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Description

1. TECHNICAL FIELD

5 The field of the invention is that of logistics and systems of
buffer storage and load sequencing (or buffer-sequencers),
configured to receive non-sequenced loads coming from at least
one external unit (for example an automated storage/removal
warehouse) and to supply at least one sequence of loads in a
10 given order to at least one picking/preparing station.

The present invention relates more precisely to the management
of a buffer storage and load sequencing system (or
buffer/sequencer) when this system comprises:

- 15 - a buffer storage unit comprising a plurality of entrance
levels and at least one recirculation level which are vertically
superimposed, each having a single entrance and a single exit
and each comprising a "first-in-first-out" type conveyor in a
first direction or sense for the entrance level and a second
20 sense opposite to the first sense for the at least one
recirculation level, a load present on the at least one
recirculation level being called a load in recirculation (or
load being recirculated); and
- an entrance elevator (or lift) and an exit elevator (or
25 lift), of the reciprocating and discontinuous type, respectively
positioned so as to be facing entrances and facing exits of the
entrance levels and of the at least one recirculation level.

The present invention can be applied to any type of preparing
30 station and especially but not exclusively to:

- stations for preparing customer orders (also called picking
stations), by picking products from storage containers (also
called source loads): an operator (or a robot) receives a pick
list (on paper, on the screen of a terminal, in voice form, in
35 the form of a data-processing task (in the case of a robot),
etc.). For each package to be shipped (also called a "shipping
container" or "target load"), this list informs the operator or
robot about the quantity of each type of product that he or it

must collect in storage containers and group together in the package to be shipped; and

- storage container palletizing stations (also called "source loads") themselves containing items: an operator (or a robot) receives a picking list (on paper, on a terminal screen, in voice form, in the form of data-processing tasks (when it is a robot), etc.) informing him or it that for each pallet to be shipped (also called "a shipping container" or "target load"), the quantity of each type of storage container (for example cardboard packages) that he or it must collect and discharge on the pallet to be shipped.

2. TECHNOLOGICAL BACKGROUND

The patent application FR3051948A1, filed by the holder of the present application (the firm SAVOYE), describes several possible implementations of a system for the buffer storage and sequencing of loads of the type mentioned here above, i.e. comprising a buffer storage unit itself comprising N entrance levels and at least one recirculation level, as well as an entrance elevator and an exit elevator.

The general principle of such a system consists in carrying out the functions of buffer storage and sequencing of loads by using two reciprocating elevators (entrance elevator and exit elevator respectively) in combination with a buffer storage unit under the control of a management unit (or control unit) configured to organize various movements of loads between these entities. The management unit UP especially sees to compliance with a rule according to which loads present on a same entrance level are sequenced in a rising order of sequential order numbers.

The sequencing (scheduling) capacity of the system is linked to the quantity of loads that can be temporarily stored in the buffer storage unit. By enabling recirculation (i.e. a return to the reciprocating entrance elevator, and therefore potentially towards the entrance of the buffer storage unit) of certain loads that exit the buffer storage unit, the (at least

one) recirculation level prevents a situation of blockage of the buffer storage unit without increasing its number of entrance levels.

5 The term "external unit" (that gives the non-sequenced loads) is understood for example to mean (this list is not exhaustive): an automatic system (for example an automated storage/removal warehouse); a semi-automatic system; a manual system; another buffer storage and load sequencing system; a combination of at
10 least two of the above systems; etc.

Such a system has numerous advantages, especially but not exclusively:

- minimizing (and even in certain cases totally eliminating)
15 sequencing constraints at the exit from the external unit or units by a sequencing of the loads downstream to this unit or these units and as close as possible to the preparation station or stations; this minimizing (or elimination) of constraints reduces size and complexity and therefore the cost of the
20 external unit or units;
- reducing the footprint;
- optimizing the efficiency of the total system (including especially the external unit or units, the buffer storage and sequencing system and the preparing station or stations);
- 25 • optimizing the reactivity of the overall system;
- manipulating multi-format loads if motor-driven rollers are used;
- optimizing costs if the general system comprises several preparation stations (pooling of the buffer storage and
30 sequencing system);
- etc.

At exit from the buffer storage and sequencing system, several types of load sequences can be achieved, especially but not
35 exclusively:

- a sequence comprising solely source loads, each source load being a storage container of an article or articles; or

- a sequence comprising only target loads, each target load being a shipping container of an article or articles; or
- a sequence comprising a target load, which is a shipping container of an article or articles, followed by at least one source load which is a storage container of an article or articles.

Several buffer storage and sequencing systems (each made according to the proposed solution) can be used in parallel. For example, upstream to the at least one picking/preparing station, a first system is used solely for source loads and at the same time a second system is used solely for target loads.

The present inventors have thought it desirable to optimize the management of a buffer storage and load sequencing system as described in the patent application FR3051948A1.

They have identified several modes of optimization relating particularly to the control of the entrance elevator, including a search for a solution to the following problems and issues while managing a compromise between, on the one hand, an increase in the flow rate of the sequenced loads exiting onto the exit conveyor and secondly a reduction of the risks of blockage of the system:

- selecting a load: how to choose between the loads that reach the entrance elevator via the entrance conveyor and the loads in recirculation that reach the entrance elevator via the recirculation level?
- selecting a destination level: once a load has been chosen how to choose, from among the entrance levels, that destination level to which the load must be transferred by the entrance elevator while ensuring compliance with the above-mentioned rule according to which the loads present at a same entrance level are sequenced in a rising order of sequential order numbers?
- selecting a level of loads to be recirculated: when it is not possible to choose a destination level while ensuring compliance with the above-mentioned rule, how to choose, among the entrance levels, a level of loads to be recirculated (i.e.

a level at which the loads hosted by this level will have to be transferred by the exit elevator towards the recirculation level)?

5 The invention, in at least one embodiment, is aimed mainly at providing a method for the control (management) of a buffer storage and load sequencing system offering a solution to the problems and issues mentioned here above (or at least one among them), while at the same time managing the above-mentioned
10 compromise (between increasing exit flowrate of the sequenced loads and reducing risks of blockage of the system).

3. SUMMARY

15 One particular embodiment of the invention proposes a method for managing a buffer storage and load sequencing system, configured to receive non-sequenced loads coming from at least one external unit, via at least one entrance conveyor and provide at least one sequence of loads in a given sequential order to least one
20 preparing station, through at least one exit conveyor. The system comprises:

- a buffer storage unit comprising N entrance levels and at least one recirculation level which are vertically superimposed, each having a single entrance and a single exit and each
25 comprising a "first-in-first-out" type conveyor in a first sense for the entrance levels and in a second sense opposite the first sense for the at least one recirculation level, with $N \geq 2$, a load present on the at least one recirculation level being called a load in recirculation; and
- 30 - an entrance elevator and an exit elevator, of the reciprocating and discontinuous type, respectively positioned so as to be facing entrances and facing exits of the N entrance levels and of the at least one recirculation level.

35 A management unit carries out an iterative management of the entrance elevator comprising, at each iteration, the following steps, even if there is at least one load to be recirculated in the system:

- detecting a first load at an exit of the entrance conveyor and a second load at the exit of the at least one recirculation level;
- selecting a load with the following rules: selecting the first load if there is no second load present or vice versa; if 5 the first and second loads are present, selecting the second load if at least one condition of priority is verified, if not, selecting the first load;
- selecting a destination level from among the entrance 10 levels in complying with a rule according to which loads present on a same entrance level, except for loads to be recirculated if any, are sequenced in a rising order of sequential order numbers;
- if the selection of a destination level is completed, 15 generating a task, for the entrance elevator, of transferring the selected load to the entrance of the selected destination level; if not, selecting a level of loads to be recirculated from among the entrance levels, without generating a task, for the entrance level, of transferring the selected load to the 20 entrance of the selected level of loads to be recirculated, and assigning each load of the level of loads to be recirculated a status of a load to be recirculated signifying that said load must be transferred by the exit elevator to the entrance of the at least one recirculation level.

