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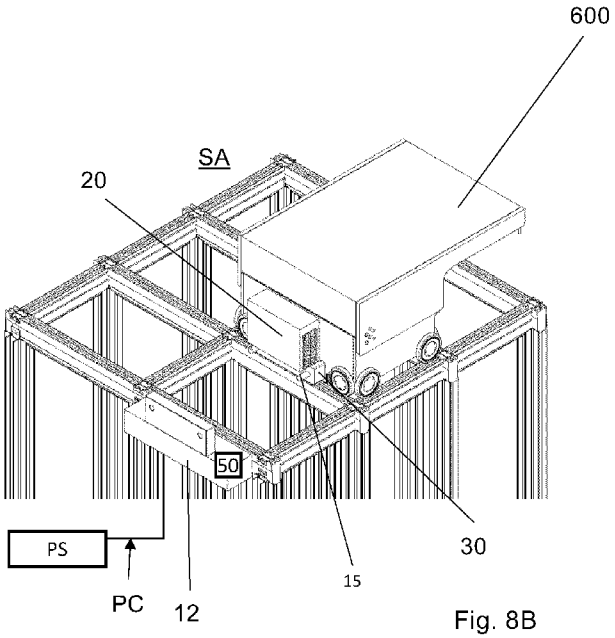

Fig. 8B

(57) Abstract: A charging station (10) for charging an energy source (620) of a vehicle (600) of an automated storage and retrieval system (1). The charging station (10) comprises a base (12), a charging interface (30) to which the vehicle (600) may connect for charging its energy source (620) and a charging unit (20). The charging unit (20) is releasably connected to the base (12). Alternatively or additionally, the charging interface (30) is releasably connected to the charging unit (20).

[Continued on next page]

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CHARGING STATION

FIELD

[0001] The present disclosure relates to a charging station for charging an energy source of a container handling vehicle of an automated storage and retrieval system. The present disclosure also relates to an automated storage and retrieval system comprising a framework structure and a charging station. The present disclosure also relates to a method for performing service, inspection and/or maintenance on a charging station of an automated storage and retrieval system.

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 container handling vehicles 201,301,401 are typically powered by an energy source in the form of a rechargeable battery. The rechargeable battery powers the wheels for moving the vehicle along the rail system, it powers the lifting device and gripper of the vehicle for handling the storage containers, it powers the

control system of the vehicle and the communication interface of the vehicle. The container handling vehicles 201,301,401 comprise a charging interface (indicated as 630 in fig. 3) to make electrical contact with a battery charger.

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] A conveyor system comprising conveyors is normally employed to transport the storage containers between the port columns 119,120 and the access station.

[0021] 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.

[0022] 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.

[0023] 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.

[0024] 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.

[0025] 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.

[0026] The above system comprises battery chargers in order to charge the batteries of the container handling vehicles. The chargers are typically located at an height immediately above and/or below the rail system 108 at an height enabling the container handling vehicles to move into electrical contact with the chargers.

[0027] These chargers may need operations in the form of service, maintenance and/or repair. In such situations, a person is moved to the location of the charger in order to perform the needed operation. The person may be transported by means of a service vehicle, or a step-deck may be located on top of the framework structure in order to allow the person to walk safely above the framework structure. In both of these situations, the operation of the system must be stopped or considerably reduced to reduce the risk of container handling vehicles hitting the person.

[0028] WO2022171838 describes a charger mounted to the grid which can be rotated for the purpose of performing maintenance, repair and service.

[0029] One object of the present invention is to reduce the need for persons moving on top of the rail system in automated storage and retrieval systems.

SUMMARY

[0030] 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.

[0031] The present disclosure relates to a charging station for charging an energy source of a vehicle of an automated storage and retrieval system, wherein the charging station comprises:

- a base;
- a charging interface to which the vehicle may connect for charging its energy source;
- a charging unit;

characterized in that:

- the charging unit is releasably connected to the base; and/or
- the charging interface is releasably connected to the charging unit.

[0032] The base may be securable to a framework structure of the automated storage and retrieval system. The base may be securable to another structure adjacent to the framework structure.

[0033] The charging interface may be a power transferring interface for transferring power from the charging station to the vehicle. The charging interface may be a power transferring and communication interface for transferring power from the charging station to the vehicle and for providing communication between the charging station and the vehicle.

[0034] The charging interface may comprise a wired power connector. The charging interface may comprise a wireless power connector. The charging interface may comprise a wired communication connector. The charging interface may comprise a wireless communication connector.

[0035] The charging interface may be integrated with the charging unit. The charging interface and the charging unit may be integrated as one single unit. In this case, the charging interface and the charging unit are releasably connected to the base.

[0036] The charging unit may be integrated with the base. The charging unit and the base may be integrated as one single unit. In this case, the charging interface is releasably connected to the charging unit and the base.

[0037] The base may at least partially be a part of the framework structure. The base may comprise apertures, recesses etc. provided in the rail system, the upright members or other parts of the framework structure in which the charging unit is insertable. The base may be pins, dogs, lugs etc. protruding from the rail system, the upright members or other parts of the framework structure to which the charging unit is connectable.

[0038] The base, the charging unit and the charging interface may be separate units which all can be releasably connected to each other.

[0039] The charging unit and/or the charging interface may comprise a vehicle connection interface connectable to the vehicle;
- the charging unit may be releasably connected to the base by means of the vehicle

connection interface; and/or
- the charging interface may be releasably connected to the charging unit by means of the vehicle connection interface.

[0040] The vehicle connection interface is allowing the charging unit to be releasably connected to the base by means of the vehicle; and/or is allowing the charging interface to be releasably connected to the charging unit by means of the vehicle.

[0041] The vehicle connection interface may be the charging interface.

[0042] The vehicle connection interface may be a connection interface allowing a gripper device of the vehicle to connect to the charging unit and/or the charging interface.

[0043] In this case, the vehicle may be a container handling vehicle used to move storage containers within the automated storage and retrieval system.

[0044] The charging station may comprise a releasable locking device for releasably locking the charging unit to the base and/or for releasably locking the charging interface to the charging unit.

[0045] Hence, unintentional movement of the charging unit relative to the base and/or unintentional movement of the charging interface relative to the charging unit is prevented when the charging station is used to charge a vehicle.

[0046] The charging station may comprise a guide for guiding the movement of the charging unit relative to the base and/or for guiding the movement of the charging interface relative to the charging unit.

[0047] The guide may be an electrical conductor for electrically connecting the charging unit to the base and/or for electrically connecting the charging interface to the charging unit.

[0048] The releasable locking device may be configured to releasably engage the guide.

[0049] The releasable locking device may comprise an electric actuator, an electromagnetic actuator etc. The actuator may be an electric motor, a linear actuator etc. The releasable locking device may comprise a position sensor for sensing the presence of the guide, for sensing a position of a locking member

engaging the guide etc. The releasable locking device may be a mechanical locking device, such as a spring plunger, ball plunger etc.

[0050] The charging station may comprise a control system, wherein the control system may comprise a control unit configured to control the releasable locking device.

[0051] The charging station may comprise a communication unit provided in communication with the control unit, wherein the communication unit may be configured to communicate with the vehicle or other parts of the automated storage and retrieval system.

[0052] The charging station may comprise a relay switch for turning on or off a supply of power to the charging unit and/or the charging interface, wherein the control unit may be configured to control the relay switch.

[0053] The relay switch may be controlled to turn off the supply of power to the charging unit before disconnection of the charging unit from the base and before connection of the charging unit to the base. The relay switch may be controlled to turn off the supply of power to the charging interface before disconnection of the charging interface from the charging unit and before connection of the charging interface to the charging unit.

[0054] The present invention 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 vehicle arranged to operate on the rail system;
wherein the automated storage and retrieval system comprises a charging station according to the above;
wherein the base is secured to or integrated with the framework structure;
wherein the vehicle is configured to disconnect the charging unit from the base and to connect the charging unit to the base; and/or

- the vehicle is configured to disconnect the charging interface from the charging unit and to connect the charging interface to the charging unit.

[0055] The vehicle may here be configured to disconnect the charging unit and the charging interface from the base and to connect the charging unit and the charging interface to the base.

[0056] The vehicle may here be configured to disconnect only the charging interface from the charging unit and to connect the charging interface to the charging unit. The control system may use the communication unit to communicate with the vehicle before, during or after the disconnection of the charging unit from the base and before, during or after the connection of the charging unit to the base, and/or to communicate with the vehicle before, during or after the disconnection of the charging interface from the charging unit and before, during or after the connection of the charging interface to the charging unit.

[0057] The control system of the charging station may use the communication unit to send information to the vehicle about the state of the locking device.

[0058] The vehicle may comprise a charging interface connectable to the charging interface of the charging station for charging an energy source of the vehicle, wherein the charging interface of the vehicle may be used to disconnect the charging unit from the base and to connect the charging unit to the base; and/or the charging interface of the vehicle may be configured to disconnect the charging interface from the charging unit and to connect the charging interface to the charging unit.

[0059] The vehicle may comprise a vehicle body, a gripping device and a lifting device for lifting the gripping device relative to the vehicle body; wherein the vehicle may be configured to engage the connection interface by means of its gripping device.

[0060] The vehicle may be a container handling vehicle.

[0061] The lifting device may be connected to the gripping device by means of lifting bands. The gripping device may comprise a lifting frame with guide pins for guiding the lifting frame relative to the connection interface. The connection interface may be provided as part of the charging interface, as part of the charging unit or as a separate connection structure connected to the charging interface or

charging unit. The connection structure may comprise a horizontal plate. The connection interface may be provided as slots or apertures in the vertical plate. The gripping device may comprise a gripper for engaging the slots or apertures of the connection interface. The gripper and/or the guide pins may protrude downwardly from the lifting frame.

[0062] The charging unit may comprise a converter for converting power supplied to the charging station to power supplied to the energy source of the vehicle. The converter may be an AC/DC converter. The converter may be a DC/DC converter.

[0063] The vehicle may be configured to:
- move the charging unit and the charging interface to and from a service area; and/or
- move the charging interface to and from the service area.

[0064] The vehicle and/or the automated storage and retrieval system may be configured to register if the vehicle is carrying parts of the charging station, as the carrying of parts of the charging station may increase the footprint of the vehicle, thereby requiring a larger distance between the vehicle and other vehicles when carrying parts of the charging station than when not vehicle for the purpose of avoiding collision.

[0065] The vehicle may be a dedicated charging station handling vehicle which sole purpose is to move parts of the charging stations to and from the service area. Alternatively, another type of device may be used to releasably connect the charging unit to the base; and/or to releasably connect the charging interface to the charging unit. This device may be an overhead crane such as a gantry crane, bridge crane etc. which can lift parts of the charging station up from the framework structure and move it sideways to the a service area.

[0066] The present disclosure also relates to a method for performing service, inspection and/or maintenance on a charging station of an automated storage and retrieval system, wherein the method comprises the steps of:
- moving a vehicle to the charging station;
- connecting the vehicle to a charging unit of the charging station or to a charging interface of the charging station;
- disconnecting the charging unit from a base of the charging station or

disconnecting the charging interface from the charging unit of the charging station;
- moving the charging unit or the charging unit and the charging interface to a service area by means of the vehicle;
- performing service, inspection and/or maintenance on the charging unit and/or and the charging interface.

[0067] The method may comprise the steps of:
- moving the charging unit or the charging unit and the charging interface from the service area to the base by means of the vehicle;
- connecting the charging unit to the base of the charging station or connecting the charging interface to the charging unit of the charging station;
- disconnecting the vehicle from the charging unit of the charging station or from the charging interface of the charging station.

[0068] According to the above, it is achieved that the need for persons moving on top of the rail system for performing service, repair and/or maintenance on charging stations is reduced.

[0069] A further advantage is that the charging stations can be located anywhere in the automated storage and retrieval system as long as the charging station is available to the vehicle. In some prior art, the locations of the charging stations are restricted to locations along the periphery of the framework structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0070] Following drawings are appended to facilitate the understanding of the disclosure . The drawings show embodiments which will now be described by way of example only, where:

[0071] Fig. 1 is a perspective view of a framework structure of a prior art automated storage and retrieval system;

[0072] Fig. 2 is a perspective view of a prior art container handling vehicle having an internally arranged cavity for carrying storage containers therein;

[0073] Fig. 3 is a perspective view of a prior art container handling vehicle having a cantilever for carrying storage containers underneath;

[0074] 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;

[0075] Figs. 5A-5F illustrate a first embodiment;

[0076] Figs. 6A – 6I illustrate a second embodiment;

[0077] Figs. 7A – 7C illustrate a third embodiment;

[0078] Figs. 8A – 8C illustrate a fourth embodiment;

[0079] Figs. 9A – 9B illustrate a fifth embodiment;

[0080] Figs. 10A – 10D illustrate a sixth embodiment;

[0081] Figs. 11A – 11B illustrate a seventh embodiment;

[0082] Fig. 12 illustrates parts of the control system of the charging station; and

[0083] Fig. 13A and 13B illustrate the locking device of the charging station.

DETAILED DESCRIPTION

[0084] In overview, embodiments provide a charging station for the energy source (e.g. battery) of a vehicle (e.g. robot) operating in an automated storage and retrieval system (e.g. the top of a storage grid thereof).

[0085] The charging station comprises a charging interface, base and a charging unit. The base is for supporting the charging unit in a particular location in the automated storage and retrieval system. This can be support in a detachable (or releasable) sense, so that the charging unit can be removed from the base and thereby potentially removed from the location of the base and to another location such as a service and maintenance location. That is, the base can provide a point of attachment for the charging unit if the charging unit is made to be separable from the base. In other words, the charging unit and the base are detachably (or releasably) connected.

[0086] The charging interface is supported by the charging unit. This support can in a detachable (or releasable) sense in that the charging interface can be removed from the charging unit. That is, the charging unit can provide a point of attachment for the charging interface if the charging interface is made to be separable from the charging unit. In other words, the charging unit and the charging interface are detachably (or releasably) connected.

[0087] Embodiments include any one of (i) an integrated base and charging unit with a detachable charging interface; (ii) an integrated charging unit and charging interface, which are together detachable from the base; or (iii) a charging interface that is detachable from the charging unit, which charging unit is detachable from the base. Integrated in this sense means that the two components cannot be detached from one another.

[0088] Allowing two or more of the base, charging unit and charging interface to be removable from one another simplifies and improves safety of replacement, maintenance and service of the removed components. For example, the detachable component(s) (charging unit, or charging interface, or both) can potentially be moved away from the location of the base into a safer location or a location which facilitates ease of maintenance and service of the component, such as a service area. This can be especially beneficial if the base is located in an area which is hazardous for human operators, such as on or in in an automated storage and retrieval system with moving vehicles and/or with fall, trapping or other hazards to human operators.

[0089] The charging station is arranged such that a vehicle can approach the charging station and connect thereto such that the charging station is able to charge the energy source of the vehicle.

[0090] The charging unit can be configured to detach from the base upon connection of the vehicle to the charging station. Alternatively, the charging interface can be configured to detach from the charging unit upon connection of the vehicle to the charging station. The connection resulting in the detachment can be selectable so that the vehicle can approach the charging station and connect thereto for charging the energy source of the vehicle without causing the detachment of the charging station components from each other. The vehicle can also be controlled to then cause detachment of the charging station components from each other. Upon detachment, the detached component may be arranged to attach to the vehicle, or the vehicle may be arranged to pick up or attach itself to the detached component. This allows the vehicle to remove the detachable component and carry it away from the base (or charging unit or integrated base/charging unit), thus eliminating or reducing the need for the presence of a human operator in the area in which the base is located.

[0091] The charging unit or the charging interface may have a vehicle connection interface that facilitates the detachment of the charging interface from the charging unit or the charging unit from the base. That is, the vehicle connection interface is arranged to cause the charging unit to be released from the base upon connection of a vehicle to the vehicle connection interface; and/or the vehicle connection interface is arranged to cause the charging interface to be released from the charging unit upon connection of a vehicle to the vehicle connection interface. The connection interface may itself serve as the vehicle connection interface.

[0092] The charging interface and/or the charging unit can be configured to allow an engagement device (e.g. a gripper) of the vehicle to engage therewith to facilitate removal of the detachable component from the other component(s) of the charging station. The vehicle may include the corresponding engagement device configured to releasably engage (e.g. grip) the charging interface and/or the charging unit. The engagement device may be the same as that used for engaging and lifting storage containers, or may be another form of engagement device configured specifically for engaging and lifting the charging interface and/or the charging unit.

[0093] The nature of the connection between the charging unit and the charging interface or between the base and the charging unit can be such that the detachable component moves along a guide so as to be detachable from the other component(s).

[0094] A releasable locking device can selectively lock the detachable component to the other components of the charging station so that the detachable component cannot be moved relative to the other components until the releasable locking device is released (e.g. in response to a command from a control unit of the charging device, vehicle or automated storage and retrieval system).

[0095] This overview is provided to introduce in simplified form a selection of concepts that are further described herein. The overview is not intended to identify key or essential features of the invention.

[0096] In the following, embodiments of the invention 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 invention to the subject-matter depicted in the drawings.

[0097] 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.

[0098] 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.

[0099] 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.

Example 1

[0100] It is now referred to fig. 5a and fig. 5b. Here a simplified version of the automated storage and retrieval system 1 is shown for the purpose of illustrating a charging station 10 and the interaction between the charging station and a container handling vehicle 600. The framework structure 100 here comprises twelve upright members 102 defining six storage columns 105. Similar to prior art, the rail system 108 is provided on top of the upright members 102. The container handling vehicle 600 is here of the cantilever type similar to, but not necessarily identical to, the container handling vehicle 600 of fig. 3.

