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Apparatus for the automated removal of workpieces arranged in a container

The present invention relates to an apparatus for the automated removal of workpieces arranged in a container, having an object recognition device for detecting the workpieces and a gripper for gripping and removing the workpieces from the container, and having a controller for evaluating the data of the object recognition device, for path planning and for controlling the gripper. The present invention further relates to a feed module for such an apparatus.

Such an apparatus is known, for example, from EP 2 679 352 A1 which is incorporated in full as a subject matter of the present application.

Such apparatus for the automated removal of workpieces arranged in a container have previously been individually planned, manufactured and assembled for the specific application in each case. The respective very specific circumstances can hereby be taken into account. However, this is associated with high costs and a great time effort.

Further apparatuses for the automated handling of workpieces are known from DE 20 2010 015 780 U1, DE 195 19 524 A1, US 2013/0086801 A1, DE 103 56 536 A1, and EP 2 578 365 A2.

It is therefore the object of the present invention to provide an apparatus for the automated removal of workpieces arranged in a container, the apparatus being able to be designed, manufactured and/or assembled in a simpler and less expensive manner.

This object is achieved in accordance with the invention by an apparatus in accordance with claim 1.

The present invention in this respect shows an apparatus for the automated removal of workpieces arranged in a container having an object recognition device for detecting the workpieces and having a gripper for gripping and removing the workpieces from

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the container. The apparatus in this respect furthermore has a controller for evaluating the data of the object recognition device, for path planning and for controlling the gripper. Provision is made in accordance with the invention that the apparatus is structured in a modular manner from a handling module and a feed module. The handling module in this respect comprises the gripper kinematics, whereas the feed module comprises an arrangement for providing a container having workpieces. Both the design and the manufacture and assembly of apparatus for the automated removal of workpieces arranged in a container are substantially simplified by the modular construction in accordance with the invention. The individual modules can in this respect in particular be planned, designed and preassembled separately. Furthermore, the same handling module can, for example, be equipped with respective different feed modules depending on which specific function is desired. Apparatus for the automated removal of workpieces arranged in a container can be so-to-say mass produced due to the modular construction. Provision is made that the arrangement for providing a container having workpieces of the feed module is accessible from the outside, which allows the introduction of full containers into the feed module and the removal of empty containers from the feed module, and that the apparatus comprises an output module which has at least one workpiece placement area on which the workpieces are placed down in a separated manner and/or in a defined position. It is furthermore provided that the output module, the handling module and the feed module each comprise cell walls that protect the respective modules from unauthorized entry, wherein the modules have mechanical connection points for connection amongst one another, wherein the feed module comprises the object recognition device. The gripper kinematics the handling module is equipped with is in this respect preferably a robot or an area gantry with which the gripper is moved. It can in particular be a six-axis robot in this respect.

The working space of the gripper of the handling module in this respect preferably extends beyond the base area of the handling module so that workpieces in the region of the feed module can be gripped.

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At least one handling module can be in particular a robot module with a robot, its working zone extending beyond a zone of the robot module through the open side of the robot module into a bordering zone.

The apparatus is in this respect in particular structured such that workpiece can be removed from a container which is provided via the feed module by the gripper of the handling module and can be placed down on the workpiece placement area of the output module. The placing down can in this respect take place either directly or via buffer stations and/or further grippers. The output module in this respect preferably has a transport path for the workpieces using which the separated workpieces and/or the workpieces placed down in a defined position can be transported away and can be fed to further work steps. The apparatus in accordance with the invention can furthermore have a machining and/or assembly module, with the machining and/or assembly module having an end placement area at which workpieces are placed down by a gripper of a handling module and can have a machining and/or assembly unit which machines and/or assembles the workpieces.

In this respect, the machined and/or assembled workpieces can preferably again be gripped by a gripper of a handling module and can be placed onto a workpiece placement area of an output module. The machining and/or assembly module can optionally, however, itself have a transport path for the transporting away of the machined and/or assembled workpieces and can thus represent a combined output module and machining and/or assembly module.

The machining and/or assembly module is in this respect preferably connectable to a handling module such as was presented in more detail above.

One or more of the above-described modules in accordance with the invention preferably has a cell frame. The module can in this respect in particular have a base plate.

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The handling module can in this respect in particular have a base plate on which the gripper and the gripper kinematics, in particular a robot or an area gantry, are arranged. Further advantageously, the handling module has at least two cell walls. Further advantageously, the handling module has at least one open side, preferably two open sides. The handling module can in this respect preferably be connected to a feed module at at least one open side. The handling module can further preferably be connected via a further open side to a machining and/or assembly module and/or to an output module.

The feed module preferably has a base plate and/or three cell walls, while one side remains open to be connected to the handling module.

The modules in accordance with the invention preferably have mechanical connection points for connection to one another. The mechanical connection points can in this respect in particular be arranged at the cell frames. A mechanical connection of the cell frames of the handling module and of a feed module in accordance with the invention in particular hereby becomes possible.

Furthermore, the individual modules can have electrical interfaces, pneumatic interfaces and/or hydraulic interfaces for connection to one another. In this respect, an electrical interface, pneumatic interface and/or hydraulic interface is/are in particular provided between a handling module and a feed module.

The individual modules can furthermore have an interface for connection to a production control system via which interface the operation of the modules can be coordinated with the operation of a further production system.

Furthermore, the individual modules can have interfaces between themselves, which allow for a coordination of the operation of each individual module. A data exchange can in this respect in particular take place between the controls of the individual modules via the interfaces. Alternatively or additionally, the interfaces can allow the

control of actuators of one module via a control of another module and/or can allow the evaluation of data of a sensor of one module via the control of another module.

The handling module can in this respect in particular have an electrical supply, a pneumatic supply and/or a hydraulic supply. The handling module furthermore preferably has an electrical interface, a pneumatic interface and/or a hydraulic interface by which further modules, and in particular a feed module, can be connected to the electrical supply, the pneumatic supply and/or the hydraulic supply of the handling module.

The controller for evaluating the data of the object recognition device, for the path planning and for controlling the gripper is furthermore preferably arranged at the handling module. The controller in this respect preferably comprises an interface via which an object recognition device can be connected which is arranged in the region of the feed module. The controller can in this respect particularly preferably obtain and evaluate sensor data which are generated via a sensor of the object recognition device via the interface. Provision can furthermore be made that the controller arranged in the region of the handling module controls actuators of the feed module.

The handling module can in this respect have an operating module which is preferably accessible from an outer side of a cell wall of the handling module. In this respect, the controller can preferably be accessed via the operating module. An input/output interface can in this respect in particular be provided, in particular a display or monitor and/or input devices such as a keyboard. The handling module can furthermore have a switch cabinet which is likewise preferably accessible from an outer side of a cell wall. The energy supply is preferably arranged in the switch cabinet.

The modular construction of the apparatus in accordance with the invention in particular allows the same handling module to be connected to different feed modules and/or output modules to adapt the apparatus to the respective specifically desired function.

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The handling module is in this respect preferably completely preassembled mechanically and/or electrically and/or pneumatically and/or hydraulically. In this respect, the gripper kinematics is in particular completely wired to the controller and/or to the energy supply. The assembly work is hereby substantially reduced; the handling module preferably only has to be put down and connected to the mains supply in this respect.

The feed module is furthermore preferably completely preassembled mechanically and/or electrically and/or pneumatically and/or hydraulically so that it only still has to be connected to the handling module at the installation site.

The handling module and/or the feed module is/are in this respect advantageously transportable in a hanging manner or by a fork lift as complete units.

Possible embodiments of an apparatus in accordance with the invention which are provided by different feed modules and/or output modules will be presented in the following:

In a possible embodiment of the present invention, the arrangement for providing a container having workpieces of the feed module can be accessible from the outside. This accessibility in particular allows the introduction of full containers into the feed module and/or the removal of empty containers from the feed module.

The accessibility in this respect in particular allows the feed and removal of containers via a transport vehicle such as a fork lift. The arrangement for providing a container can in this respect in particular be accessible via a door which is arranged in a cell wall of a cell frame of the feed module.

Provision can furthermore be made that the arrangement for providing a container having workpieces can take up at least two containers. This makes it possible to continue work immediately with the second container after the emptying of a first

container. Both containers are advantageously in the working space of the gripper of the handling module for this purpose.

In accordance with the invention, the feed module can have a separating device via which a feed zone for one or more containers can be separated from a working zone, in particular from the working zone of the gripper. This makes it possible to remove an empty container or to feed a full container while a second container is being emptied. A hood can in particular be provided as the separating apparatus which is arranged in the feed module such that the feed zone can selectively be covered by it for one or the other container. The hood hereby separates the working zone of the gripper from the respective feed zone while it releases the other container for the gripper. The hood is in this respect preferably arranged movable at the feed module, in particular displaceable and/or pivotable. The hood can in particular be a displaceable hood, a pivotable flap or a roller blind.

In a further embodiment of the present invention, the feed module can cooperate with a driverless transport system.

In a further embodiment of the present invention, the arrangement for providing a container having workpieces of the feed module can be supplied with containers via an automatic container feed and/or removal path. Provision can in particular be made in this respect that the arrangement for providing a container having workpieces can take up at least two containers. Provision can, however, be made in this respect that the removal of workpieces is only possible from a single container or only in a single container position.

The feed module preferably has a transport arrangement for transporting the containers in the interior of the feed module. The transport arrangement can in this respect preferably cooperate with the automatic container feed and/or removal path.

It is furthermore conceivable that the transport arrangement within the feed module and the container feed and/or removal path are combined in one transport path.

In accordance with the invention, a light barrier can be provided which secures the feed zone. It is preferably arranged in the transition zone between the feed station and the automatic container feed and/or removal path.

In a first variant, the arrangement for providing a container having workpieces of the feed module can in this respect have a transverse shuttle which cooperates with a container feed path and with a container removal path each having opposite transport directions. The container feed path can in this respect in particular feed full containers into the zone of the transverse shuttle. The containers are emptied in the zone of the transverse shuttle. The empty containers are then again transferred to the container removal path. The removal of the workpieces from the containers in this respect takes place in the zone of the transverse shuttle, with the transverse movement of the containers being able to take place before, during and/or after the removal of the workpieces. The light barrier in this respect preferably separates the feed zone or removal zone of the transverse shuttle from the container feed path and/or from the container removal path.

In an alternative embodiment, the arrangement for providing a container having workpieces of the feed module can have a rotary table on which the containers can be arranged, with the containers being travelable from a feed zone of the feed module into a working zone of the gripper of the handling module, or vice versa, by rotating the rotary table. The rotary table can in this respect be loaded with containers, for example, either via a transport vehicle such as a fork-lift, or containers can be removed in this manner. Alternatively, the rotary table can also cooperate with an automatic container feed path and/or removal path. The rotary table in this respect preferably has separating walls which separate the feed zone from the working zone.

In a further alternative embodiment, a transport path for containers can lead through the feed module. It can in particular be a transport belt on which the containers are traveled in a filled state into the zone of the feed module and on which they are also again removed from the feed module after the emptying in the zone of the feed module.

In a possible embodiment of the present invention, the feed module can also take over the transporting away of the workpieces in addition to the providing of the containers. In this case, the feed module forms a combination of a feed module and an output module. In this respect, only one transport path is preferably provided on which both the containers are transported in and away and the separated and/or positioned workpieces are transported away. In this respect, the containers having unordered workpieces and also palletizing baskets for receiving the separated and/or positioned workpieces can in particular be transported on the transport path. The palletizing baskets can in this respect in particular have nests for receiving the workpieces.

In further possible embodiments of the present invention, the apparatus can have a buffer station, whereas the controller can be configured in such a manner that the gripper places the workpieces after the removal from the container onto the buffer station, whereas the controller can be configured in such a manner that the workpieces are able to be picked up from the buffer station by a gripper and placed down in an end placement area. The gripper which picks the workpieces from the buffer station can in this respect be the same gripper which also carries out the removal from the container or it can be a different gripper.