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The general principle of the proposed solution consists in carrying out an iterative management of the entrance elevator in which, in order to promote the reduction of risks of blockage relative to the increase in the exit flowrate of sequenced loads 30 (in the management of the above-mentioned compromise), the capacity for sorting the loads to be recirculated and of loads in recirculation is improved (in so doing the sorting capacity of the entire system is improved):

- in seeking to generate a transfer task for the entrance 35 elevator even if there is at least one load to be recirculated in the system; and
- in giving preference when possible (i.e. if the at least one priority condition is verified) in the selection of loads

at the entrance to the entrance elevator, to the loads in recirculation coming from the at least one recirculation level.

Besides, the selection of a level of loads to be recirculated (in a given iteration of the iterative management) is associated with the assignment of the "to be recirculated" status to each load of the level of loads to be recirculated, but does not imply the generation, for the entrance elevator, of a task of transferring the selected load to the entrance of the selected level of loads to be recirculated. Thus, the following iteration of the iterative management is used to generate such a transfer mission, thus optimizing the choice of the entrance level on which the next selected load will be placed.

Here below, referring to the figures, we describe various characteristics of the process of selecting a destination level and the process of selecting a level of loads to be recirculated, further improving the capacity of sorting the loads to be recirculated and of the loads in recirculation and therefore further reducing the risks of blockage of the system.

Various implementations and characteristics of the proposed method of management are specified in the set of claims. They are also described in detail (with their associated advantages) and illustrated through examples given here below in the description.

Another embodiment of the invention proposes a computer program product comprising program code instructions for the implementing of the above-mentioned method (in any one of its different embodiments) when said program is executed on a computer.

Another embodiment of the invention proposes a computer-readable and non-transient storage medium storing a computer program comprising a set of instructions executable by a computer to implement the above-mentioned method (in any one of its different embodiments).

Another embodiment of the invention proposes a unit for the management of a buffer storage and load sequencing system configured to receive non-sequenced loads coming from at least one external unit, via at least one entrance conveyor and to provide at least one sequence of loads in a given sequential order to least one preparing station, through at least one exit conveyor, the system comprising:

- a buffer storage unit comprising N entrance levels and at least one recirculation level which are vertically superimposed, each having a single entrance and a single exit and each comprising a "first-in-first-out" type conveyor in a first sense for the entrance levels and in a second sense opposite the first sense for the at least one recirculation level, with $N \geq 2$, a load present on the at least one recirculation level being called a load in recirculation; and
- an entrance elevator and an exit elevator, of the reciprocating and discontinuous type, respectively positioned so as to be facing entrances and facing exits of the N entrance levels and of the at least one recirculation level.

Said unit of management is configured to carry out an iterative management of the entrance elevator according to the method of management, according to any one of its embodiments described further below.

4. LIST OF FIGURES

Other features and advantages of the invention shall appear from the following description given by way of an indicative and non-exhaustive example and from the appended drawings, of which:

- Figure 1 is a side view of a buffer storage and load sequencing system according to one particular embodiment of the invention;
- Figure 2 is a flowchart of the management of the entrance elevator according to one particular embodiment of the invention;

- Figure 3 is a flowchart of the management of the exit elevator according to one particular embodiment of the invention; and

- Figure 4 is a block diagram of a management unit according to one particular embodiment of the invention.

5. DETAILED DESCRIPTION

In all the figures of the present document, the identical elements and steps are designated by a same numerical reference.

Figure 1 illustrates a buffer storage and load sequencing system according to one particular embodiment of the invention. It is configured to receive non-sequenced loads coming from an external unit (not shown), through an entrance conveyor CE and to give at least one sequence of loads in a given sequential order (sequenced loads) to a preparation station (also called "picking station") PP (occupied by an operator or a robot), via an exit conveyor CS.

20

In other words, the system (or buffer sequencer) sorts out the loads as a function of a list of loads awaited (or expected) at exit and of loads that it discovers at entrance.

The list of loads awaited at exit is given by the management unit UP. It comprises pairs associating a sequential order number and a load identifier. The list of loads awaited at exit therefore gives a list of sequential order numbers which is obligatorily a rising order that is not strict (but not necessarily continuous). Examples of lists of sequential order numbers:

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- example 1: 1, 2, 3, 4, 5, 6, 7, 8;
- example 2: 1, 1, 2, 3, 4, 4, 4, 4, 5, 6, 7, 8, 8, 9, 9, 10;
- example 3: 1, 1, 2, 3, 6, 7, 8, 8, 10.

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The next number on the list of loads awaited at exit is the first on the list, which therefore has the lowest value.

When a load has been processed (deposited on the exit conveyor), its sequential order number is removed from the list. The preceding examples of sequential order number lists are updated, assuming that a load having a sequential order number 1 has been deposited on the exit conveyor:

- example 1: 2, 3, 4, 5, 6, 7, 8;
- example 2: 1, 2, 3, 4, 4, 4, 4, 5, 6, 7, 8, 8, 9, 9, 10;
- example 3: 1, 2, 3, 6, 7, 8, 8, 10.

The external unit is for example an automated storage/removal warehouse. In one variant, the external unit is another buffer storage and load sequencing system. In another variant, the buffer storage and load sequencing system receives non-sequenced loads coming from several external units (either via several entrance conveyors CE each specific to one of the external units or via an entrance conveyor CE used jointly by several external units).

The buffer storage and load sequencing system comprises an entrance elevator EE, an exit elevator ES, a buffer storage unit US and a management unit UP.

The entrance elevator EE and exit elevator ES are vertical reciprocating and discontinuous elevators each comprising a single nacelle 21, 22 carrying out alternating or reciprocating vertical movements (the nacelle rises and descends in alternation). By opposition, a "continuous elevator" (also called a "paternoster") is a vertical elevator comprising a plurality of nacelles circulating in a closed loop, without alternating movement. The single nacelle 21, 22 is a one-load unit (it comprises a single level comprising a single location configured to receive one load). Thus, the elevators EE, ES are simple, low-cost units.

The single nacelle location is for example equipped with a motor-driven conveyor section (or any other transfer device) enabling the transfer of a load on to or out of the nacelle. In one variant, the nacelle location is equipped with idlers or idle

rollers put into motion for example by a collapsible mechanical means positioned at the end of another piece of equipment (a conveyor or buffer location). Other means of putting the system into movement can be envisaged.

5

In another variant, the single nacelle of each elevator EE, ES is a multi-load unit (it comprises several levels and/or several load locations per level).

10 In another variant, the elevators EE, ES are reciprocating and discontinuous type vertical elevators, each comprising several nacelles each carrying out alternating vertical movements (the nacelle rises and descends in alternation). Each nacelle comprises one or more levels and/or one or more load locations
15 per level.

The buffer storage unit US comprises:

- N entrance levels VE_1 to VE_N , vertically superimposed, each having a single entrance and a single exit and each comprising
20 a "first-in-first-out" or FIFO type conveyor in a first sense (indicated in figure 1 by black arrows oriented from left to right, especially the arrow referenced 23), with $N \geq 2$ (for example, $N=9$ in one particular implementation). Each entrance level automatically moves the loads from upstream (entrance
25 elevator side) to downstream (exit elevator side). Each entrance level comprises an automatic step-by-step forward feed conveyor, so as to automatically move the loads forward up to a waiting position before the loads are picked by the exit elevator. They can thus be a maximum of Y loads in one level;
- 30 • a recirculation level VR, vertically superimposed with the entrance levels, having a single entrance and a single exit and comprising a "first-in-first-out" type conveyor in a second sense (indicated in figure 1 by a black arrow oriented from
right to left and referenced 24) opposite the first sense. Each
35 load present on the recirculation level VR is called a "recirculation load". The recirculation level automatically shifts the loads from downstream (on the exit elevator side) to upstream (entrance elevator side). The recirculation level VR

can be positioned at any stage whatsoever (in one particular embodiment, it is positioned vertically to the center of the superimposition of the entrance levels, in order to limit the movements of the exit elevator). In one variant, the buffer storage unit US comprises several recirculation levels;

5 • (optionally) one "fast track" level VQ vertically superimposed with the entrance levels VE_1 to VE_N and the recirculation level VR, having a single entrance and a single exit, and comprising a "first-in-first-out" type conveyor
10 according to the first sense. The fast track level is reserved for delayed loads to enable them to be picked as fast as possible by the exit elevator.

