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(54) **Title:** AUTOMATIC SORTING AND PACKAGING IN SHIPPING ORDER FULFILMENT FOR GYPSUM WALLBOARDS

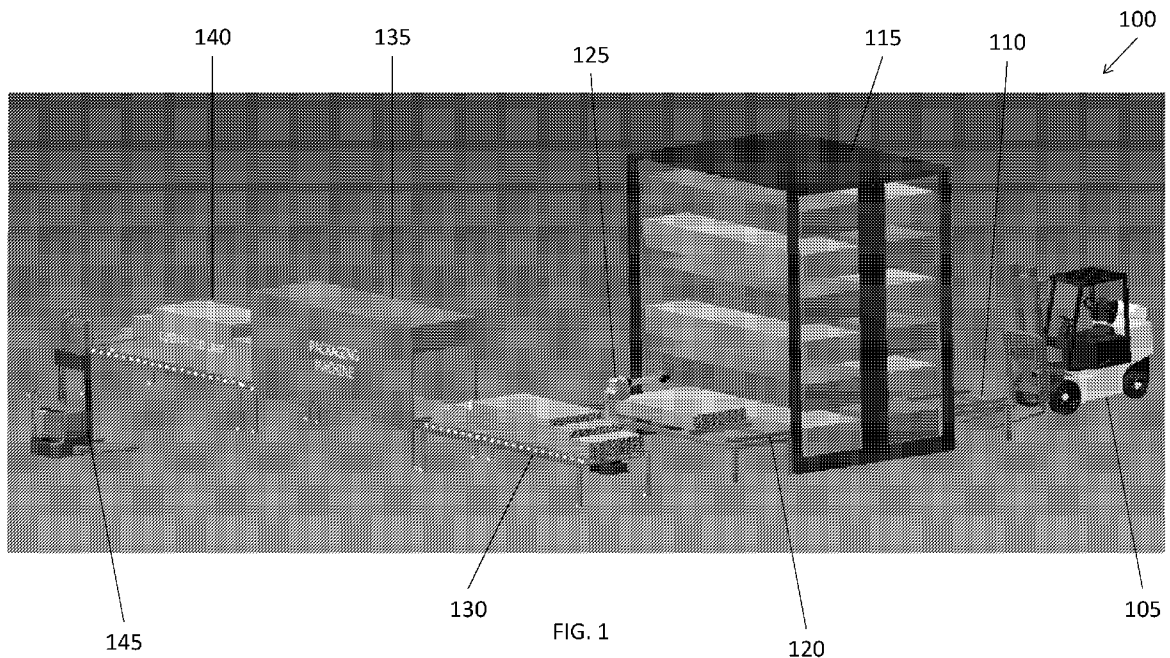


FIG. 1

(57) **Abstract:** A unit maker is described. The unit maker includes a processor for coordinating retrieval and packaging of building panels, such as wallboard. Also include in the unit maker is an automatic storage and retrieval system ("SRS") for storing wallboard of varying sizes in communication with the processor and a board sorting table in communication with the processor. The unit maker includes a robot, in communication with the processor, for retrieving the wallboard from the SRS and delivering the retrieved wallboard to the board sorting table and a packaging machine for receiving retrieved wallboard from the board sorting table and packaging the wallboard.



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**AUTOMATIC SORTING AND PACKAGING IN SHIPPING ORDER
FULFILMENT FOR GYPSUM WALLBOARDS**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to US Provisional Patent Application No. 62/907,121, filed on September 27, 2019, which is incorporated herein by reference in its entirety.

BACKGROUND

[0002] present invention relates to production machinery and collater, and more specifically, to a unit maker for building panels, particularly gypsum wallboard.