In a possible embodiment, the buffer station can in this respect be integrated into the handling module. Alternatively, the buffer station can be arranged in a buffer module. Such a buffer module can in this respect in particular be a cell frame at which the buffer station is arranged. The cell frame in this respect in particular has a base plate and at least one cell wall, preferably at least two cell walls.

The apparatus in accordance with the invention can have two handling modules which preferably interact to remove workpieces from a container and to place them down on an end placement area. In this respect, a buffer station is preferably provided, whereas the controller can be configured in such a manner that the gripper of the first handling module places down the workpieces after the removal from the container, whereas the controller can be configured in such a manner that the workpieces are picked up from

the buffer station by a gripper of the second handling module and are placed down in a workpiece placement area. The buffer station is in this respect preferably arranged in a buffer module which is arranged between the two handling modules.

In a further embodiment of the present invention, the output module can comprise a palletizing cell and/or can interact with a palletizing cell. The workpieces can in this respect in particular be placed down by a handling module in accordance with the invention in palletizing baskets of such a palletizing cell. The output module in this respect advantageously has a transport path and/or a transfer module via which the palletizing baskets can be transported to a palletizing cell.

In a further embodiment, the output module can furthermore interact with a pallet handling system, with the output module corresponding in a particularly preferred embodiment to the equipping and/or feed module of the pallet handling system.

In accordance with the invention, a plurality of handling modules can be connected in parallel with other modules. In this respect, a plurality of handling modules can in particular interact with an output module, and in particular with a transport path for the transporting away of the separated workpieces. The handling modules in such an arrangement preferably have respective separate feed modules. It is, however, alternatively also conceivable to combine a plurality of handling modules with a single feed module, in particular with a transport belt for containers having workpieces, so that the handling modules can remove workpieces in parallel from respective different containers which are, however, arranged on the same transport path.

The handling module can furthermore have an interface via which the operation of the handling module can be coordinated with the operation of at least one further module. The interface can in this respect allow a data exchange of a control of the further module in a first embodiment. Provision can alternatively or additionally be made that a control of actuators of a further module is possible via the interface and/or the utilization of sensor data from sensors which are arranged in a further module.

The handling module can furthermore have an interface to a production control system, via which interface the operation of the handling module can be coordinated with the operation of a production system.

The present invention furthermore comprises a feed module for an apparatus such as has been presented above. The feed module in this respect in particular comprises an arrangement for providing a container having workpieces. In accordance with the invention, the feed module furthermore preferably has an object recognition device for detecting the workpieces in the container. According to the invention, the feed module is to have cell walls which prevent unauthorized access to the working zone of the module and mechanical connection points for connection to the handling module. Furthermore, according to the invention, the arrangement for providing a container with workpieces of the feed module is to be accessible from outside, allowing for the entry of full containers into the handling module and the removal of empty containers from the feed module.

An interface to a handling module can furthermore be provided via which the data of the object detection device can be transferred to a controller of the gripper. Alternatively or additionally, the interface can be used to coordinate the work of the arrangement for providing a container having workpieces with the movement of the gripper.

The feed module can in this respect preferably be combined with a handling module in such a way, that a working zone of the gripper of the handling module reaches beyond a base area of the handling module, so that workpieces in the zone of the feed module can be picked up.

The feed module can in this respect preferably be combined with a robot module in such a way, that a working zone of a robot of the robot module reaches beyond a zone of the robot module through an open side of the robot module into a bordering zone of the feed module.

The arrangement for providing a container with workpieces can in this respect preferably receive at least two containers.

The feed module has in this respect preferably a separating apparatus through which a feed zone for one or more containers are separable from a working zone.

Particularly, a hood can be provided for, which is arranged in such a way in the feed module, that it optionally can be arranged for the one or the other container through the feed zone, to cover it.

The feed module has in this respect preferably an interface for a production control system, through which it is possible to coordinate the operation of the feed module with the operation of a production control system.

The feed module is in this respect preferably configured as has been presented in more detail above with respect to the embodiments of the apparatus in accordance with the invention.

The object detection, the path planning and the controller of the gripper of the handling module preferably take place in this respect as is known, for example, from EP 2 679 352 A1. The buffer station provided there does not, however, have to be necessarily implemented. The sensor arrangement can in this respect in particular be a 3D laser scanner. The object detection device in this respect in particular allows the detection of the individual workpieces in the container. A workpiece which is to be gripped can furthermore be identified in this respect as well as a corresponding path planning for controlling the gripper and/or the gripper kinematics.

The sensor arrangement of the object detection device is further preferably travelable in this respect, preferably linearly travelable. The travel direction can preferably take place in parallel with a transport direction of a transport arrangement for transporting the containers within the feed arrangement.

The controller of the apparatus according to the invention controls the individual components of the apparatus, preferably automatically. Insofar as it was described above that a component of the device according to the invention can be operated in a specific manner, the controller preferably has control routines for a corresponding automated approach.

The present invention will now be described in more detail with reference to embodiments and to drawings.

There are shown:

- Fig. 1: a schematic representation of the modular construction in accordance with the invention of an apparatus for the automated removal of workpieces arranged in a container and of a handling plant;
- Fig. 2a: a first variant of the modular construction in which an assembly module is additionally provided;
- Fig. 2b: a second variant in which the output module comprises a transfer module and a palletizing cell;
- Fig. 3: a first embodiment of an apparatus in accordance with the invention in which the containers can be traveled into the feed module via a transport vehicle;
- Fig. 4: a second embodiment in which the containers are fed in via an automated feed path and are removed via an automated removal path;
- Fig. 5: a third embodiment in which a transport belt is used for feeding and removing the containers as well as a further transport belt for removing the workpieces;

- Fig. 6: a fourth embodiment in which the feed module has a rotary plate;
- Fig. 7a: a fifth embodiment in which a buffer station is provided;
- Fig. 7b: a sixth embodiment in which the output module is formed by a palletizing cell;
- Fig. 8: a seventh embodiment in which the output module is in communication with a palletizing cell;
- Fig. 9: an embodiment of an apparatus for the automatic removal of workpieces arranged in a container in which a plurality of handling modules place workpieces down in parallel on a common output module;
- Fig. 10: a further embodiment in which a buffer module having a buffer station is interpose between two handling modules;
- Fig. 11: an embodiment of a robot module in accordance with the invention or of a handling module in accordance with the invention;
- Fig. 12a: a detailed view of the mechanical connection elements provided in Fig. 11;
- Fig. 12: a detailed view of the pneumatic connection elements provided in Fig. 11;
- Fig. 13: an embodiment of a feed station in accordance with the invention;
- Fig. 14: the combination of the embodiment of a robot and/or handling module in accordance with the invention shown in Fig. 11 with the feed module shown in Fig. 13;

Fig. 15: a representation of an embodiment of an apparatus in accordance with the invention for the automated removal of workpieces arranged in a container or of a combination in accordance with the invention of a robot and/or handling module, of a feed module and of an output module; and

Fig. 16: the combination of modules shown in Fig. 15 in its assembled arrangement.

In a first aspect, the present invention relates to the modular structure of an apparatus for the automated removal of workpieces arranged in a container. Such apparatus have an object recognition device for detecting the workpieces present in the container and have a gripper for gripping and removing the workpieces from the container to place them down on an end placement area, optionally via one or more buffer stations. The apparatus furthermore has a controller for evaluating the data of the object recognition device, for path planning and for a corresponding controlling of the gripper.

Such apparatus make it possible to separate unsorted bulk goods which are fed unordered in containers to a production unit or to a production and/or assembly line and thus to feed them to the further production.

Such apparatus in this respect typically require an adaptation to the requirements of the respective production unit or production and/or assembly line to satisfy the demands made by the different workpieces and/or by the feed and/or output of the workpieces. In this respect, the implementation previously had to be redesigned for each customer.

The present invention in contrast provides a modular structure for such an apparatus which provides an apparatus for the automated removal of workpieces arranged in a container without any complex and/or expensive individual constructions or at least with a reduction thereof, said apparatus optionally being able to be integrated into existing machining and/or production units.

The modular construction in accordance with the invention is shown schematically in Fig. 1 and divides an apparatus for the automated removal of workpieces arranged in a container into a central handling module 1 on which the gripper kinematics is arranged which is in particular a robot or an area gantry for moving the gripper. The handling module 1 is combined with a feed module 2 which has an arrangement for providing the containers having the workpieces. The arrangement of handling module 1 and feed module 2 is furthermore typically combined with an output module 3 on which the gripper of the handling module 1 places the workpieces down in a separated manner. The output module 3 in this respect typically has a transport path for transporting away the workpieces.

Respective interfaces 4 and 5 via which the individual modules are connected to one another are provided between the handling module 1, the feed module 2 and the output module 3. In this respect, it can be a mechanical interface. An electrical interface, a pneumatic interface and/or a hydraulic interface can furthermore also be provided. In addition, the interface can allow a coordination of the operation between the individual modules. An interface to a production system can additionally be provided.

In this respect, two variants of the basic modular construction shown in Fig. 1 are shown in Figs. 2a and 2b. An assembly module 6 is provided in Fig. 2a in addition to the handling module 1, the feed module 2 and the output module 7. Workpieces can, for example, be machined thereat and/or assembly steps can be carried out at the workpieces. The workpieces can in this respect first be given by the handling module to the assembly module and can be given from it back to the output module 7 via the handling module.

A variant is shown in Fig. 2b in which the handling module 1 is in communication with a palletizing cell 9 via a transfer module 8. The transfer module can, for example, be a transport belt on which palletizing baskets can be transported to the palletizing cell. The workpieces can then first be placed down into the palletizing baskets in the region of the transfer module 8. The palletizing baskets are then transported into the palletizing cell 9 for which a corresponding transport device is preferably provided.

The transfer module can either be joined to a palletizing cell or it can be integrated as a transfer module in a palletizing cell and can thus allow a direct input into the palletizing cell.

The handling module which can be combined with different feed modules in this respect serves as the base unit for all variants of the apparatus in accordance with the invention. The unit of handling module and feed module can then be expanded by different kinds of a removal module or can be attached to existing transport units, machining units and/or assembly units.

The modular structure makes it possible to meet the various, multi-variant demands of the customers with respect to production lines, machining lines and assembly lines without a respective complete new construction. The interfaces furthermore allow a simple and fast assembly on site since the individual modules are supplied preassembled and only have to be connected to one another at the assembly site.

In an embodiment of the present invention, the handling module 1 and the feed module 2 in particular each have a cell frame. The latter typically comprises a base plate as well as one or more cell walls which prevent unauthorized access to the working zone of the handling device with a set-up apparatus. The cell frames of the individual modules are in this respect connected to one another via mechanical connection points. Electrical interfaces, pneumatic interfaces and/or hydraulic interfaces can furthermore be provided for connecting the modules. The individual modules can in this respect in particular be delivered in a completely set-up manner and can then be connected to one another by a few manipulations.

The handling module 1 in this respect has the gripper kinematics in its basic equipment, i.e. an arrangement via which the gripper for removing the workpieces from the container and for placing them down on a buffer placement area or end placement area can be moved. A robot, in particular a six-axis robot, is in particular used for this purpose. Alternatively, however, an area gantry can also be used. The handling

module furthermore has a corresponding controller for the gripper kinematics and for the gripper. In the embodiment, the handling module furthermore has an operating module having a user interface via which the controller can be accessed. An electrical supply, pneumatic supply and/or hydraulic supply can furthermore be provided, in particular in a switch cabinet. The user interface and the switch cabinet are preferably accessible from the outer sides of the cell walls.

The apparatus in accordance with the invention for the removal of workpieces from the containers in this respect has an object detection device having a sensor. Said sensor is respectively arranged in the region of the feed module and can be arranged above a container to be emptied to detect the workpieces in the container. It is in this respect in particular a 3D laser scanner. The data of the sensor are in this respect evaluated to identify the individual workpieces and their positions and to determine a workpiece suitable for gripping. A track planning for the gripper or for its gripper kinematics, in particular for the robot 10, then takes place using the positional data of this workpiece. For this purpose, the sensor is in communication with the controller of the handling module via an interface.

In the following, some variants will now be described how a handling module in accordance with the invention can be combined with different feed modules and/or output modules.