The entrance elevator EE and the exit elevator ES are positioned
15 respectively at the entrance and at the exit of the N entrance levels VE_1 to VE_N of the recirculation level VR and the "fast track" level VQ of the buffer storage unit US. The nacelle 21 of the entrance elevator EE can come into a position facing the entrance of each of the N entrance levels and of the "fast track"
20 level VQ of the buffer storage unit US to insert a load therein. It can also come to a position facing the exit of the recirculation level VR to remove a load therefrom.

The nacelle 22 of the exit elevator ES can come into positions
25 each facing the exit of one of the N entrance levels and the "fast track" level VQ of the buffer storage unit US to remove a load therefrom. It can also come into a position facing the entrance of the recirculation level VR to insert a load thereon.

30 The entrance conveyor CE occupies a position enabling direct exchange of loads with the entrance elevator EE. In other words, a load can pass directly from one to the other. In the example of figure 1, the entrance elevator EE is positioned between the entrance conveyor CE and the buffer storage unit US, and the
35 entrance conveyor CE is vertically aligned with the entrance level referenced VE_1 of the buffer storage unit US. In variants, the entrance conveyor CE can occupy other vertical positions, and can especially be aligned vertically with any one of the N

entrance levels VE_1 to VE_N of the buffer storage unit US, or with the "fast track" level VQ or the recirculation level VR. In other variants, the entrance conveyor CE and the buffer storage unit US are positioned on the same side of the entrance elevator EE (in this case, the entrance conveyor CE is positioned above or beneath the buffer storage unit US). In other variants, it is possible to have several entrance conveyors CE, in accordance with all the previous variants.

10 The exit conveyor CS occupies a position enabling direct exchange of loads with the exit elevator EE. In other words, a load can pass directly from one to the other. In the example of figure 1, the exit elevator ES is positioned between the buffer storage unit US and the exit conveyor CS, and the exit conveyor CS is vertically aligned with the entrance level referenced VE_1 of the buffer storage unit US. In variants, the exit conveyor CS can occupy other vertical positions, and can especially be aligned vertically with any one of the N entrance levels VE_1 to VE_N of the buffer storage unit US, or with the "fast track" level VQ or the recirculation level VR. In other variants, the exit conveyor CS and the buffer storage unit US are positioned on the same side of the exit elevator ES (in this case, the exit conveyor CS is positioned above or beneath the buffer storage unit US). In other variants, it is possible to have several exit conveyors CS in accordance with all the previous variants.

The management unit UP enables the optimal organization of the movements of the loads in the system, and especially on the entrance elevator EE and exit elevator ES and the buffer storage unit US in order to make source loads available on the exit conveyor CS according to at least one determined sequence (comprising loads in a desired sequential order). To this end, the management unit UP receives information (in particular a load identifier) on loads passing through different places of the system, read by reader devices (not shown) such as a barcode reader, RFID label reader, etc. These places are for example situated at the extremities of the different conveyors.

More specifically, the management unit UP organizes, under the above-mentioned constraint of delivery of at least one determined sequence, different movements of loads:

- from the entrance conveyor CE to the entrance elevator EE;
- 5 • from the entrance elevator EE to the N entrance levels of the buffer storage unit US;
- from the entrance elevator EE to the "fast track" level VQ of the buffer storage unit US;
- from the N entrance levels of the buffer storage unit US
10 to the exit elevator ES;
- from the "fast track" level VQ of the buffer storage unit US to the exit elevator ES;
- from the exit elevator ES to the exit conveyor CS;
- from the exit elevator ES to the recirculation level VR;
- 15 and
- from the recirculation level VR to the entrance elevator EE.

The entrance elevator EE and the exit elevator ES work
20 simultaneously, thus increasing the rate of the buffer storage and sequencing unit.

For the system to provide a sequence of loads in a given sequential order, the management unit UP performs:

- 25 • an iterative management of the entrance elevator (see figure 2) so that it carries out a pre-sequencing when it places loads of the sequence at the entrance to the entrance levels VE₁ to VE_N and the "fast track" level VQ of the buffer storage unit US. To this end, the management unit UP ensures especially
30 compliance with a rule according to which the loads present on a same entrance level (apart from a load or loads to be recirculated, if any) are sequenced in a rising order of sequential order numbers. In other words, on each of the N entrance levels, a given load having a given rank within the
35 sequence should not be preceded by any other load (apart from possible loads to be recirculated) of a rank strictly greater than the given rank (several loads can receive the same rank within the sequence); and

- an iterative management of the exit elevator (see figure 3), so that it carries out a final sequencing when it picks loads of the sequence at exit from the N entrance levels VE_1 to VE_N and from the "fast track" level VQ of the buffer storage unit US according to the given sequential order.

In other words, the sequencing function (scheduling function) is distributed between the entrance elevator EE (which carries out the pre-sequencing) and the exit elevator ES (which carries out the final sequencing and participates in the pre-sequencing). This enables the buffer storage and load sequencing system to work at a high rate (directly related to the working rate of the entrance and exit elevators).

Thus, in the example illustrated in figure 1, the sequence to be reconstituted on the exit conveyor CS is considered to comprise the following ordered loads: C11, C12, C13, C14 and C21. The entrance elevator EE receives the loads unordered (C11, C14, C13, C22, C12 and C21). It carries out a pre-sequencing in carrying out the following successive actions:

- placing the load C11 on the entrance level VE_1 ;
- placing the load C14 on the entrance level VE_1 ;
- placing the load C13 on the entrance level VE_2 (it is not possible to place it on the entrance level VE_1 because the load C14 is already thereon);
- placing the load C22 on the entrance level VE_1 ;
- placing the load C12 on the entrance level VE_3 (it is not possible to place it on the entrance level VE_1 because the loads C14 and C22 are already thereon, nor is it possible to place it on the entrance level VE_2 because the load C13 is already thereon);
- placing the load C21 on the entrance level VE_2 (it is not possible to place it on the entrance level VE_1 because the load C22 is already thereon).

35

In figure 1, loads are referenced with alphanumeric characters (C22, C12, C13, etc.) to illustrate the working of the system. In order to show successive positions of a same load on the same

figure, the following notation is used: for a first position, the load is referenced only with its associated alphanumeric characters (for example C11), for a second position, the reference of the load is complemented by the prime symbol (for example, C11'). For a third position, the load is referenced with the double prime symbol (for example, C11''), etc.

If it should be impossible for the entrance elevator EE to deposit a load on an entrance level, the management unit UP searches for and selects a level of loads to be recirculated among the entrance levels (in other words, one of the entrance levels is selected, and the selected entrance level is called "level of loads to be recirculated"). The selected entrance level then has the "to be recirculated" status, and the loads on this level have the "to be recirculated" status. A load "to be recirculated" passes to the "in recirculation" status when it is deposited on the recirculation level VR by the exit elevator ES. The maximum number of entrance levels that can have the "to be recirculated" status simultaneously is predefined. In one particular embodiment, this maximum number is equal to N (the number of entrance levels), in order to improve the capacity for sorting loads to be recirculated and loads in recirculation.

In one particular embodiment, a discard path or track is installed, either at the entrance or at the exit of the buffer storage unit US in order to process anomalies, also called "discarded loads": unawaited loads, non-read loads, etc. The discarded loads are therefore either directly sent out by the entrance elevator or conveyed on an entrance level to be discharged by the exit elevator. A discarded load cannot take the "to be recirculated" status.

Figure 2 presents a flowchart for the management of the entrance elevator by the management unit UP according to one particular embodiment of the invention. This is an iterative management comprising, at each iteration, the steps described in detail here below, even if there is at least one load to be recirculated in the system.