[0101] As shown in fig. 5a, the container handling vehicle 600 comprises a vehicle body 601 with a cantilever structure 601CL, wheels for moving the vehicle in the X-direction and the Y-direction along the rail system 108, an engagement device (gripping device) 604 and a lifting device (in fig. 5a hidden within the cantilever structure 601CL) for lowering and elevating the gripping device 604 relative to the cantilever structure 601CL.

[0102] In fig. 5a, it is further shown that the vehicle 600 comprises a charging interface 630 for connection to the charging station 10. The charging station 630 is located on the opposite side of the cantilever structure 601CL. Inside the vehicle body 601, the vehicle 600 comprises an energy source in the form of a rechargeable battery 620, chargeable via the charging interface 630. It should be noted that the vehicle 600 may use other energy sources, such as an ultracapacitor type of energy source.

[0103] The vehicle 600, similar to the prior art vehicles 201, 301, 401 described in the introduction above, comprises first and second sets of wheels 601b, 601c which enable the lateral movement of the container handling vehicle 600 in the *X* direction and in the *Y* direction, respectively. The first set of wheels 601b is arranged to engage with two adjacent rails of the first set 110 of rails of the rail system 108, and the second set of wheels 602c is arranged to engage with two

adjacent rails of the second set 111 of rails of the rail system 108. At least one of the sets of wheels 601b, 601c can be lifted and lowered, so that the first set of wheels 601b and/or the second set of wheels 601c can be engaged with the respective set of rails 110, 111 at any one time.

[0104] The charging station 10 will now be described. The charging station 10 comprises a base 12, a charging unit 20, and a charging interface 30. A power supply PS is indicated in fig. 5a, here representing the mains, which is supplying an AC power to the charging station 10 via a power cable PC.

[0105] The base 12 is here the part of the charging station 10 which is being connected to the framework structure 100. In fig. 5a, it is shown that the base 12 is connected to the rail system 108.

[0106] The charging unit 20 is arranged to convert power to an acceptable form for charging the energy source of the vehicle or to otherwise facilitate compatible electrical power delivery to the energy source vehicle. For example, the charging unit 20 comprises electric circuitry for converting the AC power to a DC power suitable for charging the battery of the vehicle 600. The charging unit 20 charging unit 20 also comprises a control system 50, which will be described further in detail below.

[0107] The charging interface 30 is the interface to which the charging interface 30 of the vehicle 600 is connected for the purpose of charging. The charging interface can include electrical connectors for connecting to the energy source of the vehicle. For example, the charging interface 30 comprises a positive conductor pin 31P and a negative conductor pin 31N.

[0108] In the present embodiment, the base 12 and the charging unit 20 are formed as one single unit.

[0109] It should be noted that the both the charging unit 20 and the charging interface 30 need service, maintenance and/or repair. The electric circuitry of the charging unit 20 may experience faults if not maintained. In general, dust should be removed periodically. In addition, the cooling fan and/or air filter of the charging unit 20 should be replaced periodically. The positive conductor pin 31P and the negative conductor pin 31N of the charging interface 30 will become worn by repeated connection/disconnection, and as they are worn, electrical contact between the charging interface 30 and the vehicle connection interface 630 becomes reduced, which may reduce charging efficiency.

[0110] The steps of performing service, inspection and/or maintenance on the charging station 10 will now be described. Initially, the system 1 has identified that there is a need for service, inspection and/or maintenance. This may be identified by a predetermined service schedule based on time since last service, a predetermined number of charging operations, etc. Alternatively, it may be identified by a message sent by the charging station 10 itself, for example due to a malfunction detected by a sensor, etc.

[0111] In fig. 5a and fig. 5b, the vehicle 600 is moving with its charging interface 630 towards the charging station 10, where the charging interface 630 of the vehicle 600 connects to the charging interface 30 of the charging station 10. As shown in fig. 5b, the charging interface 30 has a positive conductor pin 31P and a negative conductor pin 31N faced towards the vehicle. These pins are electrical power connectors for transferring electric power during a charging operation.

[0112] In fig. 5c it is shown that the charging interface 630 of the vehicle 600 is connected to the charging interface 30 of the charging station 10. It should be noted that here, no power is transferred, as this is not considered a charging operation.

[0113] In fig. 5d, it is shown that the vehicle 600 has moved away from the charging station 10. It is further shown that the charging interface 30 of the charging station 10 has been removed. The charging unit 20 has a positive connector aperture 22P and a negative connector aperture 22N.

[0114] In fig. 5e and fig. 5f it is shown that the charging interface 30 of the charging station 10 is connected to the charging interface 630 of the vehicle 600. The vehicle 600 may now transport the charging interface 30 of the charging station 10 to a service area SA adjacent to the rail system 108. This service area is outside of the area on which vehicles normally operations, and is typically considered as an area where it is safe for persons to work. Service, inspection and/or maintenance may now be performed by persons located in this service area. After service, inspection and/or maintenance the charging interface 30 of the charging station 10 may be returned to the charging station 10 again. Alternatively, the charging interface 30 is replaced with a new one.

[0115] In fig. 5f, it is further shown that the charging interface 30 of the charging station 10 comprises two guides 15 in the form of pins for guiding the movement of the charging interface 30 relative to the charging unit 20. As shown in

fig. 5d, the charging unit 20 comprises two apertures 16 into which the guides 15 are insertable.

[0116] It is further shown in fig. 5f that the charging interface 30 has a positive conductor pin 32P and a negative conductor pin 32N faced towards the charging unit 20. The positive conductor pin 32P is insertable into the positive connector aperture 22P, and the negative conductor pin 32N is insertable into the negative connector aperture 22N. It should be noted that the positive conductor pin 31P and the negative conductor pin 31N is exposed to wear each time a vehicle is connected to the charging station for charging its battery, while the positive conductor pin 32P and the negative conductor pin 32N is only exposed to wear each time the charging interface 30 is removed from the charging unit 20.

[0117] It is now referred to fig. 13a and fig. 13b. Here, the guide 15 of the charging interface 30 of the charging station 10 are shown inserted into the aperture 16 of the charging unit 20. It is further shown that the guide 15 comprises a recess 15a. The charging unit 20 comprises a locking device 52 which in fig. 13a is engaged with the recess 15a and which in fig. 13b is not engaged with the recess 15a.

[0118] In fig. 13a, the guide 15 will be prevented from being pulled out from the aperture 16, while in fig. 13b, the guide 15 will be allowed to be pulled out from the aperture 16.

[0119] It is now referred to fig. 12. Here, the control system 50 is shown. In the present embodiment, the control system 50 comprises a control unit 51 and a communication unit 53. In addition, the locking device 52 is considered to be a part of the control system 50. It is also shown that the control system 50 comprises a relay switch 5.

[0120] Typically, it is detected that the vehicle 600 is connected to the charging interface 30. This may be detected by the position of the vehicle 600, by a sensor provided in the vehicle 600 or by a sensor in the charging station 10. If sensed by the vehicle 600, a message is sent by the vehicle 600 to the control unit 51 via the communication unit 53. Based on this information, the control unit 51 is controlling the locking device 52 to lock the guiding pin 15 (fig. 13a) to allow the vehicle to move away from the charging station 10 without the charging interface 30 or to unlock the guiding pin 15 (fig. 13b) to allow the vehicle to move away from the charging station 10 with the charging interface 30.

[0121] The communication unit 53 is here using wireless communication to communicate with the vehicle. It should be noted that the charging interface 30 and

the charging interface 630 may comprise a wired communication interface in addition to the power connectors.

[0122] The control unit 51 is also controlling the relay switch 54. The purpose of the relay switch 54 is to be able to turn on or off the supply of power to the charging interface 30 before controlling the locking device 52. In this way, there is no voltage between the apertures 22P, 22N during disconnection of the charging interface 30 from the charging unit 20 and during connection of the charging interface 30 to the charging unit 20.

[0123] It should be noted that the above actions are performed in reverse order when connecting the charging interface 30 of the charging station 10 to the charging unit 20.

Example 2

[0124] It is now referred to fig. 6a and fig. 6b. It should be noted that many of the features are similar to the one described in example 1 above. For efficiency, only differences between example 2 and example 1 will be described in detail below.

[0125] In fig. 6a and fig. 6b, the vehicle 600 is approaching the charging station 10 sideways (indicated as direction D1 in fig. 6A), while in fig. 5a and fig. 5b, the vehicle 600 is approaching the charging station 10 with the side having the charging interface 630. It should be noted that fig. 6a and fig. 6b show delivery of a charging interface 30 to the charging station 10, i.e. the charging interface 30 of the charging station 10 is connected to the charging interface 630 of the vehicle 600.

[0126] It should be noted that in the present embodiment, the conductor pins/apertures 32N, 32P, 22N, 22P are used both for the purpose of transferring electric energy (similar to example 1) and, in addition, for the purpose of guiding the charging interface 30 relative to the charging unit 20. Hence, in the drawings, the conductor pins/apertures 32N, 32P, 22N, 22P are also referred to as guides 15/apertures 16.

[0127] In fig. 6c (showing a side of the charging station 10) and in fig. 6e (showing a vehicle facing side of the charging station 10), it is shown that the positive and negative conductor pins 32P, 32N of the charging interface 30 are oriented vertically and are pointing downwardly, while the positive and negative conductor pins 31P, 31N of the charging interface 30 are oriented horizontally.

[0128] In fig. 6d (showing details of the circle B of fig. 6c) it is further shown that the charging unit 20 has a horizontal, upwardly facing surface 23 in which the apertures 22N, 22P (i.e. also aperture 16) are provided.

[0129] As the vehicle 600 is moving towards the charging station 10, the charging interface 30 connected to the charging interface 630 will become closer to the apertures 22N, 22P. Before arriving at the apertures 22N, 22P, the downwardly protruding pins 32P, 32N will move slightly above the upwardly facing surface 23. When the downwardly protruding pins 32P, 32N are vertically aligned with the apertures 22N, 22P, the vehicle 600 will move the charging interface 30 down (indicated by arrow D2 in fig. 6d), causing the downwardly protruding pins 32P, 32N to become inserted into the apertures 22N, 22P. The vehicle 600 may now move away from the charging station 10 (either direction D3 or direction D4). Due to the vertical engagement of the downwardly protruding pins 32P, 32N within the apertures 22N, 22P, the charging interface 30 will remain connected to the charging unit 22. Hence, the charging interface 630 of the vehicle 600 will become disconnected from the charging interface 30 of the charging station 10, as shown in fig. 6g.

[0130] It should be noted that in this example, the locking device 52 of example 1 is not essential.

[0131] The vehicle may move its charging interface 630 by elevating a first set of its wheels relative to a second one of its wheels. This is an action which is normally done when changing direction of movement from the X-direction to the Y-direction or vice versa. By using this type of elevation, the vehicle 600 should move in the direction D3 when leaving the charging station 10. This is illustrated in fig. 6H and fig. 6I. In fig. 6H, the wheels 601b (and hence the vehicle body 601) are elevated relative to the rails as indicated by a height Δh. Here it is shown that the downwardly protruding pins 32P, 32N has not been inserted into the apertures 22N, 22P. In fig. 6I, the wheels 601b are lowered, and hence also the vehicle body 601 has been lowered, causing the downwardly protruding pins 32P, 32N to be inserted into the apertures 22N, 22P (in fig. 6I, the downwardly protruding pins 32P, 32N are not visible).

[0132] Alternatively, the vehicle 600 comprise a separate elevation mechanism in order to move the charging interface 630 of the vehicle 600 vertically relative to the vehicle body. In yet an alternative, the charging station 10 comprises an elevation mechanism for elevating at least the part of the charging unit 20 comprising the apertures 22N, 22P. By using this type of elevation, the vehicle 600 could move in the direction D3 or D4 when leaving the charging station 10.

[0133] It should be noted that the above actions are performed in reverse order when disconnecting the charging interface 30 of the charging station 10 from the charging unit 20.

Example 3

[0134] It is now referred to fig. 7a and fig. 7b. It should be noted that many of the features are similar to the one described in example 1 above. For efficiency, only differences between example 3 and the above example 1 will be described in detail below.

[0135] As shown in fig. 7a and 7b, the charging interface 30 is larger than in the first example. In particular, the width w30 of the charging interface 30 of fig. 7B is larger than the corresponding width of the charging interface 30 of fig. 5e.

Example 4

[0136] It is now referred to fig. 8a, fig. 8b and fig. 8c. It should be noted that many of the features are similar to the one described in examples 1 and 2 above. For efficiency, only differences between example 4 and the above examples 1 and 2 will be described in detail below.

[0137] In the present embodiment, the charging unit 20 and the charging interface 30 are formed as one single unit. Here, the charging unit 20 and the charging interface 30 together are releasably connected to the base 12. Hence, both the charging unit 20 and the charging interface 30 are moved to and from the service area SA.

[0138] Here, apertures 16 are provided in the base 12 (fig. 8a), while guides 15 are provided on the one single unit formed by the charging unit 20 and the charging interface 30. The control system 50 is here provided as part of the base 12. The control system 50 may here comprise a locking device 52 for releasably locking the guide 15 to the aperture 16.

Example 5

[0139] It is now referred to fig. 9a and fig. 9b. It should be noted that many of the features are similar to the one described in examples 1 and 2 above. For efficiency, only differences between example 5 and the above examples will be described in detail below.

[0140] In the present embodiment, the charging unit 20 and the charging interface 30 are formed as one single unit. Here, the charging unit 20 and the charging interface 30 together are releasably connected to the base 12. Hence, both the charging unit 20 and the charging interface 30 are moved to and from the service area SA.

[0141] The base 12 is here secured to four upright members 102 of the framework structure 100 below the rail system 108. Also here, the base 12 is supplied with power from the power supply PS via the power cable PC.

[0142] The charging interface 30 is here an inductive charging interface, i.e. the vehicles are charged wirelessly. When connected to the base 12, the charging interface 30 is provided on top of the charging station 10, immediately below the rails of the rail system 108 in order to minimize the distance to a vehicle located above the charging station 10. The vehicles being charged in this type of charging station should be provided with an inductive charging interface (not shown) located in the lower part of the vehicle body. During charging, the vehicle should then be parked above the charging station 10 in a position in which the distance between the respective charging interfaces is as short as possible.

[0143] In fig. 9b it is shown that the charging unit 20 and the charging interface 30 together have a shape of a rectangular prism, and is provided with a connection interface CI in the form of four rectangular slots provided in the upper periphery. The connection interface CI is similar to the connection interface of the storage containers 106 in the automated storage and retrieval system 1. Hence, the vehicle 600 is here using the gripping device 603 and lifting device 604 to move the charging unit 20 and the charging interface 30 between the base 12 and the service area SA in similar way as the vehicle is moving storage containers. Hence, the prior art container handling vehicles 201, 301, 401 may be used to move the charging unit 20 and the charging interface 30 (it should be noted that these vehicles are not necessarily wirelessly charged by the same charging station 10).

[0144] The charging unit 20 and the charging interface 30 is here guided vertically up and down relative to the base 12 by means of the upright members 102. Hence, the separate guide 15 and the separate aperture 16 are not essential features. However, electrical contact must be provided between the base 12 and the charging unit 20. This may be provided as vertical pins/apertures.

Example 6

[0145] It is now referred to fig. 10a – 10d. It should be noted that many of the features are similar to the one described in example 4 above. For efficiency, only differences between example 6 and the above examples will be described in detail below.

[0146] In the present embodiment, the charging unit 20 and the charging interface 30 are formed as one single unit as in example 4. Here, the charging unit 20 and the charging interface 30 together are releasably connected to the base 12. Hence, both the charging unit 20 and the charging interface 30 are moved to and from the service area SA.

[0147] The connection to and from the base 12 are similar to the one in example 2, i.e. with two vertical conductor pins 32N, 32P also serving as the guide 15 which are insertable into a vertical connector aperture 22N, 22P also serving as a guiding aperture 16 (see fig. 10d).

[0148] The charging station 10 here further comprises a horizontal connection structure 14 connected to the charging interface 30 (and hence also to the charging interface 30). The horizontal connection structure 14 is provided with a connection interface CI similar to the one of example 5. Hence, also here, the gripping device 604 and the lifting device 603 are used to move the charging unit 20, the charging interface 30 and the connection structure 14 up and down relative to the base 12 and to move the charging unit 20, the charging interface 30 and the connection structure 14 to and from the service area SA.

Example 7

[0149] It is now referred to fig. 11a – 11b. It should be noted that many of the features are similar to the one described in example 6 above. For efficiency, only differences between example 7 and the above examples will be described in detail below.

[0150] The main difference between example 7 and example 6 is the size of the horizontal connection structure 14, in fig. 11a it is shown that the size is ca 50% of the size in fig. 10a.

[0151] The vehicle 600 is here shown with a vertical supporting surface 601SS below the cantilever structure 601CS. Here, only two of the grippers 604b, the two being closest to the vertical supporting surface 601SS are used to connect to the connection interface CS. This could potentially cause the charging unit 20 and the charging interface 30 to pivot below the two grippers 604b. However, as the

charging interface 30 is located vertically below the charging interface 30 (as indicated by line SL in fig. 11d), the connection interface 30 is supported by the vertical supporting surface 601SS. Hence, pivoting is avoided.

Alternative embodiments

[0152] It should be noted that in the example of fig. 5 above, the positive/negative pins 32P, 32N and apertures 22P, 22N may serve the purpose of the guide 15 and aperture 16.

[0153] It should further be noted that charging interface 30 may comprise guides protruding both towards the charging unit 20 and towards the vehicle 600. In such a case, the locking device 52 is provided in the charging unit 20 as in example 1 above, for releasably locking the guides protruding towards the charging unit 20. In addition, the vehicle 600 may comprise a corresponding locking device for releasably locking the guides protruding towards the vehicle 600. In this way, the risk of accidental release of the charging interface 30 from the vehicle 600 during transportation of the charging interface 30 between the charging station 10 and the service area SA is considerably reduced.

