ABSTRACT

A system is disclosed for loading cases with items comprising: an item delivery apparatus operable to deliver a plurality of items to a transfer station; a collation platform operable to support a group of items; a pedestal apparatus operable to support the group of items; a first transfer apparatus operable to transfer a plurality of items from the item delivery apparatus to the collation platform. A second transfer apparatus transfers the group of items from the collation platform to the pedestal apparatus. At least one movement rod moves the group of items. A case movement apparatus such as a six-axis robotic arm is moves an erected case in a path that sheaths a group of items located on said pedestal apparatus with an erected case. The path of the case may have a tilted position and include an arced pivoting movement.

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METHOD AND APPARATUS LOADING OF CASES WITH ITEMS

FIELD

[0001] The present invention relates generally to methods and systems for the loading of items into cases.

BACKGROUND

[0002] Containers are used to package many different kinds of items. One form of container used in the packaging industry is what is known generically as a “box” and it can be used to hold various items including products and sometimes other boxes containing products. Some in the packaging industry refer to boxes used to package one or more products as "cartons". Also, there are containers/boxes that are known by some as “cases”. Examples of cases include what are known as regular slotted cases (“RSC”). In this patent document, including the claims, the words “cases”, "cartons" and “containers” are used collectively and interchangeably to refer to boxes, cartons, and/or cases that can be used to package items.

[0003] Cases come in many different configurations and are made from a wide variety of materials. However, many cases are foldable and are formed from a flattened state - commonly called a case blank. Cases may be made from an assortment of foldable materials, including but not limited to cardboard, chipboard, paperboard, corrugated fibreboard, other types of corrugated materials, plastic materials, composite materials, and the like and possibly even combinations thereof.

[0004] In many known systems, case blanks may be serially retrieved from a magazine, and reconfigured from a flattened state into an erected state, and then placed in a slot on a conveyor. The erected case may then be moved by the conveyor to a loading station where the case may be filled with one or more items and then sealed.

[0005] To permit the blanks to be readily opened up into an erected state from a flattened state, the blanks may be held in the magazine in a generally completely flattened configuration and then can be folded and sealed such as by gluing or taping panels and/or flaps together to form an erected case. Specialized apparatus that can handle only flat, unfolded and unsealed blanks for cases are known.

[0006] Some blanks are provided to users not in a flat, unfolded and unsealed form, but rather in what is known as a “knock-down” blank or “KD”. A KD blank may be provided in a folded and flattened

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configuration and be partially glued or otherwise partially sealed such as along one side seam thus being formed in a generally flattened tubular shape. Accordingly, each case blank may require opposite panels to be pulled apart and reconfigured from a flattened tubular configuration to an erected. open tubular or sleeve-like configuration that is suitable for delivery to another system such as a conveyor. The blank may then have one side opening closed by folding and sealing the flaps, and may then be filled from the opposite side with one or more items while on the conveyor ('side loading'). Also, any required additional flap folding and sealing such as with glue or tape can be carried out to enclose and completely close and seal the case with one or more items contained therein. Alternately, for example, an erected blank can be reoriented from a side orientation to an upright orientation with the opening facing upwards and a having a sealed bottom end. The erected case can then be moved to a loading system where it may be filled from its top side with one or more items via an opening that is facing upwards ('top loading'). The items may be top loaded using, at least in part, gravity to "drop" the item into the erected, bottom sealed case. The top opening of the case can then be closed by folding over and sealing the top flaps.

[0007] However, in some situations, it is not desirable to top load or side load items into an erected carton/case. For example, where the size and shape of items to be loaded are narrow or tapered on the top and sides. This can present a challenge for the automated loading of items. For example, an electromechanical system may have challenges to lift and adjust a group of several items as a result of the shape of the items. Also, top loading items into a tightly fitting interior space area of an open top case can be challenging. Furthermore, some items such as glass or plastic bottles are particularly susceptible to being damaged or broken when being top loaded into an erected carton/case, particularly when they are "drop packed" into an erected case.

[0008] In some situations, it would be desirable to be able "bottom load" a carton/case. In a such a bottom loading operation, there is relative upward movement of one or more items through a case opening that is oriented/facing in a downward direction. However, there are significant challenges in bottom loading of case, such as for example the difficulty of closing the bottom flaps when items are otherwise supported within the interior storage space of an erected carton/case. Accordingly, improved methods and systems are desirable for the loading of one or more items through an opening of a case.

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SUMMARY

[0009] According to one aspect there is provided a system of loading cases with items, the system comprising: an item delivery apparatus operable to deliver a plurality of items to a transfer station; a collation platform operable to support a group of items; a pedestal apparatus operable to support the group of items; a first transfer apparatus operable to transfer a plurality of items from said item delivery apparatus at said transfer station, to said collation platform, to form the group of items on said collation platform; a second transfer apparatus operable to transfer the group of items from said collation platform to said pedestal apparatus; at least one movement rod operable to be driven in longitudinal movement by a rod movement drive apparatus; a case movement apparatus located proximate said pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a group of items located on said pedestal apparatus with an erected case; wherein in operation: (a) said item delivery apparatus delivers a plurality of items to said transfer station; (b) said first transfer apparatus transfers a plurality of items from said item delivery apparatus at said transfer station, to said collation platform, to form a group of items on said collation platform; (c) said second transfer apparatus transfers said group of items from said collation platform to said pedestal apparatus; (d) said at least one movement rod engages said group of items and moves said group of items to a loading position on said pedestal apparatus; (e) said at least one movement rod dis-engages from said group of items said group of items at said loading position on said pedestal apparatus; and (f) said case movement apparatus moves an erected case to sheath said group of items located at said loading position on said pedestal apparatus.