Except for the saturations of levels, the loads having the "discard" status are not taken into account. For example, if a "discarded" load is the load most upstream to a level (i.e. closest to the entrance level), it is the sequential order number of the load that precedes it (immediately downstream) that will be taken into account to define NumDerCharge.

In an initial step 201, the management unit detects and identifies the loads that may be present on the picking positions of the entrance elevator: picking position at the exit of the entrance conveyor CE and picking position at the exit of the recirculation level VR.

In a test step 202, the management unit retrieves the sequential order number of the loads detected and identified at the step 201 and ascertains that they are truly present in the list of loads awaited at exit. If the order number of a detected load is not in the list of loads awaited at exit, the load is discarded in a step 203. If not, there is a passage to the test step 204 (load present on the exit of the entrance conveyor ?), combined with one of the identical test steps 205 and 208 (load present at the exit of the recirculation level ?) to determine the case in which the system is situated among four possible cases:

- case 1: no load present either on the exit of the entrance conveyor or on the exit of the recirculation level (negative responses to the tests 204 and 208);
- case 2: load present on the exit of the entrance conveyor and no load present on the exit of the recirculation level (positive response to the test 204 and negative response to the test 205);
- case 3: no load present on the exit of the entrance conveyor and load present on the exit of the recirculation level (negative response to the test 204 and positive response to the test 208);
- case 4: load present on the exit of the entrance conveyor and load present on the exit of the recirculation level (positive responses to the tests 204 and 205).

In the case 1, the management unit passes to the step 212 in which the entrance elevator is put on hold (for example in front of the exit of the entrance conveyor), then returns to the
5 initial step 201.

In the case 2, the management unit passes to the step 206 in which the load present at the exit of the entrance conveyor is selected and then to the step 211 for selecting a destination
10 level among the entrance levels.

In the case 3, the management unit passes to the step 209 in which the load present at the exit of the recirculation level is selected.
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In the case 4, the management unit passes to the test step 207 in which it verifies that at least one of the following priority conditions is met:

- the sequential order number of the load present at the exit
20 of the recirculation level is lower than the sequential order number of the load present at the exit of the entrance conveyor;
- the recirculation level comprises loads in recirculation that are not sequenced in a rising order of sequential order numbers;
- 25 - the recirculation level is full and there is need for one place in order to place a load thereon;
- there is at least one load to be recirculated or that is being recirculated in the system, with a sequential order number smaller than the sequential order number of the load present at
30 the exit of the entrance conveyor;
- in the system, there is at least one load to be recirculated with the sequential order number smaller than the order number of the last load placed in the recirculation level (i.e. the load of this level closest to the entrance elevator).

35 In the event of a positive response to the test step 207, the management unit passes to the step 209 in which the load present at the exit of the recirculation level is selected. Else, the

management unit passes to the step 206 in which the load present at the exit of the entrance conveyor is selected.

At the end of the step 209, the management unit carries out a test step 210 in which it verifies that the following sorting conditions are met:

- the sequential order number of the load present at the exit of the recirculation level is strictly greater than the order number of the load in $(N.Y/k)^{\text{th}}$ place in the list of loads awaited at exit, with N being the number of entrance levels, Y the capacity of loads (or load capacity) of each entrance level and $1/3 \leq k \leq 2/3$ (for example, $k=2$); and
- the loads recirculating on the at least one recirculation level are sequenced in a rising order of sequential order numbers.

In the event of a positive response at the test step 210 (i.e. if the two sorting conditions are verified), the management unit passes to the step 212 in which the entrance elevator is put on hold (for example in front of the exit of the entrance conveyor), and then returns to the initial step 201. Else, the management unit passes to the step 211 for selecting one destination level among the entrance levels.

At the step 211, the management unit tries to select a destination level among the entrance levels, in complying with the above-mentioned rule according to which loads present on a same entrance level (apart from any load or loads to be recirculated) are sequenced in a rising order of sequential order numbers.

If the "fast track" level VQ is implemented, the management unit selects it directly if one of the following conditions is met:

- the sequential order number of the selected load is that of the next sequential number of the lists of loads awaited at exit;
- the sequential order number of the selected load is the one directly awaited after the sequential order number of the last

load placed on the "fast track" level (i.e. the one closest to the entrance elevator).

In one particular embodiment, the step 211 for selecting a destination level furthermore comprises the assigning of a note
5 or grade to each of the entrance levels (with a set of grading rules described in detail here below) and then the selection of the entrance level that has obtained the highest (positive) grade.

10

In the event of equality between several entrance levels having the same grade, the management unit gives preference for example to the first entrance level, following an order of scanning of the entrance levels, defined in a setting of parameters that
15 depends on the physical configuration of the system.

In one particular implementation, the set of grading rules comprises the following steps for assigning a grade to a given entrance level:

20

- resetting the grade at zero;
- if the given entrance level is saturated, decrementing the grade by a value C0;

- if the given entrance level is vacant:

25

- * if the selected load is a load in recirculation, incrementing the grade by a value C1;

30

- * if the sequential order number of the selected load is strictly greater than the sequential order number of the load in (N.Y)th place in a list of loads awaited at exit, with Y being the load capacity of each entrance level, and if either the at least one recirculation level is vacant or the last load that has entered the at least one recirculation level possesses a sequential order number smaller than or equal to the sequential order number of the selected load, incrementing the grade by a value C2, if not incrementing the grade by a value C3;

35

- if $\text{NumDerCharge} \leq \text{NumCharge}$, with NumDerCharge being the sequential order number of the last load placed on the given entrance level and NumCharge being the sequential order number of the selected load:

* if the difference, in the list of loads awaited at exit, between the place i of the first load having the sequential order number NumCharge and the place j of the first load having the sequential order number NumDerCharge is strictly smaller than Z (with Z being a predetermined positive integer number; in a particular implementation: $Z = Y$, with Y being the load capacity of each entrance level), incrementing the grade by a value $C4$;

5

* else, incrementing the grade by a value $C5$;

10 - if the last load placed on the given entrance level is a load to be recirculated, if the given entrance level is not vacant and if $\text{NumDerCharge} > \text{NumCharge}$, incrementing the grade by a value $C6$;

with: $C1 < C3 < C2$; $C5 \leq C2$; $C5 < C4$; $C2 < C0$; $C4 < C0$; $C6 < C3$.

15

In one particular implementation, we have:

- $C4 = C7 - (\text{NumCharge} - \text{NumDerCharge}) + Y$; and

- $C5 = C8 - (\text{NumCharge} - \text{NumDerCharge})$;

20 with $C7 > C8$ (for example, $C7 = C2 + 1$ and $C8 = C2$).

In one particular implementation, we have: $C0 = 10\ 000\ 000$; $C1 = 1\ 000$; $C2 = 2\ 000\ 000$; $C3 = 10\ 000$; $C4 = 2\ 000\ 001 - (\text{NumCharge} - \text{NumDerCharge}) + Y$; $C5 = 2\ 000\ 000 - (\text{NumCharge} - \text{NumDerCharge})$; $C6 = 1\ 000$.

25

In one particular implementation of the step 211, the selected destination level takes the status of a "to be recirculated" level (i.e. a level of loads to be recirculated) and the selected load (which at the step 217 will be deposited on the selected destination level) also takes the "to be recirculated" status (i.e. the status of a load to be recirculated) (in order to be transferred to the entrance of at the least one recirculation level by the exit elevator) if the following conditions are verified:

30

35

- the selected destination level is vacant;

- the sequential order number of the selected load is strictly greater than the sequential order number of the load

in (N.Y)th place in the list of loads awaited at exit with Y being the load capacity of each entrance level; and

- either the recirculation level is vacant or the last load placed on the recirculation level has a sequential order number smaller than the sequential order number of the selected load.

If the step 211 has been completed (i.e. if the destination level has been selected from among the entrance levels), the management unit carries out the step 217 in which it generates a task for the entrance elevator, of transferring the selected load to the entrance of the selected destination level.

