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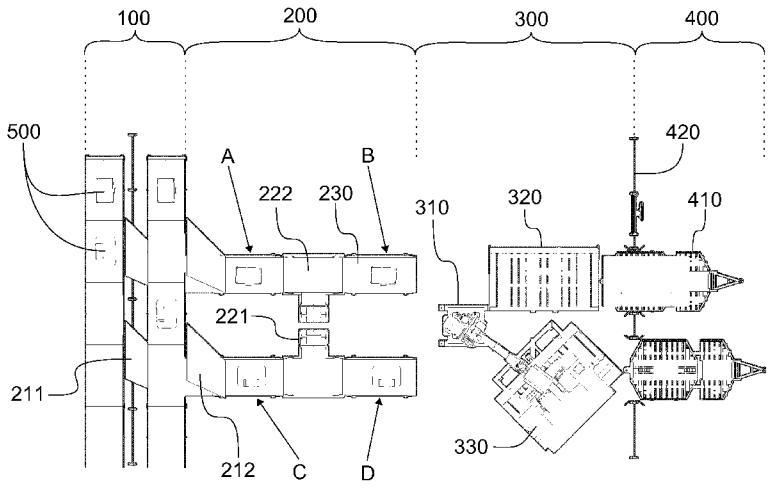


FIG. 2

(57) **Abstract**: The present invention improves the efficiency of the loading cell while maintaining and improving the flexibility of the baggage handling system of an airport such that bags may be received early with minimal labor-intensityby virtue of a novel buffer storage (200) and method of storing baggage (500) in a buffer storage (200). In said method baggage (500) and identification information thereof is received to the buffer storage (200) and in at least one physical property of the baggage (500) is measured. The baggage (500) is categorized based on destination and said measurement of the at least one physical property. The categorized baggage (500) is sorted to a buffer block (A, B, C, D) which is customized for a specific category.

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# BUFFER STORAGE AND METHOD FOR TEMPORARY STORAGE OF FLIGHT BAGGAGE

*Field of the invention*

The present invention relates to automated flight baggage handling systems used in airports. In particular, the present invention relates to buffer storages for temporary storage of travelers' baggage before preceding loading into air containers. More precisely, the present invention relates to a method of storing baggage and to a buffer storage according to the preamble portions of claims 1 and 13, respectively.

*Background art*

At airports, air travel baggage is typically transported from the check-in counter to the airplane through a series of handling steps. As the baggage leaves the check-in counter, each baggage item is given an identification number and assigned an ID tag, such as a bar code sticker or an RFID tag, corresponding to that number, wherein the baggage handling system of the airport is able to keep track of the baggage by virtue of individual ID tags. The baggage handling system comprises a data system and an electronically controlled conveyor system which is connected to the data system, wherein each baggage item can be transported to the correct flight by cooperation of the data and conveyor systems. The identification number associated with a of baggage item therefore usually contains information about the destination and flight number for each item. Further information, such as loading time of the flight, may also be used. Currently, as more often than not also the weight of the baggage is becoming available already at check-in, it is also possible to add it to the information provided by the airport baggage handling system. However, there is no guarantee on getting this information on transfer baggage, so a system-internal scale is required for ensuring the existence of the weight information.

After the baggage has been entered into the data system, the baggage leaves the check-in counter and enters into the automated conveyor system which comprises conveyors and sorting equipment for channeling baggage stream to appropriate conveyors. The baggage may alternatively enter the conveyor system from a transfer baggage subsystem which conveys baggage originating from an inbound transfer flight. The system transports the baggage to the appropriate flight based on the ID tag which is read when the baggage

item enters the conveying system. The baggage is transported with conveyors to a baggage handling area in which sorting equipment steer the baggage from conveyor to another towards the correct flight. The baggage is ultimately conveyed to a loading cell known in the industry as "a make up position" or "a packing station" in which the baggage is loaded to an air container or a trolley which transports the baggage to the airplane. The loading cell has traditionally been a manual loading station in which air containers or trolleys are loaded by hand. However, automated loading cells have recently been introduced, wherein a robot is configured to load air containers and/or trolleys automatically.

Before the baggage is loaded into the air containers, there is often a need to store the baggage temporarily. Such a situation may occur, when a passenger checks in baggage for a flight which is not "open", i.e. when the aircraft is not yet ready to be loaded or the airport baggage sorting system cannot yet transfer the baggage to the designated loading cell for example due to its internal rules of sorting. These so called "early bags" are therefore temporarily stored in buffer storages, the layout of which mainly depends on the level of automation of the airport. In the most basic systems baggage, which may not yet be loaded, is conveyed to a large storage room, where employees pick the baggage off the conveyor by hand and place it on the floor. As soon as the flight is available for loading, the baggage is placed on a conveyor that leads to the appropriate loading cell. Alternatively baggage is loaded onto carts which are transported to a storage area until the flight is open, whereby the baggage is removed from the carts and returned onto the conveyor system. Both approaches are a quite labor-intensive and inefficient as the baggage is handled by hand.

In more automated systems the baggage is steered to an automated buffer storage which may take the form of a spiral conveyor or a multistory warehouse system. US 5413205 A discloses a plurality of superposed and serpentine shaped endless conveyor paths that are used for temporary storage of baggage, i.e. as a buffer.

Buffers for automated loading cells are also known. For example, Autoloader GmbH has introduced a commercial buffer for an automated loading cell in which the buffer is arranged adjacent to a feeding device for feeding a loading robot. The buffer comprises a plurality of superposed platforms for temporary storage of bags which are made available

for the loading robot. The loading algorithm of the arrangement provides the best result when the bags are arbitrarily selected from buffer.

A different approach is known from US 6580046 B1 which discloses a method, wherein baggage property data – such as flight destination, travel class, weight, shape, volume, and consistency – is recorded and used to divide the baggage items into predetermined classes and to determine optimum assignment to loading devices in accordance with classification and flight destination. Intermediate storage is therefore only optional and intended only for increasing output. The baggage is then loaded in loading stations in accordance with the defined assignment. In practice, such an approach may however lead to problems arising from errors or deviations in the predetermined baggage loading pattern. For example, it is common that in automated loading a stack of bags formed into an air freight container builds up differently than planned or even collapses, wherein the predetermined loading pattern may no longer be executed. Such an approach is thus more suitable for manual loading, where the actual position of each baggage in the stack or a collapsed stack in the container can be manually rearranged. Hence, to overcome the challenges inherent to the automated loading of baggage into an air container or a trolley, any such system should be based on a solution that is capable of finding practical loading patterns not only predetermined, but also dynamically, even on a bag-per-bag bases if required. The method in US 6580046 B1 suggests that if the predetermined loading pattern yields loading errors detected by a sensor system, a human operator corrects them utilizing methods that do not require entry to the loading station for example using virtual reality techniques, hence enabling the system to continue the predetermined pattern, instead of taking a dynamical approach by adapting the loading pattern to the actual baggage stack in the container or trolley.