[0010] According to another aspect there is provided a system of loading cases with items, the system comprising: a case movement apparatus located proximate a pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a plurality of items located on said pedestal apparatus with an erected case; wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable to engage with, and release, a case; wherein said plurality of items are each supported on a base portion in a generally vertically upright orientation, and wherein end effector is operable to move said erected case in a path to sheath said plurality of items, said path having a tilted path position in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

[0011] According to another aspect there is provided a system of loading cases with items, the system comprising: longitudinally spaced first and second movement members operable to be driven in

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longitudinal movement by a movement drive apparatus; a case movement apparatus located proximate a pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a group of items located on said pedestal apparatus with an erected case; wherein in operation: (a) said first and second movement members, engage said group of items and move said group of items to a loading position on said pedestal apparatus; (b) said first and second movement members, dis-engage from said group of items when said group of items are at said loading position on said pedestal apparatus; (c) said case movement apparatus moves an erected case to sheath said group of items located at said loading position on said pedestal apparatus.

[0012] According to another aspect there is provided a method of loading cases with items comprising: (a) delivering a plurality of items to said transfer station; (b) transferring a plurality of items at said transfer station, to a collation platform, to form a group of items on said collation platform; (c) transferring said group of items from said collation platform to a pedestal apparatus; (d) engaging said group of items with transversely oriented trailing and leading movement rods and moving said group of items longitudinally to a loading position on said pedestal apparatus; (e) dis-engaging said leading and trailing movement rods from said group of items while said group of items are at said loading position on said pedestal apparatus; (f) sheathing said group of items located at said loading position on said pedestal apparatus with an erected case.

[0013] According to another aspect there is provided a method of loading cases with items, the method comprising: moving an erected case with a case movement apparatus in a path that sheaths a plurality of items located on a pedestal apparatus with an erected case; wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable to engage with, and release, a case; wherein said plurality of items are each supported on a base portion in a generally vertically upright orientation; and wherein said end effector moves said erected case in a path to sheath said plurality of items, said path having a tilted path portion in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

[0014] Other aspects and features will become apparent to those of ordinary skill in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the figures which illustrate example embodiments,

[0016] FIG. **1** is a perspective view of a system for loading erected cases with one or more items and closing and sealing the top and bottom ends of loaded cases;

[0017] FIG. **2** is a block diagram illustrating computer components used to manage the system of FIG. **1**;

[0018] FIG. **3A** and **3B** are top and perspective views of an example a non-erected case that can be used in the system of FIG. **1;**

[0019] FIG. **3C** is a perspective view of the case of FIGS. **3**A and **3**B, in an erected configuration;

[0020] FIG. **4** is an upper perspective view of the item transfer area and item collation area of the system of FIG. **1**, in a first operational configuration;

[0021] FIG. **5** is a perspective view of the areas of FIG. **4** in a second operational configuration;

[0022] FIG. **6** is a perspective view of the areas of FIG. **4** in a third operational configuration;

[0023] FIG. **7** is a is a perspective view of the areas of FIG. **4** in a fourth operational configuration;

[0024] FIG. **7A** is a schematic side view showing a cycle of movement of some components of the system of FIG. **1**;

[0025] FIG. **8** is a perspective view of the areas of FIG. **4** in a fifth operational configuration;

[0026] FIG. **9** is a perspective view of the item collation area, moving rod sub-system and pedestal apparatus components of the system of FIG. **1**, in a first operational configuration;

[0027] FIG. **9A**, **9B**, **9C** are perspective, side and top views respectively of the moving rod sub-system forming part of the system of FIG. **1**;

[0028] FIG. **10** an upper perspective view of the item collation area, moving rod sub-system and pedestal apparatus components of FIG. **9**, in a second operational configuration;

[0029] FIG. **11** is an enlarged perspective view of a robotic arm and some components of the pedestal apparatus, moving rod sub-system, forming part of the system of FIG. **1**, showing a case in a substantially flattened configuration;

[0030] FIG. **11A** is an enlarged perspective view of the robotic arm of system of FIG. **1** substantially in isolation;

[0031] FIG. **12** is an enlarged perspective view of a robotic arm and some components of the pedestal apparatus, moving rod sub-system, forming part of the system of FIG. **1**, showing a case in a partially erected configuration;

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[0032] FIG. **13** is an enlarged perspective view of a robotic arm and some components of the pedestal apparatus, moving rod sub-system, forming part of the system of FIG. **1**, showing a case in a fully erected configuration;

[0033] FIG. **14** is the robotic arm of FIG. **11** and some components of the system of FIG. **1** in a loading commencement operational position;

[0034] FIG. **15** is an end view of the robotic arm of FIG. **14**;

[0035] FIG. **16** is the robotic arm of FIG. **11** in a fully loaded operational position;

[0036] FIG. **17** is a side perspective view of the item collation area, moving rod sub-system and pedestal apparatus components of the system of FIG. **1**, with some components removed for clarity, and in a first operational configuration;

[0037] FIG. **18** is a perspective view of platforms and supporting components of FIG. **17** forming part of the pedestal apparatus of FIG. **10**;

[0038] FIG. **19** is a schematic perspective view of the platforms of FIG. **18**, showing various positions of a loaded case across during movement across the platforms of FIG. **18**;

[0039] FIG. **20** is an upper side perspective view of the moving rod sub-system, pedestal apparatus components and an output conveyor, forming part of the system of FIG. **1**, with some components removed for clarity, and in a first operational configuration.