If the step 211 has not been completed, the management unit carries out test steps 213 and 214. In the step 213, it detects whether the at least one exit conveyor (CS) is saturated. At the step 214, it detects whether an exit elevator picking position is occupied by a load possessing the next sequential order number in the list of loads awaited at exit. If the two conditions of the test 213 and 214 are verified, then the management unit returns to the initial step 201, and if not it goes to a test step 215 in which it detects whether the predetermined maximum number of levels to be recirculated has been attained. As mentioned further above, in one particular embodiment, this maximum number is equal to N, in order to improve the sorting capacity for sorting the loads to be recirculated and the loads in recirculation.

If the conditions of the test 215 are verified, the management unit returns to the initial step 201. Else it goes to a step 216 for selecting a level of loads to be recirculated.

In the step 216, the management unit selects a level of loads to be recirculated from among the entrance levels (without the generation of a task, for the entrance elevator, of transferring the selected load to the entrance of the selected level of loads to be recirculated) and it assigns each load of the level of loads to be recirculated (except for the loads having the "discard" status) a status of a load to be recirculated

(signifying that the load must be transferred by the exit elevator to the entrance of the recirculation level).

In one particular embodiment, the selection step 216 for
5 selecting a level of loads to be recirculated comprises the
assigning of a grade to each of the entrance levels except for
the full entrance levels for which the sequential order number
of the last load placed is smaller than or equal to the
10 sequential order number of the selected load (with a set of
grading rules described in detail here below) and then the
selection of the entrance level having the highest (positive)
grade.

In one particular implementation, the set of grading rules
15 comprises the following steps, to assign a grade to a given
entrance level (without taking account of the "discarded"
loads):

- resetting the grade at zero;
- if the loads of the given entrance level can, on the
20 recirculation level, place themselves behind the loads in
recirculation in complying with a rising order of sequential
order numbers, incrementing the grade by a value K1. It is sought
as far as possible that the loads on the recirculation level
should be arranged in a rising order, and therefore, if making
25 the given entrance level recirculate enables this property to
be kept as "true", this incrementation increases the chances
that the given entrance level will be selected by incrementing
its grade. The choice of a rising order on the recirculation
level makes it possible to replace the loads more easily, obtain
30 improved sorting and never lose time in having to shift loads
(with a higher sequential order number than the one that might
be needed) to replace them in the buffer storage unit US;
- if it is possible to entirely reintroduce the loads of the
given entrance level on the recirculation level, incrementing
35 the grade by a value K2. This incrementing favors an entrance
level that does not make it obligatory to recirculate the loads
already present on the recirculation level towards an entrance
level of the buffer storage unit US;

- if the given entrance level includes only one load, incrementing the grade by a value $K3$. This incrementing favors fast recirculation;

5 - incrementing the grade with the sequential order number of the load of the given entrance level closest to the exit elevator;

- decrementing the grade with m times the number of loads on the given entrance level. This decrementing makes it possible to take account of the time needed to recirculate all the loads present on the given entrance level;

10 with $2 \leq m \leq 10$ (for example $m=2$), $K1 > Y$, $K2 > Y$ and $K3 > Y$, Y being the load capacity of each entrance level (in one particular implementation: $K1 = K2 = K3 = 1\ 000\ 000$).

15 **Figure 3** is a flowchart of the managing of the exit elevator by the management unit UP according to one particular embodiment of the invention. It is an iterative management operation comprising, at each iteration, the steps described in detail here below.

20

In an initial step 301, the management unit detects and identifies the loads, if any, present on the picking position of the exit elevator: picking positions at the exits of the entrance levels VE_1 to VE_N and at the exit of the "fast track" level VQ.

25

In a test step 302, the management unit detects whether a load having the next sequential order number of the list of loads awaited at exit is available for picking, among the loads detected at the step 301.

30

In the event of a positive response at the test step 302, the management unit passes to the test step 303 in which it detects whether the exit conveyor is saturated.

35

In the event of a negative response at the test step 303, the management unit carries out the steps 304 to 307:

- in the step 304, the management unit selects a load having the next sequential order number of the list of loads awaited at the exit 308 (if there are several loads possessing a sequential order number of this kind, the management unit
5 selects for example the load that is closest to the position of the exit elevator);
- in the step 305, the management unit generates a task, for the exit elevator, of picking the selected load;
- at the step 306, the management unit generates, for the
10 exit elevator, a task of depositing the selected load on the exit conveyor CS;
- at the step 307, the management unit updates the list of loads awaited at the exit 308.

15 In the event of a negative response at the test step 302, or a positive response at the test step 303, the management unit carries out a test step 309 in which it verifies whether a load to be recirculated is available for picking, from among the loads detected at the step 301.

20

In the event of a positive response at the test step 309, the management unit performs the steps 310 to 313:

- at the step 310, the management unit selects a load to be recirculated (if there are several of them, the management unit
25 selects for example the load that has the lowest sequential order number);
- at the step 311, the management unit generates, for the exit elevator, a task of picking the selected load to be recirculated;
- 30 • at the step 312, the management unit generates, for the exit elevator, a task of depositing the selected load to be recirculated on the recirculation level VR;
- at the step 313, the management unit updates the statuses. It removes the "to be recirculated" status from the load and
35 assigns it the "in recirculation" status. If, following this change in status of the load, the entrance level at which it is situated no longer has any more loads "to be recirculated", the

management unit removes the "to be recirculated" status from this entrance level.

In the event of a positive response at the test step 309, the management unit returns to the initial step 301.

Figure 4 presents an example of a structure of the above-mentioned management unit UP, according to one particular embodiment of the invention. The management unit UP comprises a random-access memory 43 (for example a RAM), a processing unit 41 equipped for example with a processor and managed by a computer program 420 stored in a read-only memory 42 (for example a ROM or a hard disk drive). At initialization, the code instructions of the computer program 420 are for example loaded into the random-access memory 43 and then executed by the processor of the processing unit 41. The processing unit 41 inputs signals 44, processes them and generates output signals 45.

The input signals 44 include various pieces of information on the working of the general system (including the external unit or units, the buffer storage and sequencing system and the preparing station or stations), especially the load identifiers read (by reading devices such as barcode readers, RFID label readers, etc.) on the loads when they pass through different places of the general system (for example at the extremities of the different conveyors).

The output signals 45 include various pieces of control information for the management (controlling) of the apparatuses of the general system (especially within the buffer storage and sequencing system) in order to manage the movements of loads in the general system.

This figure 4 illustrates only one particular implementation among several possible implementations. Indeed, the management unit UP can be made equally well on a reprogrammable computing machine (a PC computer, a DSP processor or a microcontroller)

executing a program comprising a sequence of instructions and/or on a dedicated computing machine (for example a set of logic gates such as an FPGA or an ASIC or any other hardware module). Should the management unit be implanted at least on partly on a reprogrammable computation machine, the corresponding program (i.e. the sequence of instructions) can be stored in a storage medium that is detachable (such as for example a floppy disk, a CD ROM or a DVD ROM) or not detachable, this storage medium being partially or totally readable by a computer or a processor.

