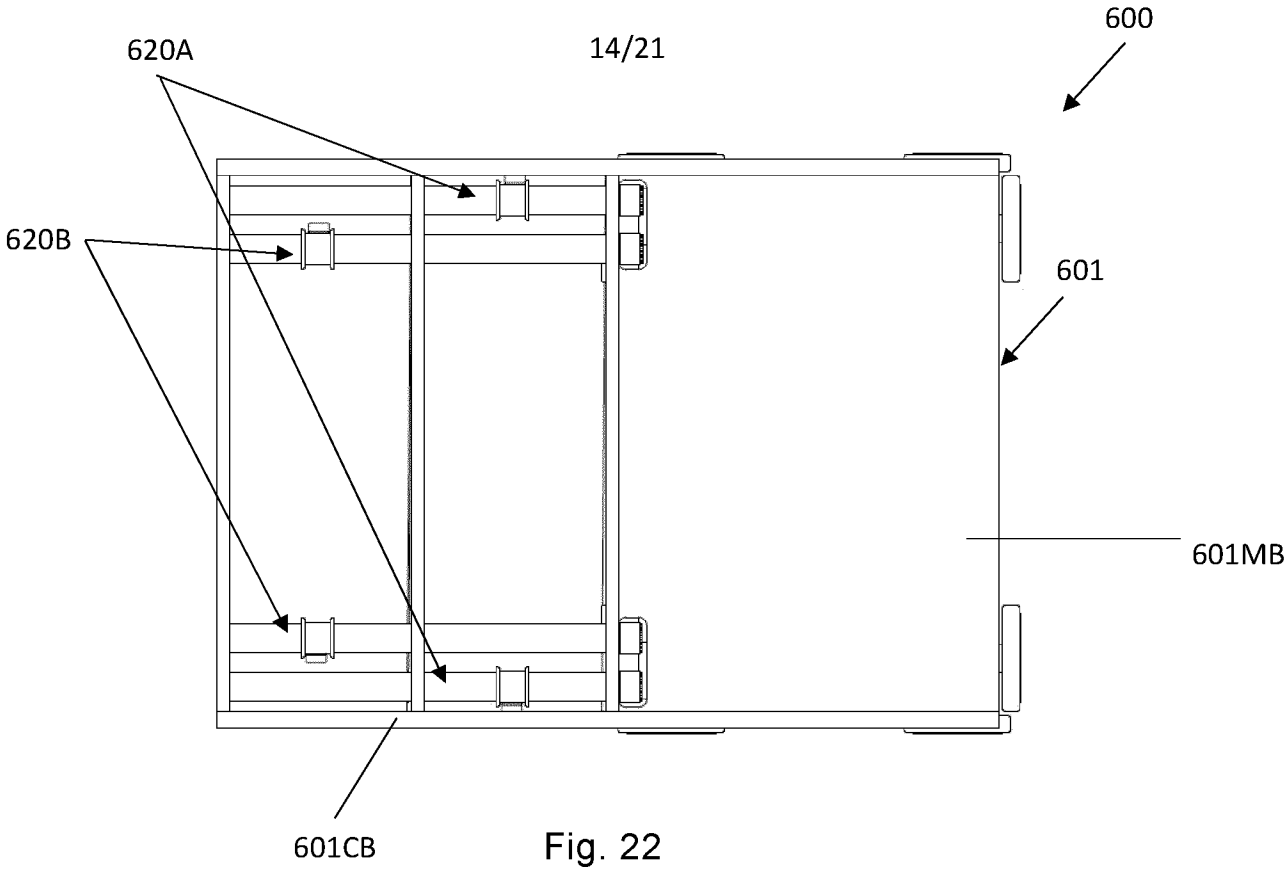


Fig. 22

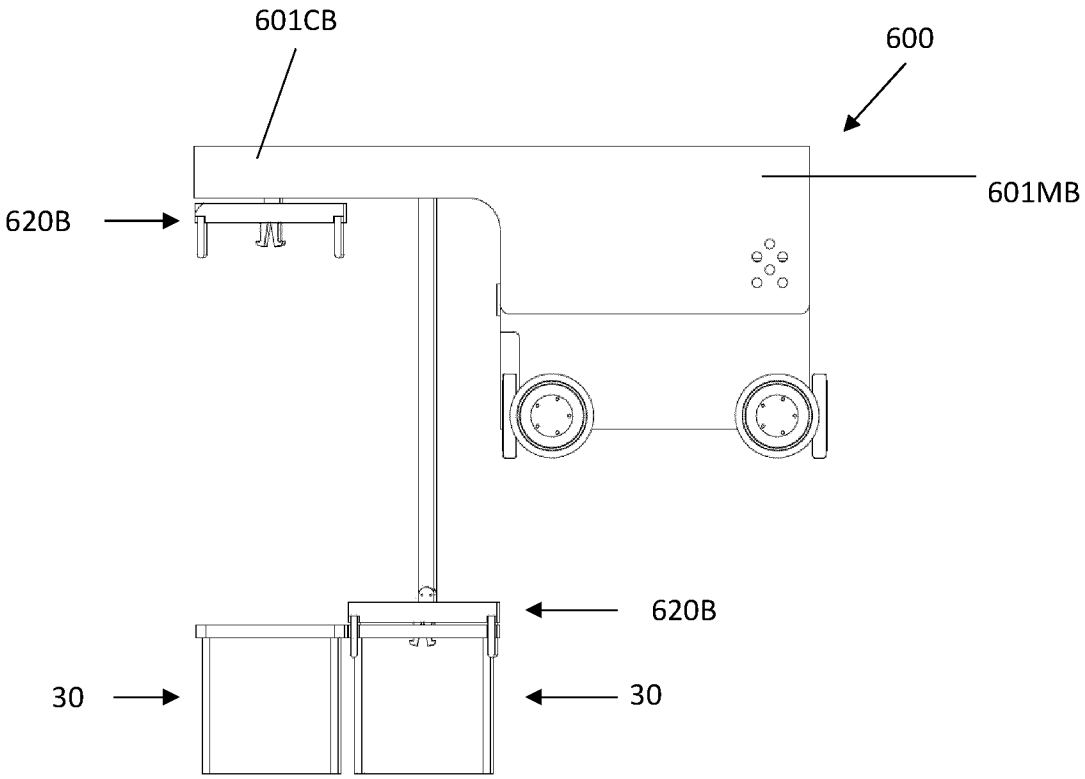