[0040] FIG. **21** an upper side perspective view of the moving rod sub-system, pedestal apparatus components and an output conveyor, of FIG. **20**;

[0041] FIG. **22** is a lower side perspective view of the moving rod sub-system, pedestal apparatus components and an output conveyor, of FIG. **21**;

[0042] FIG. **23** is a flow chart diagram illustrating an example method of filling a case with items and closing and sealing the top and bottom ends of the case; and

[0043] FIGS. **24A, 24B** and **24C** are side perspective views showing a case loading sequence.

DETAILED DESCRIPTION

System Overview

[0044] With reference to FIG. **1**, in overview, a system **100** operable for loading items **102** into cases formed from case blanks **111**A is illustrated. Individual items **102** may be singular units of a manufactured product, which may be delivered to system **100** from a separate manufacturing facility or from another source. Items **102** may include a rigid body may have interior cavity that may hold a

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substance. For example, individual items **102** may be individual glass or plastic bottles containing a liquid such as a beverage (e.g. bottles of wine or beer) or individual bottles or other rigid containers holding another material or substance such as a liquid like, for example, laundry detergent. Items **102** may alternatively be paperboard or composite cartons (such as cartons of juice or milk) or metal, paperboard or composite cans of a product such as cans of a food, or cans of spray paint. Items **102** may be a rigid item (or semi-rigid) and may be an item it is desired to be collated and/or bottom-loaded into an interior storage space **107** defined by the interior surfaces of panels A-D of an erected case **111**C (FIG. **3**). Typically, each item **102** loaded into an erected case **111C** using system **100** will be stable and self-supporting, at least when formed into a group **122** (FIG. **4**) of items. Each item **102** may be self-supporting on a base portion. Items **102** may not be a type of container containing a substance, but rather some other self-supporting rigid or semi-rigid item to be loaded into a case. In embodiments, items **102** may be self-supporting and stable only when formed into a collated group **122** of items.

[0045] Items **102** may be configured with a base portion configured to support the item **102** (such as a generally flat base support surface) in a generally vertically upright orientation. Each item **102** may be shaped with a main lower body portion having an outer surface of a first cross-sectional size / diameter and an upper neck region having an outer surface of a smaller cross-sectional size / diameter (such as in a typically shaped wine bottle). By way of example only, items **102** may be **150** ml plastic plastic or glass bottles with an upper cylindrical shorter neck region, a vertically extended generally cylindrical body portion, and ,may also have a bottle cap or other closure secured over a top opening in the neck region. The interior cavity thereof may contain a liquid or a semi-liquid product therein. Item **102** may have a shoulder formed at the join between the body portion and the neck portion / closure.

[0046] With reference to FIGS. **3**A to **3**C, each blank **111**A used in system **100**, may have opposed minor side panels A and C interconnected to a pair of opposed major side panels B and D to form a tubular sleeve, seen in FIG **3**C, when opened. An overlap strip of case blank material may be provided between panel B and panel A that can be sealed by conventional means such as a suitable adhesive, to provide an overlapping seam joint in the vicinity of "P" (see FIG **3**A). This seam joint at the overlap forms a knock-down case blank in which the panels A, B, C and D are joined into a blank **111**A that is of generally flattened tubular configuration, as shown in FIGS. **3**A and **3**B.

[0047] Also, as shown in FIGS. **3A-C**, are opposed pairs of end flaps E, H and end flaps L, I that are provided at one (e.g. top) end of the respective side panels A-D. A second set of pairs of opposed end flaps F, G and K,J are provided on the opposite, (e.g. bottom) end of side panels A-D. However, in other embodiments, cases having other panel and flap configurations can be formed. The panels and flaps

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may be connected to adjacent flaps/panels by predetermined fold/crease lines such as shown in FIGS. **3A** and **3B**. These fold / crease lines may for example be formed by a weakened area of material and /or the formation of a crease with a crease forming apparatus. The effect of the fold lines is such that one panel such as for example panel A can be rotated relative to an adjacent panel such as D or B along the fold lines. Flaps may also fold and rotate about fold lines that connect them to their respective panels.

[0048] Case blanks **111**A may be made of any suitable material(s) configured and adapted to permit the required folding/bending/displacement of the material to reach the desired configuration. Examples of suitable materials are chipboard, cardboard or creased corrugated fibre board. It should be noted that the blank may be formed of a material which itself is rigid or semi-rigid, and not easily foldable but which is divided into separate panels and flaps separated by creases or hinge type mechanisms so that the case can be erected and formed. In some embodiments, case blanks **111**A may be delivered to system **100** in a form in which the case blank is already in a tubular shape and may be completely or partially sealed at an upper end, with the bottom end being open. In some embodiments, the cases may not be rectangular or square in horizontal section shape.

[0049] System **100** may have a programmable logic controller ("PLC") **132** for controlling various operational components of the system. System **100** may also include a robotic arm **250**, a blank magazine **251** holding a plurality of vertically stacked, flattened case blanks **111A**, an item infeed conveyor **104**, a first transfer apparatus **112**, and a collation platform **120** located within an area generally designated as a collating station **119**. First transfer apparatus **112** may be operable to successively transfer a plurality of items from infeed conveyor **104** to collation platform **120**, forming a collated group **122** of items. System **100** may also include an area (such as a casing area / station **130**) where a plurality of items **102** that have been collated into a group **122**, may be loaded into an erected case **111**C (FIG. **3**C) and then the erected and loaded case has its end flaps closed and then the case is sealed. This process may be repeated to successively form a plurality of collated groups **122** each of which may be loaded into its own respective erected case **111C** and sealed therein.