In Fig. 3 in this respect, the handling module 1 is first shown which has a robot 10, the user interface 11 and the energy supply 12. The handling module 1 in this respect has two open sides via which it is in communication with a feed module 2 and with an output module 3.

In the embodiment shown in Fig. 3, the feed module 2 has two feed zones for containers which are arranged next to one another and which are each accessible from the outside via a door 13. The containers 66 can in this respect, for example, be introduced into or removed from the respective feed zone via a fork lift. To separate the feed zones for the containers from the working zone of the gripper, a hood 14 is

provided which can selectively be pushed over the feed zone for the one or for the other container. If one of the two containers is thus completely emptied, the hood travels over it and thus releases the other container for the gripper. The gripper can thus seamlessly continue with the emptying. The now emptied container can now be removed without risk due to the hood 14 which covers the feed zone for said now emptied container and can be replaced by a full container.

In Fig. 3 a transport path 15 serves as the output module on which the workpieces removed from the containers can be placed down in a separated manner. The transport path can optionally have corresponding receivers for this purpose. It is a transport belt in the embodiment.

The embodiment shown in Fig. 4 differs from the embodiment shown in Fig. 3 by a differently designed feed module 2. The feed module is in this respect in communication with an automated container feed path 16 and with an automated container removal path 17 via which full containers can be fed and empty containers can be removed. The feed direction of the feed path 16 is in this respect opposite to the removal direction of the removal path 17.

A transverse shuttle 18 is therefore provided in the feed module 2 and containers can be traveled via it in the direction of movement 19 transverse to the feed direction or removal direction respectively. Containers are therefore transported from the feed path 16 into the feed zone of the feed module. The containers can be emptied there by the handling module. An emptied container is then traveled via the transverse shuttle 18 to a transfer zone for transferring to the removal path 17 from where the emptied containers are removed. Alternatively, a filled container can also first be transported via the transverse shutter within the feed arrangement and the removal of workpieces from the container can only then take place. In the embodiment, a light barrier 20 is in this respect furthermore provided which is arranged between the feed module and the feed path 16 and/or the removal path 17. The light barrier in this respect prevents the access of persons into the region of the feed module.

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In the embodiment shown in Fig. 5, a transport path 21 for the containers is provided as the feed module 2, in particular a transport belt, via which both the feed of full containers and the removal of emptied containers takes place. The feed and removal in this respect in particular take place without a change in direction simply by continued transport on the transport path. The feed module 2 in this respect preferably has openings on its narrow sides 22 and 23 through which openings the transport path with the containers passes.

In the embodiment shown in Fig. 6, the feed arrangement has a rotary plate 24 on which a plurality of containers can be arranged. The rotary plate 24 is in this respect rotatable about a vertical axis of rotation 26 to bring the containers from a feed zone for the containers into the working zone of the handling module.

The rotary plate 24 in this respect preferably has a separating wall 25 which separates the working zone of the gripper from the feed zone for the containers. The feed and removal of the containers to and from the rotary plate can in this respect again take place via a transport vehicle, for example via a fork lift. Alternatively, such a rotary plate can also be automated with an automated feed path and/or removal path for the containers.

In the embodiments shown in Figs. 7a and 7b, a buffer station 27 is furthermore provided in the zone of the handling module 1, on which buffer station the gripper of the handling module can place down, and optionally grip again, workpieces which have been removed from the containers in the region of the feed module. The buffer station in this respect in particular allows a more precise grip and thus a more precise laying down in the region of the output module. In this respect, any desired feed module can be used as the feed module 2 which is only shown schematically in Figs. 7a and 7b. Any desired output module can furthermore also be used.

In this respect, a transport path 15 is again used as an output module in Fig. 7a. A palletizing cell 28 into which the workpieces can be placed is in contrast provided as the output module 3 in Fig. 7b.

A further embodiment is shown in Fig. 8 in which the feed and removal of the containers take place via a transport belt 21. A buffer placement area 27 is furthermore provided here in the region of the handling module. The placing down in this respect takes place into palletizing baskets 29 which are traveled over a transport path 28 to a palletizing cell.

An arrangement is shown in Fig. 9 in which a plurality of handling modules 1 are combined with a single output module 34, in the embodiment again a transport belt. The handling modules in this respect work in parallel and place respective separated workpieces on the output module 34. In the embodiment, the individual handling modules 1 are in this respect each combined with separate feed modules 35 and thus form removal units 30 to 33. In this respect, a respective two removal units 30 and 32 are provided on oppositely disposed sides of the transport belt 34 in the embodiment so that the loading takes place from oppositely disposed sides. A respective two removal units are furthermore provided after one another along the transport belt 34.

An embodiment is shown in Fig. 10 in which a plurality of handling modules are likewise used. They are in this respect, however, connected in series so that the workpieces are each handled after one another by two different handling modules. This in particular allows an increase in the gripping precision in the placing down on the end placement area. In the embodiment, the handling modules 36 and 37 are in this respect provided which are combined with a buffer station via a buffer module 38. The individual modules can in this respect, as shown schematically in Fig. 10, be combined in an offset manner, but preferably in an aligned manner. The arrangement of the two handling modules 36 and 37 and of the buffer module 38 is then combined with a feed module 39 and an output module 40. The first handling module 37 in this respect removes workpieces from the containers in the region of the feed module 39 and places them down on the buffer station of the buffer module 38 from where they are gripped again via the second handling module 36 and are placed down in the region of the output module 40.

In a further possible embodiment of the invention, the feed module can cooperate with a driverless transport system.

An embodiment of a robot module in accordance with the present invention is shown in Fig. 11 which can, for example, be used as a handling module in an apparatus in accordance with the invention for removing workpieces from a container such as has been presented above. The robot module can, however, also be used independently of this application in a variety of working areas.

The robot module 1 comprises a cell frame which comprises a base plate 41 and the cell walls 42 and 43. The robot 10 is in this respect mounted on the base plate. The robot 10 is a six-axis industrial robot in the embodiment.

The base plate 41 is in this respect rectangular, with the two cell walls 42 and 43 being arranged on oppositely disposed narrow sides of the base plate 41. The two longitudinal sides of the robot module are open in contrast. The working zone of the robot 10 extends beyond the zone of the robot module through the open sides into the adjacent zone. The robot module 1 can hereby be combined with further modules which provide or take up workpieces, for example, which are machined and/or handled by the robot.

The cell walls are in this respect made up of corner struts 46 in the embodiment which are connected to one another via transverse struts 47. The cell walls furthermore have a lining. The cell walls in this respect prevent the access to the working zone of the robot 10.

A control module for the robot is integrated into the robot module. The robot module furthermore has a user interface which is arranged at an outer wall of the cell wall 42 in the embodiment. The interface in this respect has a display 44 and input elements. A touchscreen 45 is furthermore provided as an input/output element. The control module can be accessed and in particular the movement of the robot controlled via the user interface.

The robot module furthermore has an electrical supply, pneumatic supply and/or hydraulic supply 12 which is accessible from the outside via a switch cabinet arranged in the region of the other cell wall 43. It is in this respect in particular an energy supply not just for the robot or the robot module, but rather also for further modules which can be connected via corresponding interfaces.

The robot module in accordance with the invention can be connected to further modules to form a machining unit, assembly unit and/or handling unit. The further modules preferably also have a cell frame which can be mechanically connected to the cell frame of the robot module.

The cell frame of the robot module shown in the embodiment in this respect has mechanical connection points 48 for connection to further modules. They are provided at the corner struts 46. In the embodiment, these are screw domes 49 which can be pushed through corresponding openings in the cell frame of a further module and can be screwed thereto.

Further modules for the energy supply can furthermore be connected to the robot module. A pneumatic and/or hydraulic interface 50 is provided for this purpose via which a further module can be connected to the hydraulic and/or pneumatic supply of the robot module.

In this respect, if the robot module has a hydraulic supply, it preferably comprises a pump which provides high-pressure hydraulic fluid. If a pneumatic supply is provided, it preferably comprises a compressor which provides compressed air.

The electrical connection of a further module can furthermore also take place via the electrical supply of the robot module. An electrical interface is preferably also provided for this purpose.

- 24 -

An interface to the control module of the robot can furthermore be provided via which the operation of the robot module can be combined with the operation of other modules.

In a first embodiment, the further module can in this respect itself comprise a controller which communicates, preferably communicates bidirectionally, with the control module of the robot module 1 via the interface.

In an alternative embodiment, the control of actuators of a further module can also take place via the control module of the robot module. Sensor data of sensors which are arranged in a further module can furthermore be evaluated via the control module of the robot module.

A combination of the above-named variants of an interface is furthermore also conceivable.

The robot module is built up so that it can be delivered to the installation site in a completely pre-assembled manner as a construction unit. In this respect, the cell frame can optionally be stiffened for transport via a longitudinal strut which connects the cell walls to one another in their upper regions. The transport of the robot module can in this respect take place either in a hanging manner, for example in that hooks are connected to the longitudinal strut or to the cell walls or in that the robot module is transported in a manner hanging at the robot. Alternatively, the robot module can, for example, be transported via a fork lift which grips beneath the base plate.

The robot module in this respect already has a complete wiring of the robot to the control module, to the energy supply and to the user interface. Only a few assembly steps thereby have to be carried out at the installation site.

The further modules are preferably also pre-assembled accordingly and only have to be mechanically connected to the robot module and connected via the corresponding interfaces to the energy supply and/or to the control module of the robot module.

An embodiment of a feed module is shown in Fig. 13 which can be connected to the robot module 1 in accordance with the invention which in this case works as a handling module. The feed module 2 and the robot module or handling module 1 in this respect preferably form an apparatus for the removal of workpieces arranged in a container, in particular for the removal of workpieces arranged in a container in an unordered manner.

The feed module 2 in this respect likewise has a cell frame which can be connected to the cell frame of the handling module 1. In this respect, the cell frame has a base plate 51 as well as cell walls 52, 53 and 54. One side of the feed module is open in contrast and is connected to an open side of the handling module so that the robot 10 can work in the region of the feed module.

The cell frame of the feed module in turn has corner struts 56 which are connected to one another via transverse struts 47 and longitudinal struts. Covers or windows are furthermore also provided here which protect the region of the feed module from unauthorized access.

The corner struts 46 arranged at the open side of the cell frame can in this respect be mechanically connected to the corner struts 46 of the cell frame of the robot module, in particular via the fastening points shown in Fig. 12a.

The connection to the energy supply of the robot module takes place via the interface 50 which is shown in Fig. 12b and which is connected to a corresponding interface 70 of the feed module. The interface 70 of the feed module is in this respect arranged in the interior of the feed module and is accessible via a door in an outer wall. Sensors and/or actuators of the feed module can furthermore be connected to the control module of the robot module via an electronic interface, not shown.

The feed module 2 is likewise completely pre-assembled and has a complete wiring which only makes a connection to the interfaces of the robot module necessary. The

feed module can in this respect, for example, be hung from a hook via the bores 48 and can be transported in a hanging manner. Alternatively, a transport via a fork lift is also conceivable here.

In Figs. 14, 15 and 16, the combination of the handling module 1 and of the feed module 2 is now shown which together form an apparatus for the removal of workpieces from containers 66. The handling module 1 is in this respect furthermore connected at its free side disposed opposite the feed module to an output module 3 which will be looked at in more detail later.

The feed module in this respect forms a feed arrangement for the provision of containers from which the robot can remove workpieces which can also be used independently of the modular structure in accordance with the invention. However, the above-described modular structure is particularly preferably provided here.

The feed arrangement formed by the feed module is in this respect accessible at a side for the provision and removal of containers. In the embodiment, sliding doors 55 are provided for this purpose which are let into the cell wall 54. Two feed zones provided next to one another in the feed arrangement are hereby accessible for a respective one container. The containers can in this respect be introduced into the feed arrangement via a fork lift 65 or can be removed therefrom after the emptying.

The provision of two containers in this respect has the advantage that after the emptying of a first container the apparatus can immediately start with the emptying of the second container without the removal operation having to be interrupted to replace the container. The empty container can rather be removed and can be replaced by a full container while the other container is emptied.