*Aim of the invention*

While known flight baggage buffer storages provide flexibility to the handling of flight baggage, it is an object of the present invention to improve the efficiency of the loading cell while maintaining the flexibility of the baggage handling system of an airport such that bags may be received early with minimal labor-intensity.

*Summary*

The object of the invention is achieved on the one hand with a novel method of storing baggage in a buffering storage. In said method baggage and identification information thereof is received to the buffer storage and in at least one physical property of the baggage is measured. The baggage is categorized based on destination and said measurement of the at least one physical property. The categorized baggage is sorted to a buffer block which is customized for a specific category.

According to one embodiment, each buffer block comprises a plurality of storage positions, each being adapted to receive a baggage item. The customization is further based on an estimated baggage profile which depends on a flight profile, wherein the block to be suitable for receiving baggage predominantly belonging to a specific category. The estimated baggage profile is established from statistical data concerning baggage properties corresponding to associated flight properties, wherein the predetermined baggage profile anticipates a physical property associated to a specific destination. The at least one physical property may be dimensions, presence of protrusions exceeding a predetermined limit, weight, weight distribution, moment of inertia, stiffness, friction, or volume or any combination thereof.

More specifically, the method according to the present invention is characterized by the characterizing portion of claim 1.

The object of the invention is achieved on the other hand with a novel buffer storage for temporary storage of flight baggage. The novel buffer storage comprises at least two buffer blocks which are adapted to be customized for receiving baggage belonging to different categories based on destination and at least one physical property.

According to one embodiment, the buffer storage comprises a plurality of shelves and a manipulator adapted to receive baggage from the baggage transport system of an airport, wherein the plurality of shelves form the storage positions of the buffer blocks. The shelves may be vertically movable, wherein the size of the storage positions of a buffer block may be altered according to a predetermined loading profile which is associated on the flight destination of the baggage for customizing the block for receiving baggage predominantly belonging to a specific category. The shelves may further comprise conveyors for receiving and ejecting the received baggage.

According to another embodiment, the pallet handling apparatus is adapted to receive baggage from the baggage transport system of an airport and to place them on stackable pallets and these in turn further into stacks, wherein a pallet forms a storage position and wherein at least one stack forms a buffer block. The pallets may be prismatic containers, at least one face of which is greater than the smallest dimension of the baggage contained in the pallet, wherein pallets may be stacked without causing damage to the baggage. The pallet handling apparatus may take the form of a portal pallet handling apparatus comprising a portal support and at least one hoist which is arranged to the support and adapted to move pallets between stacks and stations.

More specifically, the buffer storage according to the present invention is characterized by the characterizing portion of claim 13.

Considerable benefits are gained with aid of the present invention. Because the buffer storage has customizable blocks, it is possible to improve the efficiency of the loading cell by having baggage of different type available at any given moment while maintaining the flexibility of the baggage handling system of an airport such that bags may be received early with minimal labor-intensity. With an automated buffer storage the incoming stream of baggage is leveled out while being able to accept 'early bag' into the system. The possibility to adapt storage capacity according to the actual need is efficient in terms of use of space which is often scarce in airports which are being retrofitted with automated baggage handling equipment.

In theory, it would be possible to scan all incoming bags, calculate a loading pattern and retrieve suitable bag from a freely accessible temporary storage. Compared to this solution, the present invention provides a more robust solution, as:

- it is not possible to anticipate errors, such as collapsing bag stacks during loading or slight bag misalignments with respect to their intended position or orientation
- a temporary storage capable of storing all incoming bags at the airport soon becomes of a practically inefficient size, and
- achieving free access to a larger volume of baggage in the same temporal storage sets limits to the access time of a particular bag not taking into account delivering a predetermined set of them,

The invention with its customized buffers tackles the above-mentioned challenges by offering in real-time the baggage loading manipulator with a bag having optimal properties with respect to the already loaded bags in the container or trolley thus adjusting the predetermined loading pattern to the new situation, as required.

The invention has further benefits which are discussed more thoroughly with reference to the corresponding embodiment.

*Brief description of drawings*

In the following certain embodiments of the invention are described in greater detail with reference to the accompanying drawings in which:

Fig. 1 presents a side view of buffer storage according to one embodiment featuring a multi-level storage unit,

Fig. 2 presents an elevation view of the buffer storage of Fig. 1,

Fig. 3 presents a side elevation view of a buffer storage according to another embodiment featuring a portal manipulator and a storage area for stackable load carriers,

Fig. 4 presents a top elevation view of the buffer storage of Fig. 3, and

Fig. 5 presents an isometric view of the buffer storage of Fig. 3.

*Detailed description of preferred embodiments*

The buffer storage according to the present invention may be arranged as an integral part of the baggage handling system of an airport with minimal changes to the local infrastructure. The buffer storage may be arranged as a lateral branch of the conveying system in the same manner as conventional buffers. Preferably however, the buffer storage is provided adjacent to the loading cell, most preferably within reach of the loading robot of an automated loading cell. If the buffer storage is arranged adjacent to a loading cell, the baggage may be quickly made available for loading. For this reason embodiments of the invention are discussed hereafter considering positioning in connection with the loading cell as the most probable application of the invention. It is, however, to be noted that the

embodiments are also applicable when the buffer storage is provided remotely from the loading cell.

Figs. 1 and 2 illustrate a buffer storage 200 for temporary storage of flight baggage 500 according to one embodiment of the present invention. In said embodiment the buffer storage 200 – taking the form of a multilevel storage – is located between the baggage handling system 100 of the airport and an automated loading cell 300. The buffer storage 200 therefore evens out baggage stream coming from the baggage handling system 100 to correspond to the output of the loading cell 300. Specifically in this embodiment, baggage 500 traveling on conveyors 111, 112 of the baggage handling system 100 is fed to the buffer storage 200 via feeding chutes 211, 212 which are connected automated eject stations on the conveyors 111, 112. On the other hand, the buffer storage 200 is positioned within reach of the loading robot 310 of the loading cell 300. The buffer storage 200 is in other words integrated into the infrastructure of the airport, whereby distinguishing between, e.g. the buffer storage 200 and loading cell 300, may be considered mostly semantic. The loading cell 300 is further adjacent to the air freight container transport system 400 which transports loaded air freight containers 330 to the aircraft by means of dollies 410 or similar. The loading cell 300 is usually divided from the air freight container transport system 400 with a safety guard 420.