[0050] In some other embodiments, top end flaps of each erected case **111**C may be closed and sealed or partially sealed prior to loading of items **102** therein. Within the casing area **130** may be located several components including robotic arm **250**, a pedestal apparatus **140**, and a rod movement sub-system **203** that may include a pair of transversely oriented, longitudinally movable, movement rods **200-1** and **200-2** (see also FIGS. **9**A-**9**C). A second transfer apparatus **175** may operate to successively move groups **122** of collated items **102** from collation platform **120** to pedestal apparatus **140**.

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[0051] Collation platform **140** may receive individual items **102** delivered singly in series and transferred from infeed conveyor **104**. Items **102** may be delivered to a transfer location in a single line of items, with no spacing between the adjacent items **102** in the line. In other embodiments, items **102** may be delivered either in a predefined spacing therebetween or with randomly sized spacing between each of the items. System **100** may be operable to transform the plurality of individual items **102** provided to system **100** into a series of collated groups **122** of items **102** that can each be delivered serially to casing area **130** for loading and sealing in its own case.

[0052] Individual items **102** may be delivered by input conveyor **104** in series in a generally vertically upright orientation, each item **102** supported on its base portion, to a transfer station **110** (FIG. **1**) that is at a location at the end area of infeed conveyor **104** and the input area of collation platform **120**. A plurality of items **102** which form a sub-group of items (that may form a row **118** of items in a group **122** - see FIG **6**), may be transferred from input conveyor **104** to collation platform **120**. Successive sub-groups / rows **118** of items **102** may be transferred from input conveyor **104** to collation platform **120** to form a completed, collated group **122**. Several sub-groups / rows **118** of items (each of which may form a single row in a group **122** comprising multiple rows of items) may be aggregated / collated to form a group **122** of items **102**. Thus, between input conveyor **104** and collation platform **120**, individual items **102** may be transformed from a series of individual items **102** delivered in series, into a collated group **122** on collation platform **120**.

[0053] Collation platform **120** may have an item support surface made of a strong, low friction material such as UHMW polyethylene to allow items **102** to easily slide over the support surface.

[0054] A group **122** may be formed on collation platform **120** in an ordered array of items **102** (e.g. a rectangular array of a first number N**1** of rows of items with a second number N**2** of items in each row). Depending upon the desired configuration of the array of items **102** when loaded into an erected case **111**C, adjacent rows of items may be transversely offset from each other (e.g. if the items **102** are generally cylindrical and are interleafed at their outer abutting surface areas). The number of items **102** in each group **122** to be loaded into a single erected case **111**C may be determined based on one or more specific dimensions and shape associated with the individual items **102** and the shape of the interior storage space **107** and its dimensions, in an erected case **111**C.

[0055] At least some, if not all, of the components of system **100** may be mounted to a system frame **115** (only some of which is illustrated in the Figures). System frame **115** may include various inter-connected vertical and horizontal post / beam support members such as frame members **115'** and

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be configured to permit certain components of system **100** that are described herein to be mounted thereto.

[0056] Collated groups **122** of items **102** are sequentially transferred from collation platform **120** to a central loading platform **164** (FIG. (**9**) of pedestal apparatus **140** in casing area **130**, using a combination of transfer apparatus **175** and a rod movement sub-system **203**. As will become evident, rod movement sub-system performs a plurality of different functions within system **100**. At casing area **130**, each collated group **122** of items **102** is sequentially, bottom loaded into an interior storage space **107** (FIG. **3**C) of an erected case **111C** by having an erected case **111C** moved by robotic arm **250** under control of PLC **132** in a particular and pre-determined path such that the group of items **102** is sheathed by an erected case **111C**. An erected case **111C** may be moved on a path whereby it is tilted at an angle and then brought down over top of a group **122** of collated items **102**, so as to encapsulate or enclose the collated group of items **102** within the interior storage space **107** of the erected case **111**C, while the group **122** of items **102** is positioned on the collation platform **120** and while the group **122** may be stationary relative to frame **115**. The path of movement of the erected case **111**C as it is moved by robotic arm **250** is such that none of the lower flaps (e.g. flaps J, K F and G) are caught on any upper edges or upper surfaces of any items **102** in the group **122**, and so the erected case **111**C will be moved to a position where the lower panels, J, K, F and G remain oriented vertically downwards when the group **122** of items **102** has been received within storage space **107** of erected case **111**C.

[0057] Once a group **122** of items **102** is properly positioned within the storage space **107** of an erected carton **111C**, at least two opposed bottom flaps of each erected case **111C** (e.g. trailing flap G and leading flap F) may be moved to a closed position using a combination of pedestal apparatus **140** and movement rods **200-1**, **200-2** of rod movement sub-system **203**. Thereafter, a case **111D** with at least the flaps G and F having been moved to a closed position, may be moved from the pedestal apparatus **140** to output conveyor **170**. During movement to output conveyor **170** and / or while being moved on output conveyor **170**, case **111D** may have the remaining top and bottom flaps closed, and the top and bottom ends may also be fully sealed. Case **111D** may also be optionally labelled while moving through output conveyor **107** using a labelling apparatus. Thereafter, output conveyor **170** may deliver each loaded and fully sealed case **111E** to an output station, where for example fully closed, sealed and loaded cases **111E** may be successively stacked on a pallet by a conventional stacking apparatus (not shown) to be ready for shipping to a destination.