However, a separation of the feed zones for the containers from the working zone of the gripper with which the workpieces are removed from the container is required for this purpose. For this purpose, a displaceable hood 57 is provided which can be

pushed either over the feed zone for the first container or over the feed zone for the second container and thus separates it from the working space of the gripper.

The doors 55 are in this respect preferably configured such that they can only be opened when the feed zone associated with the respective door is separated from the working zone of the gripper via the displaceable hood 47. It is hereby ensured that there is no risk of injury on the removal and setting of a container into the feed arrangement.

The apparatus in accordance with the invention for the removal of workpieces from the containers in this respect has an object detection device having a sensor 63 which can be arranged above the respective container and which detects the workpieces in the container. It is in this respect in particular a 3D laser scanner. The data of the sensor arrangement are in this respect evaluated to identify the individual workpieces and their positions and to determine a workpiece suitable for gripping. A t planning for the gripper or for its gripper kinematics, in particular for the robot 10, then takes place using the positional data of this workpiece.

The sensor arrangement 63 is in this respect arranged travelable in the feed arrangement. A travel arrangement 64 is in particular provided for this purpose along which the sensor 63 can selectively be arranged above the first and second containers. This has the advantage, on the one hand, that only one sensor arrangement for detecting the workpieces has to be used since it can be traveled over the respective container in dependence on the container which is to be emptied. On the other hand, the sensor arrangement can be traveled away out of a region above the container after the workpieces have been detected so that the working zone of the gripper is not restricted by the sensor arrangement. After a workpiece has been removed, the sensor arrangement is then traveled back over the container to detect the remaining workpieces.

In the embodiment of the present invention, in which the total control electronics for the gripping from the container is arranged in the region of the robot module 1, the

sensor arrangement 63 is connected to the control module of the robot module, with the data of the sensor module being evaluated via the control module.

The handling module is, as shown in Figs. 15 and 16, connected to an output module on the open side disposed opposite the feed module. In the embodiment, it also has a cell frame which is connected to the cell frame of the handling module 1. The output unit in this respect has a transport path on which the gripper of the handling unit places down the workpieces removed from the container. The transport path is in this respect a roller belt. Nests into which the workpieces are placed can optionally be transported thereon. The cell frame of the output module also protects here against unauthorized access to the working zone of the robot 10. Doors 71 are provided for maintenance work via which the interior of the cell formed by the feed module, the handling module and the output module can be entered.

Due to the modular structure, the apparatus in accordance with the invention for the removal of workpieces from a container can be used in a plurality of different areas with only small construction and assembly effort. The handling module in accordance with the invention can in this respect in particular be combined with output units already present at the customer side so that only a corresponding connection of the handling module has to be designed from new, in particular via construction of a cell frame. The handling module can furthermore also optionally be combined with already present feed modules.

The robot module in accordance with the invention can, however, also be used in other applications for a simple and inexpensive setup of a robot cell. It can in this respect in particular be combined with machining and/or assembly modules.

P a t e n t k r a v

- 5 **1.** Indretning til automatiseret udtagning af emner, der er anbragt i en beholder (66), med en objektgenkendelsesindretning (63) til registrering af emnerne og mindst en griber til at gribe og udtage emnerne fra beholderen og med en styreindretning til evaluering af dataene fra objektgenkendelsesindretningen til banepanlægning og til styring af griberen,
- 10 hvor indretningen er opbygget modulært af mindst et håndteringsmodul (1), mindst et tilførselsmodul (2) og et afgivelsesmodul (3), hvor håndteringsmodu- let (1) har griberkinematikken (10), især en robot eller en fladeportal, tilførsels- modulet har en anordning til tilvejebringelse af en beholder (66) med emner og objektgenkendelsesindretningen (63),
- 15 og afgivelsesmodulet (3) har mindst en emneaflægningssindretning (15), hvorpå emner aflægges enkeltvist og/eller i en defineret position,
- 20 hvor anordningen til tilvejebringelse af en beholder (66) med emner af tilførselsmodulet (2) er tilgængeligt udefra, hvilket muliggør indføring af fulde be- holdere (66) i tilførselsmodulet og udtagning af tomme beholdere fra tilførsels- modulet, og
- 25 hvor afgivelsesmodulet (3), håndteringsmodulet (1) og tilførselsmodulet (2) hver især har cellevægge (42, 43, 52 -54), der beskytter det pågældende mo- duls arbejdsområde mod uberettiget adgang, hvor modulerne har mekaniske forbindelsespunkter (48) til forbindelse med hinanden.
- 30 **2.** Indretning ifølge krav 1, hvor afgivelsesmodulet har en transportstrækning (15) til emnerne, og/eller
- hvor et arbejdsrum af håndteringsmodulets (1) griber rækker ud over en grund- flade af håndteringsmodulet (1), således at emner gribes i tilførselsmodulets område, og/eller
- hvor der ved mindst et håndteringsmodul (1) er tale om et robotmodul (1) med en robot (10), hvis arbejdsområde strækker sig ud over et område af robotmo- dulet (10) gennem mindst en åben side af robotmodulet (10) til et tilstødende område.

- 5 **3.** Indretning ifølge et af de foregående krav, med et bearbejdnings- og/eller montagemodul, hvor bearbejdnings- og/eller montagemodulet har en emneaf-lægningsindretning, hvorpå emner aflægges ved hjælp af en griber af et hånd-teringsmodul (1), og en bearbejdnings- og/eller montageenhed, der bearbejder og/eller monterer emnerne, hvor de bearbejdede og/eller monterede emner fortrinsvis gribes af en griber af et håndteringsmodul og aflægges på afgivel-sesmodulets (3) emneaf-lægningsindretning.
- 10 **4.** Indretning ifølge et af de foregående krav, hvor et eller flere af modulerne har cellerammer (46) og/eller en bundplade (41), og/eller hvor de mekaniske forbindelsespunkter (48) er anbragt på cellerammene (46).
- 15 **5.** Indretning ifølge et af de foregående krav, hvor de enkelte moduler har elek-trik-, pneumatik- og/eller hydraulikgrænseflader (50) til forbindelse med hinan-den, og/eller hvor der er tilvejebragt grænseflader, der muliggør koordinering af driften af de enkelte moduler, og/eller hvor der er tilvejebragt en grænseflade til et fremstillingsstyringssystem, der muliggør koordinering af modulerne med et yderligere fremstillingssystem.
- 20 **6.** Indretning ifølge et af de foregående krav, hvor anordningen til tilvejebrin-gelse af en beholder med emner af tilførselsmodulet (2) er tilgængelig udefra via en dør (13), hvor anordningen til tilvejebringelse af en beholder med emner kan optage mindst to beholdere (66), og/eller hvor tilførselsmodulet (2) fortrin-s-vis har en separationsindretning (14), ved hjælp af hvilken et tilførselsområde
- 25 til en eller flere beholdere kan separeres fra et arbejdsområde, hvor der især er tilvejebragt en hætte (14), der er anbragt således i tilførselsmodulet (2), at den valgfrit kan anbringes over tilførselsområdet til den ene eller den anden beholder for at dække denne.
- 30 **7.** Indretning ifølge et af de foregående krav, hvor anordningen til tilvejebrin-gelse af en beholder med emner af tilførselsmodulet (2) forsynes med behol-dere via en automatisk beholdertilførsels- og/eller bortledningsstrækning (16, 17), hvor anordningen til tilvejebringelse af en beholder med emner fortrinsvis kan optage mindst to beholdere, og/eller hvor tilførselsmodulet (2) fortrinsvis

5 har en transportanordning (18) til transport af beholderne i tilførselsmodulets indre, hvor transportanordningen (18) fortrinsvis kan arbejde sammen med den automatiske beholdertilførsels- og/eller bortledningsstrækning eller er kombineret med denne, og/eller hvor der er tilvejebragt en fotocelle (20), der sikrer tilførselsområdet.

8. Indretning ifølge et af de foregående krav,
hvor anordningen til tilvejebringelse af en beholder med emner af tilførselsmodulet har en tværgående shuttle (18), der arbejder sammen med en beholder-tilførselsstrækning (16) og en beholderbortledningsstrækning (17) med hver især modsatte transportretninger,
10 eller
hvor anordningen til tilvejebringelse af en beholder med emner af tilførselsmodulet (2) har et drejebord (24), hvorpå beholderne kan anbringes, hvor beholderne ved at dreje drejebordet (24) kan bevæges fra et tilførselsområde af tilførselsmodulet til et arbejdsområde af håndteringsmodulets griber og omvendt, hvor drejebordet (24) fortrinsvis har skillevægge (25), der separerer tilførselsområdet fra arbejdsområdet,
15 og/eller
20 hvor en transportstrækning (21) til beholdere fører gennem tilførselsmodulet.

9. Indretning ifølge et af de foregående krav, hvor tilførselsmodulet (2) udover tilvejebringelse af beholderne også overtager borttransporten af emnerne, hvor der fortrinsvis kun er tilvejebragt en transportstrækning (21), hvorpå både
25 beholderne til- og borttransporteres, og de enkeltvise og/eller positionerede emner borttransporteres, hvor beholderne med underordnede emner og palleteringskurve til optagelse af de enkeltvise og/eller positionerede emner fortrinsvis transporteres på transportstrækningen, hvor palleteringskurvene fortrinsvis har huller til optagelse af emnerne.

30 10. Indretning ifølge et af de foregående krav,
med en mellemstation (27), hvor styreindretningen er udformet således, at griberen efter udtagning fra beholderen lægger emnerne af på mellemstationen (27), hvor styreindretningen er udformet således, at emnerne optages af en

- griber af mellemstationen (27) og lægges i en slutaflægningsindretning, hvor mellemstationen (27) fortrinsvis er integreret i et håndteringsmodul (1), og/eller mellemstationen (27) er anbragt i et mellemmodul, og/eller mellemstationen er anbragt i afgivelsesmodul, og/eller
- 5 med to håndteringsmoduler (36, 37), hvor indretningen fortrinsvis har en mellemstation (38), hvor styreindretningen er udformet på en sådan måde, at det første håndteringsmoduls (36) griber efter udtagning fra beholderen lægger emnerne af på mellemstationen (38), hvor styreindretningen er udformet således at emnerne optages af en griber af det andet håndteringsmodul (37) fra
- 10 mellemstationen og lægges af i en emneaflegningsindretning, hvor mellemstationen fortrinsvis er anbragt i et mellemmodul (38), der er anbragt mellem de to håndteringsmoduler.
- 11.** Indretning ifølge et af de foregående krav, hvor afgivelsesmodulet (3) omfatter en palletteringscelle og/eller kan arbejde sammen med en palletteringscelle, hvor emnerne især aflægges i en palletteringscelles palletteringskurve, og/eller
- 15 hvor afgivelsesmodulet (3) kan arbejde sammen med et palletteringssystem, hvor afgivelsesmodulet i en særligt foretrukket udførelsesform svarer til palletteringshåndteringssystemets udrustnings- og/eller tilførselsmodul.
- 20
- 12.** Indretning ifølge et af de foregående krav, med flere håndteringsmoduler (1), der arbejder sammen med afgivelsesmodulet (34), især en transportstrækning til borttransport af de enkeltvise emner, hvor håndteringsmodulerne fortrinsvis hver især har separate tilførselsmoduler (35).
- 25
- 13.** Tilførselsmodul (2) til en indretning ifølge et af de foregående krav, med en anordning til tilvejebringelse af en beholder (66) med emner, hvor tilførselsmodulet har cellevægge (52 - 54), der beskytter modulets arbejdsområde mod uberettiget adgang, og mekaniske forbindelsespunkter til forbindelse med håndteringsmodulet (1),
- 30

hvor anordningen til tilvejebringelse af en beholder (66) med emner af tilførselsmodulet (2) er tilgængeligt udefra, hvilket muliggør indføring af fulde beholdere (66) i tilførselsmodulet og udtagning af tomme beholdere fra tilførselsmodulet, og

5 hvor tilførselsmodulet har en objektgenkendelsesindretning (63) til registrering af emnerne i beholderen.