[0154] It should be noted that the charging interface 630 of the container handling vehicle 600 can be located at other locations than the one described above.

[0155] It should be noted that the charging station 10 can be used to charge other vehicles of the system 1. Moreover, in some of the embodiments, also other vehicles may be used to transport the charging interface 30 and/or the charging unit 20 to and from the service area. One example of such other vehicle is the delivery vehicle described in NO 344662, which is a type of container handling vehicle without gripping device/lifting device. Another example of such other vehicle is a service vehicle or support vehicle described in NO 344995. Other types of dedicated service vehicles may also be used.

[0156] In the preceding description, various aspects of the charging station and the automated storage and retrieval system according to the invention 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 embodiments, as well as other

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

Also described herein are the following numbered clauses:Clause 1. A charging station (10) for charging an energy source (620) of a vehicle (600) of an automated storage and retrieval system (1), wherein the charging station (10) comprises:
- a base (12);
- a charging interface (30) to which the vehicle (600) may connect for charging its energy source (620);
- a charging unit (20);
characterized in that:
- the charging unit (20) is releasably connected to the base (12); and/or
- the charging interface (30) is releasably connected to the charging unit (20).

Clause 2. The charging station (10) according to clause 1, wherein the charging interface (30) is integrated with the charging unit (20).

Clause 3. The charging station (10) according to any preceding clause, wherein the charging unit (20) is integrated with the base (12).

Clause 4. The charging station (10) according to any preceding clause, wherein the charging unit (20) and/or the charging interface (30) comprises a vehicle connection interface (30; CI) connectable to the vehicle (600);
- the charging unit (20) is releasably connected to the base (12) by means of the vehicle connection interface (30; CI); and/or
- the charging interface (30) is releasably connected to the charging unit (20) by means of the vehicle connection interface (30; CI).

Clause 5. The charging station (10) according to clause 4, wherein the vehicle connection interface (30; CI) is the charging interface (30).

Clause 6. The charging station (10) according to clause 4 or 5, wherein the vehicle connection interface (30; CI) is a connection interface (CI) allowing a gripper device (604) of the vehicle (600) to connect to the charging unit (20) and/or the charging interface (30).

Clause 7. The charging station (10) according to any preceding clause, wherein the charging station (10) comprises a releasable locking device (52) for releasably locking the charging unit (20) to the base (12) and/or for releasably locking the charging interface (30) to the charging unit (20).

Clause 8. The charging station (10) according to any preceding clause, wherein the charging station (10) comprises a guide (15) for guiding the movement of the charging unit (20) relative to the base (12) and/or for guiding the movement of the charging interface (30) relative to the charging unit (20).

Clause 9. The automated storage and retrieval system (1) according to clause 8 when dependent from clause 7, wherein the releasable locking device (52) is configured to releasably engage the guide (15).

Clause 10. The charging station (10) according to any one of clause 7 - 9, wherein the charging station (10) comprises a control system (50), wherein the control system (50) comprises a control unit (51) configured to control the releasable locking device (52).

Clause 11. The charging station (10) according to clause 10, wherein the charging station (10) comprises a communication unit (53) provided in communication with the control unit (51), wherein the communication unit (53) is configured to communicate with the vehicle (600) or other parts of the automated storage and retrieval system (1).

Clause 12. The charging station (10) according to clause 10 or 11, wherein the charging station (10) comprises a relay switch (54) for turning on or off a supply of power to the charging unit (20) and/or the charging interface (30), wherein the control unit (51) is configured to control the relay switch (54).

Clause 13. An automated storage and retrieval system (1) comprising a framework structure (100), wherein the framework structure (100) comprises:
- upright members (102);
- a storage volume comprising storage columns (105) provided between the upright members (102);
- a rail system (108) provided on top of the upright members (102);
wherein the automated storage and retrieval system (1) comprises a vehicle (600) arranged to operate on the rail system (108);
wherein the automated storage and retrieval system (1) comprises a charging station

according to any one of clauses 1 – 12;
wherein the base (12) is secured to or integrated with the framework structure (100);
wherein the vehicle (600) is configured to disconnect the charging unit (20) from the base (12) and to connect the charging unit (20) to the base (12); and/or
- the vehicle (600) is configured to disconnect the charging interface (30) from the charging unit (20) and to connect the charging interface (30) to the charging unit (20).

Clause 14. The automated storage and retrieval system (1) according to clause 13, wherein the vehicle (600) comprises a charging interface (630) connectable to the charging interface (30) of the charging station (10) for charging a energy source (620) of the vehicle (600), wherein the charging interface (630) of the vehicle (600) is used to disconnect the charging unit (20) from the base (12) and to connect the charging unit (20) to the base (12); and/or the charging interface (630) of the vehicle (600) is configured to disconnect the charging interface (30) from the charging unit (20) and to connect the charging interface (30) to the charging unit (20).

Clause 15. The automated storage and retrieval system (1) according to any of clause 1 - 9, wherein the vehicle (600) comprises a vehicle body (601), a gripping device (604) and a lifting device (603) for lifting the gripping device (604) relative to the vehicle body (601); wherein the vehicle (600) is configured to engage the connection interface (CI) by means of its gripping device (604).

Clause 16. The automated storage and retrieval system (1) according to clause 13, wherein the vehicle (600) is configured to:
- move the charging unit (20) and the charging interface (30) to and from a service area (SA); and/or
- move the charging interface (30) to and from the service area (SA).

Clause 17. A method for performing service, inspection and/or maintenance on a charging station (10) of an automated storage and retrieval system (1), wherein the method comprises the steps of:
- moving a vehicle (600) to the charging station (10);
- connecting the vehicle (600) to a charging unit (20) of the charging station (10) or to a charging interface (30) of the charging station (10);

- disconnecting the charging unit (20) from a base (12) of the charging station (10) or disconnecting the charging interface (30) from the charging unit (20) of the charging station (10);
- moving the charging unit (20) or the charging unit (20) and the charging interface (30) to a service area (SA) by means of the vehicle (600);
- performing service, inspection and/or maintenance on the charging unit (20) and/or and the charging interface (30).

Clause 18. A method according to clause 17, wherein the method comprises the steps of:
- moving the charging unit (20) or the charging unit (20) and the charging interface (30) from the service area (SA) to the base (12) by means of the vehicle (600);
- connecting the charging unit (20) to the base (12) of the charging station (10) or connecting the charging interface (30) to the charging unit (20) of the charging station (10);
- disconnecting the vehicle (600) from the charging unit (20) of the charging station (10) or from the charging interface (30) of the charging station (10).

LIST OF REFERENCE NUMBERS

1	Prior art automated storage and retrieval system
10	charging station
14	horizontal connection structure
15	guide
15a	recess
16	guiding aperture
20	charging unit
22N	negative connector aperture
22P	positive connector aperture
23	upwardly facing surface
30	charging interface
31N	negative conductor pin
31P	positive conductor pin
32N	negative conductor pin
32P	positive conductor pin
50	control system
51	control unit
52	locking device
53	communication unit
54	relay switch
PC	power cable
PS	power supply
SA	service area
SL	line
Δh	height
100	Framework structure

102 Upright members of framework structure

104 Storage grid

105 Storage column

106 Storage container

106' Particular position of storage container

107 Stack

108 Rail system

110 Parallel rails in first direction (X)

112 Access opening

119 First port column

120 Second port column

201 Prior art container handling vehicle

201a Vehicle body of the container handling vehicle 201

201b Drive means/wheel arrangement/first set of wheels in first direction (X)

201c Drive means/wheel arrangement/second set of wheels in second direction (Y)

301 Prior art cantilever container handling vehicle

301a Vehicle body of the container handling vehicle 301

301b Drive means/first set of wheels in first direction (X)

301c Drive means/second set of wheels in second direction (Y)

304 Gripping device

401 Prior art container handling vehicle

401a Vehicle body of the container handling vehicle 401

401b Drive means/first set of wheels in first direction (X)

401c Drive means/second set of wheels in second direction (Y)

404 Gripping device

404a Lifting band

404b Gripper

404c Guide pin

404d Lifting frame

500 Control system

X First direction

Y Second direction

Z Third direction

CLAIMS

1. A charging station (10) for charging an energy source (620) of a vehicle (600) of an automated storage and retrieval system (1), wherein the charging station (10) comprises:
- a base (12);
- a charging interface (30) to which the vehicle (600) may connect for charging its energy source (620);
- a charging unit (20);
characterized in that:
- the charging unit (20) is releasably connected to the base (12); and/or
- the charging interface (30) is releasably connected to the charging unit (20).

2. The charging station (10) according to claim 1, wherein the charging interface (30) is integrated with the charging unit (20).

3. The charging station (10) according to any preceding claim, wherein the charging unit (20) is integrated with the base (12).

4. The charging station (10) according to any preceding claim, wherein the charging unit (20) and/or the charging interface (30) comprises a vehicle connection interface (30; CI) connectable to the vehicle (600);
- the charging unit (20) is releasably connected to the base (12) by means of the vehicle connection interface (30; CI); and/or
- the charging interface (30) is releasably connected to the charging unit (20) by means of the vehicle connection interface (30; CI).

5. The charging station (10) according to claim 4, wherein the vehicle connection interface (30; CI) is the charging interface (30).

6. The charging station (10) according to claim 4 or 5, wherein the vehicle connection interface (30; CI) is arranged to allow an engagement device (604) of the

vehicle (600) to connect to the charging unit (20) and/or the charging interface (30) so as to allow the vehicle to lift or carry the charging unit and/or the charging interface.

7. The charging station (10) according to any preceding claim, wherein the charging station (10) comprises a releasable locking device (52) for releasably locking the charging unit (20) to the base (12) and/or for releasably locking the charging interface (30) to the charging unit (20).

8. The charging station (10) according to any preceding claim, wherein the charging station (10) comprises a guide (15) for guiding the movement of the charging unit (20) relative to the base (12) and/or for guiding the movement of the charging interface (30) relative to the charging unit (20).

9. The charging station (1) according to claim 8 when dependent on claim 7, wherein the releasable locking device (52) is configured to releasably engage the guide (15).

10. The charging station (10) according to claim 7 or 9, or claim 8 when dependent on claim 7, wherein the charging station (10) comprises a control system (50), wherein the control system (50) is configured to control the releasable locking device (52).

11. The charging station (10) according to claim 10, wherein the charging station (10) comprises a communication unit (53) provided in communication with the control system (50), wherein the communication unit (53) is configured to communicate with the vehicle (600) or other parts of the automated storage and retrieval system (1).

12. The charging station (10) according to claim 10 or 11, wherein the charging station (10) comprises a relay switch (54) for turning on or off a supply of power to

the charging unit (20) and/or the charging interface (30), wherein the control unit (51) is configured to control the relay switch (54).

13. An automated storage and retrieval system (1) comprising a framework structure (100), wherein the framework structure (100) comprises:
- upright members (102);
- a storage volume comprising storage columns (105) provided between the upright members (102);
- a rail system (108) provided on top of the upright members (102);
wherein the automated storage and retrieval system (1) comprises a vehicle (600) arranged to operate on the rail system (108);
wherein the automated storage and retrieval system (1) comprises a charging station according to any one of claims 1 – 12;
optionally wherein the base (12) is secured to or integrated with the framework structure (100);
further optionally wherein the vehicle (600) is configured to disconnect the charging unit (20) from the base (12) and/or to connect the charging unit (20) to the base (12); and/or
- the vehicle (600) is configured to disconnect the charging interface (30) from the charging unit (20) and/or to connect the charging interface (30) to the charging unit (20).

14. The automated storage and retrieval system (1) according to claim 13, wherein the vehicle (600) comprises a charging interface (630) connectable to the charging interface (30) of the charging station (10) to charge an energy source (620) of the vehicle (600),

optionally wherein the charging interface (630) of the vehicle (600) is configured to disconnect the charging unit (20) from the base (12) and/or to connect the charging unit (20) to the base (12); and/or

the charging interface (630) of the vehicle (600) is configured to disconnect the charging interface (30) from the charging unit (20) and/or to connect the charging interface (30) to the charging unit (20).

15. The automated storage and retrieval system (1) according to claims 13 or 14, or the charging station according to any of claims 1 - 12, wherein the vehicle (600) comprises a vehicle body (601), an engagement device (604) and a lifting device (603) for lifting the engagement device (604) relative to the vehicle body (601);

wherein the engagement device is configured to engage the charging interface, the charging unit, and/or the vehicle connection interface (CI) to allow the vehicle to lift the charging interface and/or the charging unit.

16. The automated storage and retrieval system (1) according to claim 13, 14 or 15, wherein the vehicle (600) is configured to:
- move the charging unit (20) and the charging interface (30) between the base and a service area (SA); and/or
- move the charging interface (30) between the base and the service area (SA).

17. A method for performing service, inspection and/or maintenance on a charging station (10) of an automated storage and retrieval system (1), wherein the method comprises the steps of:
- moving a vehicle (600) to the charging station (10);
- connecting the vehicle (600) to a charging unit (20) of the charging station (10) or to a charging interface (30) of the charging station (10);
- disconnecting the charging unit (20) from a base (12) of the charging station (10) or disconnecting the charging interface (30) from the charging unit (20) of the charging station (10);
- moving the charging unit (20), or the charging unit (20) and the charging interface (30), to a service area (SA) by means of the vehicle (600);
- performing service, inspection and/or maintenance on the charging unit (20) and/or the charging interface (30).

18. A method according to claim 17, wherein the method further comprises the steps of:
- moving the charging unit (20), or the charging unit (20) and the charging interface

(30), from the service area (SA) to the base (12) by means of the vehicle (600);
- connecting the charging unit (20) to the base (12) of the charging station (10) or connecting the charging interface (30) to the charging unit (20) of the charging station (10);
- disconnecting the vehicle (600) from the charging unit (20) of the charging station (10) or from the charging interface (30) of the charging station (10).

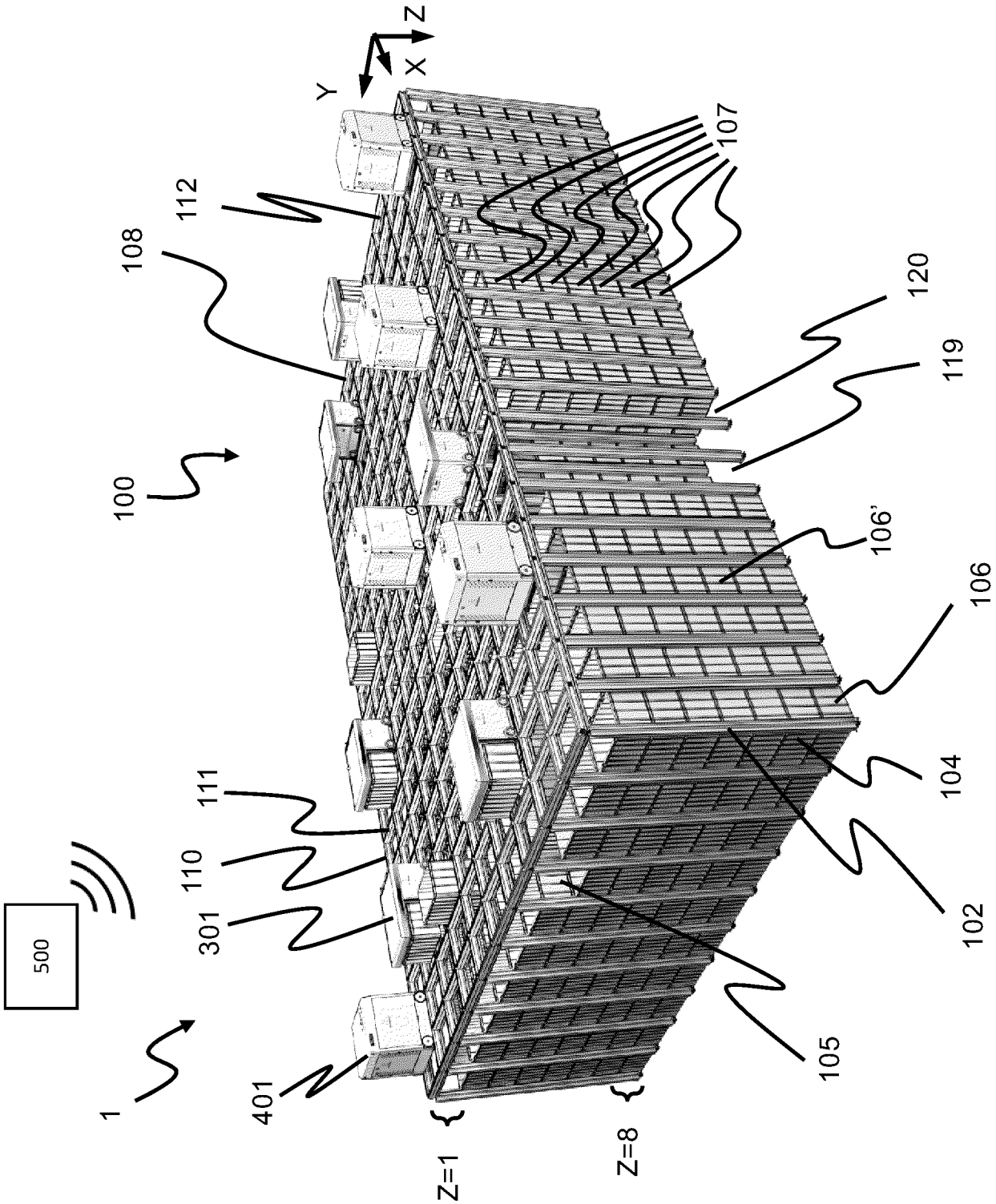

Fig. 1
(Prior Art)