The buffer storage 200 comprises at least two buffer blocks which are adapted to be customized for receiving baggage 500 belonging to different categories based on destination and at least one physical property. The buffer storage 200 therefore comprises means for sorting flight baggage 500 into said at least two categories, which sorting means may be arranged in conjunction with the buffer itself or in conjunction with the baggage handling system 100, whereby the sorting means communicate with the buffer storage. Moreover, the sorting means, adaptation of buffer blocks as well as the categorization criteria may be established in a variety of ways which are discussed hereafter in connection with exemplary embodiments.

Referring now to the buffer storage 200 of the embodiment of Figs. 1 and 2. As can be seen from the Figures, the buffer storage 200 comprises an infrastructure interface 210 which in turn comprises first and second feeding chutes 211, 212 for receiving baggage 500 ejected from the conveyors 111, 112 of the baggage handling system 100 of the air-

port. The infrastructure interface 210 further comprises a communications interface (not shown) which communicates with the data system of the airport infrastructure. The buffer 200 also comprises data processing means which may be integrated to the data system or which may be provided as a separate processor communicating with the data system of the airport over said communications interface. The interfaces of the buffer storage 200 communicate with the infrastructure such that both baggage 500 and the identification information thereof can be received the buffer storage 200. The identification information is received, for example, by reading the ID tag attached to the baggage item 500, wherein information recorded for that ID tag is accessed through the communications interface. Depending on the amount of information recorded for each bag earlier in the baggage handling, the buffer storage 200 may gather more information with aid of sensors sensing physical properties of the baggage 500. The means for measuring physical properties may be arranged into the buffer 200 or outside thereof. Said means is discussed more thoroughly hereafter.

The buffer storage 200 further comprises a plurality of superposed shelves 230 which are arranged in laterally divided blocks. In the embodiment of Figs. 1 and 2 it is possible to distinguish four blocks A, B, C, D arranged in a two by two matrix. Each shelf 230 comprises a horizontal conveyor – such as a belt conveyor – for lateral movement of the baggage. The feeding chutes 211, 212 are arranged to feed baggage to the shelves 230 of buffer blocks A, C closest to the conveyor system 100 of the airport. Elevators 221 have been provided for serving sequential blocks A, B and C, D. The elevator 221 comprises vertical guides and drives for moving the elevator platform between shelves 230. The elevator platform also comprises a horizontal conveyor for lateral movement of baggage from block to another. The shelves 230 are preferably arranged within reach of the loading robot 310 such that it can pick an item 500 from any of the superposed shelves of that block. Alternatively, the robot 310 picks items from a specific shelf which is designated to feed the robot or from a separate feeding station (not shown).

As mentioned above, the blocks A, B, C, D of the buffer 200 are adapted to be customized for receiving baggage 500 belonging to different categories based on destination and at least one physical property. Categorization may be on flight destination and at least

one physical property, preferably a plurality of physical properties, as well as segregation, for example.

In any case, it is common that a specific loading cell is used for loading only flights having a specific destination or continent. For example, two adjacent loading cells might be designated to handle all Asian flights or one loading cell is used to load all transfer flights to Amsterdam. Categorization by destination is typically handled by the baggage handling system of the airport, wherein baggage 500 is ejected from the conveyor system 100 to the correct loading cell 300. Such preliminary sorting would lead the baggage 500 automatically to the correct buffer 200, if the buffer 200 is arranged in connection with the loading cell 300. Therefore buffer blocks are not randomly available but reserved for baggage 500 having a destination of a flight being loaded by the corresponding loading cell 300.

The baggage 500 coming in to the baggage handling system 100 of the airport is typically further categorized by so called segregation which information is contained in the data record of the baggage and displayed on or referred to in the ID tag. The baggage is segregated into different classes depending on whether the bag is 'local', 'transfer', 'business' or 'priority', for example. Segregation is well known in the field. Therefore according to one embodiment, buffer blocks A, B, C, D are adapted to receive baggage items 500 belonging to a specific segregation class, such as 'transfer'. One way of customizing a buffer block to receive transfer baggage is to reserve one or more stacks of shelves 230 for baggage that is initially flown to the same destination as the others but which is set out to continue to a further destination. Such baggage is grouped into a particular block, wherein it is possible to dedicate one or more air freight containers 330 for baggage 500 being segregated as transfer baggage to a further destination. The buffer storage 200 therefore comprises means for customizing blocks based on segregation. Such means may be construed as a processor which is programmed to control the conveyors of the shelves 230 and the elevator 221 to convey baggage 500 accordingly. The processor may be a separate processor unit (not shown) provided into the actual buffer storage or it may be integrated to the infrastructure of the airport, i.e. the data system.

The buffer storage is programmed by the controller to receive, sort and dispatch baggage utilizing the available storage space in the buffer blocks with respect to the information

on the optimal dispatching sequence. Should no specific sorting and dispatching sequence preference exist, the baggage is stored following the categorization by logical (flight, segregation) and physical properties. Since at any particular time a need for dispatching one or several baggage items from the buffer may arise, additional programming is provided for delivering them via an alternative route (for example an output or a by-pass conveyor) outside the buffer storage. Known principles for optimizing depositing and retrieval routes of items to and from storage positions may be used in programming the controller of the buffer storage.

One way of adapting a buffer block to receive 'business' baggage is to direct the business baggage to a block such that the business baggage is readily available to be loaded as the topmost items on an air freight container 330. Accordingly, said bags will be unloaded first, whereby they are among the first on the conveyor belt in the baggage claim area of the destination.

The buffer blocks A, B, C, D of the storage 200 are adapted to be customized for receiving baggage 500 belonging to different categories based on at least one physical property. The buffer therefore comprises means for measuring said at least one physical property. The measuring means may be considered as part of the categorizing means. Preferably, however, said measuring means is adapted to measure a plurality of physical properties based on which baggage is rationally categorized. For example, the property or properties may be selected from the following:

- dimensions,
- presence of protrusions, such as a handle, exceeding a predetermined limit,
- weight,
- weight distribution,
- moment of inertia,
- stiffness,
- friction,
- volume.