10 **14.** Tilførselsmodul ifølge krav 13, hvor der er tilvejebragt en grænseflade til et håndteringsmodul, via hvilken objektgenkendelsesindretningens (63) data kan overføres til en styreindretning af griberen, og/eller via hvilken anordningens arbejde til tilvejebringelse af en beholder (66) med emner kan koordineres med griberens bevægelse.

15 **15.** Tilførselsmodul ifølge krav 13 eller 14, hvor anordningen til tilvejebringelse af en beholder (66) med emner kan optage mindst to beholdere, hvor tilførselsmodulet fortrinsvis har en separationsindretning (14), via hvilken et tilførselsområde til en eller flere beholdere kan separeres fra et arbejdsområde, hvor der især er tilvejebragt en hætte (14), der er anbragt i tilførselsmodulet på en sådan måde, at den valgfrit kan anbringes over tilførselsområdet til den ene
20 eller den anden beholder for at dække denne,
og/eller hvor tilførselsmodulet har en grænseflade til et fremstillingsstyringssystem, ved hjælp af hvilket driften af tilførselsmodulet kan koordineres med driften af et fremstillingssystem.

25

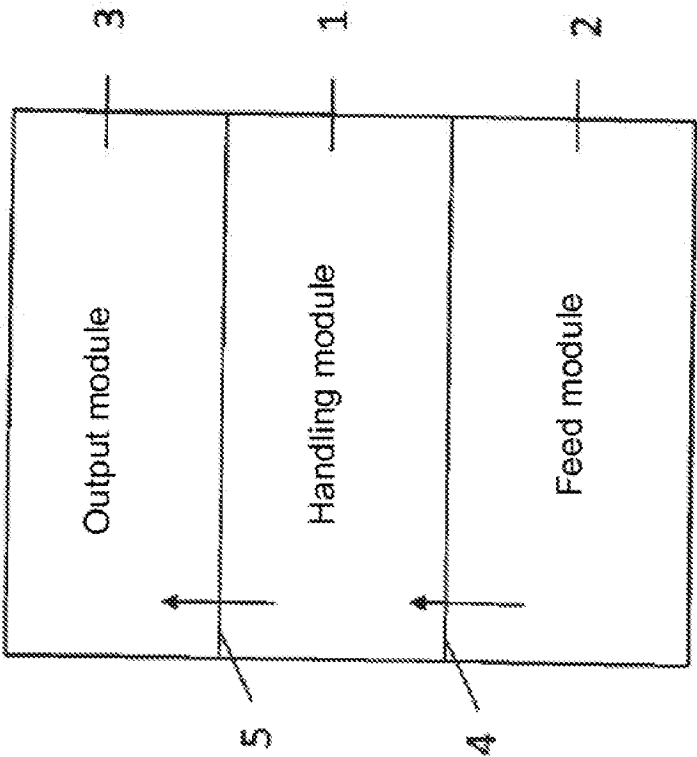
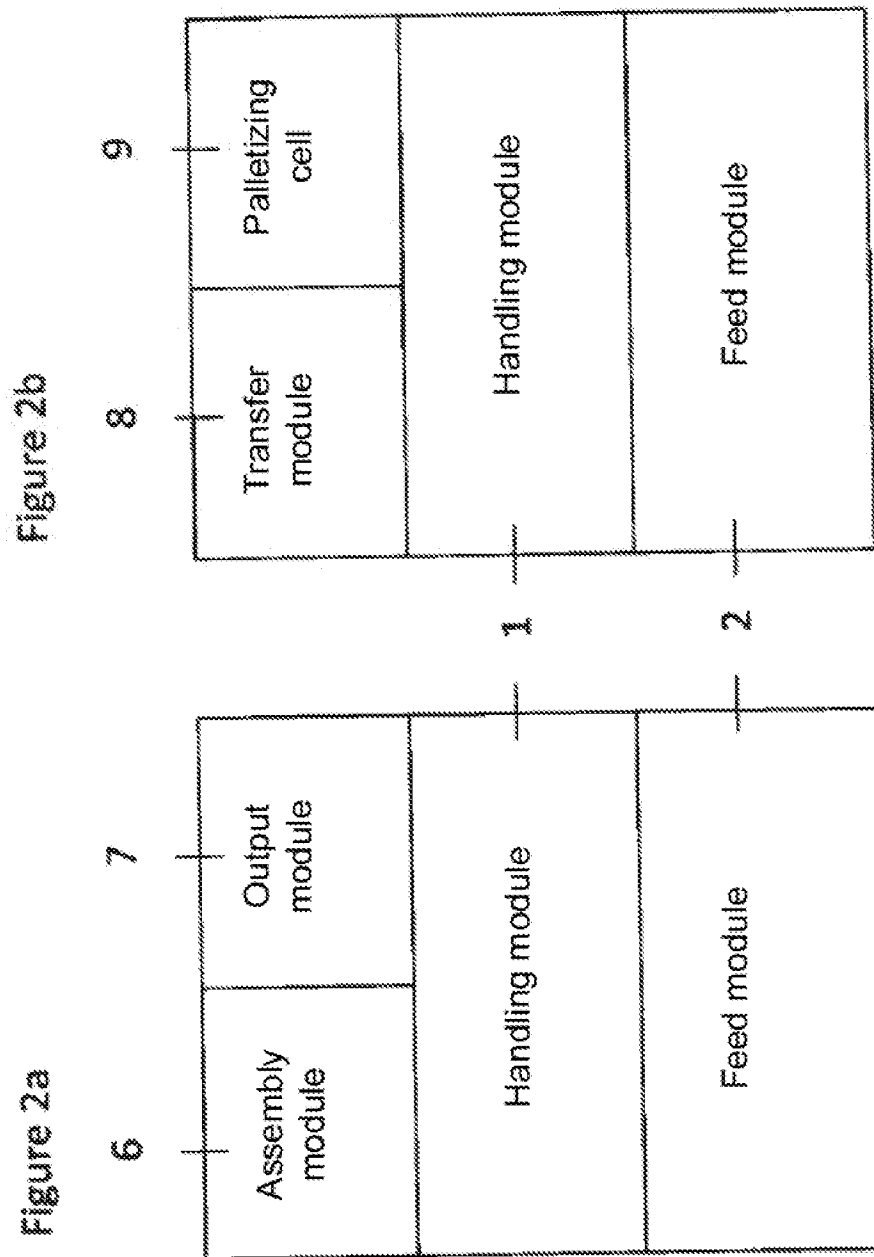
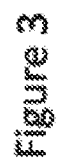


Figure 1





3234

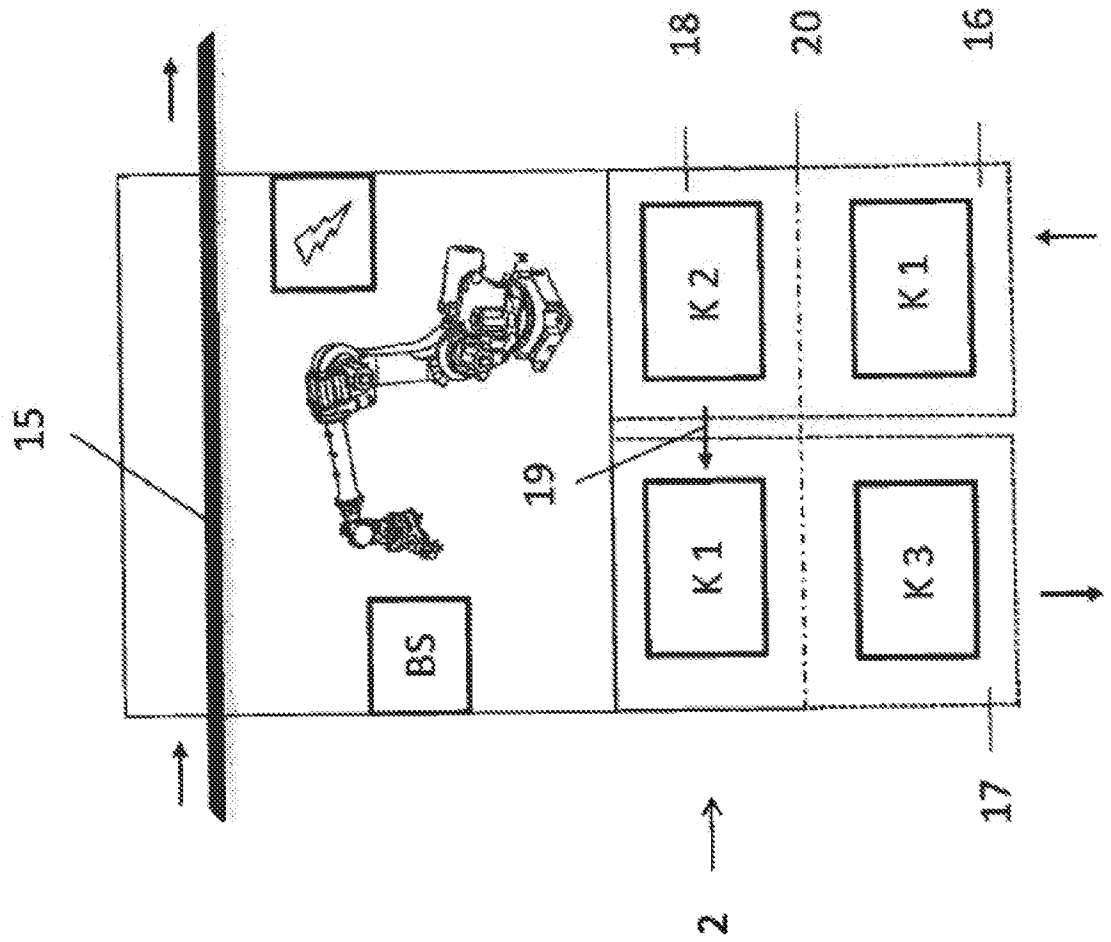
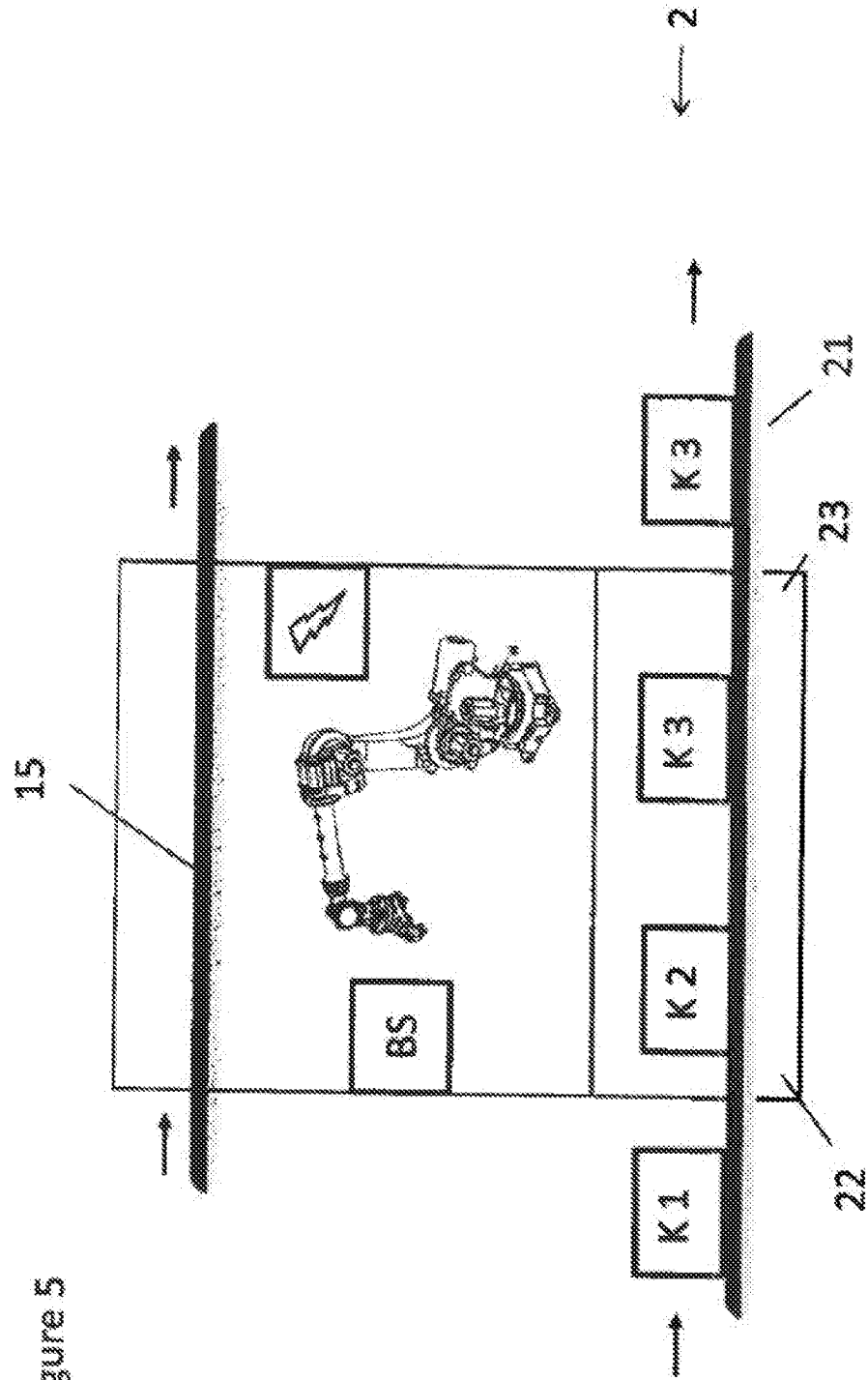