Fig. 23

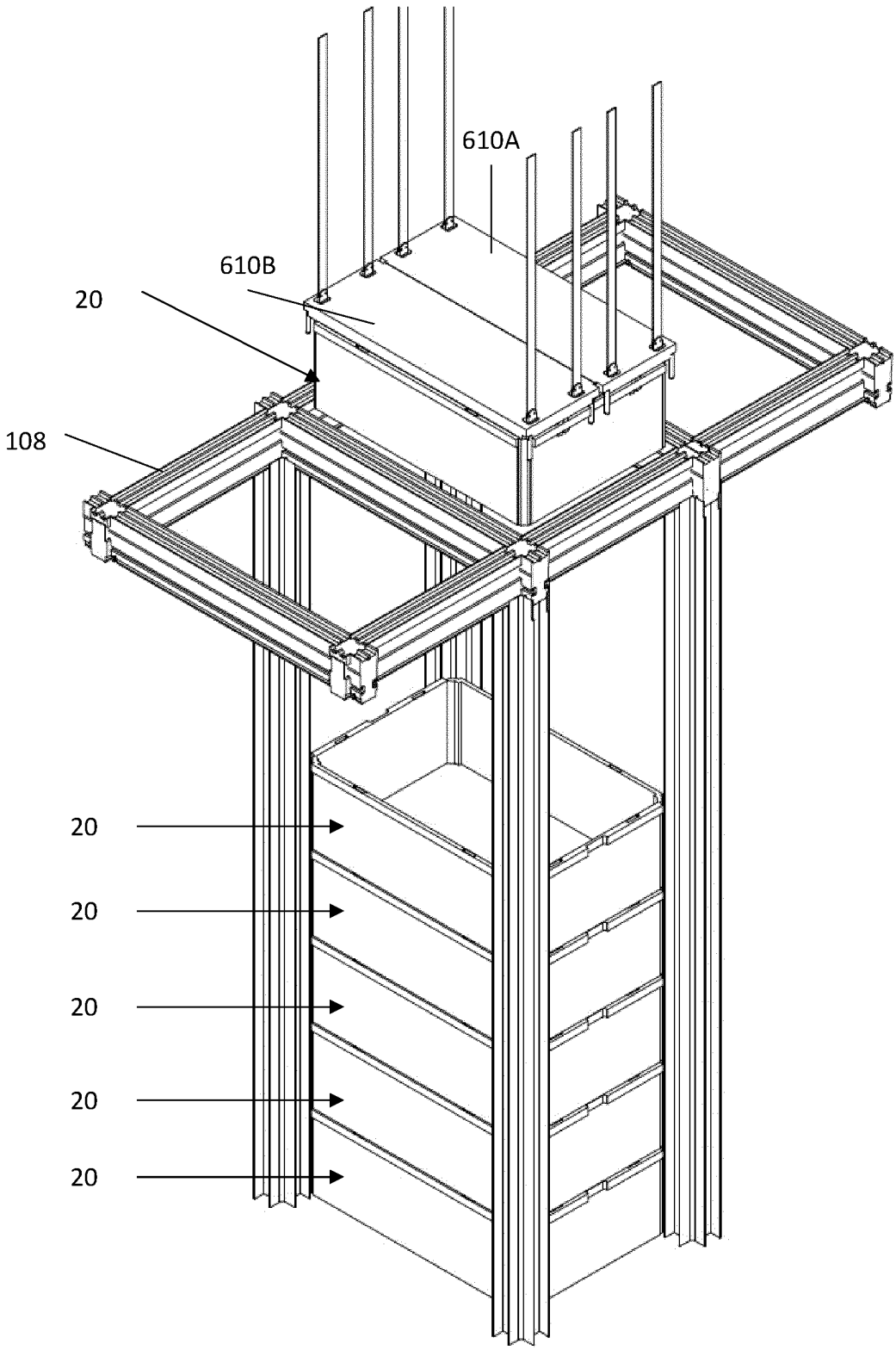


Fig. 24