[0003] Building panels having a core of set gypsum sandwiched between two sheets of facing paper have long been used as structural members in the fabrication of buildings. Such panels are typically used to form the partitions or walls of rooms, elevator shafts, stairwells, ceilings, exterior surfaces, roofing and the like. Depending on the application, building professionals and distributors of building supplies have need of panels in different sizes as provided by the manufacturer. When an order is placed with the manufacturer for panels, such as gypsum wallboard, sheathing or roofing of different sizes (“a unit”), a conventional approach to the preparation of the gypsum wallboard package for shipment includes manual handling/collating and unit creation, which is labor- and time-intensive.

SUMMARY

[0004] Embodiments of the present invention are directed to a unit maker. The unit maker includes a processor for coordinating retrieval and packaging of panels, such as gypsum wallboard, sheathing and roofing. Also included in the unit maker is an automated storage and retrieval system (“SRS”) for storing panels of varying sizes in communication with the processor and a board sorting table in communication with the processor. The

unit maker includes a robot, in communication with the processor, for retrieving the panel from the SRS and delivering the retrieved panel to the panel sorting table and a packaging machine for receiving retrieved panel from the panel sorting table and packaging the panel.

[0005] Embodiments of the present invention are directed to a computer-controlled method of assembling building panels, including gypsum wallboard, sheathing and roofing, including receiving, by a processor, an order for a custom package comprising, for example, large wallboard and small wallboard and sorting, by the processor, the order for the custom package from large wallboard to small wallboard; The method retrieves the large wallboard from an automatic vertical storage and retrieval system, retrieves the small wallboard from the SRS, and packages the retrieved small wallboard and the retrieved large wallboard.

[0006] Embodiments of the invention provide a system for creating a unit of building panel, such as wallboard and sheathing and roofing panels. The system includes a memory communicatively coupled to the processor, the memory having stored therein instructions that when executed cause the processor to receive an order for a custom package comprising, for example, large wallboard and small wallboard and sort the order for the custom package from large wallboard to small wallboard. The instructions cause the processor to retrieve the large wallboard from an automatic vertical storage and retrieval system (“SRS”), retrieve the small wallboard from the SRS, and package the retrieved small wallboard and the retrieved large wallboard.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 depicts an exemplary embodiment of the unit maker consistent with the present invention;

[0008] FIG. 2 depicts a high-level block diagram computer system 200, which can be used to implement one or more aspects of the present invention; and

[0009] FIG. 3 depicts a flow chart of a method of building a packaged customized unit consistent with embodiments of the present invention.

DETAILED DESCRIPTION

[0010] FIG. 1 depicts an exemplary embodiment of the unit maker 100 consistent with the present invention. After the building panel is manufactured, building panels of the same size can be transported from the assembly line to a storage area using mobilized equipment 105. The building panel is stored in storage locations according to size, with similar size being stored together. The mobilized equipment 105 can be a forklift, an automatic guided vehicle (AGV), or a mobile lift jack, for example. The mobilized equipment 105 can further place the building panel on a board loading table 110. The board loading table 110 is located adjacent to an automatic vertical storage and retrieval system (“SRS”) 115. The board loading table typically has rollers.

[0011] The SRS 115 includes storage trays for storing building panels. The building panels can be, for example, gypsum wallboard. The SRS 115 has a plurality of storage locations. An extractor device moves vertically along the SRS 115 to deliver the building panel to a storage location for storage or for removing building panel from a storage location to a board outfeed table 120. A control system (not shown), such as a programmable logic controller (“PLC”) or distributed control system (“DCS”) serves as an interface between an operator and the SRS 115. An exemplary SRS is the KARDEX REMSTAR TOWERMAT.