Figure 4

5
4
3
2
1

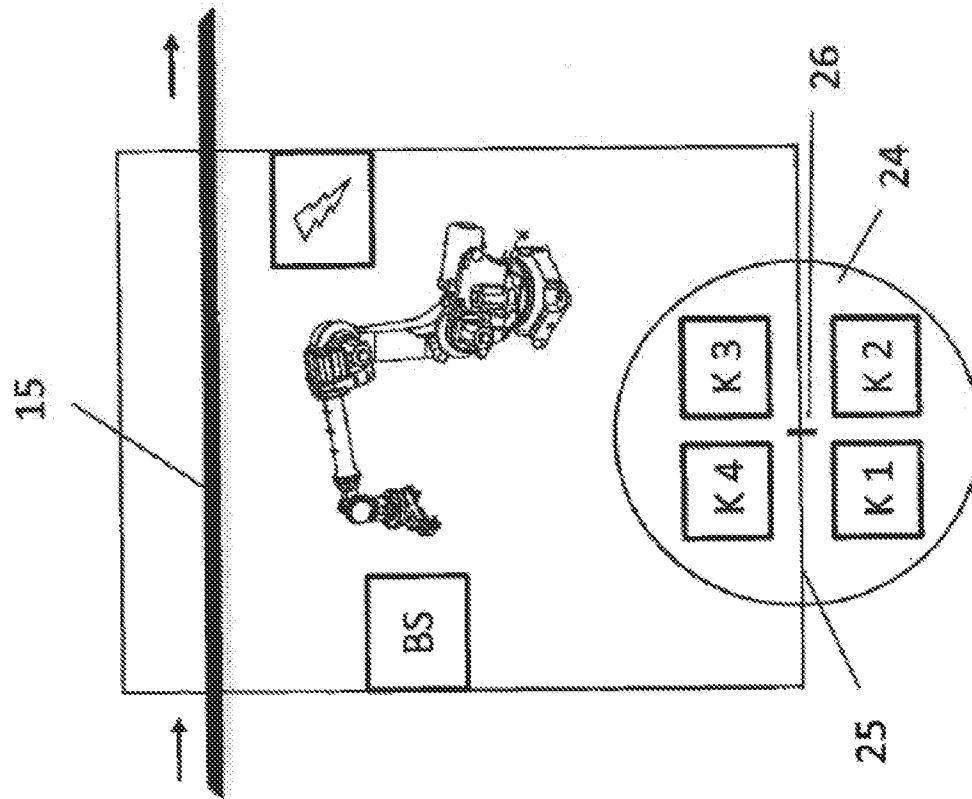
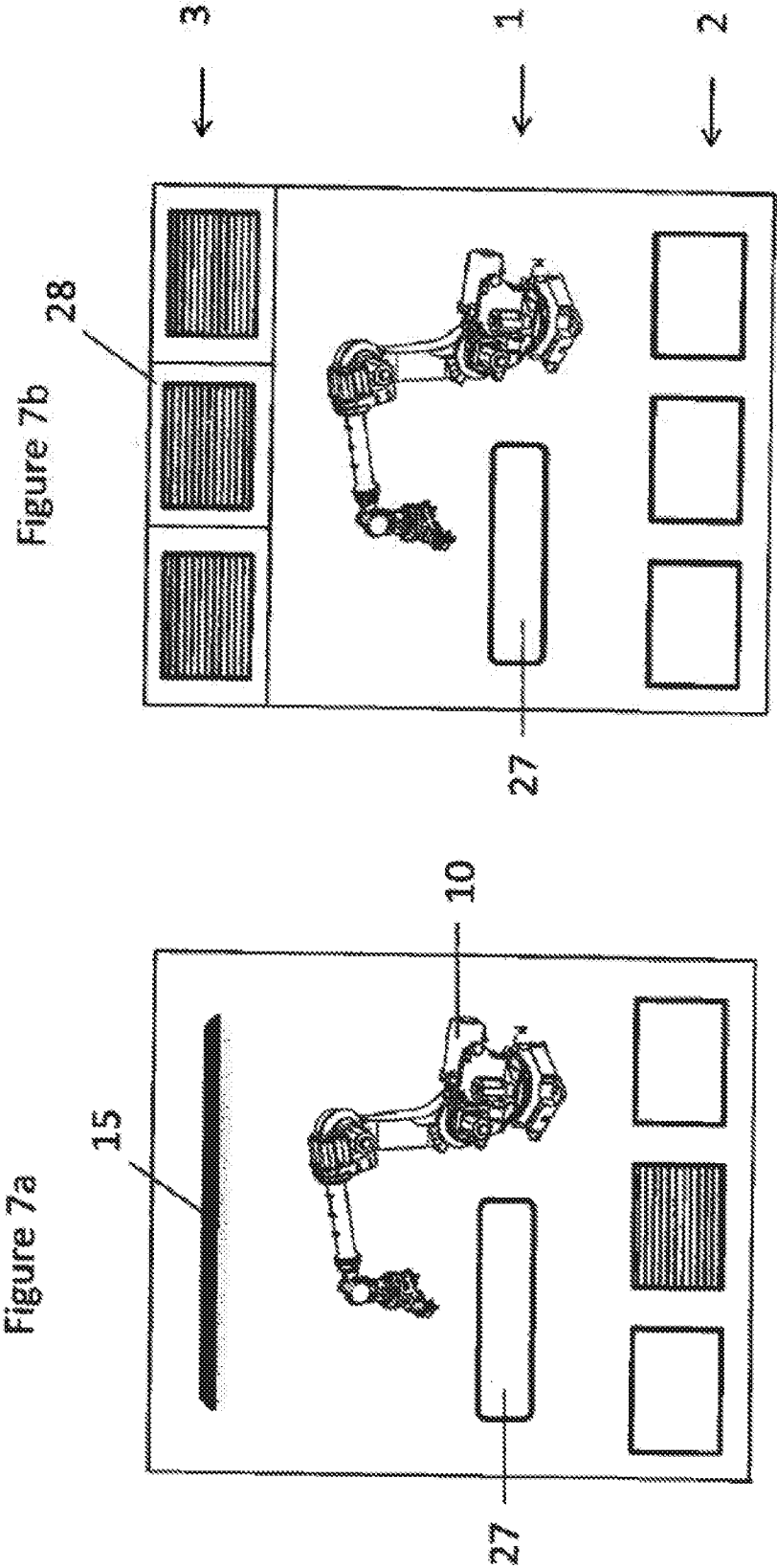