[0058] An example of a scheme for the power and data/communication configuration for system **100** is illustrated in FIG **2**. The operation of the components of system **100** may be controlled by PLC

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132. PLC **132** that may be accessed and configured by a human operator through a Human Machine Interface (HMI) module **133** secured to frame **115**. HMI module **133** may be in electronic communication with PLC **132**. PLC **132** may be any suitable PLC and may for example include a unit chosen from the Logix **5000** series devices made by Allen-Bradley / Rockwell Automation, such as the ControlLogix **5561** device. HMI module **132** may be a Panelview part number **2711**P-T**15**C**4**D**1** module also made by Allen-Bradley / Rockwell Automation.

[0059] Electrical power can be supplied to PLC **132**/HMI **133**, and to all the various servo motors and DC motors that are described further herein. Compressed/pressurized air can also be supplied to the vacuum generators and pneumatic actuation through valve devices such as solenoid valves that are controlled by PLC **132**. Servo motors may be connected to and in communication with servo drives that are in communication with and controlled by PLC **132**. Similarly, DC motors may be connected to DC motor drives that are in communication with and controlled by PLC **132**, again all as described further herein. Additionally, various other sensors are in communication with PLC **132** and may (although not shown) also be supplied with electrical power.

[0060] With reference again to FIGS. **3**A, **3**B, and **3C**, an example of one kind of knock-down case blank **111**A that can be processed by system **100** to form a regular slotted case (RSC) is disclosed. System **100** may be configured so that other types of knock-down case blanks, and knock-down case blanks of different sizes may also be processed.

[0061] Each case blank may be generally initially formed and provided in a knock-down configuration **111**A – i.e., a flattened tubular configuration -- as shown in FIGS. **3A** and **3B**. Each tubular case blank **111**A may have a height dimension "Ht"; a length dimension "L"; and a major panel Length "Q" (see FIG **3**A). By inputting each of these three dimensions for a blank to be processed by system **100** into PLC **132**, PLC **132** can determine if the system **100** can process that sized blank **111**A without the necessity for manual intervention to make an adjustment to one or more components of system **100**. If PLC **132** determines that the adjustment can be made without human intervention, PLC **132** may make the necessary adjustments to positions and/or movements of at least some of the components forming system **100**.

[0062] As will be described further hereinafter, case blank **111**A may be transformed from a knock-down configuration (i.e., a generally flattened tubular configuration) to an open sleeve erected configuration (open tubular configuration) **111**C, the erected case **111**C may be loaded, and the end flaps may be folded and sealed to form a desired erected, loaded and fully closed and sealed case configuration **111**E. System **100** is configured to deliver each erected case **111C** with a downwardly

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facing, bottom opening with flaps F, G, J, K being in an orientation that is generally planar with corresponding connected side panels A, C, B and D, suitable for loading a group of items **102** through the bottom opening into the interior storage space **107** of the erected case **111**C where the group of items **102** are to be held.

First Transfer Apparatus and Item Collation

[0063] With reference now to FIG. **4**, infeed conveyor **104** may be a driven conveyor with a moving belt **104'** that provides an upward facing, moving support surface that can support a plurality of items **102** thereon. Infeed conveyor **104** may be configured to deliver the individual items **102** from a source / supply of such items to a transfer location at transfer station **110**, adjacent and generally level with the support surface of collation platform **120**. The support surface of belt **104'** of infeed conveyor **104** may be configured as a movable continuous belt having an upper run and lower run with items supported on the upper run and may be made from a suitable material that will allow items to easily slide over it when pushed by header 116, such as suitable hard plastic commonly used in belt conveyors. Belt **104'** may be driven by a suitable motor **105** such as a DC motor or a variable frequency drive motor controlled by PLC **132** through a DC motor drive (sold by Oriental under model AXH-**5100**-KC-**30**) by PLC **132**. The upward facing surface of belt **104'** may have an end-run portion at a location that is adjacent to, and may have a side edge region that is directly adjacent / proximate a forward transverse edge region of support surface of collation platform **120**. In other embodiments other types of item delivery / supply apparatuses may be provided, including other types of conveyors such as by way of example only magnetic conveyors or roller conveyors.

[0064] System **100** may also include first transfer apparatus **112** at transfer station **110** located proximate and oriented in a longitudinal direction. Transfer apparatus **112** may have a pusher header **116** that operates across the end of belt **104'** of infeed conveyor **104** and onto the forward edge region of collation platform **120**. First transfer apparatus **112** may include a linear actuator **114** attached to pusher header **116** that is capable of intermittent, linear, reciprocating back and forward movement under the control of PLC **132** in a longitudinal direction (Y direction). When activated by PLC **132**, linear actuator **114** may be configured to translate header **116** between a first retracted position and a second extended position, in a longitudinal direction (direction Y) that may be generally perpendicular to the direction of inflow of items **102** on conveyor belt **104'** at the end region of the infeed conveyor **104**. The reciprocating, linear movement of header **116** may be generated using a piston, lead screw, or belted motor system. An example a suitable motor is a servo motor such as the model MPL-B**330**P-MJ**24**AA

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made by Allen Bradley. According to some belted embodiments, a motor **121** such as a servomotor, stepper motor, or other rotational system may be configured to drive a belt or chain. A belt **113** may be mounted between idler wheels and inter-connected to a sliding rack **117**. Header **116** may be removably or permanently affixed to sliding rack **117**. An example of a suitable rail system for sliding rack **117** is the Bosch Rexroth ball rail system in which the rails are made from steel and the blocks have a race of ceramic balls inside allowing the block to slide on the rails. Motor **121** may further include an encoder communicably linked to PLC **132**.