[0012] The building panels can be a with a substrate that includes one or more materials or fibers. Non-limiting examples of suitable materials for the wallboard include foam, glass, carbon, lignocellulose (also termed lignocellulosic materials), polymers (e.g., polyolefins (such as polypropylene and polyethylene) and polystyrenes), foamboard (e.g., polyisocyanurates), gypsum, metals, cement, or any combination thereof. The wallboard may be a lignocellulose composite panel including engineered wood products. Engineered wood products include a plurality of substrates composed of wood and/or lignocellulose materials and one or more adhesives to bind, couple, bond, affix, or otherwise join the

plurality of materials to one another to form the engineered wood product. Non-limiting illustrative examples of engineered wood products include particleboard, fiberboard (*e.g.*, medium density fiberboard (MDF) and high-density fiberboard (HDF)), wafer board, oriented strand board (OSB), plywood, laminated veneer lumber (LVL), laminated veneer boards (LVB), engineered wood flooring, and the like. The wallboard may include one or more layers.

[0013] The unit maker 100 includes a robotic arm 125 for transferring the building panel from the board outfeed table 120 of the SRS 115 and transferring the building panel to a board sorting table 130. The robotic arm may be manufactured by FANUC, for example.

[0014] If a requested customized unit, such as packaged customized unit 140, includes more than one size of building panel, the process is repeated until all of the building panel units are on the sorted board table 130. In an exemplary embodiment, the building panel units are stacked so that the building panel having the largest dimensions is on the bottom of the stack and the building panel having the smallest dimensions is on the top of the stack, but the systems and the methods of the disclosure are not so limited. The sorted board table 130 can be any table known in the art.

[0015] From the sorted board table 130, the stack of building panels on the sorted board table 130 are transferred to a packing machine 135. The packing machine 135 packages the packaged customized unit 140, after which the packaged customized unit 140 is delivered by mobile equipment 145. Neither mobile equipment 105 nor mobile equipment 145 forms a part of unit maker 100, but, rather, are used to feed and deliver, respectively, building panel and customized units 140 to and from the unit maker 100.

[0016] A computer, DCS, or PLC (not shown) is used to control integration of the pieces of equipment that comprise unit maker 100. The computer, DCS, or PLC that controls the unit maker 100 may be the same computer, DCS, or PLC that controls the SRS 115.

[0017] FIG. 2 depicts a high-level block diagram computer system 200, which can be used to implement one or more aspects of the present invention. More specifically, computer system 200 can be used to implement some hardware components of embodiments of the present invention. Although one exemplary computer system 200 is

shown, computer system 200 includes a communication path 255, which connects computer system 200 to additional systems (not depicted) and can include one or more wide area networks (WANs) and/or local area networks (LANs) such as the Internet, intranet(s), and/or wireless communication network(s). Computer system 200 and additional system are in communication via communication path 255, e.g., to communicate data between them.

[0018] Computer system 200 includes one or more processors, such as processor 205. Processor 205 is connected to a communication infrastructure 260 (e.g., a communications bus, cross-over bar, or network). Computer system 200 can include a display interface 215 that forwards graphics, text, and other data from communication infrastructure 260 (or from a frame buffer not shown) for display on a display unit 225. Computer system 200 also includes a main memory 210, preferably random access memory (RAM), and can also include a secondary memory 265. Secondary memory 265 can include, for example, a hard disk drive 220 and/or a removable storage drive 230, representing, for example, a floppy disk drive, a magnetic tape drive, or an optical disk drive. Removable storage drive 230 reads from and/or writes to a removable storage unit 240 in a manner well known to those having ordinary skill in the art. Removable storage unit 240 represents, for example, a floppy disk, a compact disc, a magnetic tape, or an optical disk, etc. which is read by and written to by removable storage drive 230. As will be appreciated, removable storage unit 240 includes a computer readable medium having stored therein computer software and/or data.

[0019] In alternative embodiments, secondary memory 265 can include other similar means for allowing computer programs or other instructions to be loaded into the computer system. Such means can include, for example, a removable storage unit 245 and an interface 235. Examples of such means can include a program package and package interface (such as that found in video game devices), a removable memory chip (such as an EPROM, or PROM) and associated socket, and other removable storage units 245 and interfaces 235 which allow software and data to be transferred from the removable storage unit 245 to computer system 200.