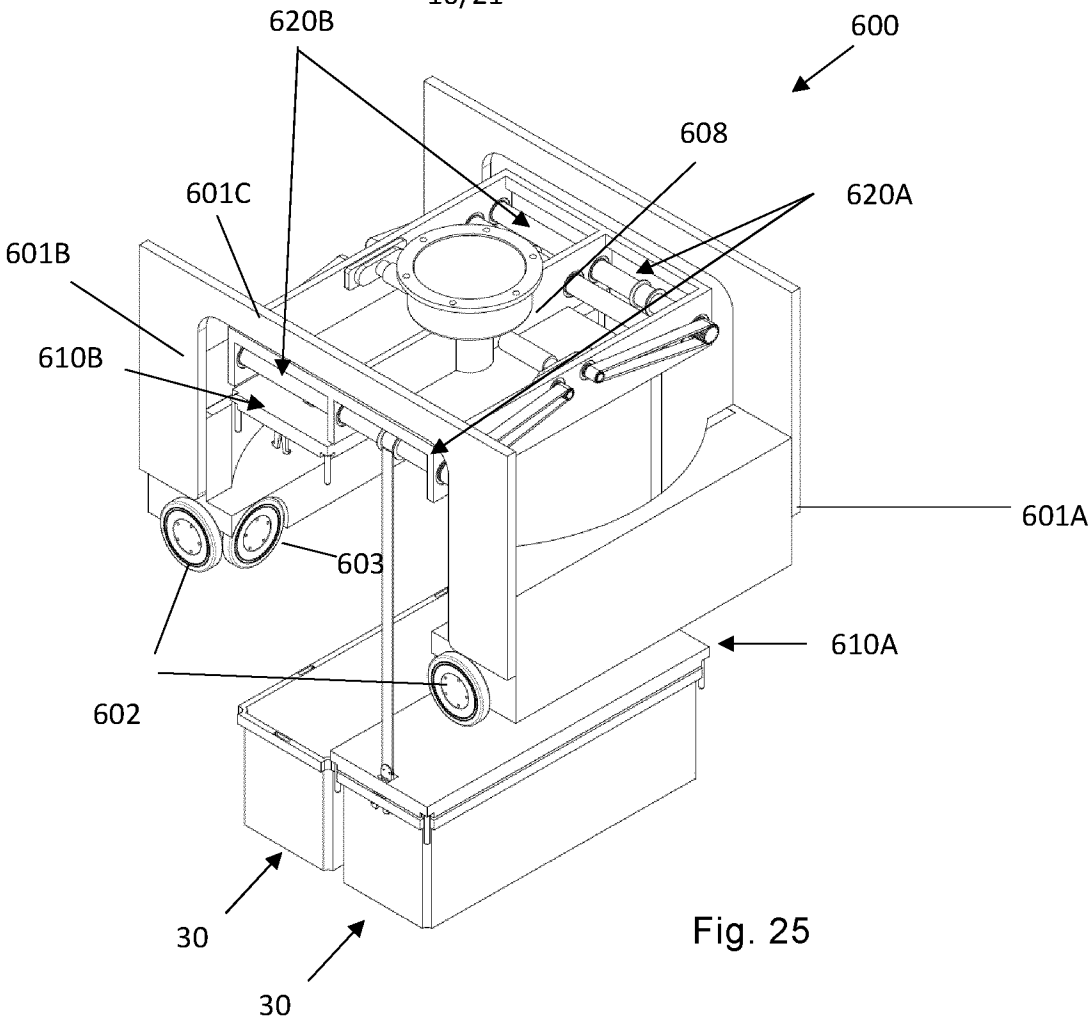
620B
600
608
601C
620A
601B
610B
601A
603
610A
602
30
30