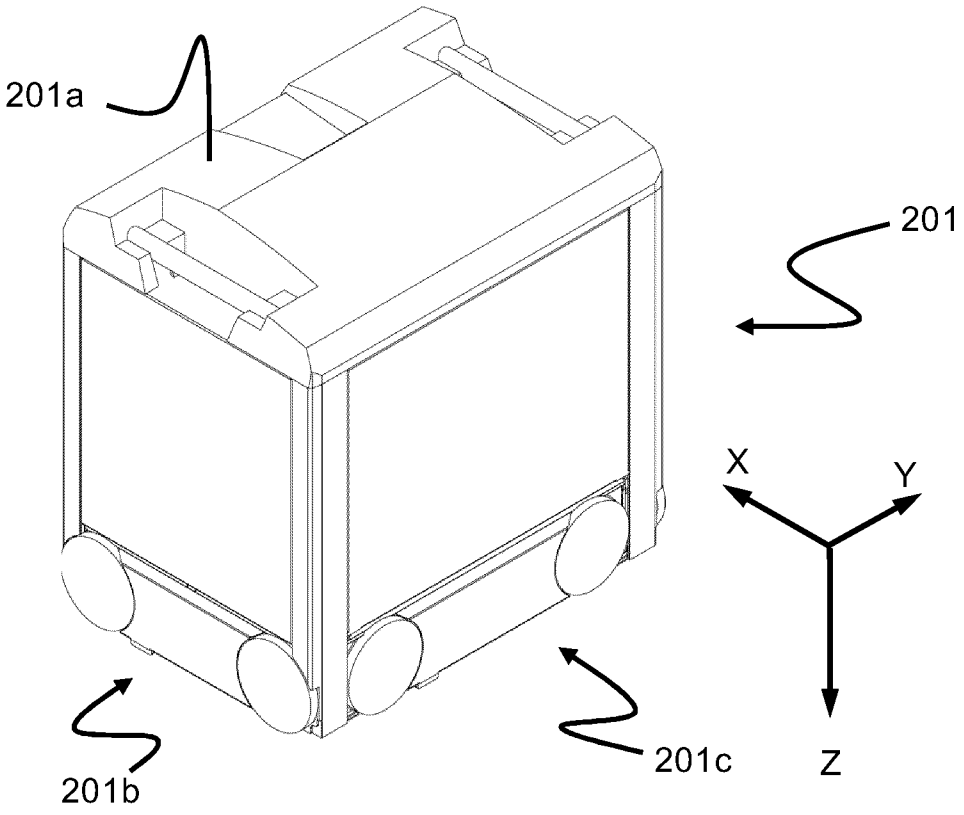

Fig. 2
(Prior Art)

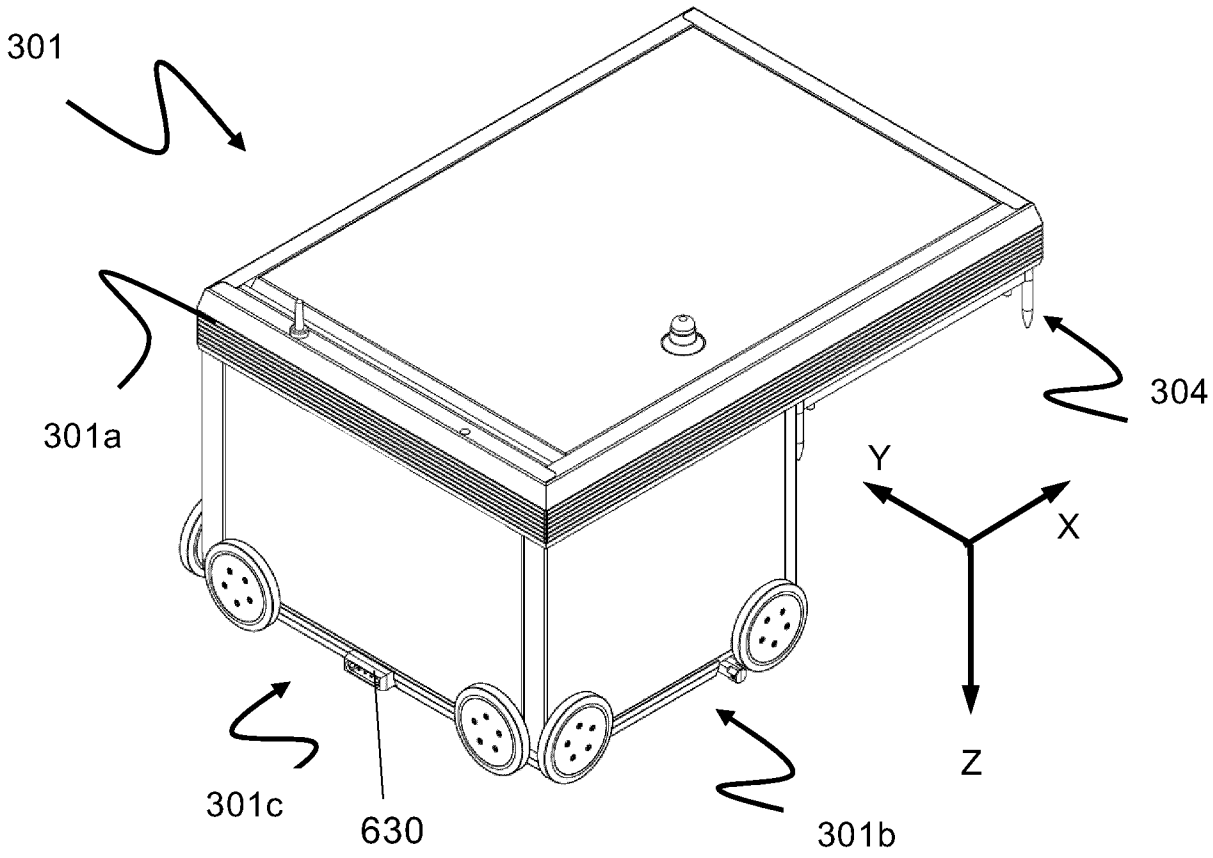

Fig. 3
(Prior Art)

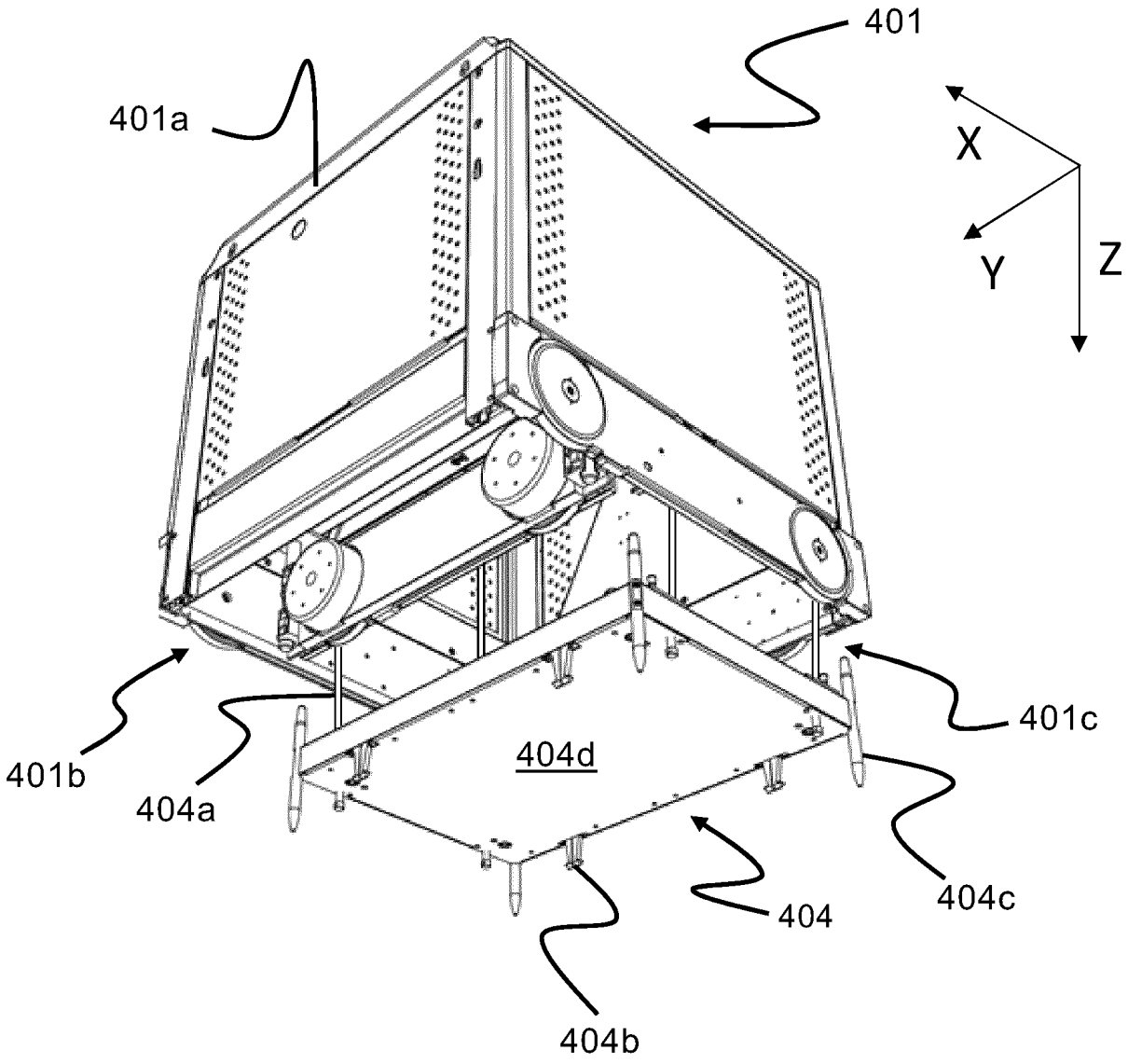

Fig. 4
(Prior Art)

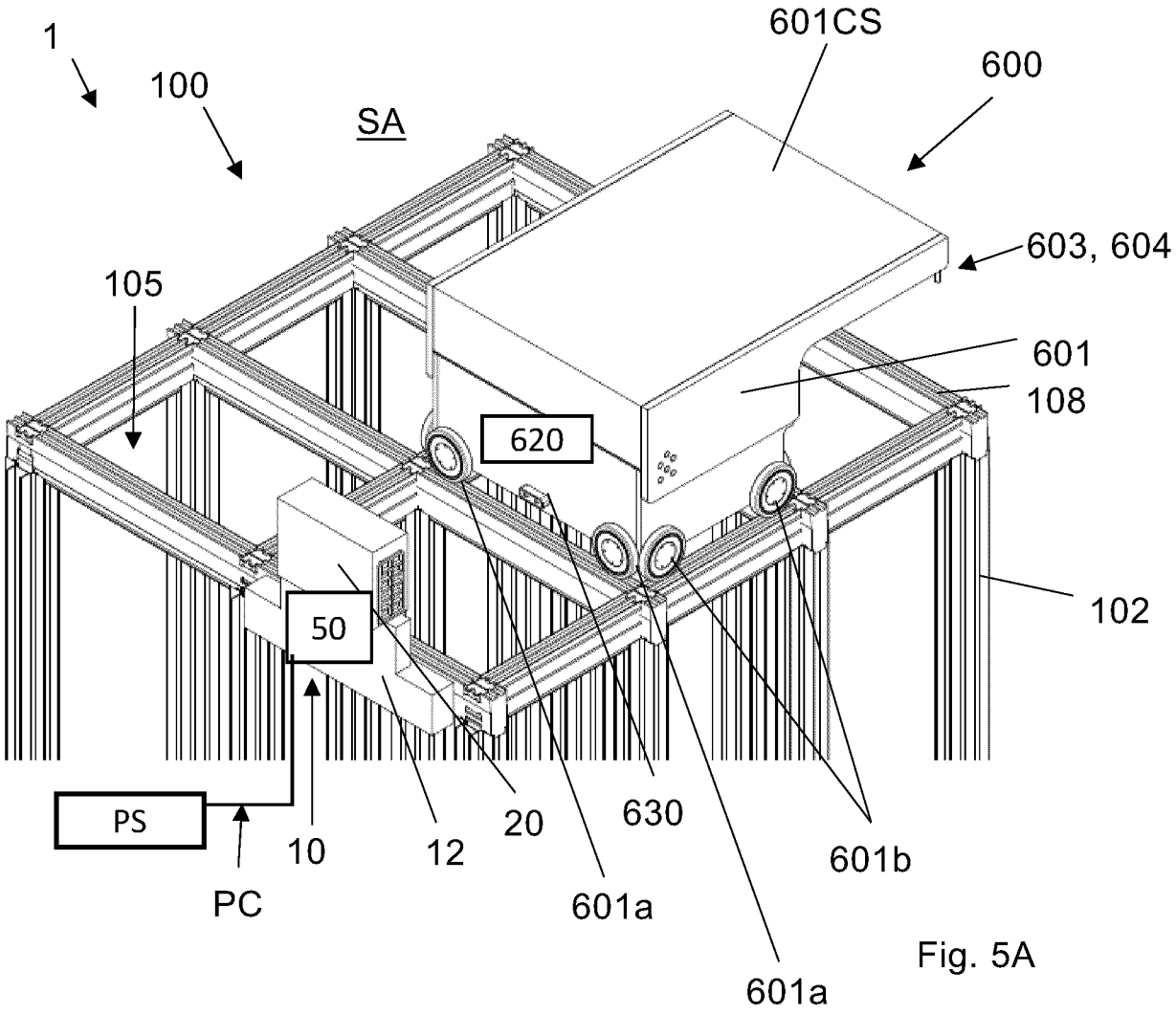
1
100
SA
601CS
600
603, 604
105
601
108
620
102
50
PS
10
12
20
630
601b
PC
601a
601a