According to one embodiment, said measuring means is arranged as an integral part of the buffer storage 200. In the example of Fig. 3, the means is embedded into the receiving station 263 of the buffer, which receiving station is discussed in greater detail in con-

nection with the embodiment of Figs. 3 to 5. According to another embodiment, the measuring means is not provided as an integral part of the physical buffer storage 200 but as a remote sensor arrangement located 'upstream' of the buffer 200, preferably being integrated to the baggage handling system 100 of the airport or even at the check-in counter. Said measuring means may be established, for example, as a scanning port detecting protrusions and probing the baggage to establish the stiffness thereof. According to a third embodiment, the measuring means is located both within the buffer storage 200 and integrated to the baggage handling system 100. In any case the measuring means is adapted to communicate with the controller of the buffer storage 200. The two latter embodiments have the advantage of providing information about the approaching baggage before it arrives to the buffer, wherein it is possible to compute the required space and amount of storage positions for each baggage category as well as to calculate a forecast to the loading algorithm of the loading cell 300. Such information is valuable, e.g. in anticipating if the loaded baggage stack is expected to become unstable during loading (Figs. 1 and 3) or if for achieving optimal use of space, a bag or set of bags with certain characteristics should be loaded in the container or trolley following a predetermined loading pattern. By having the information about the baggage available, it is possible to dynamically determine the next piece of baggage to be loaded by utilizing the actual contents of the container or the trolley as well as the buffer storage.

According to one embodiment, buffer blocks are customized according to an estimated baggage profile depending on flight profile in order for the block to be suitable for receiving baggage predominantly belonging to a specific category. Such an estimated baggage profile is established from statistical history data which has been gathered from previous flights and which concerns baggage properties on different flight types. The data is preferably gathered over an extensive period of time such that the sample is as statistically meaningful as possible. Data may be gathered about the correlation between the number of baggage belonging to a category of a physical property, such as size, weight and stiffness, as well as segregation class, wherein particulars of a specific flight correspond to baggage profile which may be derived from statistical data. As certain loading cells are used to load certain flights, a loading cell may therefore be assigned a specific profile. The predetermined baggage profile therefore anticipates a physical property associated to a profile of the corresponding flight, or flights where applicable.

For example, morning flights boarding a relatively high number of business passengers with mainly carry-on luggage are inherently different from holiday flights or transfer flights as far as their baggage profile is concerned. Therefore a buffer block of the buffer being utilized for temporal storage of the baggage is customized such that very few storage positions are reserved for the business flight, wherein more space is vacant for the baggage associated with another flight or flights being loaded in the adjacent loading cell.

As another example, it has been statistically established, that long haul transfer and leisure flights carry predominantly a small amount large and hard shelled baggage having a regular shape, whereas on shorter point-to-point flights the baggage is statistically less stiff and smaller in size. These flights have therefore different baggage profiles, wherein the buffer blocks serving loading stations of such flights are customized accordingly by arranging a large amount of small storage positions or a small amount of large positions, for example. This information is further exploited in planning the loading pattern for loading the containers 330. It is to be understood that instead of containers 330, the loading cell 300 may load any air freight carrier, such as a trolley for example.

Regardless of what the customization is based on, there is probably little need to modify the buffer storage 200 between each flight. It may on the contrary adequate to customize buffer blocks occasionally whenever there is updated information available on statistically meaningful changes in flight profiles, for example. It is however possible to keep the buffer very responsive in adapting the buffer to comply with every flight according to baggage data gathered at check-in and from the measuring means explained above. Such may be the case, when a particular loading station has not been assigned for a particular flight profile or destination. The degree and frequency of customization is therefore dependent on the application at hand.

Above, the invention has been described as carried out by a buffer 200 being based on a multistory warehouse with dynamic shelves providing for variable storage positions and transfer of baggage from shelf to another. The buffer 200 may alternatively be constructed by employing a plurality of crate-like pallets and a manipulator of a gantry crane type. Indeed, according to another embodiment illustrated in Figs. 3 to 5 the buffer storage comprises a portal pallet handling apparatus 260 which is preferably arranged between

the baggage handling system 100 and the loading cell 300 as in the former embodiment. In said embodiment, the buffer storage 200 receives baggage 500 from the baggage sorting system 100 of the airport, whereby the baggage items 500 are inserted into pallets 250. The buffer storage 200 arranges the baggage containing pallets 250 into stacks, wherein a pallet 250 forms a storage position and wherein at least one stack forms a buffer block A, B, C, D.

The pallets 250 may be, e.g. prismatic containers which are dimensioned to receive baggage 500 such that the pallets 250 may be stacked without damaging the baggage 500. Therefore at least one face of the pallet 250 is greater than the smallest dimension of the baggage 500 contained in the pallet 250. In any case the pallets 250 preferably such that in one orientation they may be nested and in another orientation, they are stackable. Naturally, pallets 250 of different size may be provided for baggage 500 of different size, wherein one type of pallet 250 may be assigned for baggage of a certain category. It is preferable to receive the baggage 500 into the buffer 200, wherein baggage 500 is placed into the pallets 250. Empty pallets 250 are conveyed to the pallet packing device, e.g. to the receiving station 263, with the pallet handling device or some other conveyor adapted to transport empty pallets 250 from and to a storage. Buffer blocks may be used as an empty pallet storage. Alternatively baggage 500 could be placed in pallets 250 in the baggage handling system 100 of the airport, which would require extensive modification of the infrastructure. According to a preferable embodiment, the buffer 200 is therefore equipped with a palletizing station which is adapted to place a baggage item belonging to a category into a pallet 250 assigned for such a category.

The palletizing station may be arranged at the receiving station 263 which is adapted to receive baggage 500 to the buffer storage 200 and to manipulate the baggage 500 to a correct attitude for storage. The same applies for the embodiment of Figs. 1 and 2. The receiving station 263 may comprise the palletizing function and/or measuring means for measuring the at least one physical property of the baggage 500. Generally speaking, the categorizing means for the categorization of baggage may be arranged partly or in full to the receiving station 263 of the buffer storage 200.

As is further apparent from Figs. 3 to 5, the pallet handling apparatus 260 of the buffer storage 200 comprises a portal support 265 and at least one, preferably at least two hoists

261, 262 which are arranged to the support 265. The hoists 261, 262 are adapted to move pallets 250 between stacks and stations 263, 264. The hoists 261, 262 are configured to pick up either one pallet 250 or a plurality of superposed pallets 250, whereby the pallet handling apparatus 260 is adapted to move entire stacks of pallets in one lift. The pallet handling apparatus 260 is also used to deliver pallets 250 from the blocks A, B, C, D to the loading cell 300, particularly to the loading robot 310, via a feeding station 264. The feeding station 264 is arranged adjacent to the loading cell 300 for feeding the robot of the loading cell 300. The feeding station 264 may the form of a simple horizontal plane or conveyer or plurality of superposed planes or conveyors. The feeding station 264 may be further equipped with pallet handling equipment which ejects the baggage item 500 from the pallet 250 and transports the empty pallet to the empty pallet storage or to the receiving station 263.