[0065] According to some embodiments, a particular header **116** of one shape / dimensions may be removed and interchanged with another header **116** having an alternative shape / dimensions. Accordingly, if the size and/or shape of individual items **102** require a specific header design, the specific header **116** of a desired shape/dimensions can be selected and installed to correspond/fit the particular items **102** being processed by system **100** at a particular time. Header **116** may have a generally flat pushing surface that is vertically oriented, and which also extends across the body regions of a plurality individual items **102** located at the end region of infeed conveyor **104**. In some embodiments, header **116** may have a complementary engaging surface shape to that of the body region surface shape of the individual items being delivered by infeed conveyor **104**. For example, header **116** may have a plurality of concave surface shapes arranged in series, which closely match the convex outer surfaces of a plurality of items **102** arranged in series when located at the end region of infeed conveyor **104**.

[0066] As shown in in FIG **4**, in a first retracted position, header **116** does not impede flow of the infeed conveyor **104** and is positioned outside of the conveyor path of the conveyor belt **104'** in the end region. This allows an inflow of several individual items **102** into the end transfer region of infeed conveyor **104**. Therefore, several items **102** that form a sub-group **122** of items may be positioned to extend across the width of the operational surface of header **116**.

[0067] System **100** may be configured to operate infeed conveyor **104** (with items **102** delivered in tight contact, serial formation) and header **116** in a manner that provides for the smooth sliding movement of a sub-group of items **102** from infeed conveyor **104** onto collation platform **120** to form a row **118** of items. For example, based on a calculated timing of operation of infeed conveyor **104**, PLC **132** may send an input signal to intermittently start and stop movement of infeed conveyor **104** to deliver a given number **N2** of items **102** to a transfer position. Alternatively, one or more electronic eye sensors. such as the model **42**KL-D**1**LB-F**4** eye sensors made by ALLEN BRADLEY may be communicably linked to PLC **132**, and based on a sensed value/signals (e.g. an indicator that the number N**2** of specific individual item **102** that will form a sub-group are all located in the desired specific positions at a

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transfer position), responsive to the sensed value/signals, PLC **132** may signal to the infeed conveyor **104** to stop movement of the belt **104'** of infeed conveyor **104**. The number of individual products **102** that are positioned on infeed conveyor **104** spanning across the operational surface of header **116** and forming a sub-group of items **102**, may correspond to the number of items **N2** desired for a collated row **118** for each arrayed group **122** of products **102** that it is desired to fit into a sealed case **111**E, the sealed case **111E** containing a number **N1** of collated rows **118** in the arrayed group.

[0068] With particular reference now to FIG. **5**, header **116** may be configured and operable to move from the first retracted position to the second extended position, in a longitudinal direction (Y direction) in a plough like movement, to transversely push and slide the predetermined number of individual items **102** in the subgroup at the transfer location from the infeed conveyor **104** onto an upper item support surface of collation platform **120**.

[0069] Upon determination from PLC **132** that the collated row **118** is present at the transfer position spanning across the surface of header **116**, PLC **132** may send a signal to linear actuator **114** to activate and initiate the movement of the header **116**. Header **116** will move from the first position to the second position. Through this movement, header **116** will abut individual items **102** and push the items from infeed conveyor **104** onto the collation platform **120**. This movement may be done in a manner that the items **102** slide smoothly and together on their bases from the infeed conveyor **104** onto the upper surface of collation platform **120**. Movement of header **116** may be at a predefined speed. Accordingly, the movement of a collated row **118** of items **102** may be of a character that the individual items **102** will be less likely to topple over. This movement will produce a first collated row **118** on the collation platform **120**.

[0070] After moving from the first position to the second position, header **116** will be returned back by control of PLC **132**, to the first retracted position (i.e. the position shown in FIG. **2**). Once returned to the retracted position, a new plurality of individual items **102** may be delivered to the end region of infeed conveyor **104** and the transfer location, under control of PLC **132**. This subgroup may then also be pushed by header **116** onto collation platform, also causing any prior sub-groups/rows **118** of items that are already on collation platform **120**, to move longitudinally, further downstream on the support surface of collation platform **120**. As will be evident from FIG. **6**, this process may be repeated until the desired number **N1** of subgroups of items **102,** arranged in collated rows **118**, are on the collation platform **120** to form a desired size of group **122** of collated items **102** to be loaded into an erected case **111**C.

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[0071] The item support surface of collation platform **120** may be a low friction material which allows for easy sliding of items **102** when supported on their bases, across the adjacent and vertically and transversely aligned upward facing support surfaces. Sides plates may be also provided in association with collation platform **120** extending on both transverse sides of the length of the collation platform **20**, to form bumper members (bumpers) **126** with inward facing support surfaces at a fixed width / transverse spacing corresponding to the width of a collated row **118**. Bumpers **126** may be constructed with metal support frames and having inner support surfaces of a similar low friction, high rigidity material such as UHMW polyethylene, to allow each collated row **118** to maintain its positioning and restrict sliding movement to a single dimension (e.g. easy sliding in the longitudinal direction Y along the collation platform **120**).

[0072] According to some embodiments, the distance between bumpers **126** may be adjustable, such that the bumpers **126** may be repositioned to operate with an alternative header **116** of different width dimensions, to allow for different dimensions of collated items **102** and/or different numbers of items in each row **118** of a desired group **122**. For automatic adjustment by PLC **132**, bumpers **126** could be mounted on an adjustment mechanism that provides for spacing adjust by operation of a servo motor in a manner similar to that described elsewhere herein.