Fig. 5A

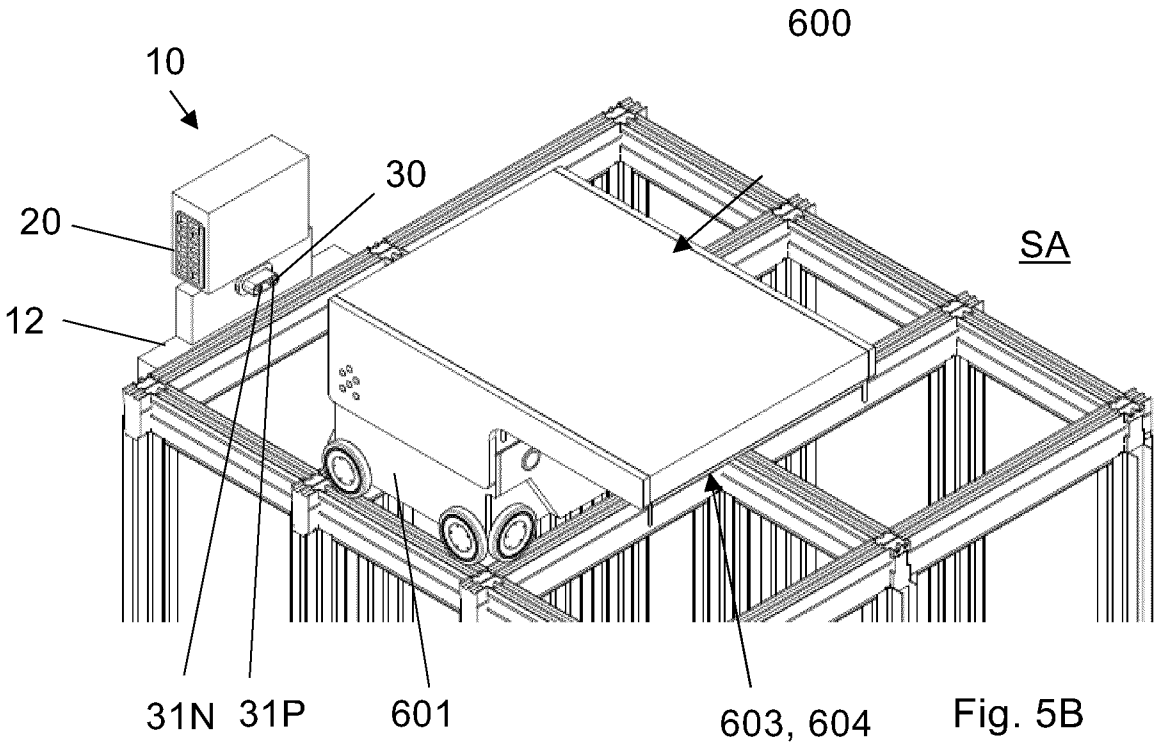
600
10
30
20
SA
12
31N
31P
601
603, 604

Fig. 5B

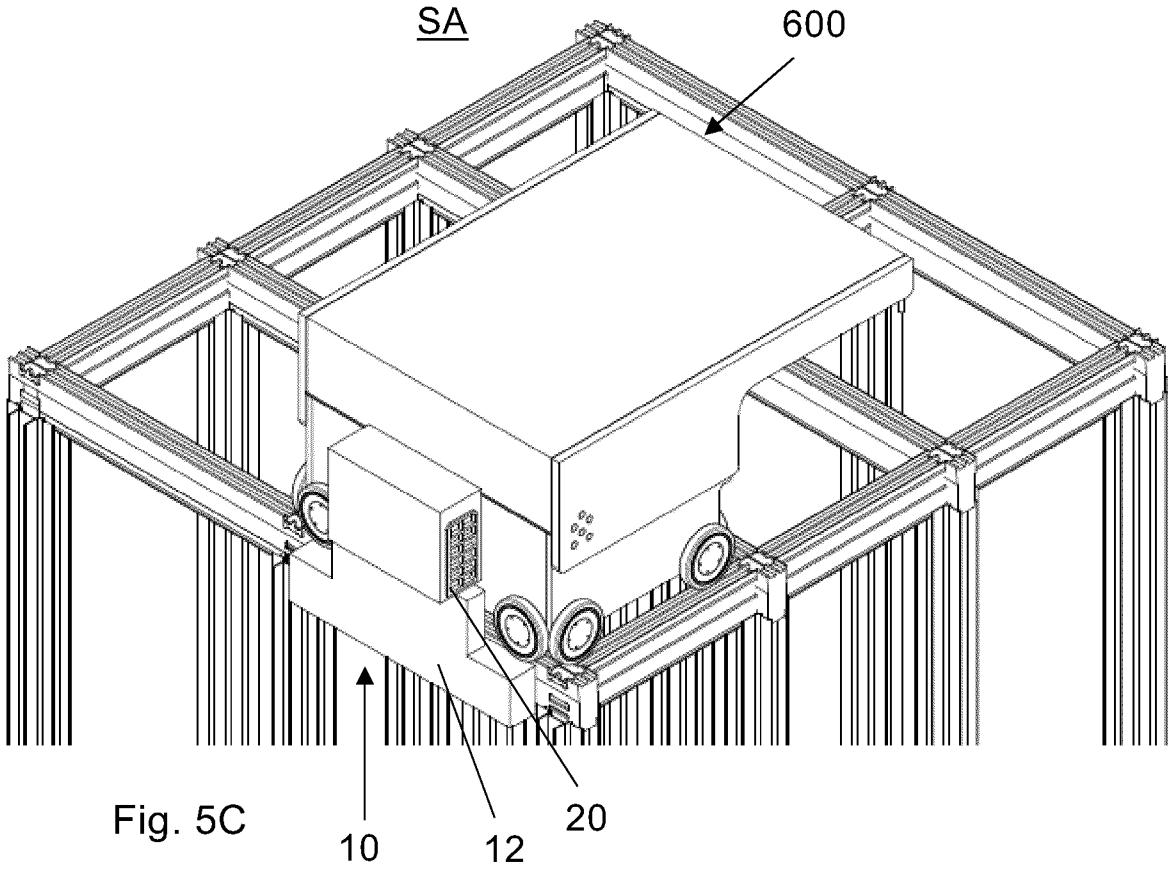

Fig. 5C

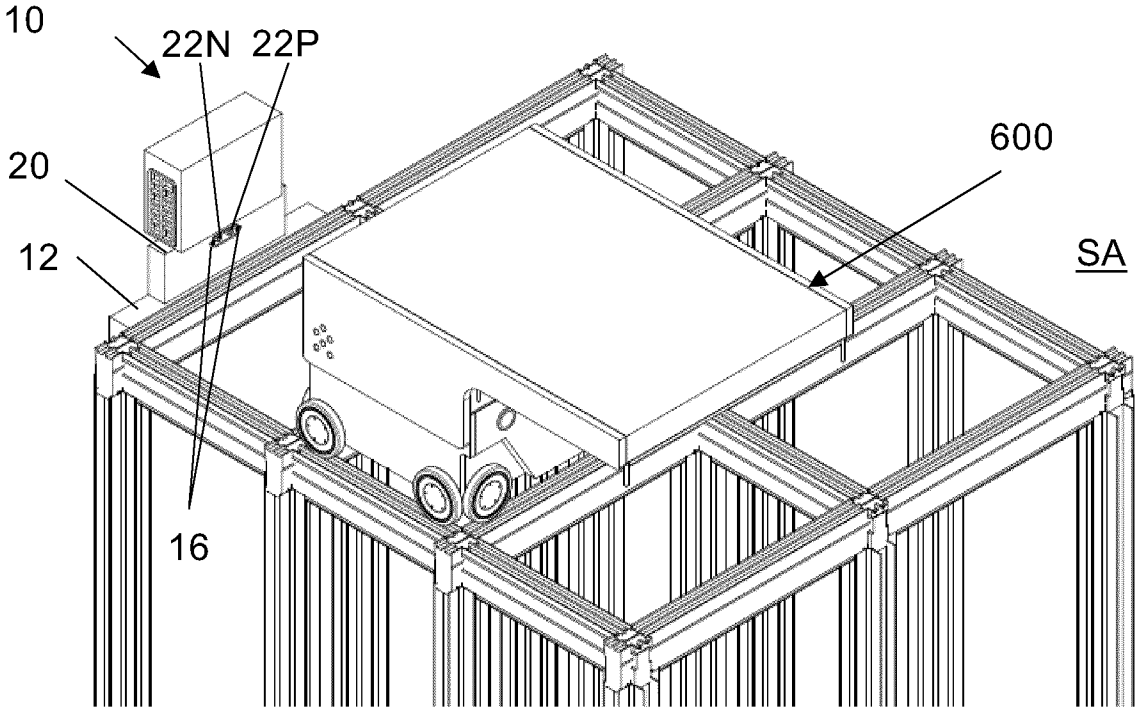

Fig. 5D

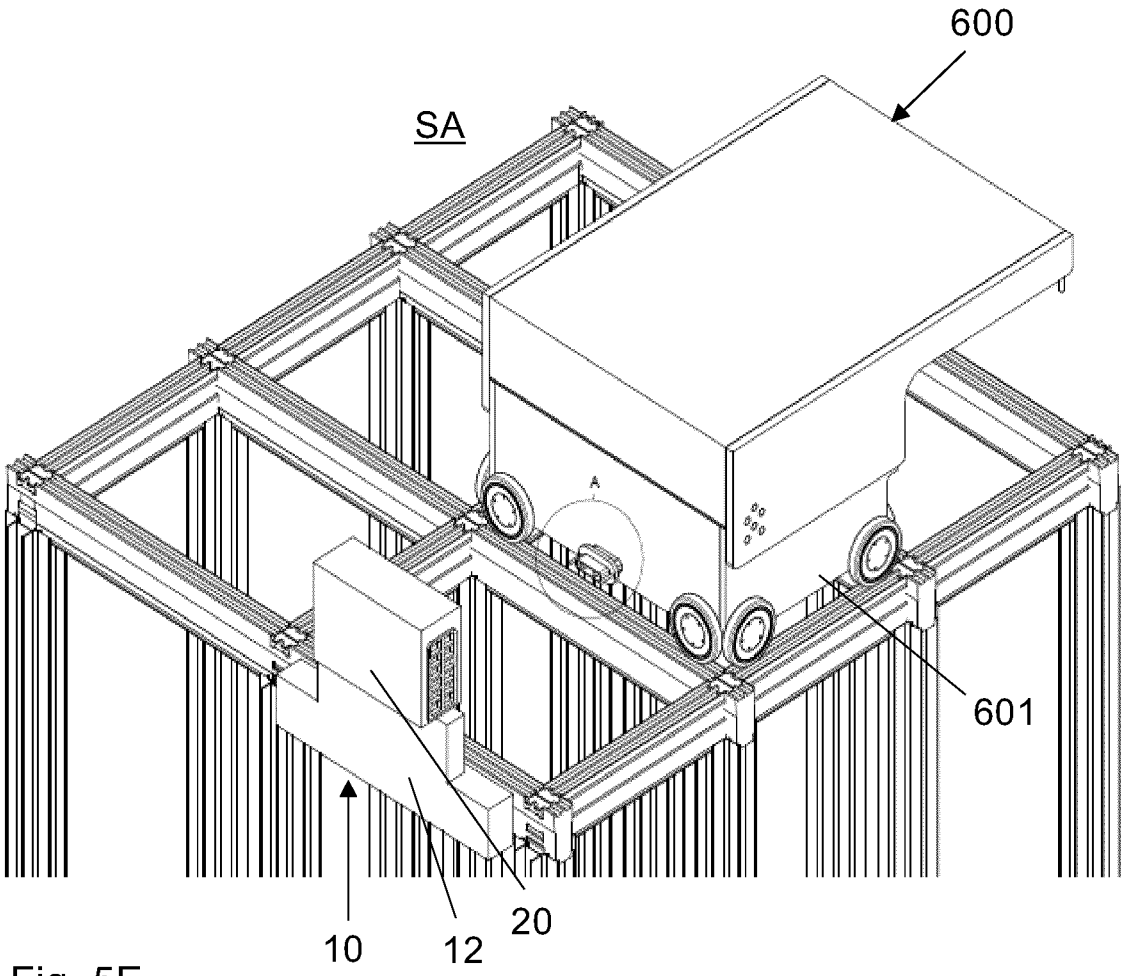

Fig. 5E

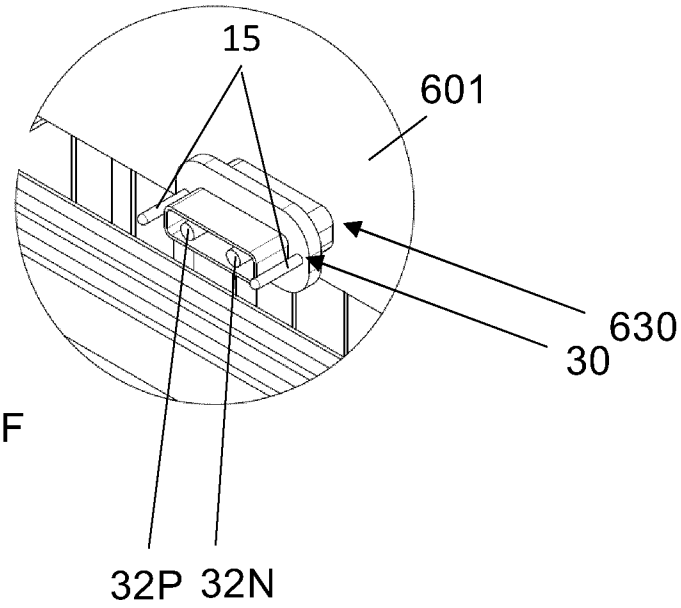

Fig. 5F

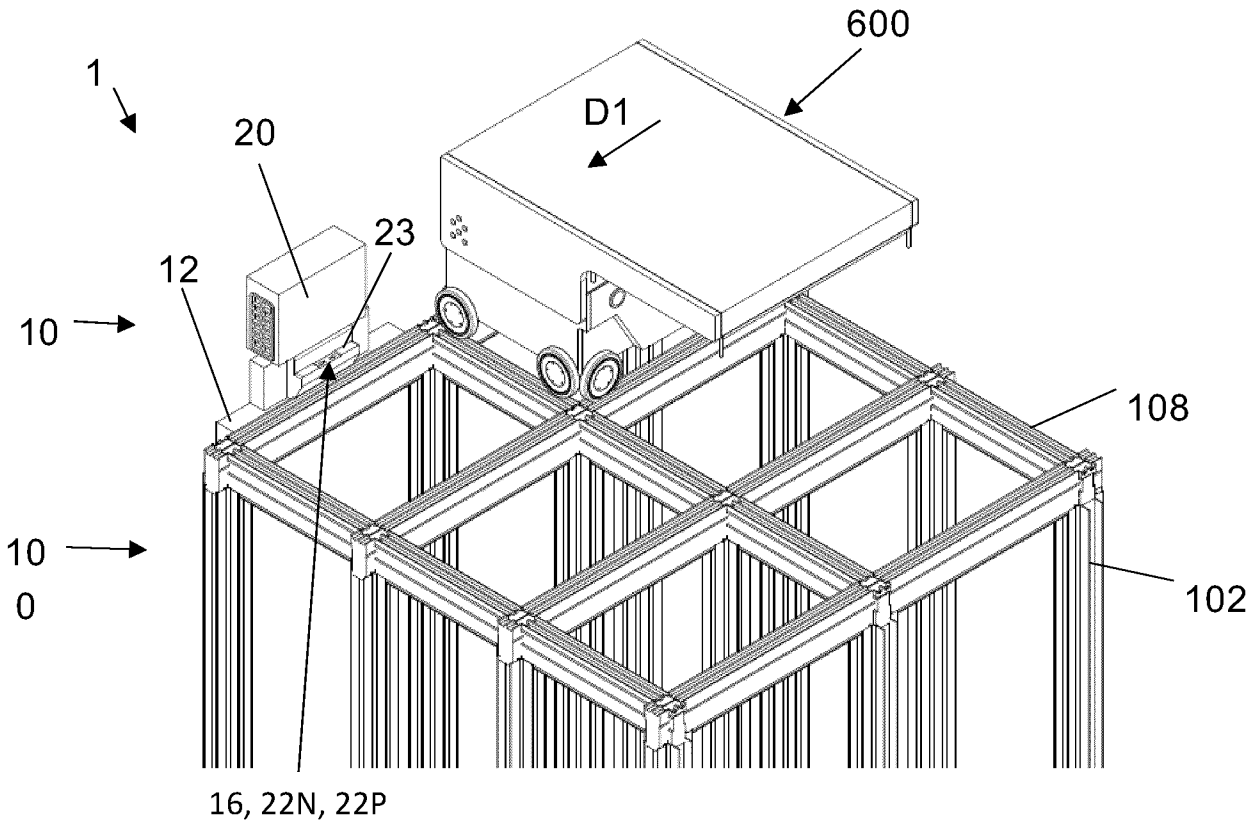

Fig. 6A

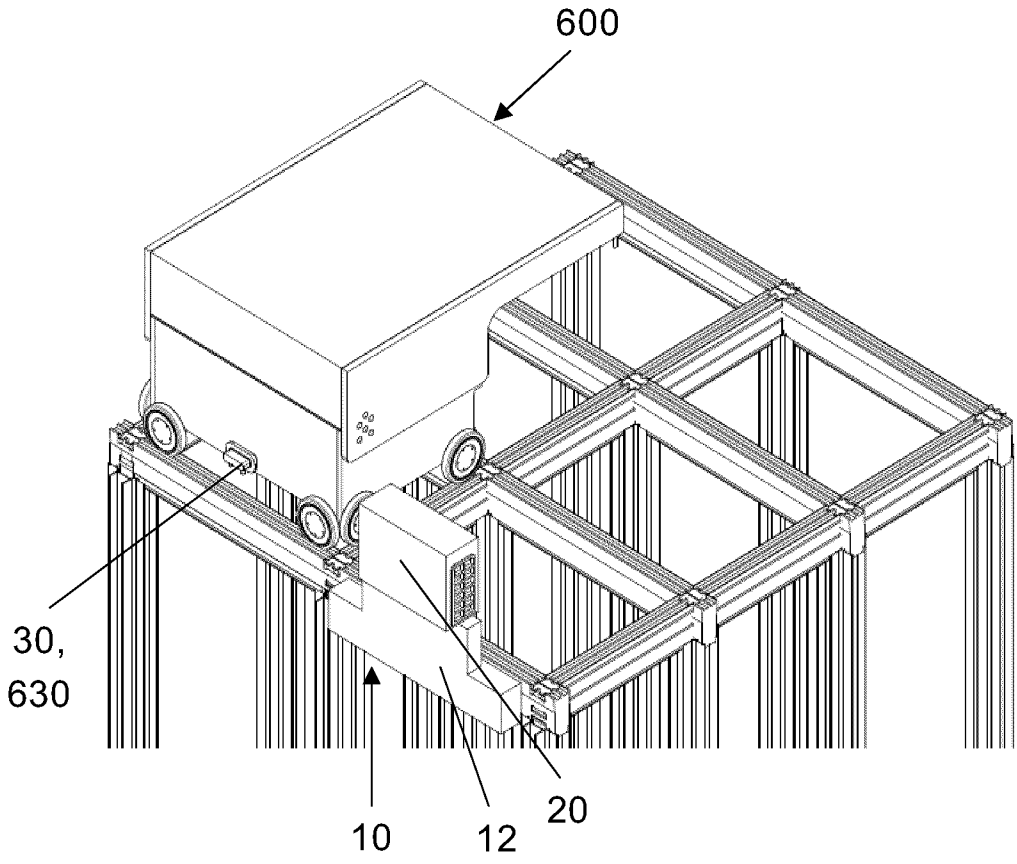

Fig. 6B