Fig. 25

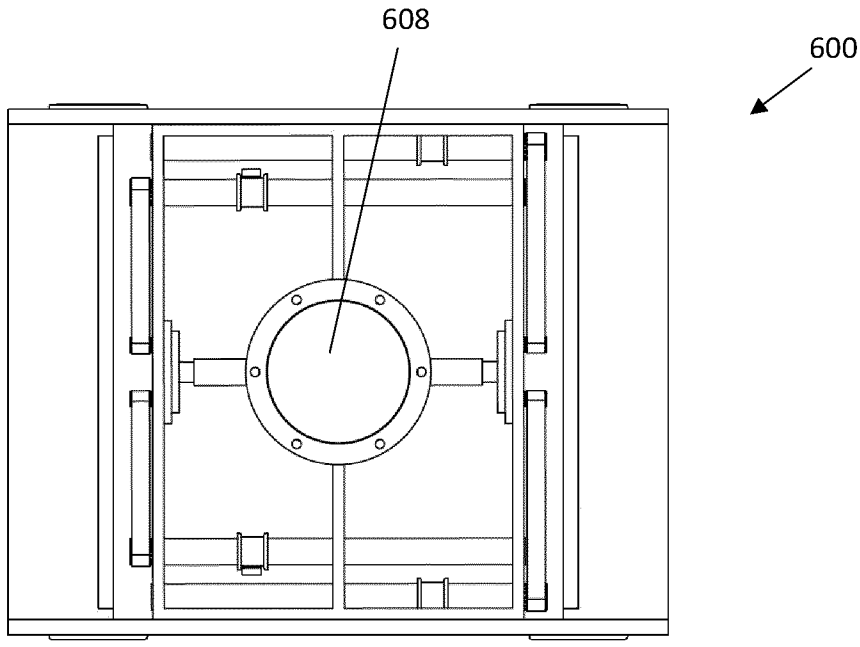
608
600

Fig. 26

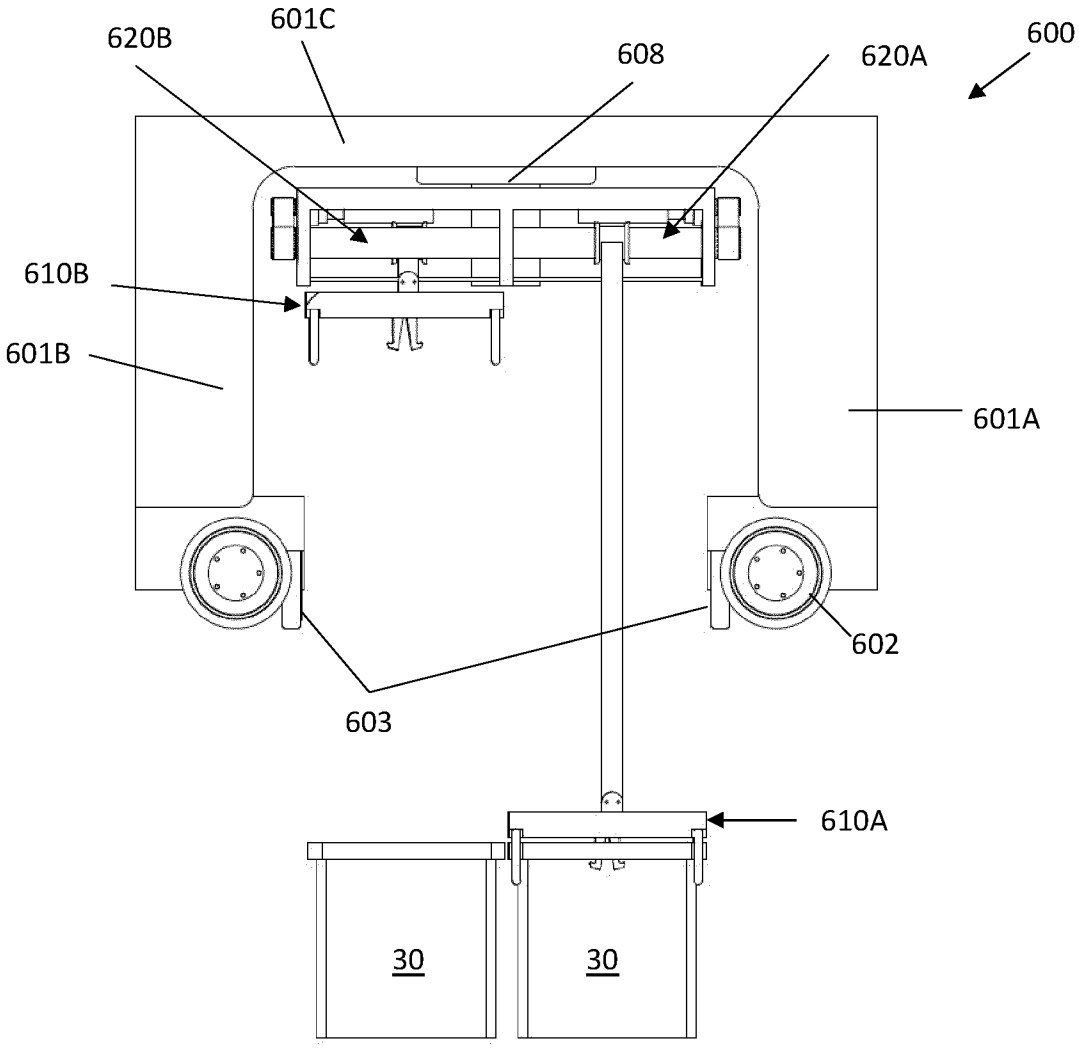


Fig. 27

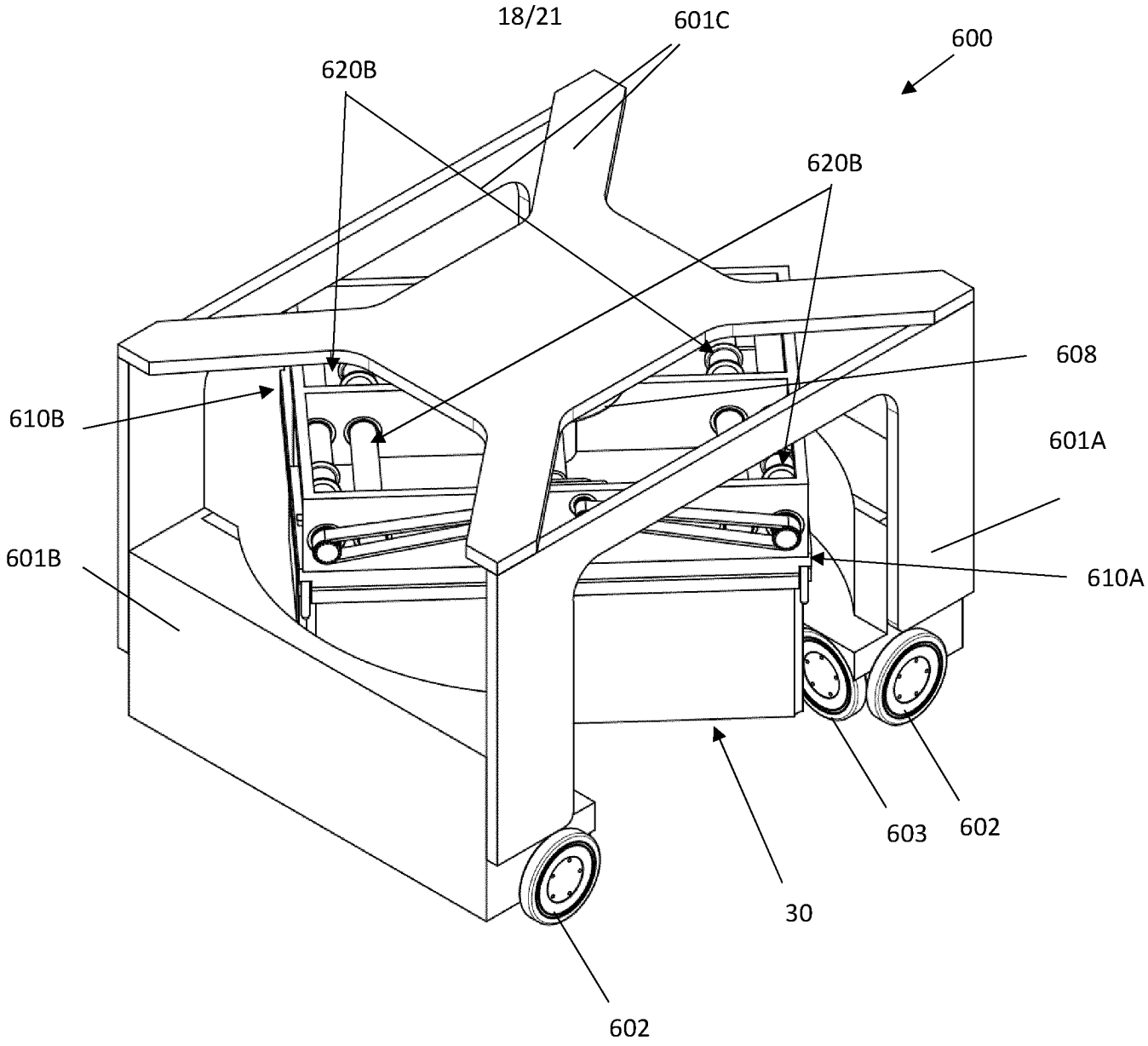


Fig. 28

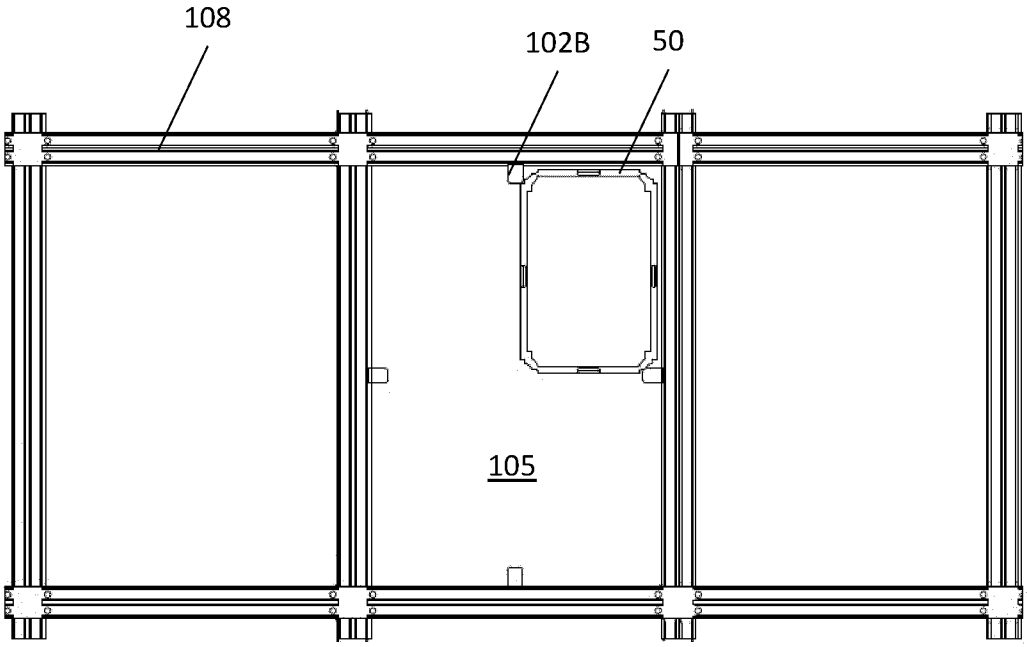


Fig. 29

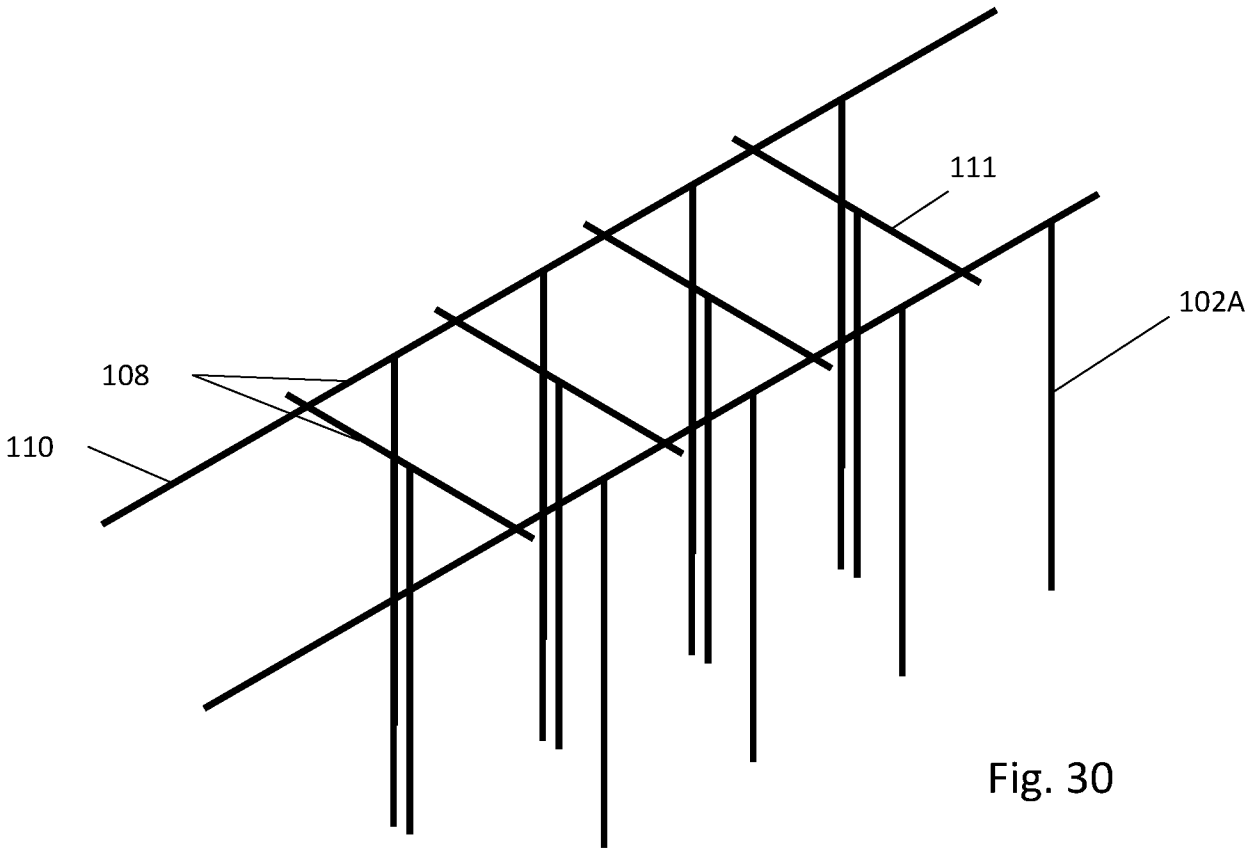