[0020] Computer system 200 can also include a communications interface 250. Communications interface 250 allows software and data to be transferred between the computer system and external devices. Examples of communications interface 250 can include a modem, a network interface (such as an Ethernet card), a communications port, or a PCM-CIA slot and card, etcetera. Software and data transferred via communications interface 250 are in the form of signals which can be, for example, electronic, electromagnetic, optical, or other signals capable of being received by communications interface 250. These signals are provided to communications interface 250 via communication path (i.e., channel) 255. Communication path 255 carries signals and can be implemented using wire or cable, fiber optics, a phone line, a cellular phone link, an RF link, and/or other communications channels.

[0021] In the present description, the terms “computer program medium,” “computer usable medium,” and “computer readable medium” are used to generally refer to media such as main memory 210 and secondary memory 265, removable storage drive 230, and a hard disk installed in hard disk drive 220. Computer programs (also called computer control logic) are stored in main memory 210 and/or secondary memory 265. Computer programs can also be received via communications interface 250. Such computer programs, when run, enable the computer system to perform the features of the present invention as discussed herein. In particular, the computer programs, when run, enable processor 205 to perform the features of the computer system. Accordingly, such computer programs represent controllers of the computer system.

[0022] FIG. 3 depicts a flow chart of a method of building a packaged customized unit consistent with embodiments of the present invention. An order is received, by processor 205, for a customized unit of building panel (block 310). The customized unit is typically of varying sizes of building panel. The building panel sizes can vary by length, width, height, thickness, or a combination thereof. The processor 305 sorts the sizes of building panel in the customized unit order by size, from largest to smallest (block 320). The processor sets the initial size building panel to retrieve at the largest size in the order (block

330). The unit maker 100 will act to retrieve the building panel of the selected size from the SRS 115 to the board sorting table 130 (block 340).

[0023] Retrieval 340 performs its function through a number of sub-blocks. Initially, the SRS 115 takes all board of the requested size and moves it to the board outfeed table 120. The robotic arm 125 takes the building panel from the board outfeed table 120 and moves it to the board sorting table 130.

[0024] Next, a check is made to determine if there is more building panel of another (smaller) size needed (block 350). If so, the next smallest size building panel ordered is selected (block 360), and flow continues to block 340 where the next smallest size building panel is retrieved as previously discussed. If not, processor 205 instructs that the customized unit be packaged by packaging machine 135 (block 370). Finally, the customized unit is delivered via instruction from processor 205 (block 380).

[0025] “Combinations” is inclusive of blends, mixtures, alloys, reaction products, and the like. The terms “first,” “second,” and the like, do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The terms “a” and “an” and “the” do not denote a limitation of quantity and are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. “Or” means “and/or” unless clearly stated otherwise. Reference throughout the specification to “some embodiments”, “an embodiment”, and so forth, means that a particular element described in connection with the embodiment is included in at least one embodiment described herein, and may or may not be present in other embodiments. In addition, it is to be understood that the described elements may be combined in any suitable manner in the various embodiments. A “combination thereof” is open and includes any combination comprising at least one of the listed components or properties optionally together with a like or equivalent component or property not listed

[0026] Unless specified to the contrary herein, all test standards are the most recent standard in effect as of the filing date of this application, or, if priority is claimed, the filing date of the earliest priority application in which the test standard appears.

[0027] Unless defined otherwise, technical and scientific terms used herein have the same meaning as is commonly understood by one of skill in the art to which this application belongs. All cited patents, patent applications, and other references are incorporated herein by reference in their entirety. However, if a term in the present application contradicts or conflicts with a term in the incorporated reference, the term from the present application takes precedence over the conflicting term from the incorporated reference.

[0028] While particular embodiments have been described, alternatives, modifications, variations, improvements, and substantial equivalents that are or may be presently unforeseen may arise to applicants or others skilled in the art. Accordingly, the appended claims as filed and as they may be amended are intended to embrace all such alternatives, modifications variations, improvements, and substantial equivalents.