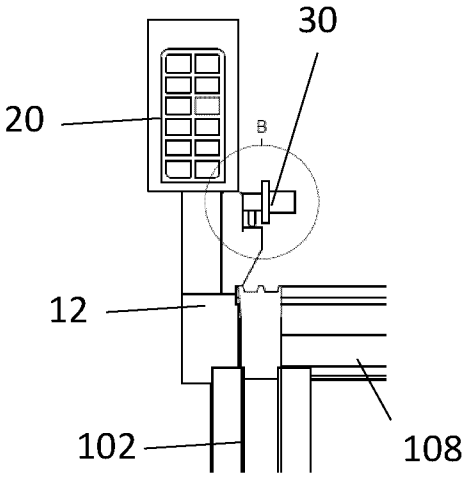

Fig. 6C

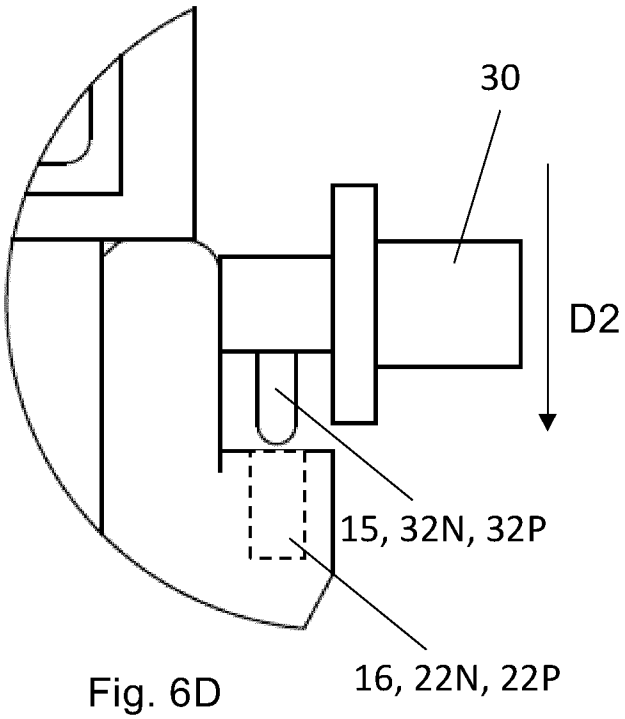

Fig. 6D

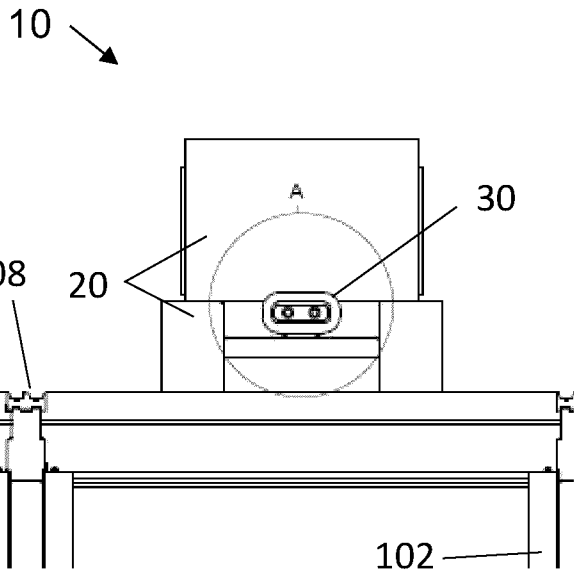

Fig. 6E

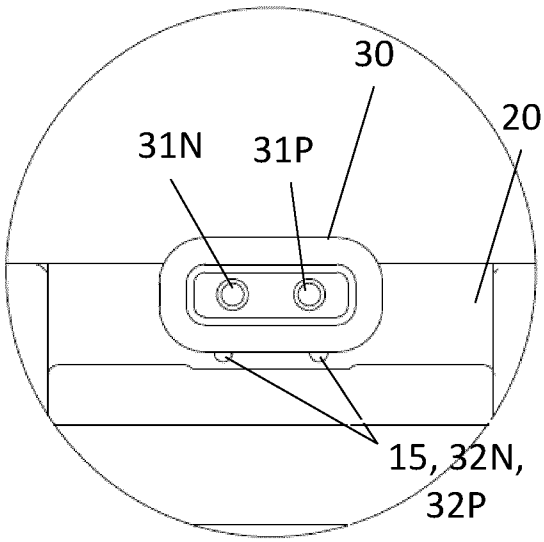

Fig. 6F

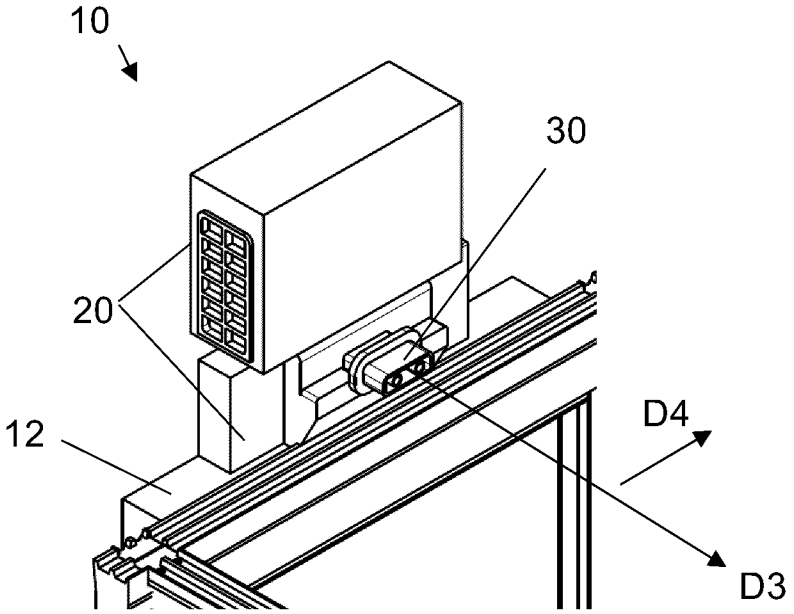

Fig. 6G

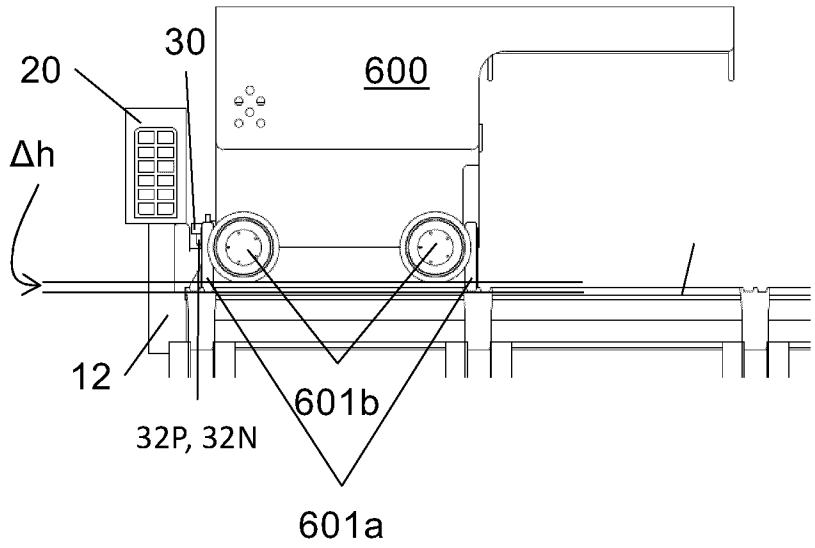

Fig. 6H

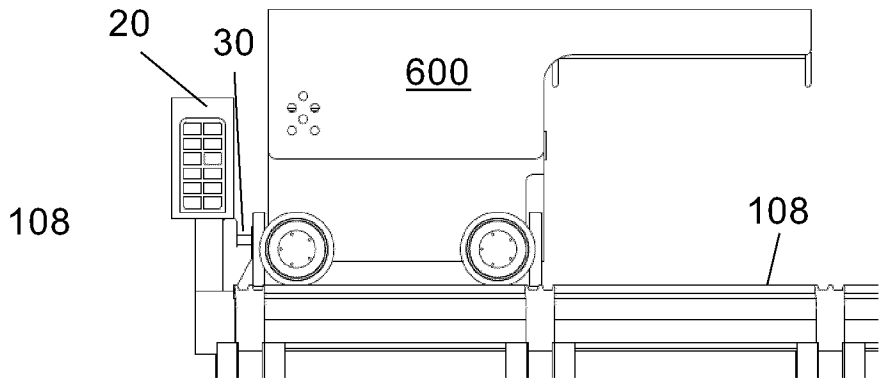

Fig. 6I

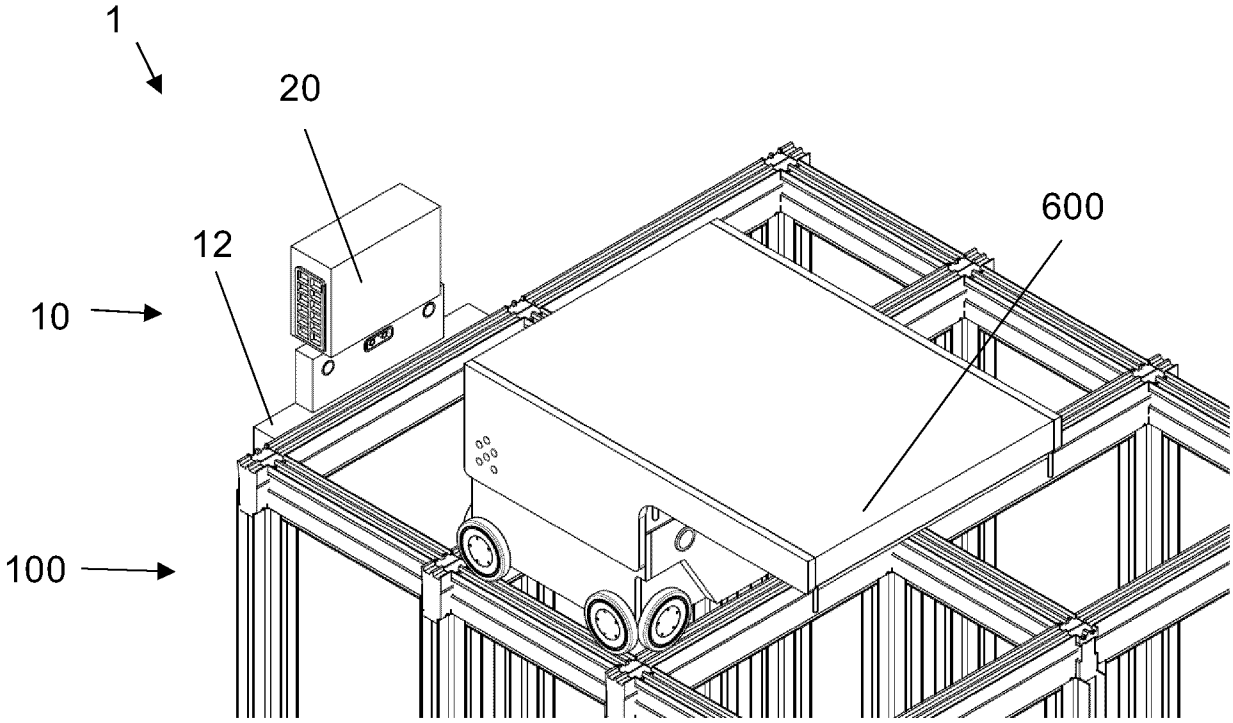

Fig. 7A