Fig. 30

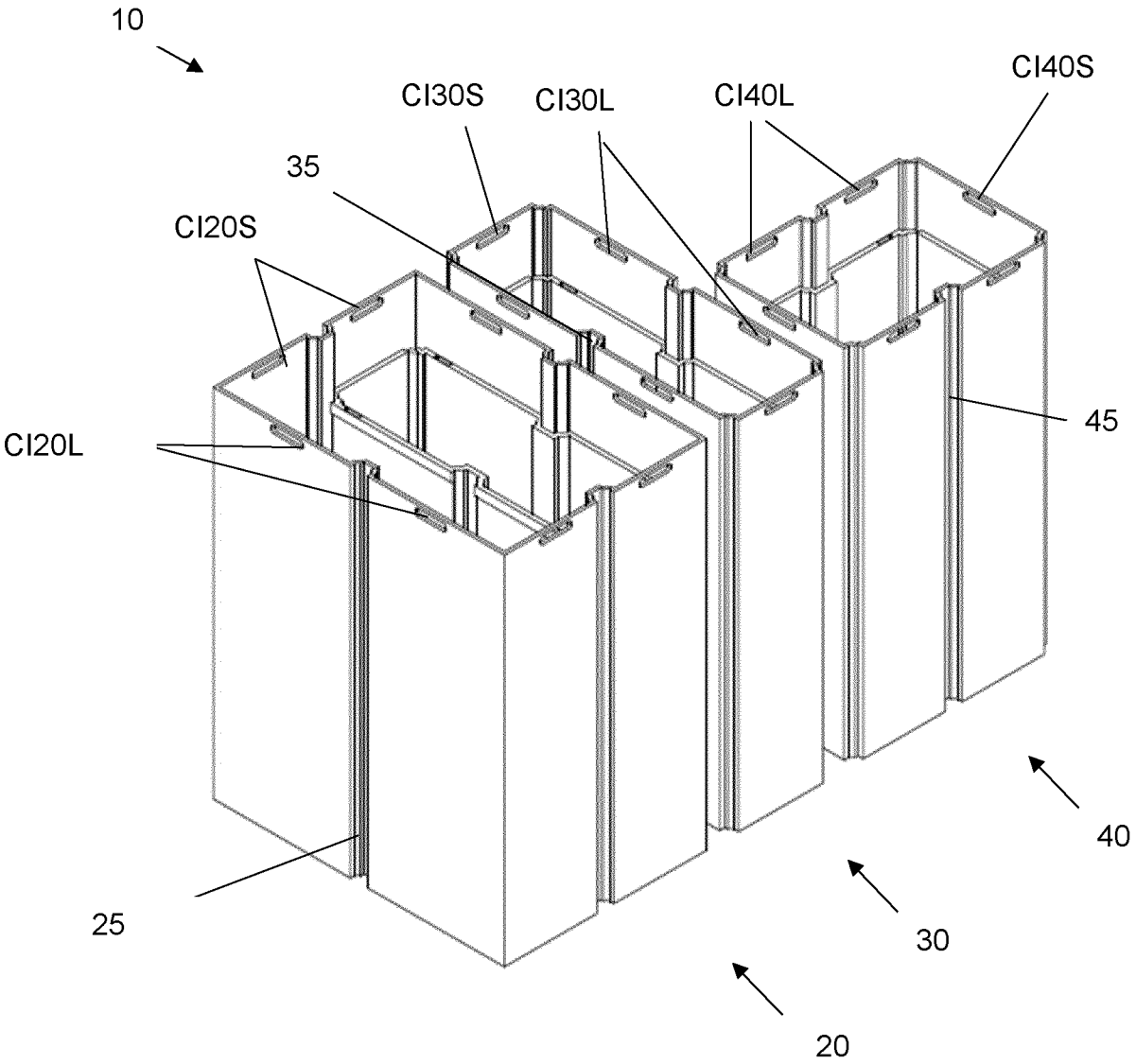


Fig. 31

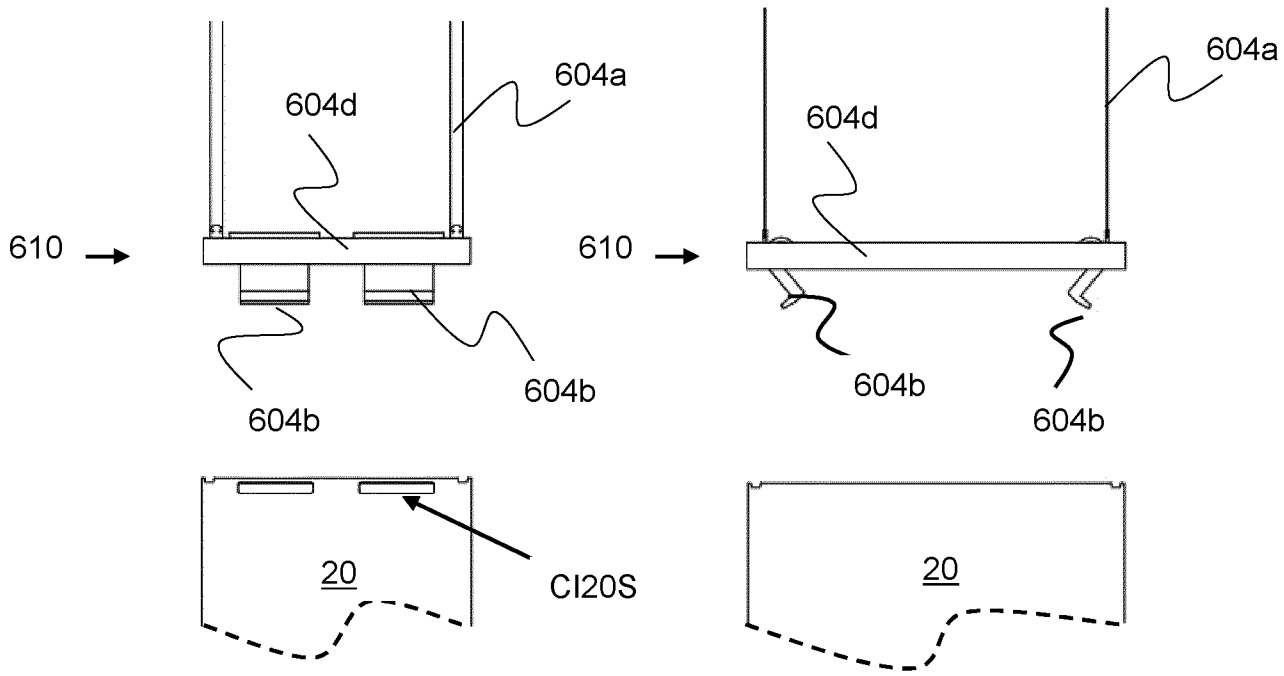
610
604d
604a
604b
604b
20
CI20S
610
604d
604a
604b
604b
20

Fig. 32

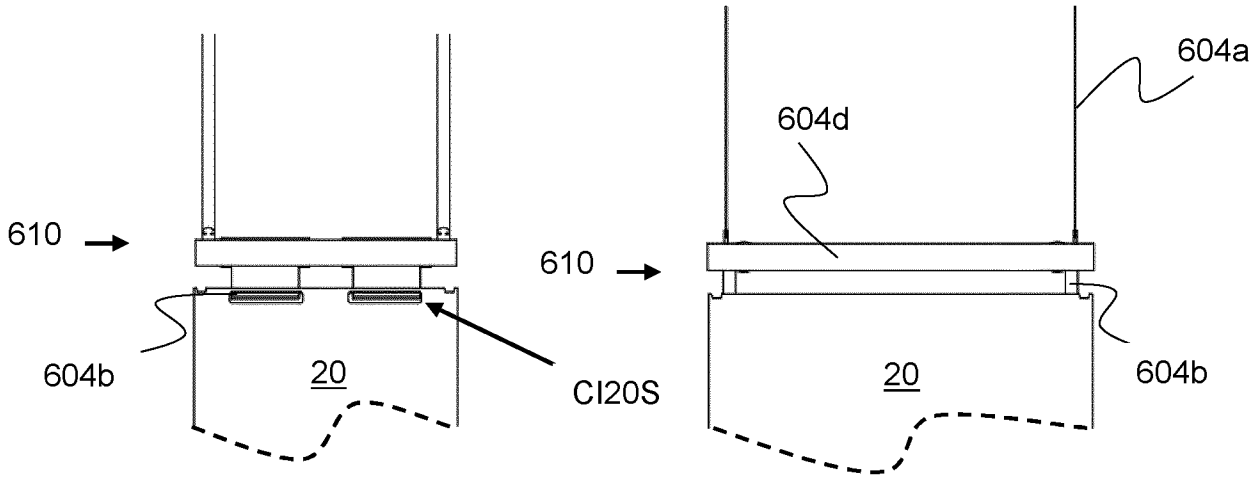
610
604b
20
CI20S
610
604d
604a
20
604b

Fig. 33

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/062836

**A. CLASSIFICATION OF SUBJECT MATTER**
INV. B65D21/02 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)
B65D 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

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"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

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 30 September 2024 | 10/10/2024 |

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

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International application No
PCT/EP2024/062836

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No
PCT/EP2024/062836

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