In both main embodiments illustrated in Figs. 1 to 2 and 3 to 5, respectively, each block A, B, C, D of the buffer block 200 is preferably configured to serve more than one loading cell 300. In the example of Fig. 4, all blocks A to D serve each loading robot 310 as the hoists 261, 262 are able to convey which ever pallet 250 to which ever feeding station 264. In the example of Fig. 2, blocks A and B as well as C and D are adapted to serve also loading robots (not shown) above and underneath robot 310 illustrated in the Figure.

Table 1: List of reference numbers.

| Number | Part | Number | Part |
|---|---|---|---|
| 100 | baggage handling system (infrastructure) | 261 | first hoist |
| 111 | first conveyor | 262 | second hoist |
| 112 | second conveyor | 263 | receiving station |
| 200 | buffer storage | 264 | feeding station |
| A … D | buffer block | 265 | portal support |
| 210 | infrastructure interface | 300 | loading cell |
| 211 | first feeding chute | 310 | robot |
| 212 | second feeding chute | 320 | air freight container manipulator |
| 220 | manipulator | 330 | air freight container |
| 221 | elevator | 400 | air freight container transport system (infrastructure) |
| 222 | lateral shifter | 410 | dolly |
| 230 | shelf | 420 | safety guard |
| 250 | pallet | 500 | flight baggage |
| 260 | portal pallet handling apparatus | | |

*Claims*

1. Method of storing baggage (500) in a buffer storage (200), the method comprising the steps of:
   - receiving baggage (500) and identification information thereof to the buffer storage (200),
   - measuring at least one physical property of the baggage (500),
   - categorizing the baggage (500) based on at least destination and said measurement of the at least one physical property,

   **characterized** in sorting the categorized baggage (500) to a block (A, B, C, D) of the buffer storage (200) which block is customized for a specific category.

2. Method according to 1, wherein each buffer block comprises a plurality of storage positions each adapted to receive a baggage item (500).

3. Method according to 1 or 2, wherein the buffer block is customized according to an estimated baggage profile depending on flight profile in order for the block (A, B, C, D) to be suitable for receiving baggage (500) predominantly belonging to a specific category.

4. Method according to 3, wherein the estimated baggage profile is established from statistical data concerning baggage properties associated with corresponding flight properties.

5. Method according to 4, wherein the predetermined baggage profile anticipates a physical property associated to a specific destination.

6. Method according to any of the preceding claims, wherein at least one or any combination of the following physical properties is measured for categorization:
   - dimensions,
   - presence of protrusions exceeding a predetermined limit,
   - weight,
   - weight distribution,
   - moment of inertia,
   - stiffness

- friction,
- volume.

7. Method according to claim any of the preceding claims, wherein the buffer storage (200) is arranged in the vicinity of the loading cell (300) for directly feeding the loading robot (310) of the cell (300).

8. Method according to any of the preceding claims, wherein the buffer storage (200) receives baggage items (500) from a baggage sorting system (100) of an airport and feeds a loading robot (310) of an automated loading cell (300) for loading an air freight container (330).

9. Method according to any of the preceding claims, wherein baggage (500) is received to a receiving station (263) of the buffer storage (200), which receiving station manipulates the baggage (500) to a correct attitude for storage.

10. Method according to any of the preceding claims, wherein for customization the buffer block (A, B, C, D), the size of the storage positions of is altered by vertically moving shelves (230) of the buffer block (A, B, C, D).

11. Method according to any of the preceding claims, wherein the buffer storage (200) receives baggage from the baggage sorting system (100) of an airport, the baggage is inserted into a pallet (250), wherein the buffer storage (200) arranges the pallets (250) into stacks, wherein a pallet (250) forms a storage position and wherein at least one stack forms a buffer block.

12. Method according to claim 11, wherein the pallets (250) are prismatic containers, at least one face of which is greater than the smallest dimension of the baggage (500) contained in the pallet (250), wherein pallets (250) may be stacked without causing damage to the baggage (500).

13. Buffer storage (200) for temporary storage of flight baggage (500), **characterized** in that the buffer storage (200) comprises at least two buffer blocks (A, B, C, D) which are adapted to be customized for receiving baggage (500) belonging to different categories based on destination and at least one physical property.

14. Buffer storage (200) according to claim 13, wherein each buffer block (A, B, C, D) comprises a plurality of storage positions each adapted to receive a baggage item (500).

15. Buffer storage (200) according to claim 13 or 14, wherein the buffer storage (200) comprises categorization means which is adapted to sort baggage (500) to a specific buffer block (A, B, C, D) based on at least one physical property.

16. Buffer storage (200) according to 15, wherein the categorization means comprises a device for measuring at least one physical property.

17. Buffer storage (200) according to 16, wherein the device for measuring at least one physical property is adapted to measure at least one or any combination of the following physical properties for categorization:
- dimensions,
- presence of protrusions exceeding a predetermined limit,
- weight,
- weight distribution,
- moment of inertia,
- stiffness
- surface friction,
- volume.

18. Buffer storage (200) according to 16 or 17, wherein the device for measuring at least one physical property is integrated outside the buffer (200) to the infrastructure of the airport.

19. Buffer storage (200) according to any of claims 13 to 18, wherein the buffer storage (200) is arranged in the vicinity of the loading cell (300) for directly feeding the loading manipulator (310) of the cell (300).

20. Buffer storage (200) according to any of claims 13 to 19, wherein the buffer storage (200) is adapted to receive baggage (500) from a baggage sorting system (100) of an airport and to feed a loading robot (310) of an automated loading cell (300) for loading an air freight container (330).

21. Buffer storage (200) according to any of claims 13 to 20, wherein the buffer storage (200) comprises a receiving station (263) which is adapted to receive baggage (500) to the buffer storage (200) and to manipulate the baggage (500) to a correct attitude for storage.

22. Buffer storage (200) according to any of claims 13 to 21, wherein the buffer storage (200) comprises a plurality of shelves (230) and a manipulator (220) adapted to receive baggage (500) from the baggage transport system (100) of an airport, wherein the plurality of shelves (230) form the storage positions of the buffer blocks.

23. Buffer storage (200) according to claim 22, wherein the shelves (230) are vertically movable, wherein the size of the storage positions of a buffer block may be altered according to a predetermined loading profile which is associated on the flight destination of the baggage for customizing the block for receiving baggage (500) predominantly belonging to a specific category.

24. Buffer storage (200) according to claim 22 or 23, wherein the shelves (230) comprise conveyors for receiving and ejecting the received baggage (500).

25. Buffer storage (200) according to any of claims 13 to 21, wherein pallets (250) are prismatic containers, at least one face of which is greater than the smallest dimension of the baggage (500) contained in the pallet (250), wherein pallets (250) may be stacked without causing damage to the baggage (500).