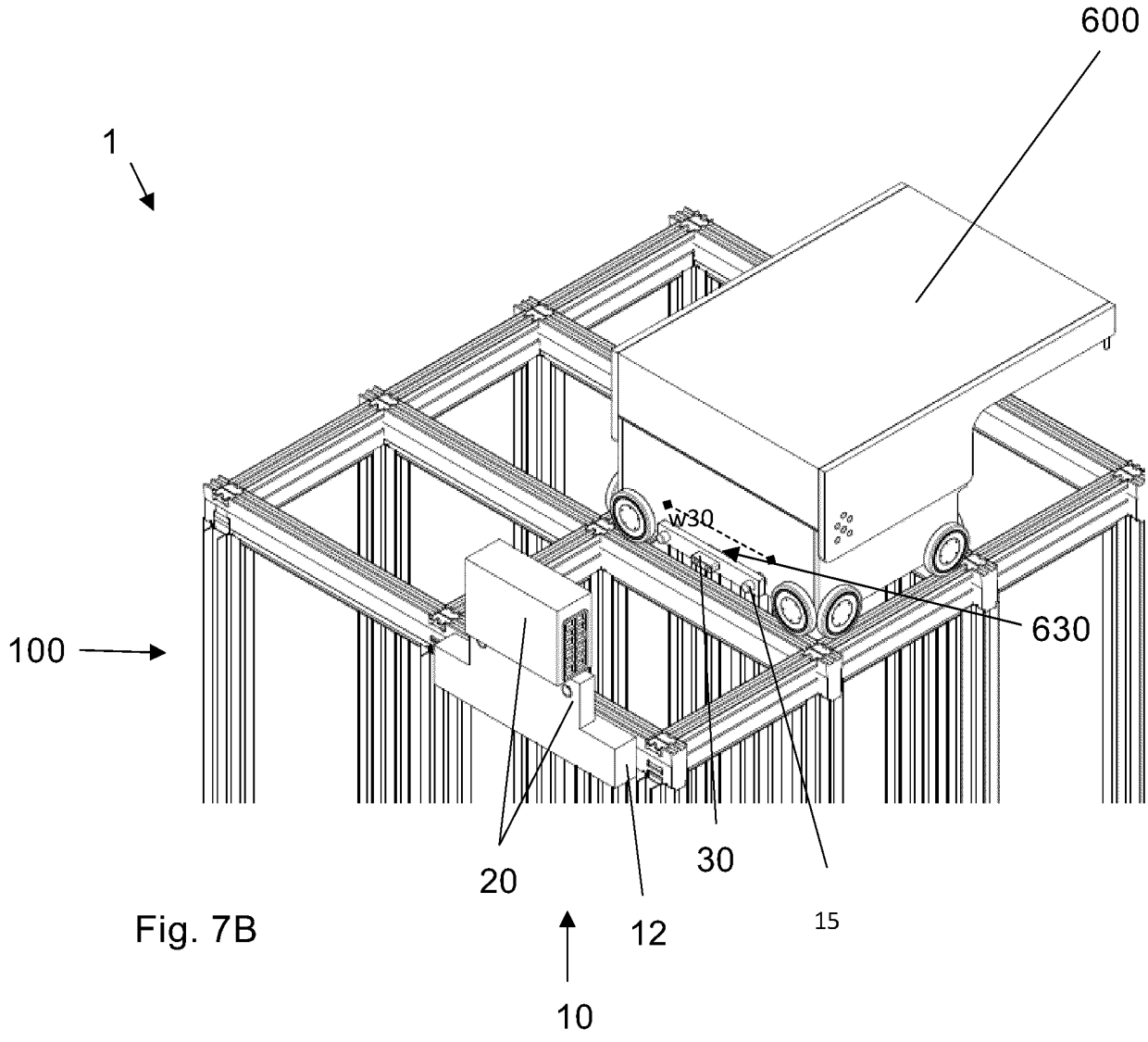

Fig. 7B

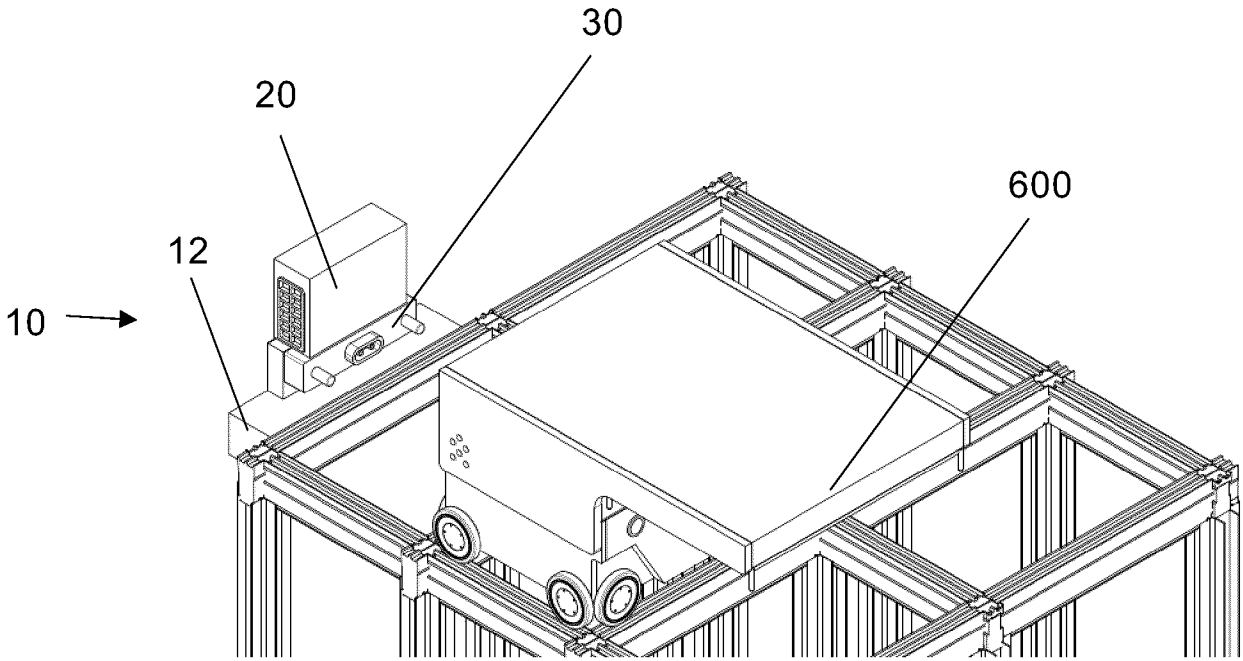

Fig. 7C

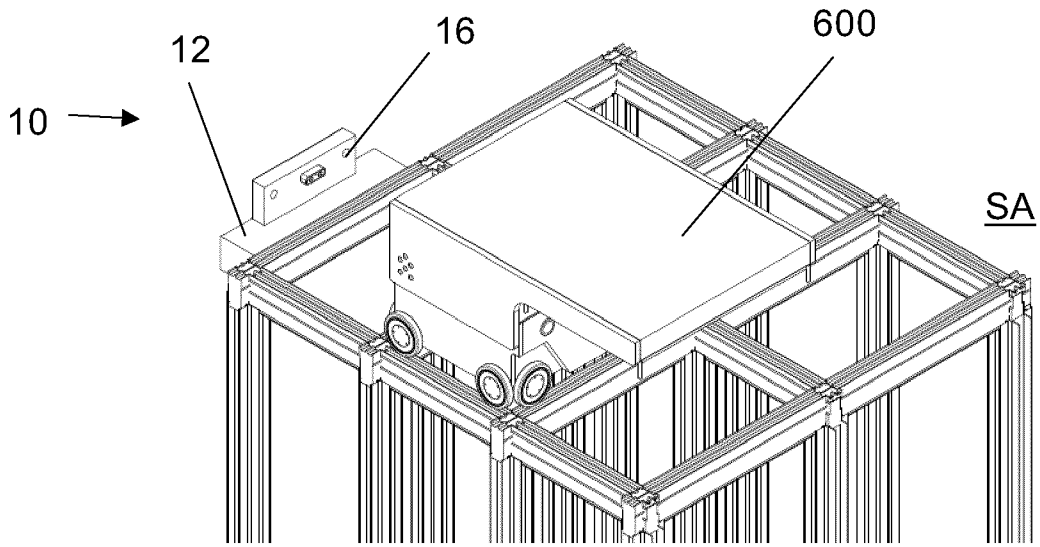

Fig. 8A

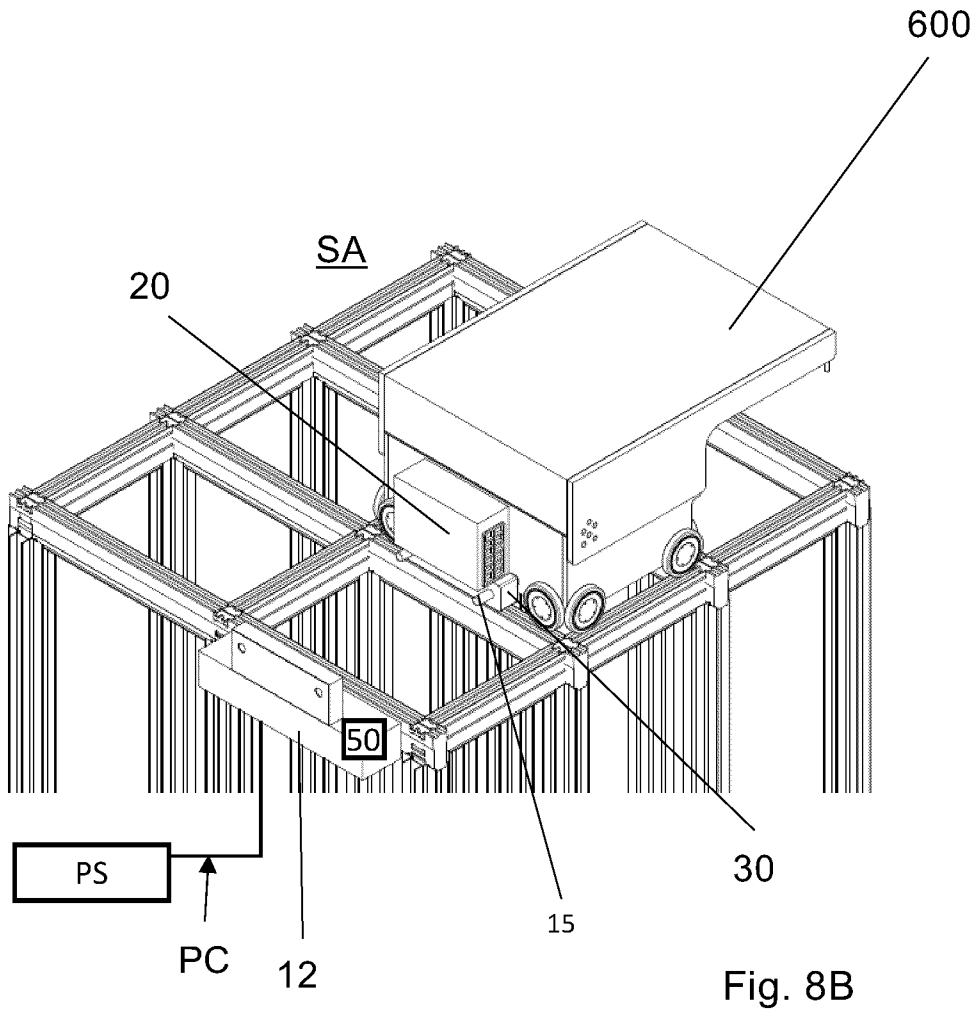

Fig. 8B

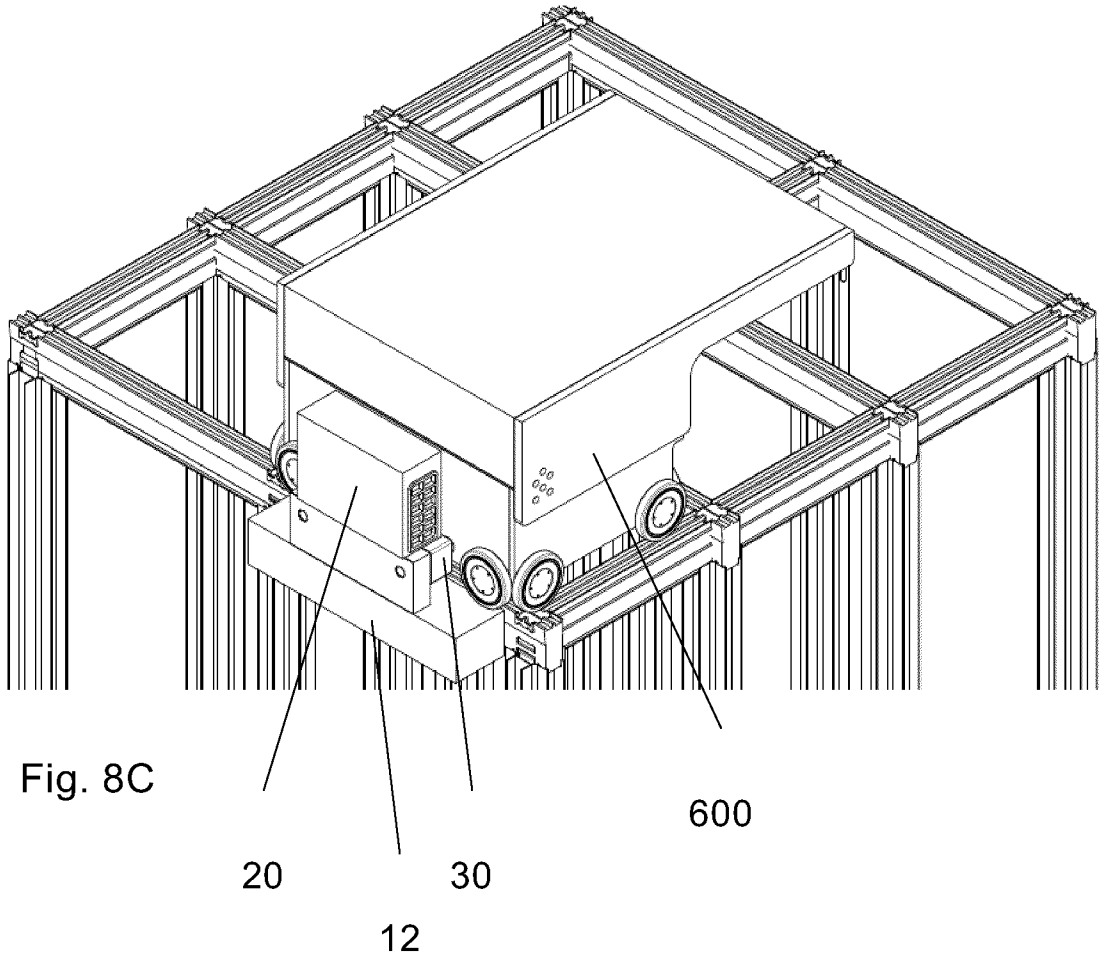

Fig. 8C

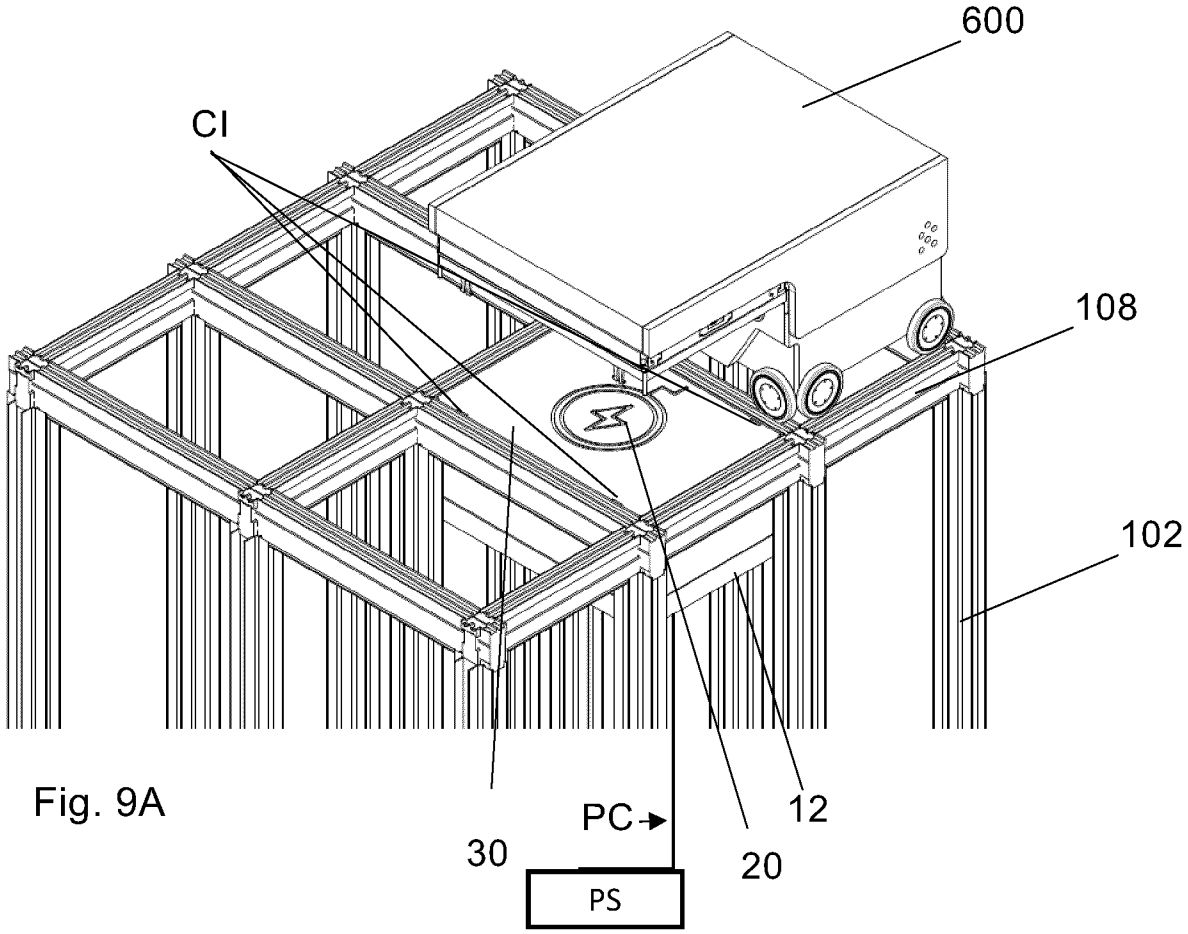

Fig. 9A

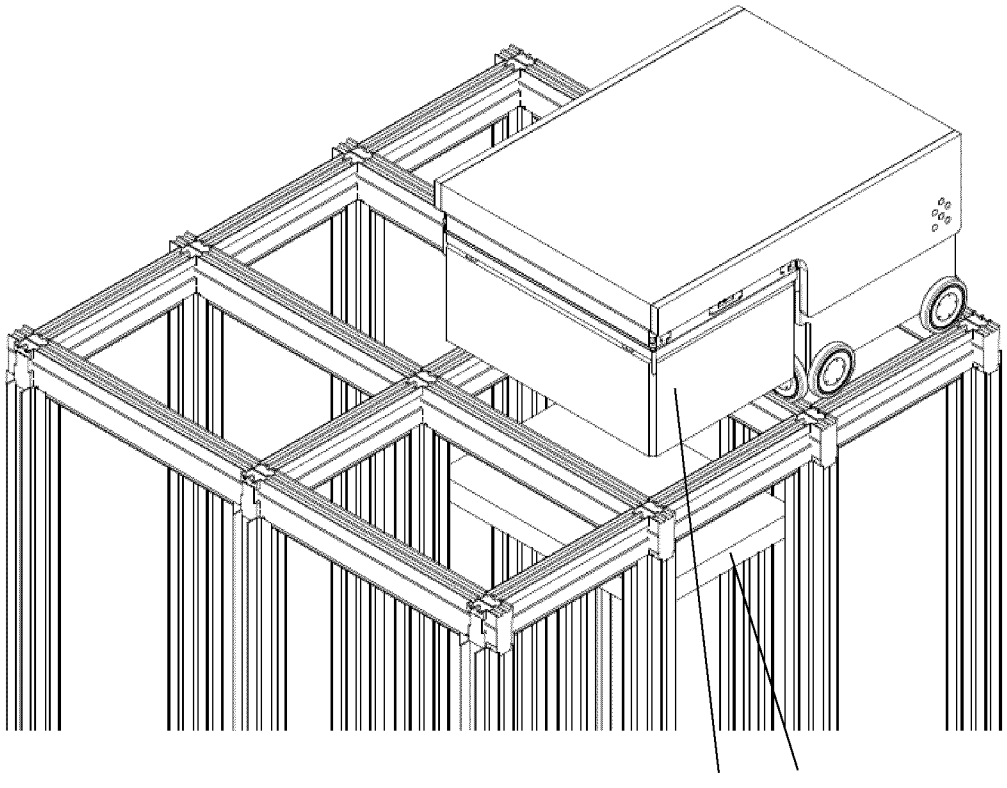

Fig. 9B

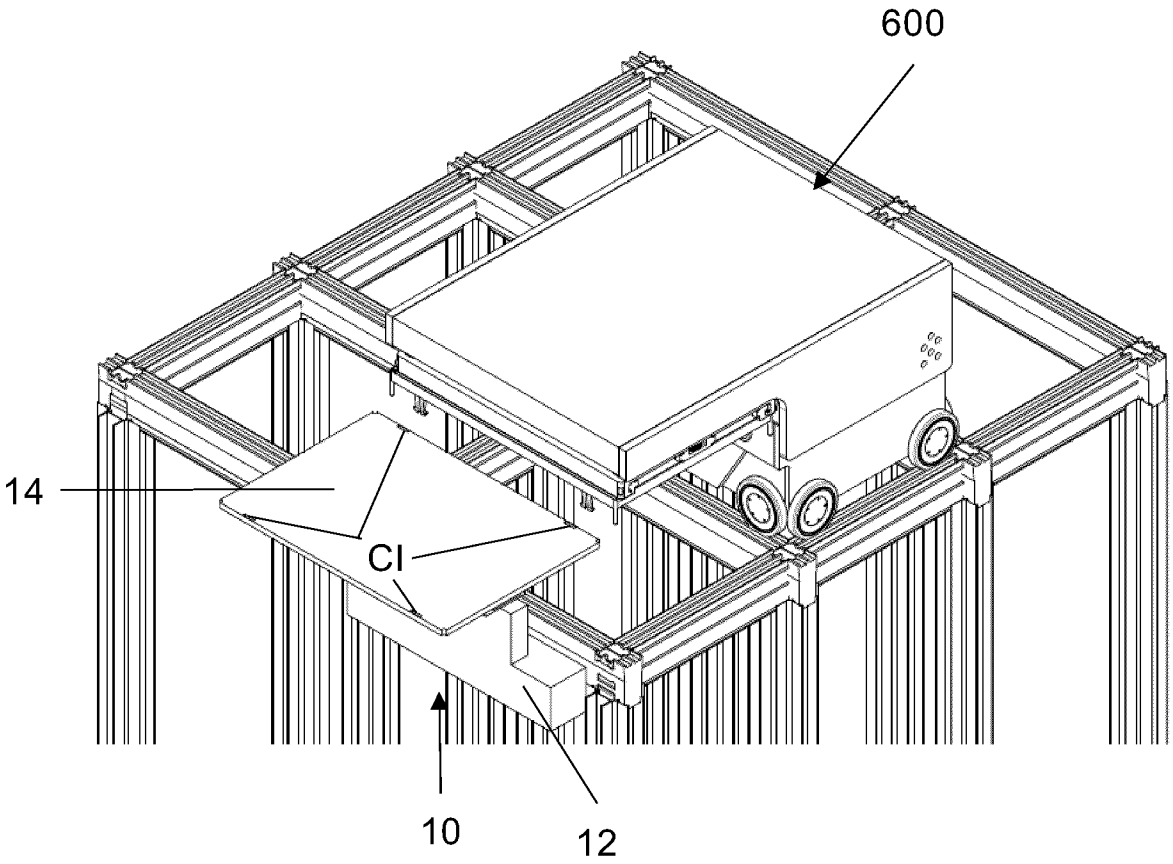

Fig. 10A