Figure 6



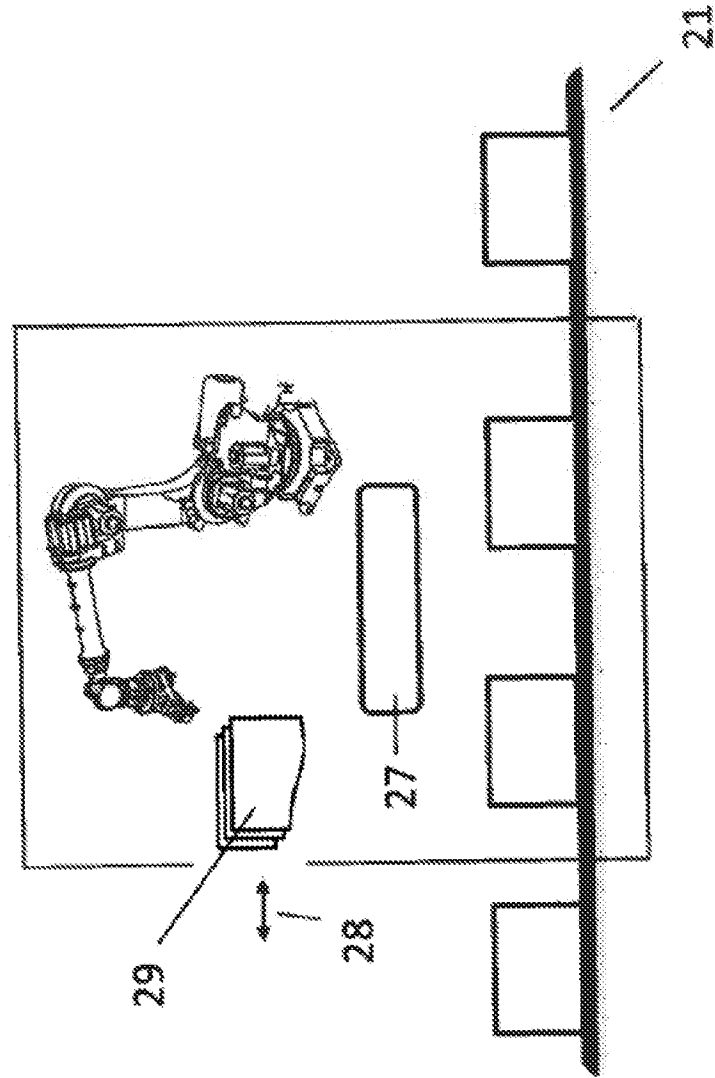


Figure 8

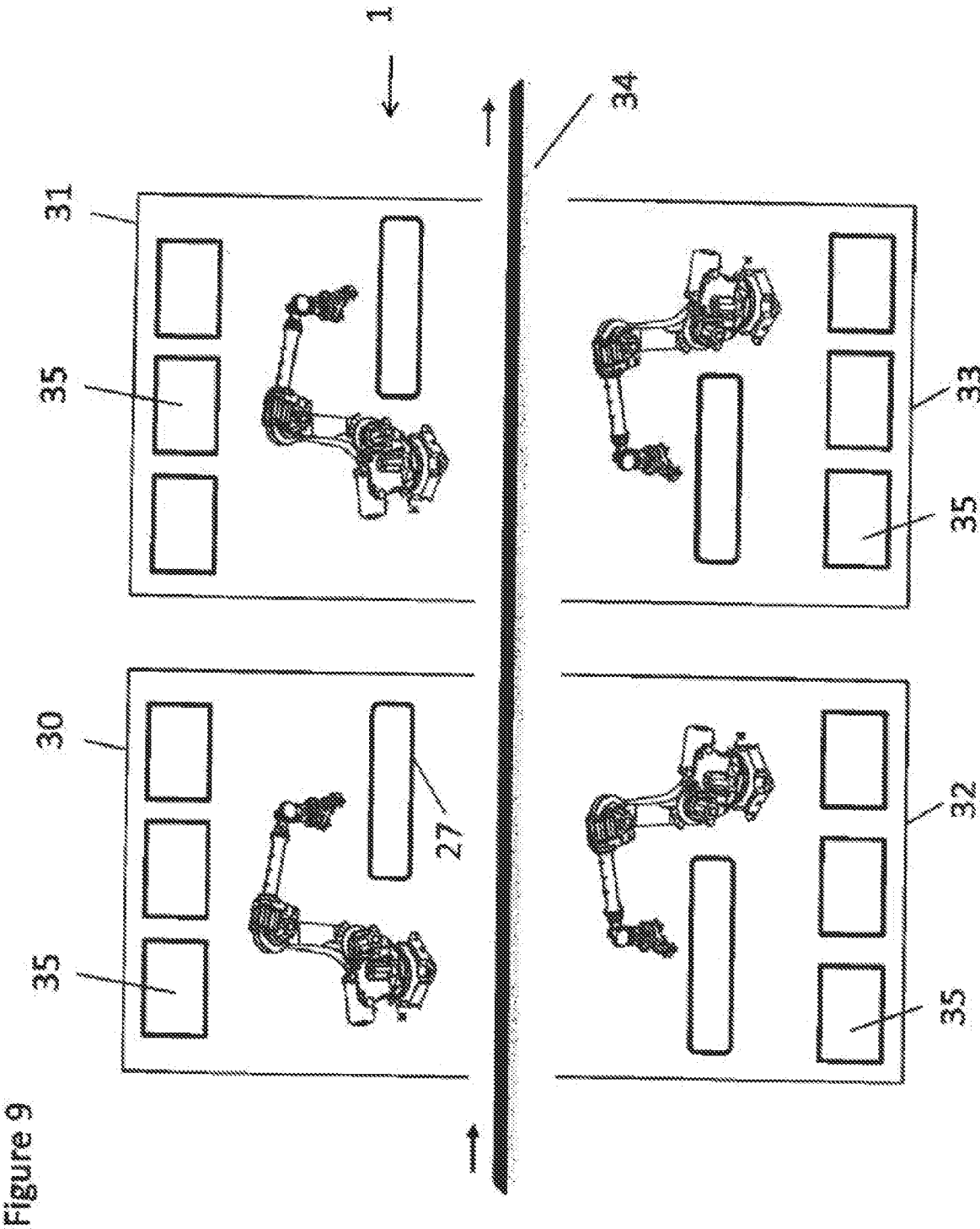


Figure 9

Figure 10

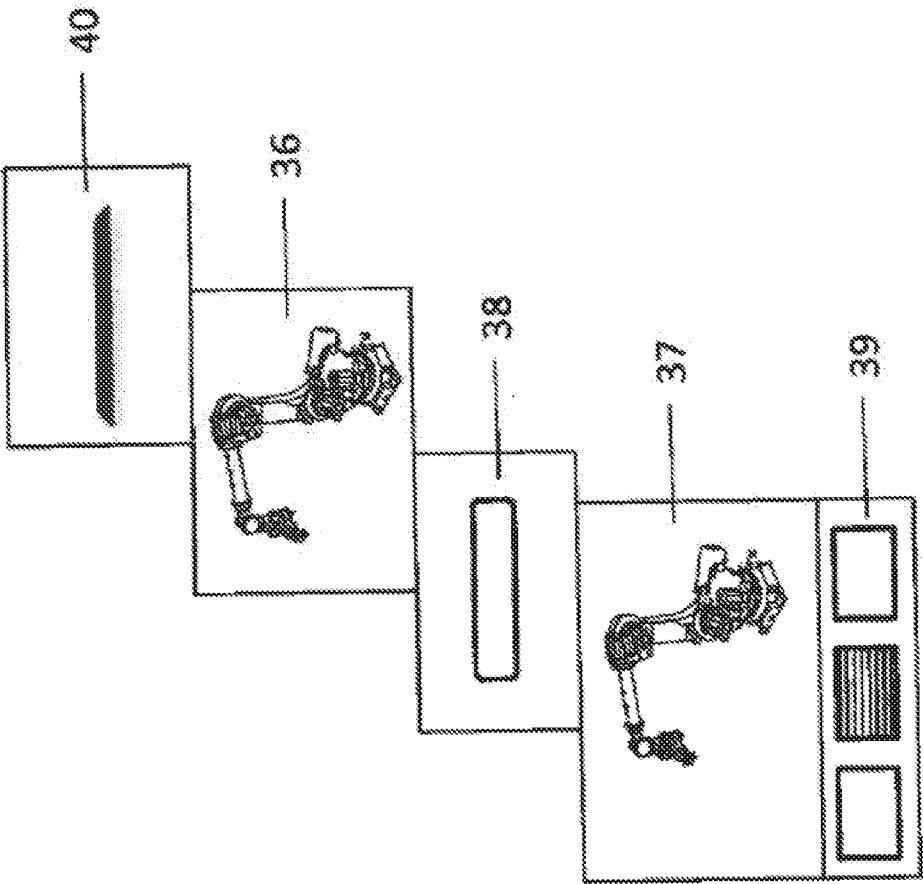


Figure 11

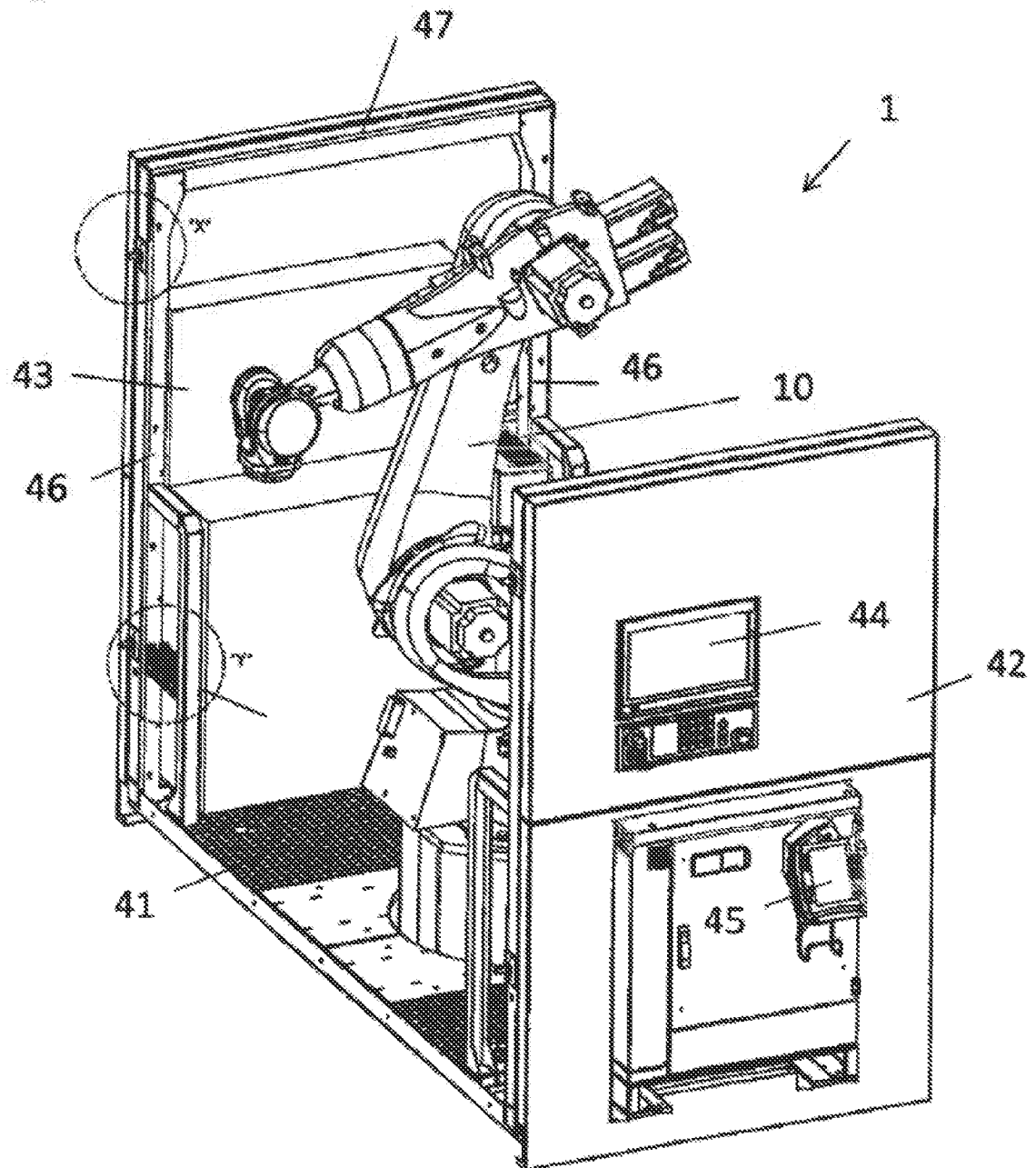


Figure 12a

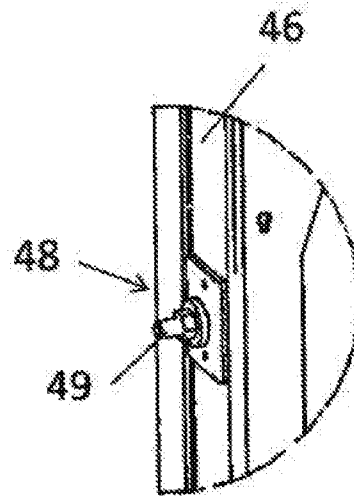


Figure 12b

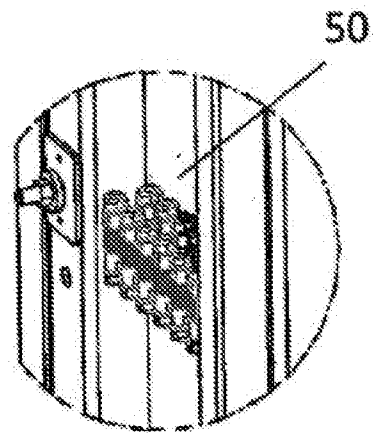
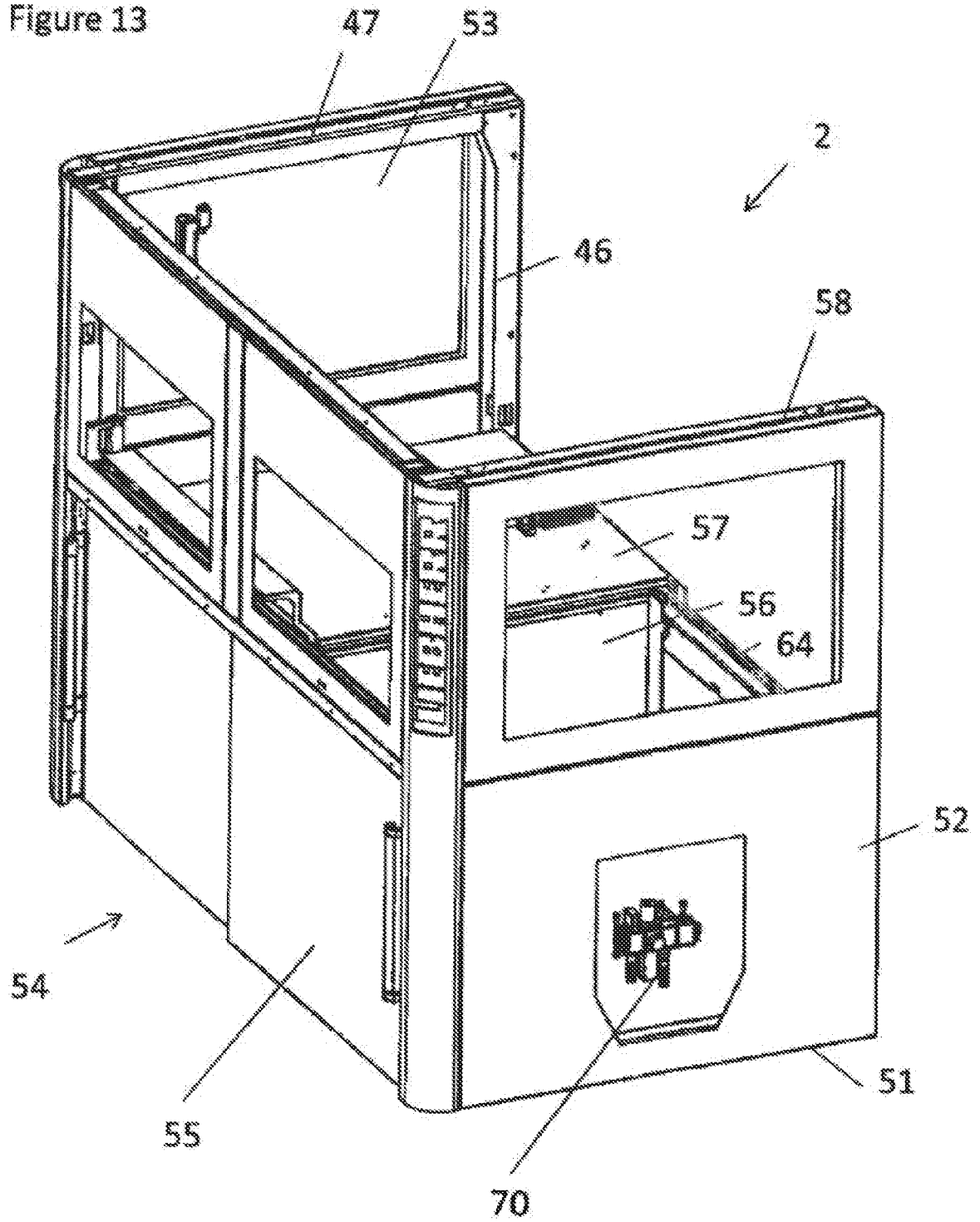