[0073] To prevent toppling of a subgroup / row **118** of items **102**, and / or of a plurality of adjacent rows **118** of items **102**, on collation platform **120**, as header **116** pushes items from infeed conveyor **104** onto collation platform **120**, a topple plate **124** that may comprise part of first transfer apparatus **112**, may also be provided at collating station **119**. Topple plate **124** may be a vertically and transversely extending plate that may have a generally flat support surface **124'** (FIGS. **5** and **6**) that can be moved to support positions that ensure that the individual items **102** remain upright and are prevented from falling over throughout the transfer of the several subgroups/rows **118** of items **102** from infeed conveyor **104** to collation platform **120**, during the successive longitudinal pushing movements of header **116**. Support surface **124'** of topple plate **124** may be positioned on an opposite side of the rows **118** of items to header **116,** as the rows of items are being collated on collating platform **120**. Header **116** may be positioned in consistent or intermittent abutment or be positioned proximate to the first collated row **118** on collating platform **120**.

[0074] Topple plate **124** may be connected to a sliding beam apparatus **128**. Sliding beam apparatus **128** may be inter-connected to a drive belt **134** (FIG. **7**) with belt **134** being operable to be moved by a motor **136** (FIGS. **4** and **7**). Sliding beam apparatus **128** may be cantilever supported at one end by a carriage block **129** that may be operable to movement on longitudinal and horizontal guiderails

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138, to ensure stability while sliding beam apparatus **128** moves backwards and forwards in a horizontal longitudinal direction Y. An example usable motor is a servo motor such as the model MPL-B**330**P-MJ**24**AA made by Allen Bradley. Again, a suitable rail system is the Bosch Rexroth ball rail system referenced above. Carriage block **129** may be interconnected to drive belt **134**. Accordingly, turning motor **136** may drive belt **134** to move carriage block **129** to slide on guide rails **138** to translate sliding beam apparatus **128** in longitudinal cyclical movement under control of PLC **132**, such as indexed forward movement, and continuous rearward movement. The result is topple plate **124** moves under control of PLC **132** in backwards and forwards, longitudinal horizontal motion.

[0075] Movement of topple plate **124** in the longitudinal direction may be controlled by PLC **132** and may be operable to occur in co-ordination with the movement of header **116**. The movement of topple plate **124** can be configured such that as header **116** pushes each additional collated row **118** of items **102** from infeed conveyor **104** onto collation platform **120**, topple plate **124** will index forward longitudinally, in the same longitudinal direction and the same distance of movement of the first row **118**. This forward movement of header **116**, and any rows **118** or items in front of header **116**, can be co-ordinated to be in tandem, at the same or a similar speed as the forward movement of topple plate **124**. Alternatively, topple plate **124** may move a defined, limited distance before movement of header **116** commences, but the distance being sufficiently small to prevent toppling over of any items **102**. A longitudinal operating window of movement of topple plate **124** may extend from proximate a first upstream transverse edge area of the collation platform **120** (i.e. allowing receipt of the first collated row **118** on to the collation platform) to proximate a second downstream transverse edge of the collation platform **120** (i.e. allowing receipt of the final collated row **118** of items **102** to form a completed group **122** on collation platform **120** arranged in an ordered array).

[0076] Topple plate **124** may also be capable of up and down vertical movement relative to the upper surface of collation platform **120**. A vertical movement apparatus **142** may be connected to topple plate **124** and may also be supported on sliding beam apparatus **128**, for longitudinal movement therewith. Vertical movement apparatus **142** may include a reciprocating driven rod member, operable to driven up and down by a motor **146** under control of PLC **132**. Alternatively, vertical movement apparatus **142** may by a servo-driven device. The driven rod member may be interconnected at its lower distal end to topple plate **124**. The driven rod member may be a piston rod of a double/two-way acting (up and down) pneumatic cylinder operated by pressurized air delivered to the piston through air hoses, with electronic valves selectively controlling the flow of pressurized air, with the valves being part of air valve system **332** (FIG. **2**) controlled by PLC **132**. The vertical up and down movement of the driven rod

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member may be guided by a pair of transversely spaced guide rods **144**, that may be cylindrical rods that have bottom ends fixedly attached to a top edge portion of topple plate **124**. Guide rods **144** may pass through and side within vertical cylindrical guide passages within sliding beam apparatus **128**. Thus, when driven member of motor **146** moves upwards and downwards, guide rods stabilize the up and down vertical movement of topple plate **124**.

[0077] An operational window of vertical movement of topple plate **124** may be defined at a minimum bottom / downward operating position that ensures the collated items **102** do not topple/fall over while sliding from infeed conveyor **104** onto collation platform **120**; and a maximum top / upward position that provides an adequate clearance height such that the lower edge of the topple plate **124** is located above the highest portion of collated items **102** to allow for the topple plate **124** to move longitudinally rearward, over top of, and past the group **122**, without interfering with / contacting the items. Topple plate **124** may move vertically to have clearance over the collated items **102**, then return to the first position proximate leading upstream edge area of collation platform **120**.

[0078] An encoder may be provided for at least motor **136** and the encoder may rotate in relation to the rotation of the respective drive wheel of motor **136**. The encoder may be in communication with, and provide signals through the servo drive to PLC **132**. Thus PLC **132** can in real time know/determine/monitor the horizontal position of belt **134** in space and may also be able to adjust the vertical position of the driven rod of motor **146** by operating motor **146**, in part based on the longitudinal position and direction of movement of topple plate **124**. PLC **132** can determine and monitor in real time the longitudinal (Y direction) and also adjust the vertical position (Z direction) between a fully up and fully down position, of topple plate **124** at any given time. The particular types of encoder that may be used is known as an "absolute" encoder. Thus system **100** can be "zeroed" such that due to the calibration of the encoder of motor **136** the zero-zero position of the end effector in the Y direction is set within PLC **132**. The zero-zero position can be set with the transfer at its most horizontally left position. PLC **132** can then substantially in real time, keep track of, and change the vertical and horizontal position of topple plate **124** as PLC **132** moves system **100** through the processing sequence for moving a group of items **102** from infeed conveyor **104** to collation platform **120**.