26. Buffer storage (200) according to 25, wherein the buffer storage (200) comprises a pallet handling apparatus which is adapted to receive stackable pallets (250) from the baggage transport system (100) of an airport and to arrange the pallets (250) into stacks, wherein a pallet (250) forms a storage position and wherein at least one stack forms a buffer block.

27. Buffer storage (200) according to 25 or 26, wherein the buffer storage (200) comprises a receiving station (263) which is adapted to receive pallets (250) each containing at least one baggage (500) and to appoint the pallets (250) to an appropriate buffer block.

28. Buffer storage (200) according to any of claims 25 to 27, wherein the pallet handling apparatus is a portal pallet handling apparatus (260) comprising a portal support (265) and at least one hoist (261, 262) which is arranged to the support (265) and adapted to move pallets (250) between stacks and stations (263, 264).

29. Buffer storage (200) according to any of claims 21 to 28, wherein the categorization means are arranged to the receiving station (263).

30. Buffer storage (200) according to any of claims 19 to 29, wherein the buffer storage (200) comprises a feed station (264) which is arranged adjacent to the loading cell (300) for feeding the robot of the loading cell (300).

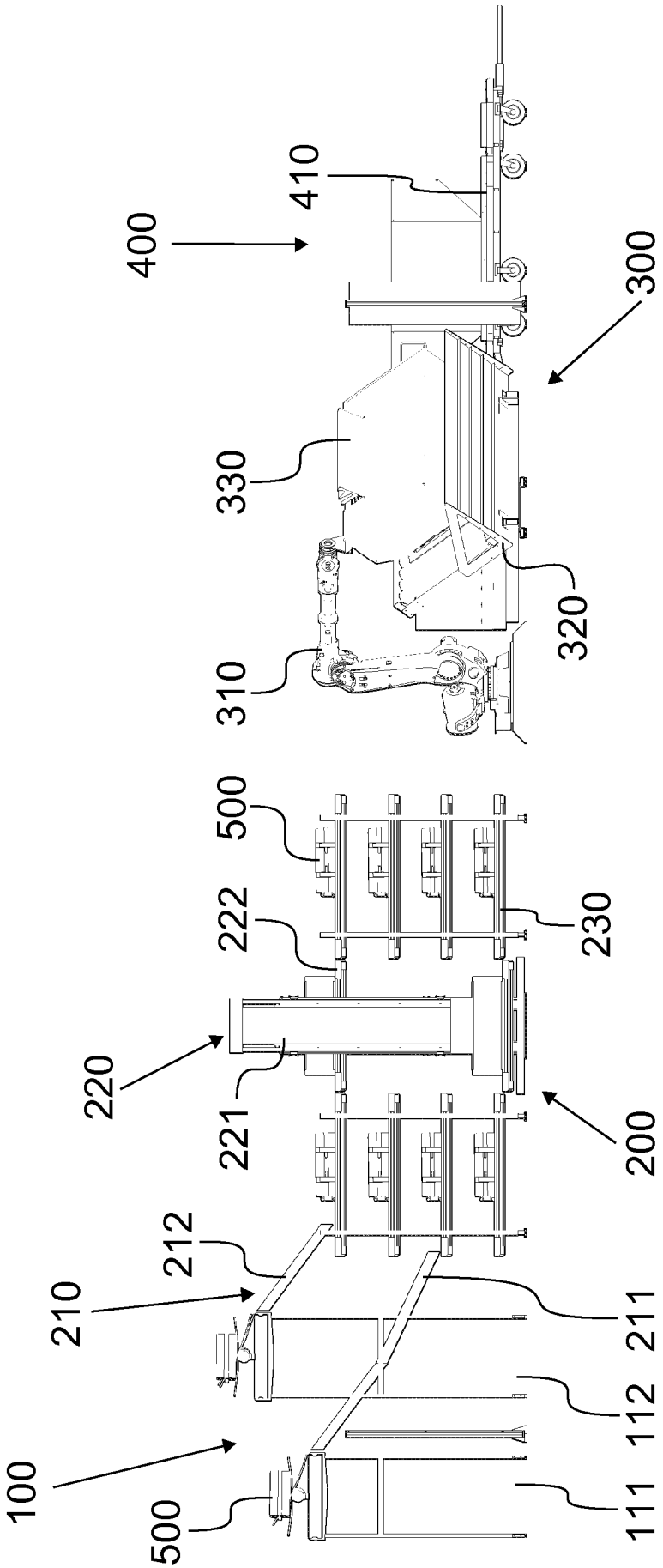
400
410
300
330
320
310
500
222
230
220
221
200
212
210
211
112
100
500
111