CLAIMS

What is claimed is:

1. A unit maker, comprising:
 - a processor for coordinating retrieval and packaging of building panel;
 - an automatic storage and retrieval system (“SRS”) for storing building panel of varying sizes in communication with the processor;
 - a board sorting table in communication with the processor;
 - a robot, in communication with the processor, for retrieving the building panel from the SRS and delivering the retrieved building panel to the board sorting table; and
 - a packaging machine for receiving retrieved building panel from the board sorting table and packaging the building panel.
2. The unit maker of claim 1, further comprising a first mobilized equipment for loading the building panel onto the SRS.
3. The unit maker of claim 1, further comprising a second mobilized equipment for retrieving the packaged building panel from the packaging machine.
4. The unit maker of claim 1, wherein the SRS comprises a board outfeed table.
5. The unit maker of claim 1, wherein the SRS comprises a second processor.
6. The unit maker of claim 5, wherein the second processor comprises a distributed control system.
7. The unit maker of claim 5, wherein the second processor comprises a programmable logic controller.

8. A computer-controlled method of assembling building panel, comprising:
 - receiving, by a processor, an order for a custom package comprising large building panel and small building panel;
 - sorting, by the processor, the order for the custom package from large building panel to small building panel;
 - retrieving the large building panel from an automatic storage and retrieval system (“SRS”);
 - retrieving the small building panel from the SRS; and
 - packaging the retrieved small building panel and the retrieved large building panel.
9. The method of claim 8, further comprising receiving the large building panel in the SRS.
10. The method of claim 8, further comprising shipping the packaged small building panel and large building panel.
11. The method of claim 8, wherein retrieving the large building panel further comprises placing the large building panel on a board sorting table.
12. The method of claim 11, wherein retrieving the small building panel further comprises placing the small building panel on a board sorting table.
13. The method of claim 12, wherein the small building panel is placed on the large building panel on the board sorting table.
14. The method of claim 8, wherein packaging the retrieved small building panel and retrieved large building panel comprises wrapping the building panel in packaging.

15. A system for creating a unit of building panel comprising:

a processor;

a memory communicatively coupled to the processor, the memory having stored therein instructions that when executed cause the processor to:

receive an order for a custom package comprising large building panel and small building panel;

sort the order for the custom package from large building panel to small building panel;

retrieve the large building panel from an automatic storage and retrieval system (“SRS”);

retrieve the small building panel from the SRS; and

package the retrieved small building panel and the retrieved large building panel.

16. The system of claim 15, further comprising instructions that when executed cause the processor to receive the large building panel in the SRS.

17. The system of claim 15, further comprising instructions that when executed cause the processor to ship the packaged small building panel and large building panel.

18. The system of claim 15, further comprising instructions that when executed cause the processor to place the large building panel on a board sorting table.

19. The system of claim 18, further comprising instructions that when executed cause the processor to retrieve the small building panel further comprises placing the small building panel on a board sorting table.

20. The system of claim 19, wherein the small building panel is placed on the large building panel on the board sorting table.