Patentkrav

1. Fremgangsmåde til styring af et system til bufferlagring og sekvensering af laster, der er konfigureret til at modtage usekvenserede laster fra mindst én ekstern enhed via mindst én indgangstransportør (CE) og tilvejebringe mindst én sekvens af laster i en ønsket rækkefølge til mindst én forberedelsesstation (PP) via mindst én udgangstransportør (CS), idet systemet omfatter:
- 10 - en bufferlagringsenhed (US), der omfatter N indgangsniveauer (VE_1 til VE_N) og mindst ét recirkulationsniveau (VR), der er lodret anbragt over hinanden, hvert med en enkelt indgang og en enkelt udgang, og som hvert omfatter en transportør af typen "først ind, først ud" i en første retning for indgangsniveauerne og i en anden retning modsat den første retning for det mindst ene recirkulationsniveau, hvor $N \geq 2$, idet en last, der forefindes på det mindst ene recirkulationsniveau, kaldes last under recirkulation, og
 - en indgangselevator (EE) og en udgangselevator (ES) af alternerende og diskontinuerlig type, der henholdsvis er placeret over for indgangene til og over for udgangene fra de N indgangsniveauer og det mindst ene recirkulationsniveau, kendetegnet ved, at en styreenhed (UP) udfører en iterativ styring af indgangselevatoren, hvilket ved hver iteration omfatter de følgende trin, selv hvis der forefindes mindst én last, der skal recirkuleres i systemet:
 - detektering (201) af en første last på en udgang fra indgangstransportøren og en anden last på udgangen fra det mindst ene recirkulationsniveau
 - 30 - valg (204 til 209) af en last med følgende regler: valg (206) af den første last, hvis der ikke forefindes en anden last, eller omvendt (209); hvis den første og anden last forefindes, valg (209) af den anden last, hvis mindst én prioritetsbetingelse (207) er opfyldt, ellers valg (206) af den første last
 - 35 - valg (211) af et destinationsniveau blandt indgangsniveauerne under overholdelse af en regel, ifølge hvilken laster, der forefindes på det samme indgangsniveau, bortset fra én eller

flere eventuel(le) last(er), der skal recirkuleres, sekvenseres i stigende rækkefølge af sekvensnumre

- hvis valget af et destinationsniveau (211) lykkes, generering (217) for indgangselevatoren af en opgave med at overføre den valgte last til indgangen til det valgte destinationsniveau, 5 ellers valg (216) af et niveau, der skal recirkuleres, blandt indgangsniveauerne uden generering for indgangselevatoren af en opgave med at overføre den valgte last til indgangen til det valgte niveau, der skal recirkuleres, og tildeling til hver last 10 i det niveau, der skal recirkuleres, af en status som last, der skal recirkuleres, hvilket betyder, at lasten skal overføres til indgangen til mindst ét recirkulationsniveau ved hjælp af udgangselevatoren.

15 2. Fremgangsmåde ifølge krav 1, kendetegnet ved, at den mindst ene prioritetsbetingelse (207) tilhører gruppen omfattende:

- sekvensnummeret for den anden last er lavere end sekvensnummeret for den første last
- det mindst ene recirkulationsniveau omfatter laster under 20 cirkulation, der ikke er sekvenseret i en stigende rækkefølge af sekvensnumre
- mindst ét recirkulationsniveau er fuldt, og der er behov for et sted til at placere en last
- i systemet forefindes mindst én last, der skal recirkuleres, 25 eller som er under recirkulation, med et sekvensnummer, der er lavere end sekvensnummeret for den første last
- i systemet forefindes mindst én last, der skal recirkuleres, med et sekvensnummer, der er lavere end sekvensnummeret for den sidste last, som er placeret i det mindst ene 30 recirkulationsniveau.

3. Fremgangsmåde ifølge et hvilket som helst af kravene 1 og 2, kendetegnet ved, at den iterative styring af indgangselevatoren, hvis den anden last er valgt (209), omfatter 35 et trin (210) til at teste mindst én sorteringsbetingelse, samt ved, at:

- hvis den mindst ene sorteringsbetingelse (210) er opfyldt, udføres et trin med at sætte inputelevatoren på hold (212) i stedet for trinnet med at vælge (211) et destinationsniveau
- ellers udføres trinnet med at vælge (211) et destinationsniveau.

5

4. Fremgangsmåde ifølge krav 3, kendetegnet ved, at den mindst ene sorteringsbetingelse (210) tilhører gruppen omfattende:

- sekvensnummeret for den anden last er strengt større end sekvensnummeret for lasten på den (N.Y/k)'te plads på en liste over forventede udgange, hvor N er antallet af indgangsniveauer, Y er lastkapaciteten for hvert indgangsniveau, og $1/3 \leq k \leq 2/3$, og

- lasterne under recirkulation på det mindst ene recirkulationsniveau sekvenseres i en stigende rækkefølge af sekvensnumre.

15

5. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 4, kendetegnet ved, at trinnet med at vælge (211) et destinationsniveau omfatter:

20

- tildeling af en karakter til hvert indgangsniveau, med et sæt karakterregler, og

- valg af indgangsniveauet med den højeste karakter, samt ved, at sættet af karakterregler med henblik på at tildele en karakter til et givet indgangsniveau omfatter:

25

- initialisering af karakteren til nul

- hvis det givne indgangsniveau er mættet, reduktion af karakteren med en værdi C0

- hvis det givne indgangsniveau er tomt:

30

* hvis den valgte last er en last under recirkulation, øgning af karakteren med en værdi C1

* hvis sekvensnummeret for den valgte last er strengt større end sekvensnummeret for lasten på den (N.Y)'te plads på en liste over forventede udgange, hvor Y er lastkapaciteten for hvert indgangsniveau, og at enten det mindst ene recirkulationsniveau er tomt, eller den sidste last, der er kommet ind i det mindst ene recirkulationsniveau, har et sekvensnummer, der er mindre end eller lig med sekvensnummeret for den valgte last, øgning

35

af karakteren med en værdi C2, ellers øgning af karakteren med en værdi C3

- hvis $\text{NumDerCharge} \leq \text{NumCharge}$, hvor NumDerCharge er sekvensnummeret for den sidste last, der er blevet placeret på det givne indgangsniveau, og NumCharge er sekvensnummeret for den valgte last:

* hvis forskellen på listen over forventede udgange mellem stedet i for den første last med sekvensnummeret NumCharge og stedet j for den første last med sekvensnummeret NumDerCharge er strengt mindre end Z, hvor Z et forud fastlagt positivt heltal, øgning af karakteren med en værdi C4

* ellers øgning af karakteren med en værdi C5

- hvis den sidste last, der er blevet placeret på det givne inputniveau, er en last, der skal recirkuleres, hvis det givne indgangsniveau ikke er tomt, og hvis $\text{NumDerCharge} > \text{NumCharge}$, øgning af karakteren med en værdi C6,

hvor:

$$C1 < C3 < C2; C5 \leq C2; C5 < C4; C2 < C0; C4 < C0; C6 < C3.$$

6. Fremgangsmåde ifølge krav 5, kendetegnet ved, at:

-

$$C4 = C7 - (\text{NumCharge} - \text{NumDerCharge}) + Y;$$

og

-

$$C5 = C8 - (\text{NumCharge} - \text{NumDerCharge});$$

hvor $C7 > C8$.

7. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 6, kendetegnet ved, at hvis valget af et destinationsniveau (211) lykkes, og hvis følgende betingelser er opfyldt:

- det valgte destinationsniveau er tomt

- sekvensnummeret for den valgte last er strengt større end sekvensnummeret for lasten på den (N.Y)'te plads på en liste over forventede udgange, hvor Y er lastkapaciteten for hvert indgangsniveau, og

- enten er det mindst ene recirkulationsniveau tomt, eller også har den sidste last, der er blevet placeret på det mindst ene

recirkulationsniveau, et sekvensnummer, der er lavere end sekvensnummeret for den valgte last, så tager det valgte destinationsniveau status som et niveau, der skal recirkuleres, og den valgte last tager status som en last, 5 der skal recirkuleres for at blive overført til indgangen til mindst ét recirkulationsniveau ved hjælp af udgangselevatoren.

8. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 7, hvorved bufferlagringsenheden (US) i øvrigt omfatter et "fast track"-niveau (VQ), der er lodret anbragt over 10 indgangsniveauerne (VE_1 til VE_N) og det mindst ene recirkulationsniveau (VR), og som har en enkelt indgang og en enkelt udgang og omfatter en transportør af typen "først ind, først ud" i den første retning, 15 kendetegnet ved, at trinnet med at vælge (211) et destinationsniveau, hvis én af følgende betingelser er opfyldt, omfatter et valg af "fast track"-niveauet:

- sekvensnummeret for den valgte last er det næste sekvensnummer på en liste over forventede udgange, og
- 20 - sekvensnummeret for den valgte last er det, der forventes direkte efter sekvensnummeret for den sidste last, der er blevet placeret i "fast track"-niveauet.

9. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 25 8, kendetegnet ved, at trinnet til valg (216) af et niveau, der skal recirkuleres, omfatter:

- tildeling af en karakter til hvert indgangsniveau, undtagen det eller de fulde indgangsniveau(er), hvis sekvensnummer for den sidst placerede last er mindre end eller lig med 30 sekvensnummeret for den valgte last, med et sæt karakterregler, og
- valg af indgangsniveauet med den højeste karakter som niveau, der skal recirkuleres, samt ved, at sættet af karakterregler med henblik på at tildele 35 en karakter til et givet indgangsniveau omfatter:

- initialisering af karakteren til nul
- hvis lasterne i det givne indgangsniveau på det mindst ene recirkulationsniveau kan placeres bag lasterne under

recirkulation under overholdelse af en stigende rækkefølge af sekvensnumre, øgning af karakteren med en værdi K1

- hvis det er muligt fuldstændigt at indføre lasterne i det givne indgangsniveau på det mindst ene recirkulationsniveau igen, øgning af karakteren med en værdi K2

- hvis det givne indgangsniveau kun omfatter én last, øgning af karakteren med en værdi K3

- øgning af karakteren med sekvensnummeret for den last i det givne indgangsniveau, der er tættest på udgangselevatoren

10 - reduktion af karakteren med m gange antallet af laster på det givne indgangsniveau,
hvor $2 \leq m \leq 10$, $K1 > Y$, $K2 > Y$ og $K3 > Y$, hvor Y er lastkapaciteten for hvert indgangsniveau.

15 10. Fremgangsmåde ifølge krav 9, kendetegnet ved, at: $K1 = K2 = K3$.

11. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 10, kendetegnet ved, at den iterative styring af indgangselevatoren, hvis valget af et destinationsniveau (211) ikke lykkes, omfatter en test af følgende to betingelser:

20 - den mindst ene udgangstransportør (CS) er mættet (213), og
- en position for udtagning ved hjælp af udgangselevatoren er optaget af en last med det næste sekvensnummer på en liste over

25 forventede udgange (214),
samt ved, at trinnet til valg (216) af et niveau, der skal recirkuleres, ikke udføres, hvis de to betingelser (213, 214) er opfyldt, ellers udføres det.

30 12. Fremgangsmåde ifølge et hvilket som helst af kravene 1 til 11, kendetegnet ved, at den iterative styring af indgangselevatoren, hvis valget af et destinationsniveau (211) ikke lykkes, omfatter en test af den følgende yderligere betingelse:

35 - et forud fastlagt maksimalt antal niveau(er), der skal recirkuleres, er nået (215),

samt ved, at trinnet til valg (216) af et niveau, der skal recirkuleres, ikke udføres, hvis den yderligere betingelse (215) er opfyldt, ellers udføres det.

5 13. Fremgangsmåde ifølge krav 12, kendetegnet ved, at det forud fastlagte maksimale antal niveau(er), der skal recirkuleres, er lig med antallet N af indgangsniveauer.

14. Computerprogram, der omfatter programkodeinstruktioner til
10 udførelse af fremgangsmåden ifølge mindst ét af kravene 1 til 13, når programmet køres på en computer.

15. Ikke-flygtigt, læsbar computerlagermedium, der lagrer et computerprogramprodukt ifølge krav 14.

15

16. Styreenhed (UP) til styring af et system til bufferlagring og sekvensering af laster, der er konfigureret til at modtage usekvenserede laster fra mindst én ekstern enhed via mindst én indgangstransportør (CE) og tilvejebringe mindst én sekvens af
20 laster i en ønsket rækkefølge til mindst én forberedelsesstation (PP) via mindst én udgangstransportør (CS), idet systemet omfatter:

- en bufferlagringsenhed (US), der omfatter N indgangsniveauer (VE₁ til VE_N) og mindst ét recirkulationsniveau (VR), der er
25 lodret anbragt over hinanden, hvert med en enkelt indgang og en enkelt udgang, og som hvert omfatter en transportør af typen "først ind, først ud" i en første retning for indgangsniveauerne og i en anden retning modsat den første retning for det mindst ene recirkulationsniveau, hvor $N \geq 2$, idet en last, der
30 forefindes på det mindst ene recirkulationsniveau, kaldes last under recirkulation, og

- en indgangselevator (EE) og en udgangselevator (ES) af alternerende og diskontinuerlig type, der henholdsvis er placeret over for indgangene til og over for udgangene fra de N
35 indgangsniveauer og det mindst ene recirkulationsniveau, kendetegnet ved, at styreenheden (UP) er konfigureret til at udføre en iterativ styring af indgangselevator ifølge

fremgangsmåden til styring ifølge et hvilket som helst af kravene 1 til 13.