FIG. 1

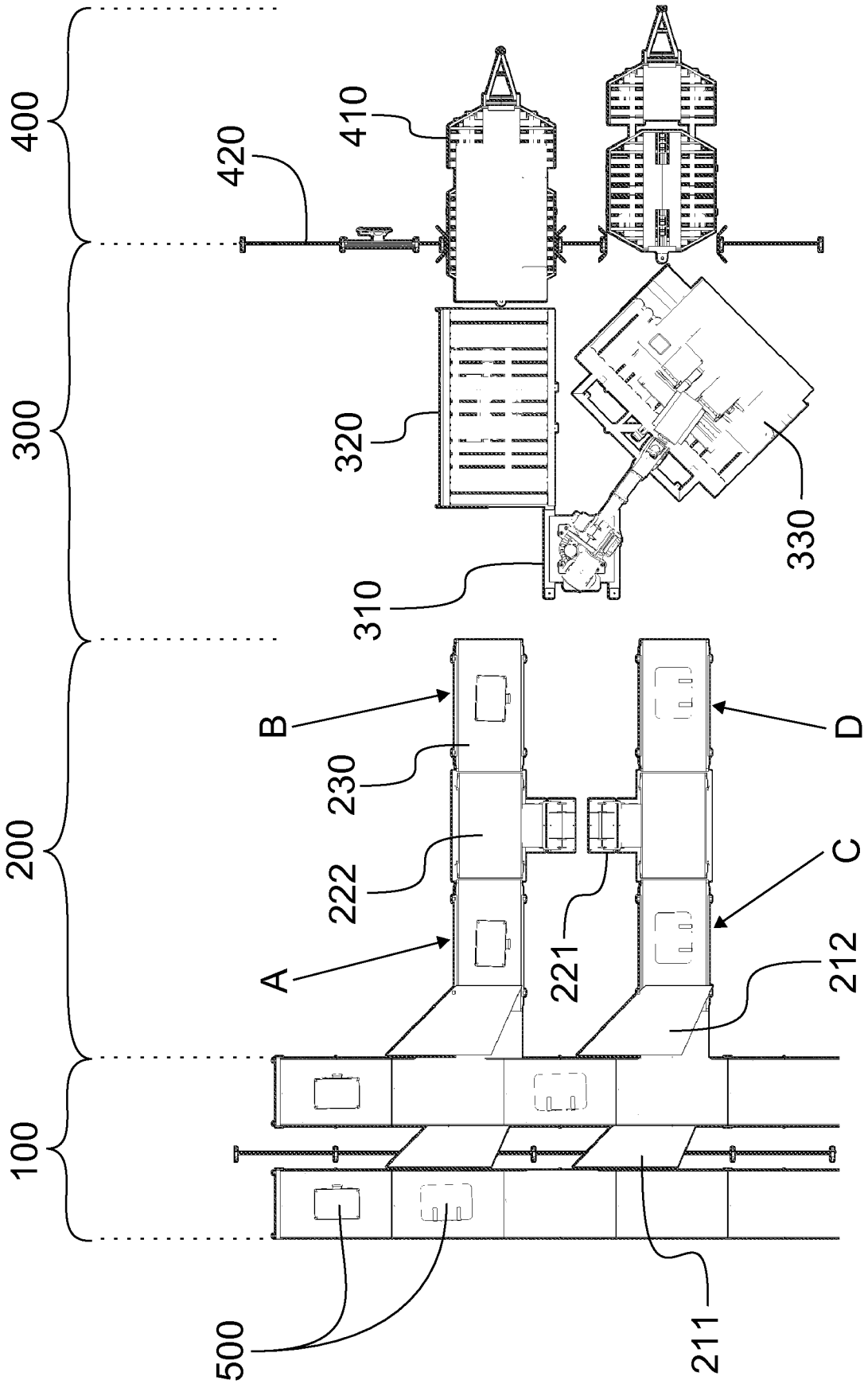


FIG. 2

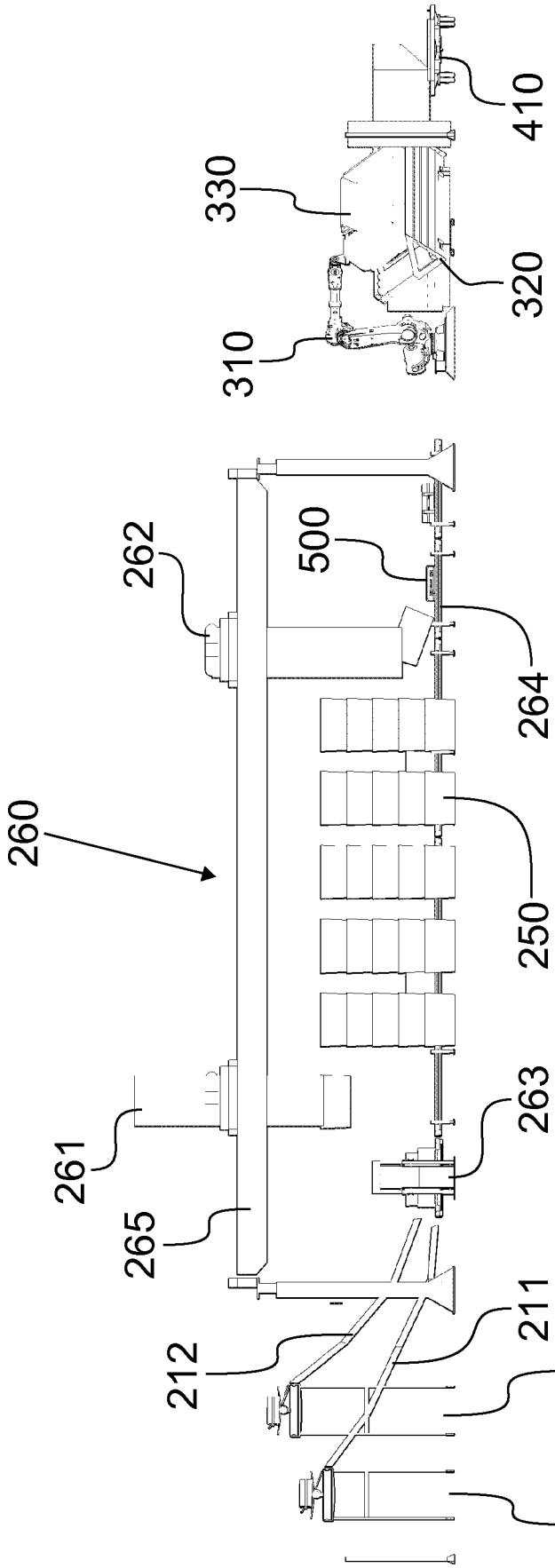


FIG. 3

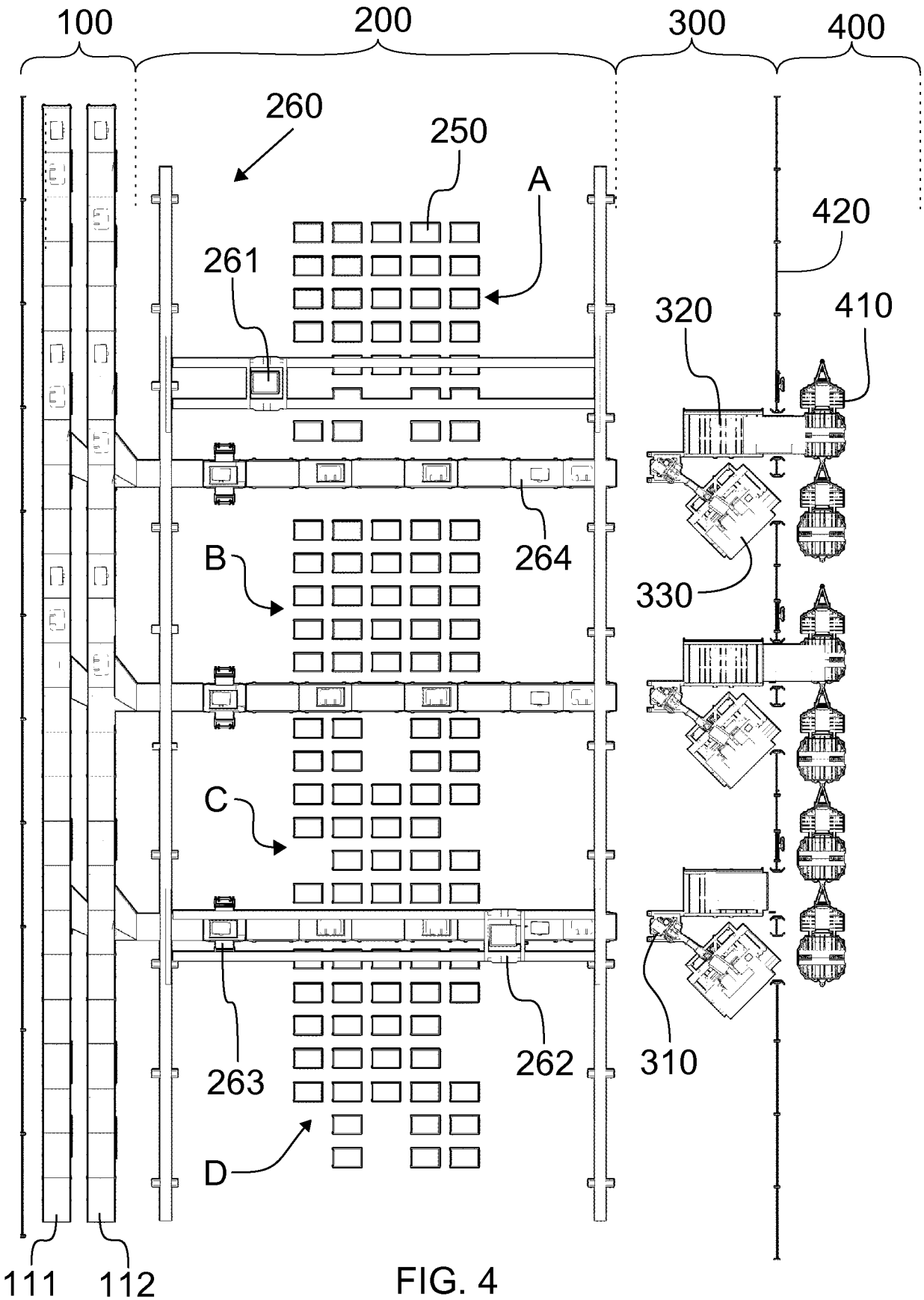
100
200
300
400
260
250
A
261
420
320
410
264
B
330
C
263
262
310
D
111
112

FIG. 4

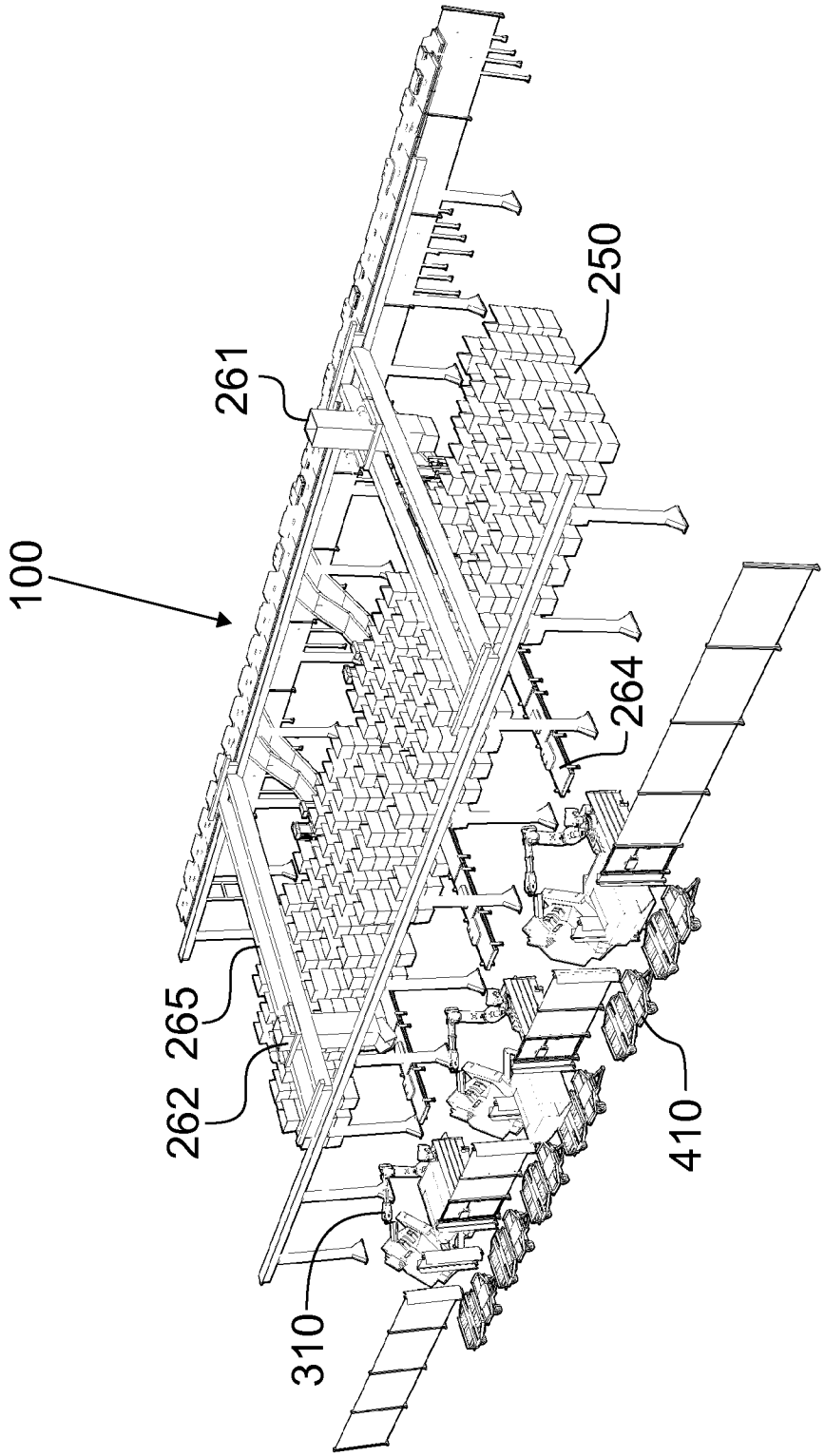


FIG. 5

**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/FI2011/051028

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B64F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI, COMPDX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 6580046 B1 (KOINI MARTIN et al.) 17 June 2003 (17.06.2003)<br>abstract; column 2, line 21 – column 7, line 20; claims 1 – 20; figures 1 – 3 | 1 - 30 |
| A | DE 102009052547 A1 (ABERLE ROBOTICS GMBH)<br>12 May 2011 (12.05.2011)<br>whole document | 1 - 30 |
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 04 September 2012 (04.09.2012) | 05 September 2012 (05.09.2012) |


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International application No.
PCT/FI2011/051028

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PCT/FI2011/051028

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
***B64F 1/36*** (2006.01)