Figure 13



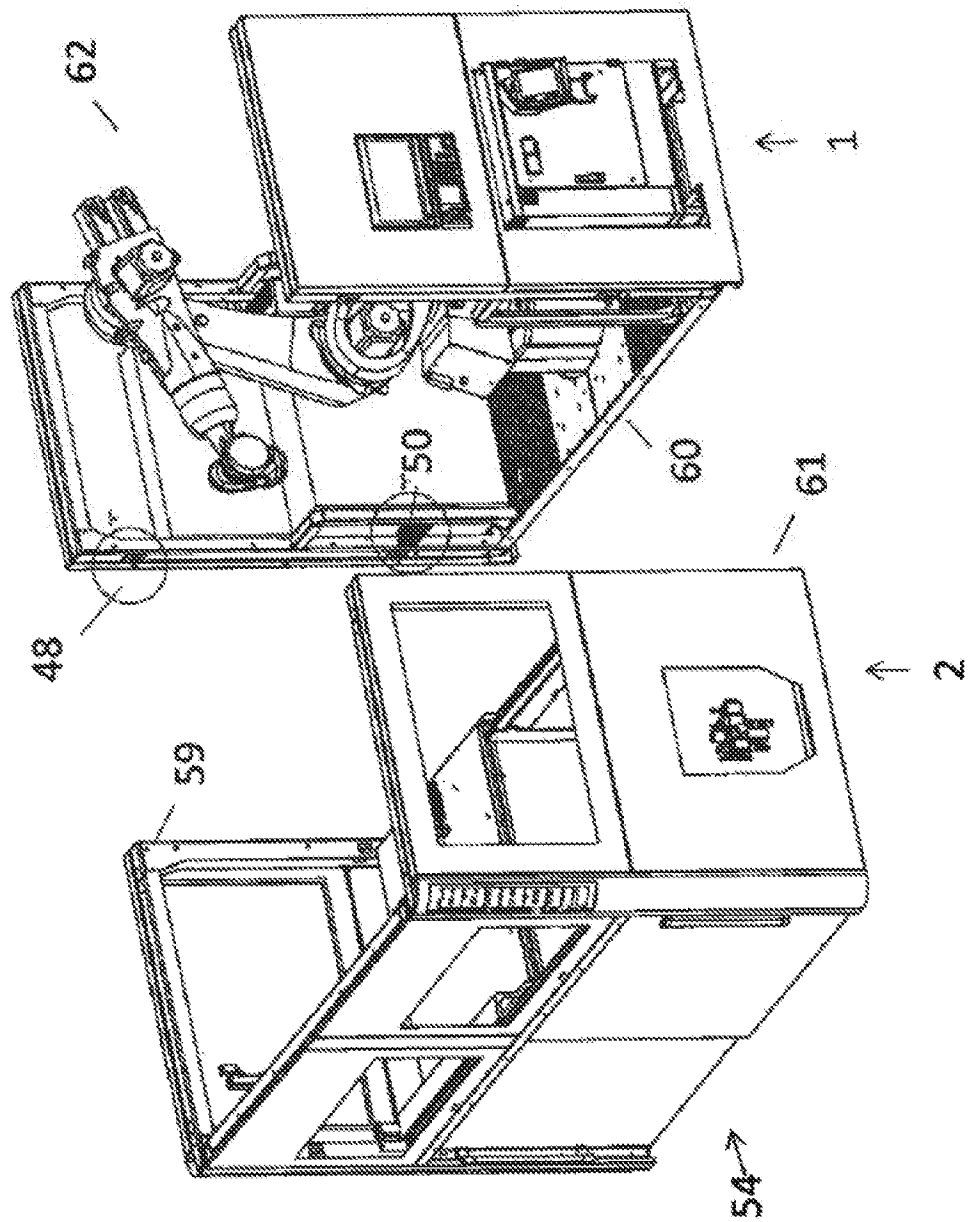


Figure 14

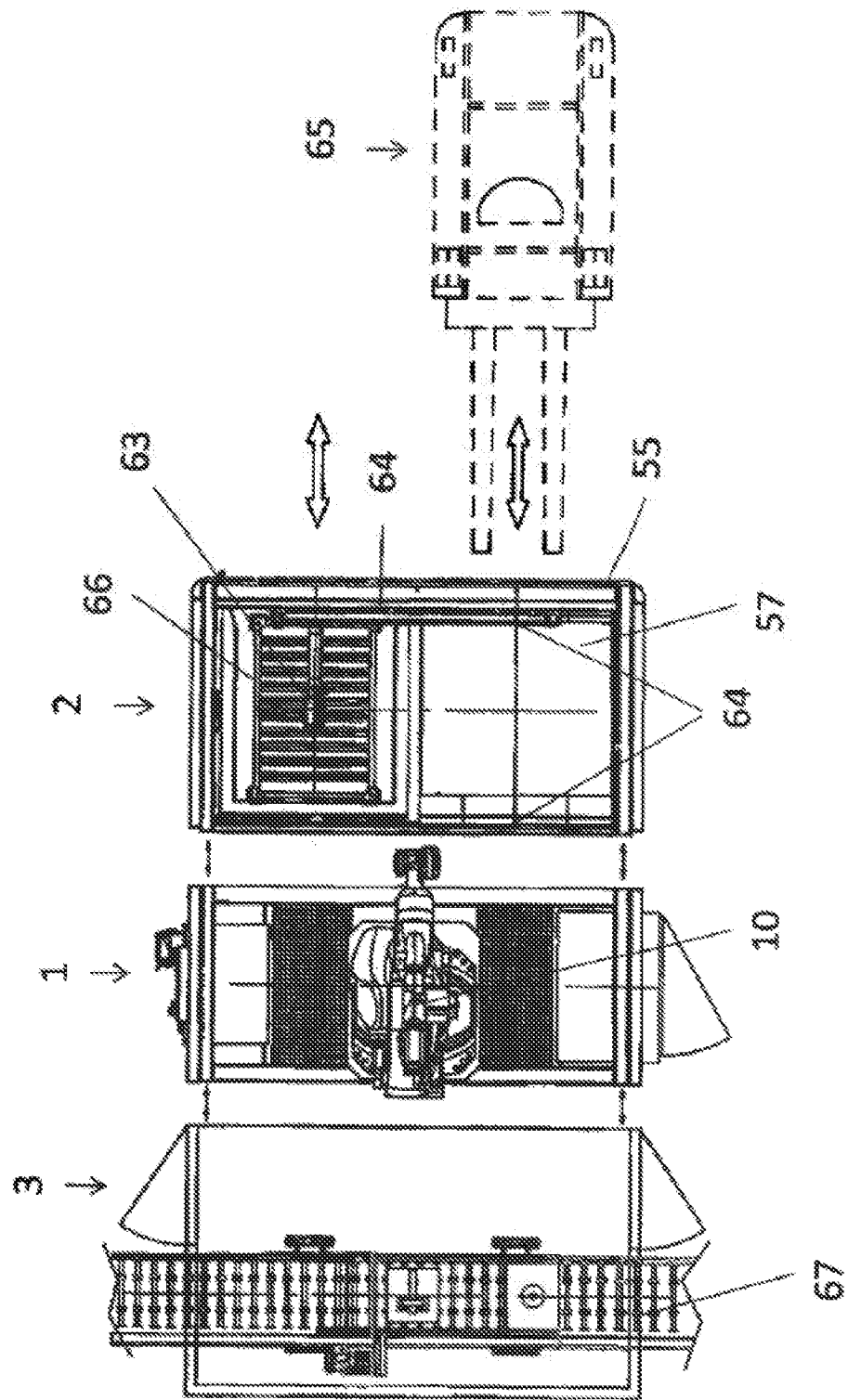


Figure 15

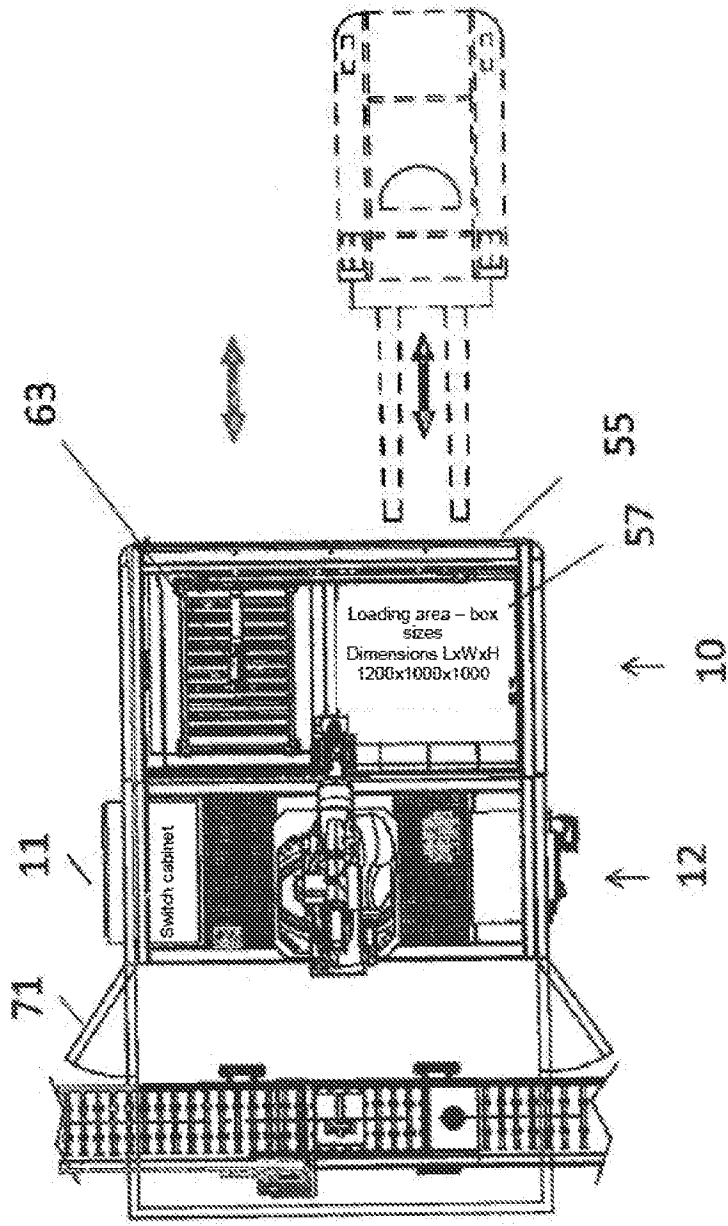


Figure 16