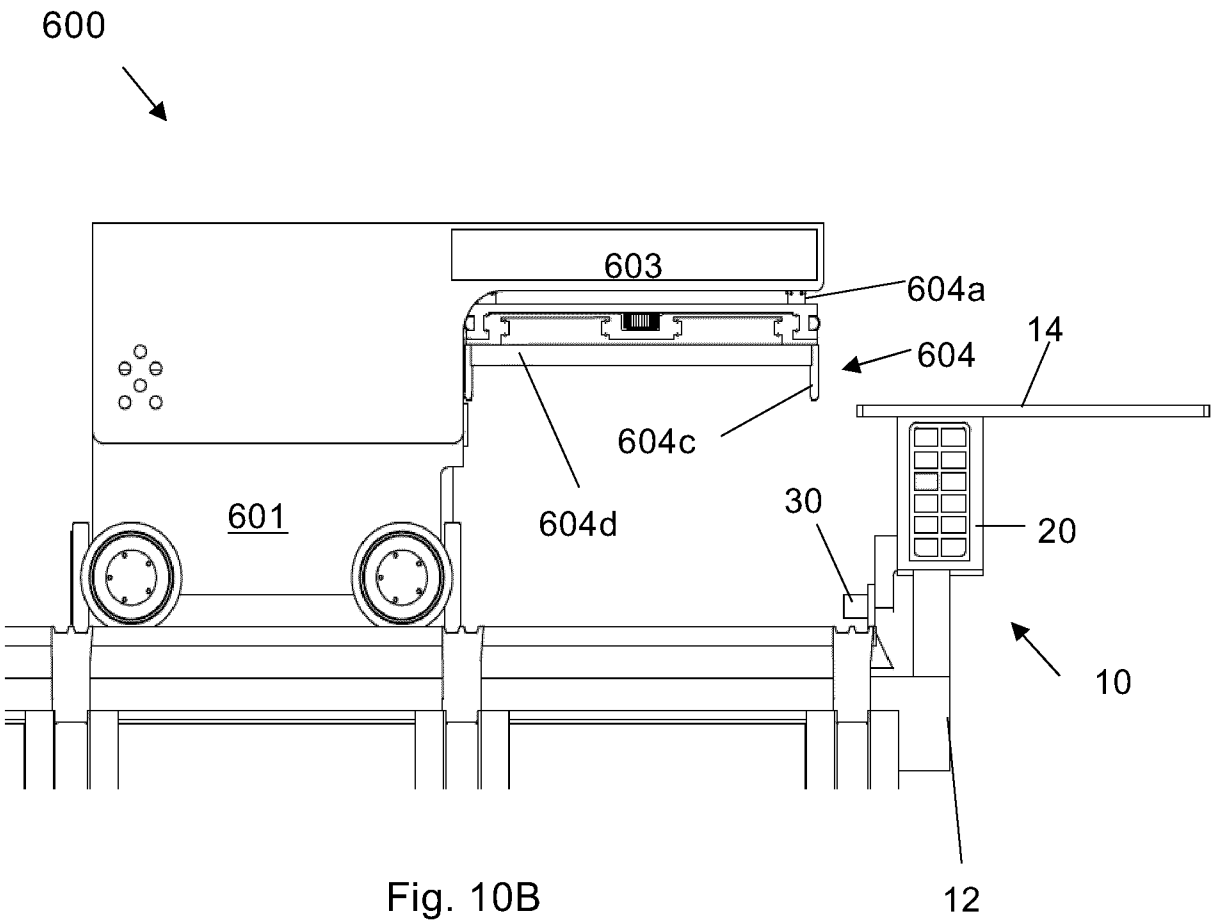

Fig. 10B

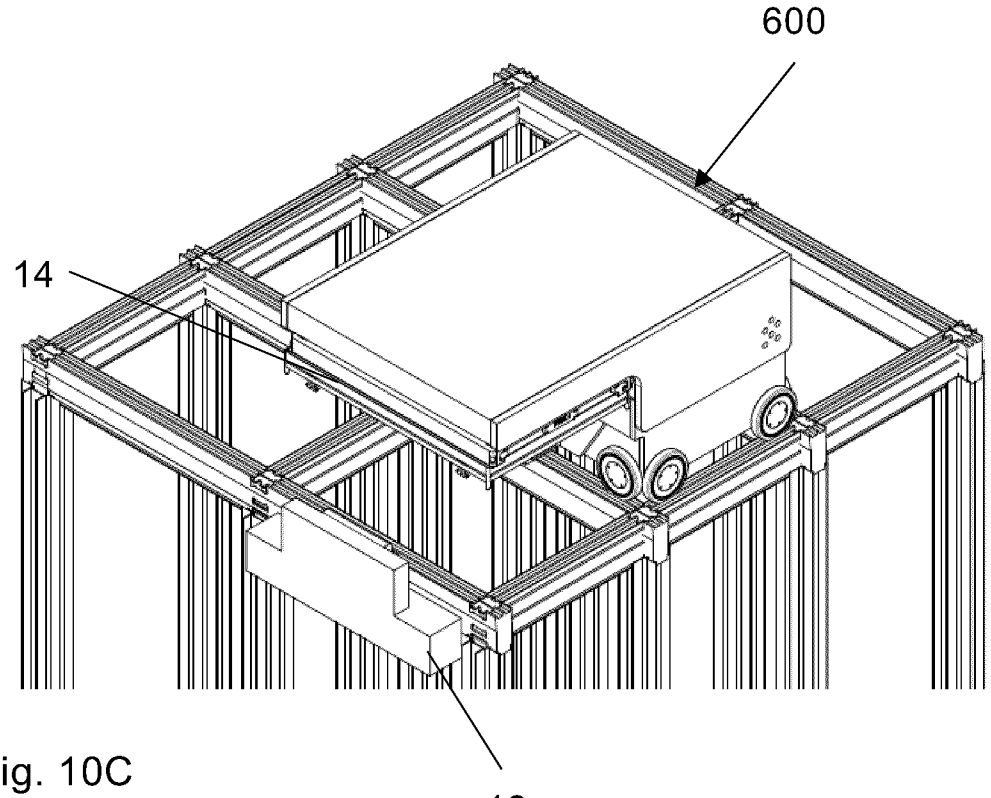

Fig. 10C

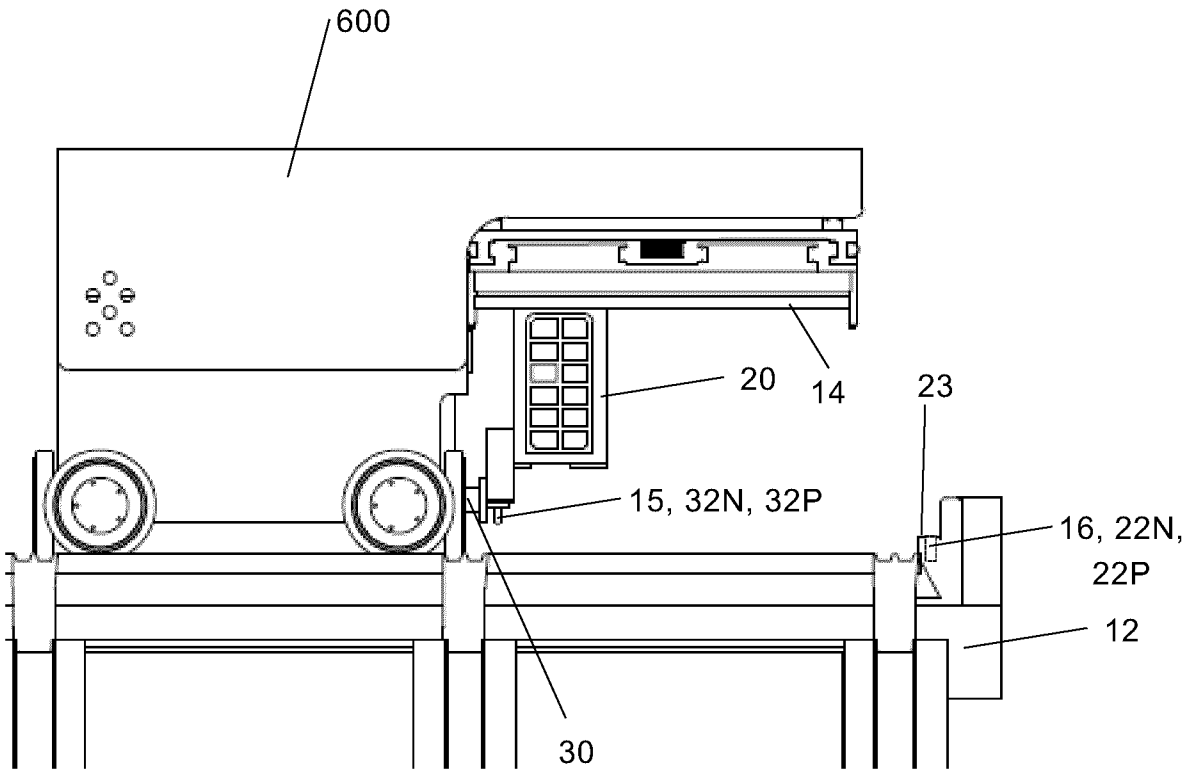

Fig. 10D

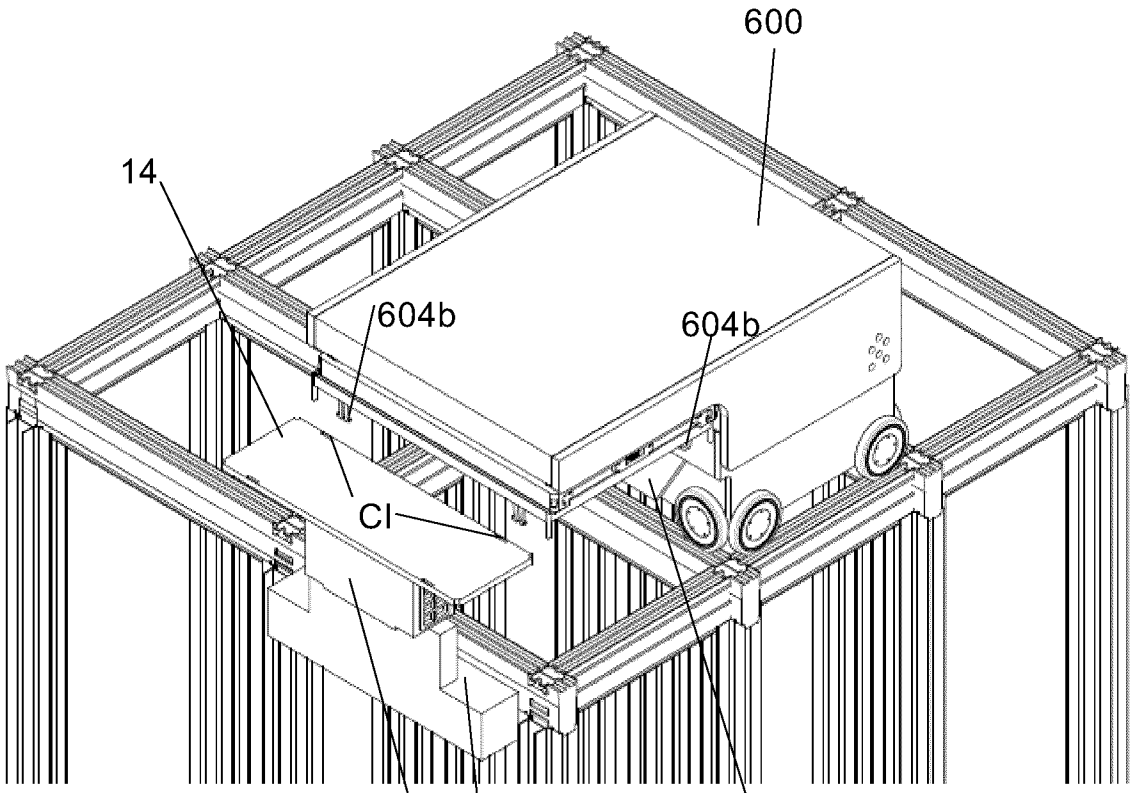

Fig. 11A

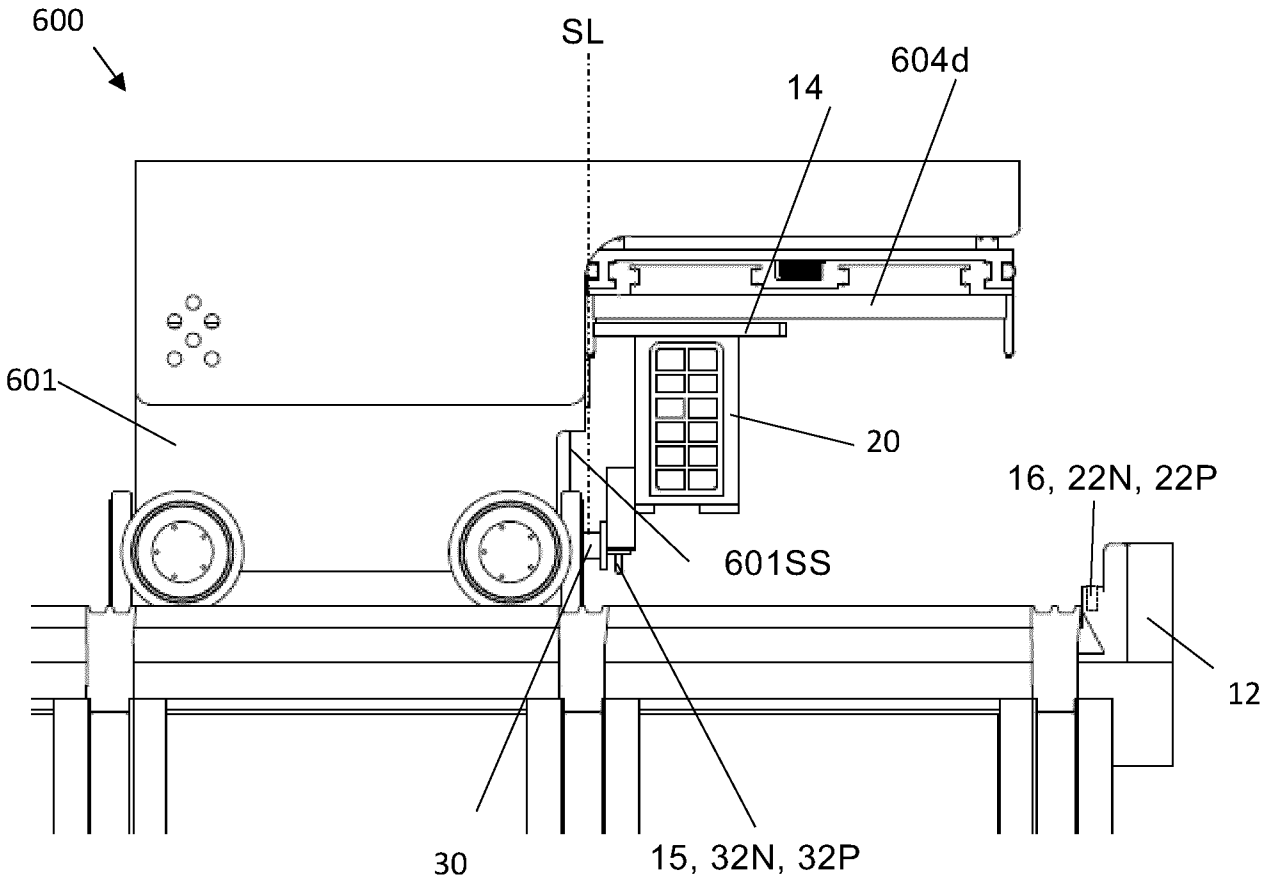

Fig. 11B

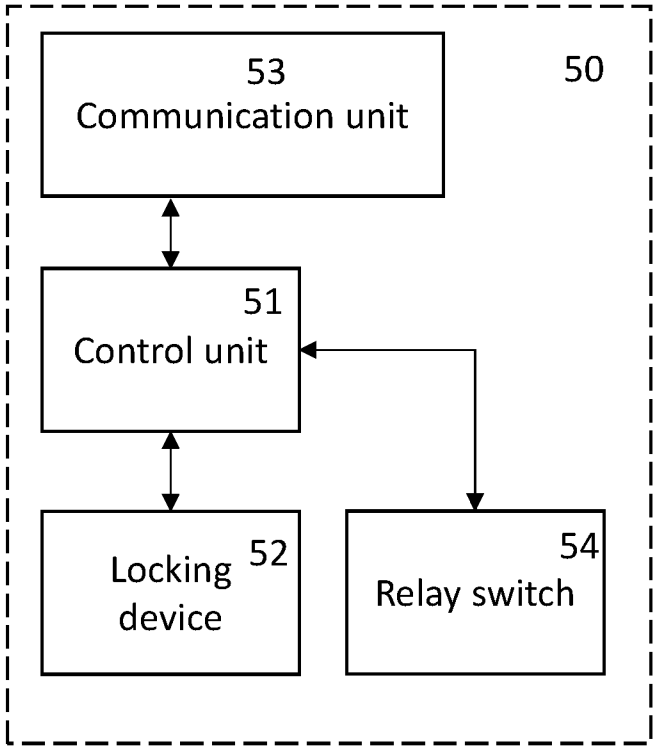

Fig. 12

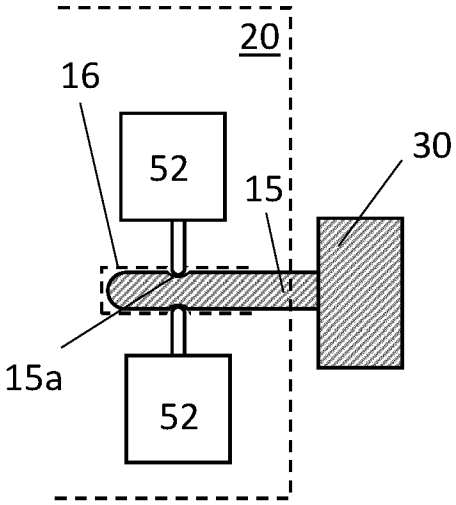

Fig. 13a

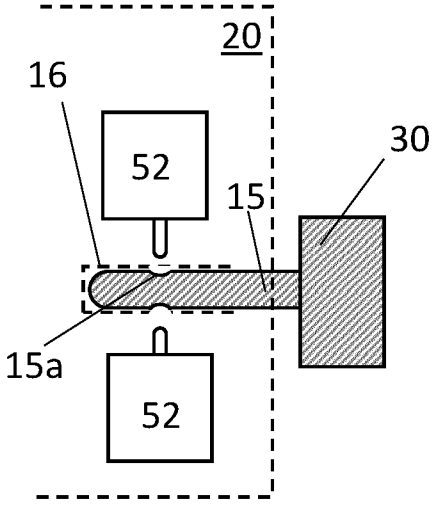

Fig. 13b