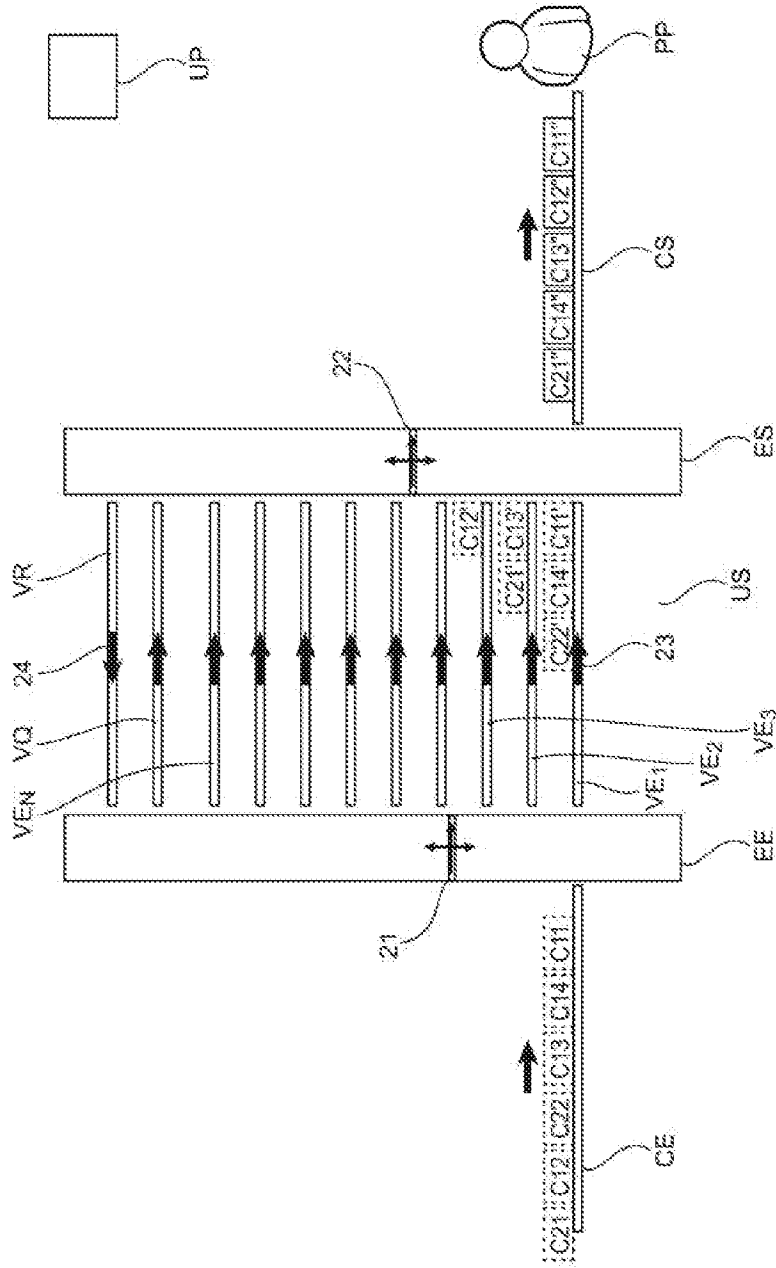


Fig. 1

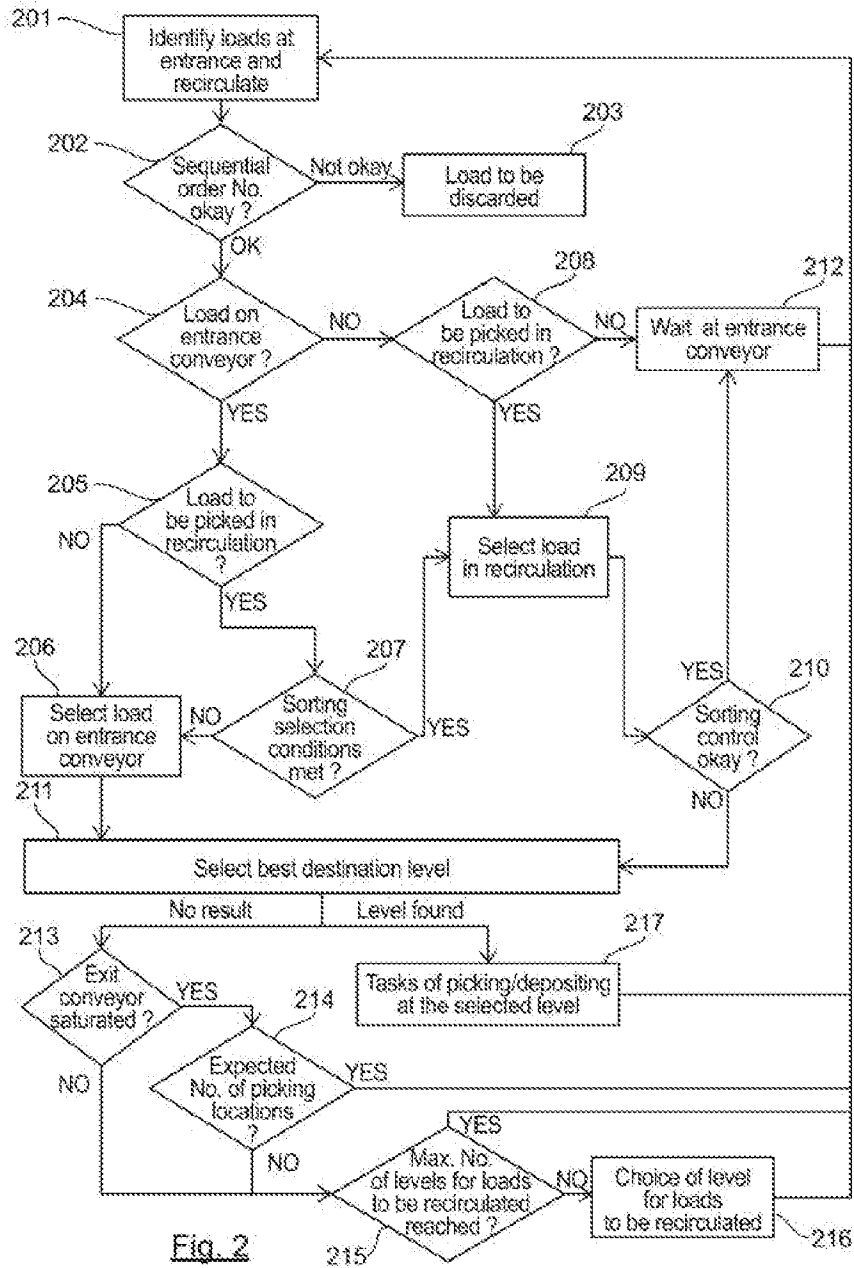


Fig. 2

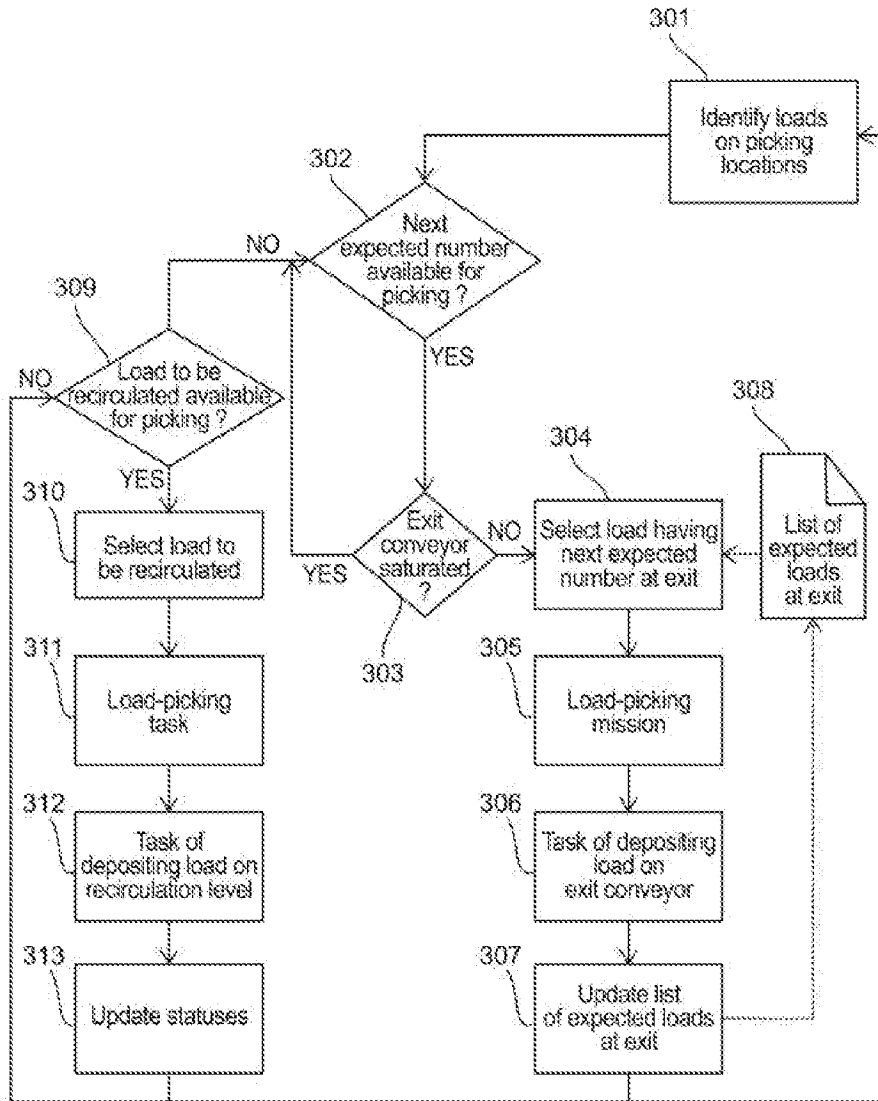


Fig. 3

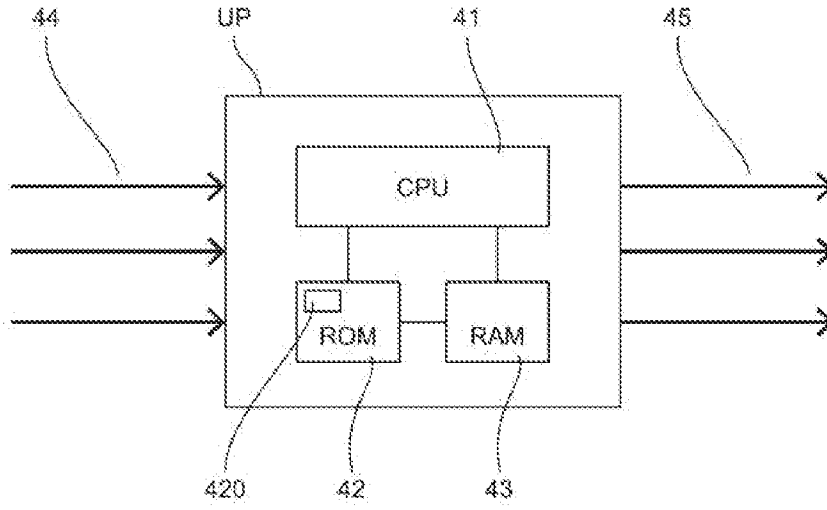


Fig. 4