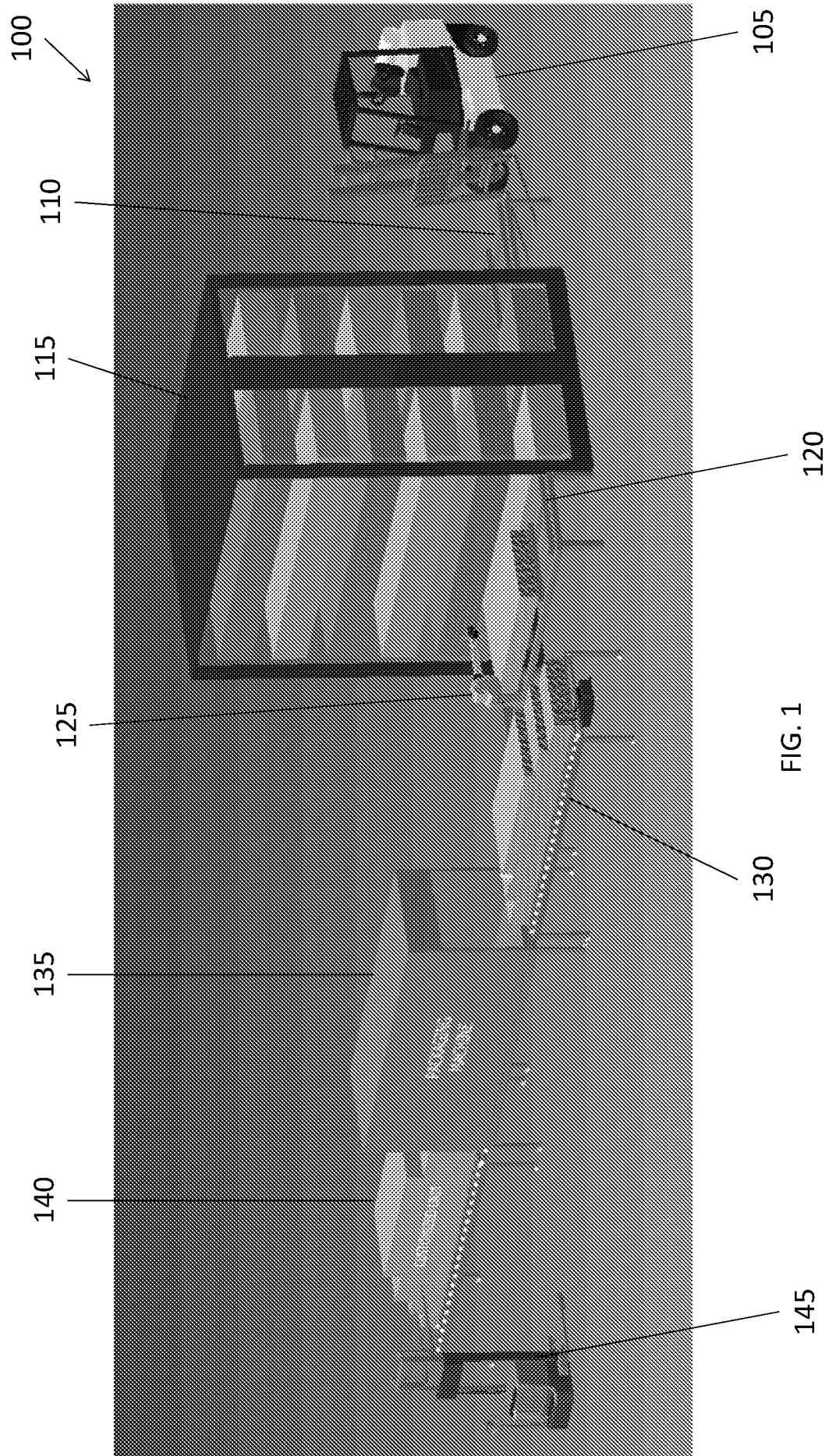


FIG. 1

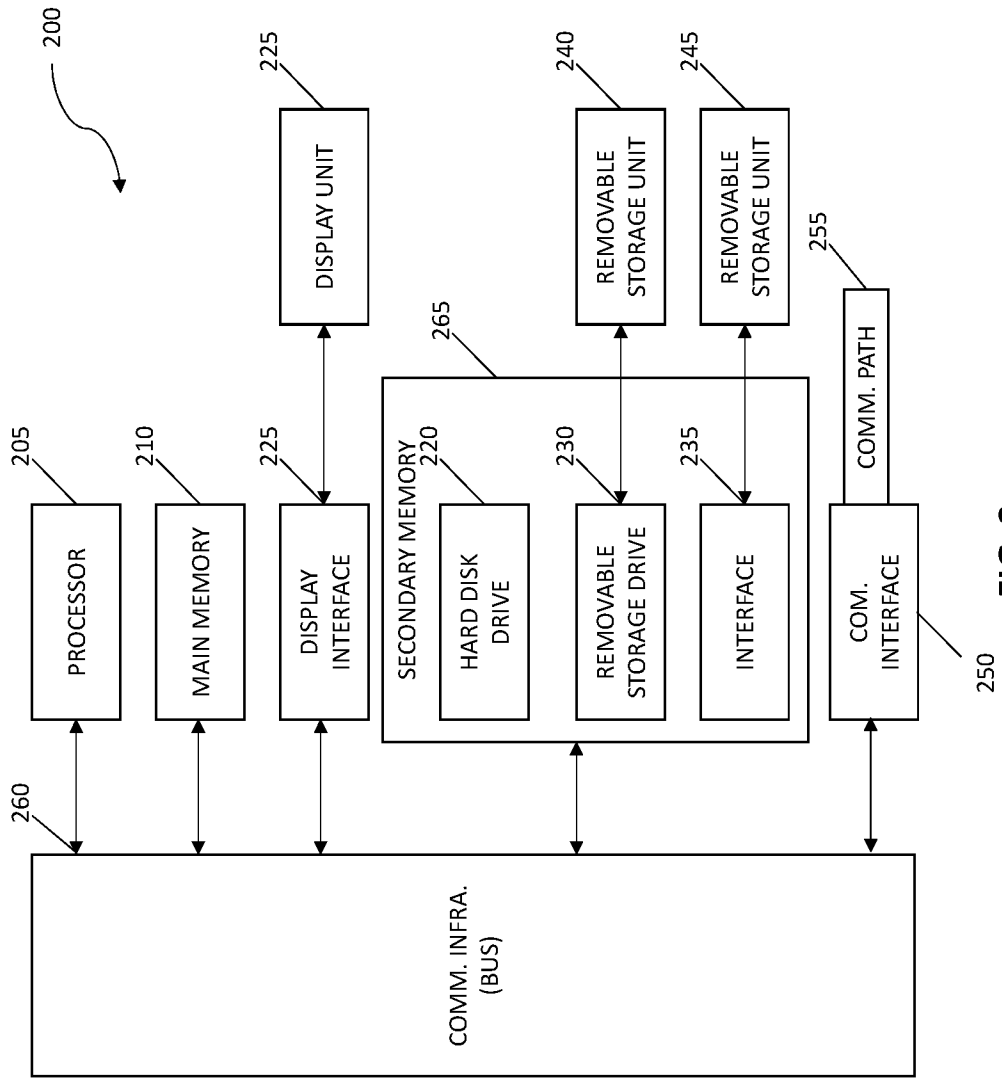


FIG. 2

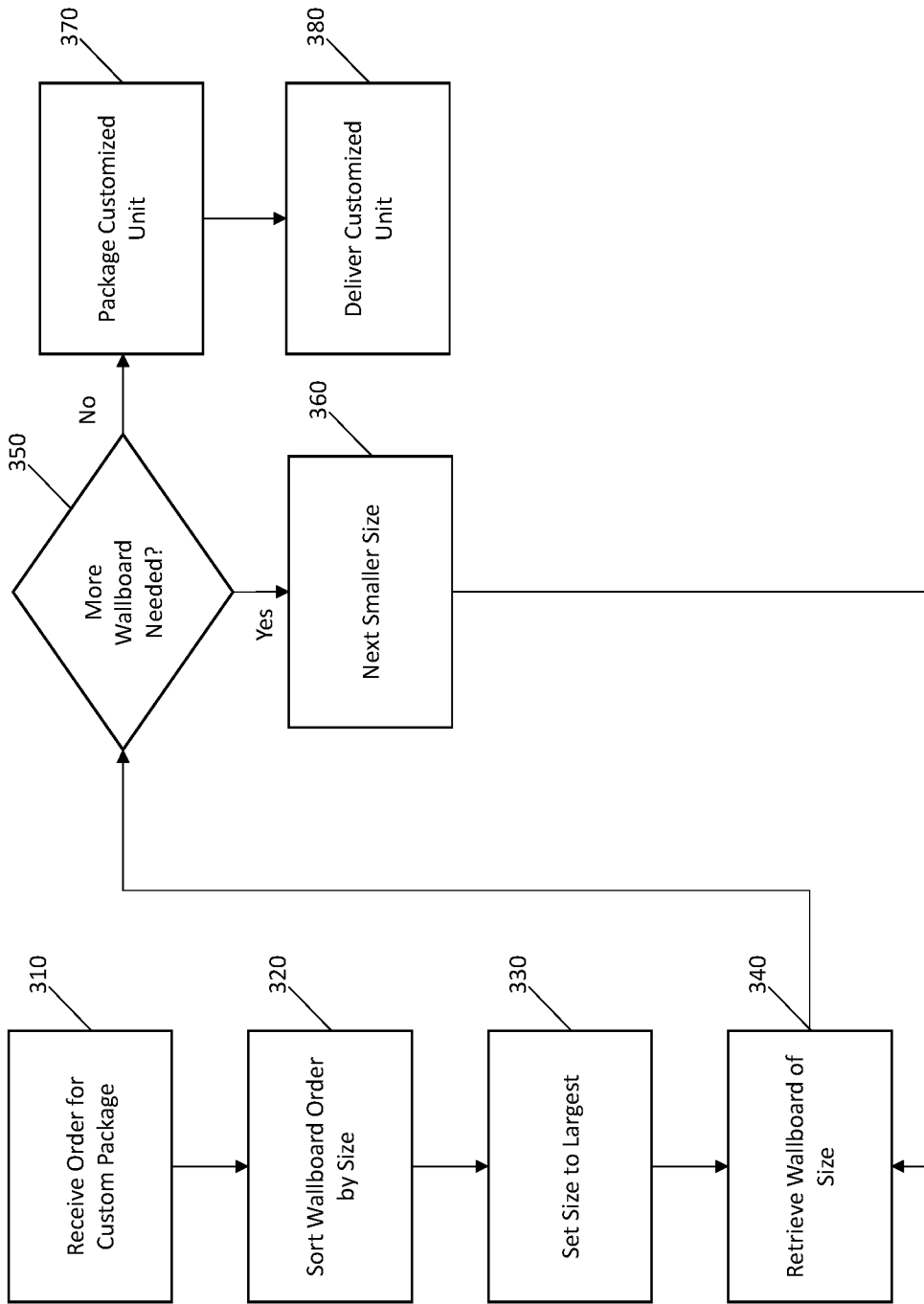


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No PCT/US2020/052597

A. CLASSIFICATION OF SUBJECT MATTER INV. G05B19/418 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G05B B29C G06Q B65B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2018/186572 A1 (ISSING ELMAR [DE]) 5 July 2018 (2018-07-05) the whole document -----	1-20
X	US 2018/137459 A1 (JACOBS JEFFREY M [US] ET AL) 17 May 2018 (2018-05-17) paragraphs [0006], [0023] - [0029], [0035]; figures 1-4 -----	1-20
X	US 2018/215543 A1 (LERT JR JOHN G [US] ET AL) 2 August 2018 (2018-08-02) paragraphs [0002], [0013], [0014], [0019], [0024]; figures 1-3, 7 -----	1-20
X	US 2011/295413 A1 (HARA YUSUKE [JP] ET AL) 1 December 2011 (2011-12-01) paragraphs [0014], [0029]; figures 1-3, 4B, 8 -----	1-20
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "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	
3 December 2020	11/12/2020	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Itoafa, Alex	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2020/052597

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