[0079] Also associated with topple plate **124** may be a first, generally horizontally oriented caterpillar device **148**. Caterpillar device **148** may have a hollow cavity holding hoses and wires carrying pressurized air/vacuum and electrical/communication wires/hoses. Caterpillar **148** allows such hoses and wires to move longitudinally as the beam apparatus **128** and topple plate **124** are moved longitudinally backwards and forwards (in direction Y). Caterpillar device **148** allow hoses and wires to

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supply motor **146** with pressure for controlling the pneumatic movement of the driven member of motor **146**. An example of suitable caterpillar devices that could be employed is the E-Chain Cable Carrier System model # **240**-**03**-**055**-**0** made by Igus Inc. It should be noted that electrical communication between the PLC **132** and the drive mechanisms of topple plate **124** could in other embodiments be accomplished using wireless technologies that are commercially available.

[0080] Motors **121**, **136** may be provided and be in electronic communication with PLC **132** through a servo drive (as seen in FIG **3**) and operate in both directions and if they are servo motors/drives at varying speeds. Examples that could be used are servo VPL-B**1003**T-PJ**12**AA made by ALLEN BRADLEY, in combination with servo drive **2094**-BC**01**-MP**5**-S also made by ALLEN BRADLEY and gear head AE**090**-**010**-P**2** FOR VPL-_**100**_ A/B made by Apex.

Motor **146** may be operated dependent at least in part upon the horizontal position of topple plate **134**, by the turning on and off pressurized air, by PLC **132** operating appropriate electronic valves of valve system **332**.

Second Transfer Apparatus

[0081] Turning again to FIG. **7**, second transfer apparatus **175** may also be provided at collating station **119**, operating generally between collation platform **120** and pedestal apparatus **140** in casing area **130**. Transfer apparatus **175** may be configured to transfer successively, each group **122** of collated items **102** from the collation platform **120** to pedestal apparatus **140**. When transferred to pedestal apparatus **140**, each group **122** of items **102** is then sheathed / covered by robotic arm **250** with an erected case **111**C. In the casing area **130** may be located, in addition to robotic arm **250** and pedestal apparatus **140**, rod movement sub-system **203** that may include a pair of transversely oriented, independently longitudinally movable, movement rods **200**-**1** and **200**-**2**.

[0082] Pedestal apparatus **140** provides one or more generally horizontal support surfaces upon which a collated group **122** of items **102** can be moved over and supported while being sheathed by / enclosed within an erected case **111C** by robotic arm **250**. The horizontal item support surfaces of pedestal apparatus **140** may be made from a suitably strong, low friction material such as a low friction stainless steel. Transfer from collation platform **120** to pedestal apparatus **140** may be performed using transfer apparatus **175** to move each collated group **122** of items **102** from the collation platform **120** onto an input transfer platform **162** of pedestal apparatus **140**. Transfer apparatus **175** may comprise a generally flat, transversely extending rigid plate **150** with a vertical and transversely oriented forward engagement surface **150'** movable in the longitudinal (Y) direction and in the vertical (Z) direction.

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Engagement surface **150'** may have a contoured engagement / pushing surface that matches an outer curved surface of the body region of each item **102**. With particular reference also now to FIG. **8**, transfer apparatus **175**, controlled by PLC **132**, is operable to position transfer paddle **150** to engage with the collated items **102** in a first position behind each collated group **122** of items **102** on the collation platform **120**, and push collated items **102**, moving them with sliding movement longitudinally downstream across the collation platform **120** and onto to the support surface of input transfer platform **162** of pedestal apparatus **140** (the position shown in FIG. **8**).

[0083] Transfer apparatus **175** may include a horizontal movement system **151** and a vertical movement system **152** in electronic communication with, and both being controlled by, PLC **132**. Horizontal movement system **151** may be mounted on moving support components of vertical movement system **152**. The movement of the transfer paddle **150** may be defined by the combined movement of horizontal movement system **151** and vertical movement system **152**. Horizontal movement system **151** and vertical movement system **152** may each comprise a belted - motor driven system.

[0084] Horizontal movement system **151** may include a horizontally and longitudinally oriented, horizontal movement support frame member **149** which supports a motor **153** that drives a continuous, horizontally oriented drive belt **154** that is also supported for movement on support frame member **149**. Drive belt **154** may be supported for movement between a drive wheel **153'** of motor **153** and an idler wheel **147**. Horizontal movement system **151** may also include a rail support frame **171** that supports laterally spaced, longitudinal and horizontal guide rails **156**. A carriage **173** may be mounted for sliding horizontal and longitudinal movement along guide rails **156**. A transversely and horizontally oriented support cantilevered beam **177** may be connected to and supported by carriage **173**. Cantilevered beam **177** may extend from carriage **173** that is generally located on the transversely opposite side of the flow path of items **102** to the carriage block **129** and guiderails **138** that support cantilever sliding beam apparatus **128**. In this way, the support and driving apparatuses of topple plate **124** may be located in positions that do not interfere with the support and driving apparatuses of transfer paddle **150**.

[0085] A transfer paddle mounting plate **155** may be fixedly connected to carriage **173** and interconnected with drive belt **154**. Transfer paddle **150** may be fixedly connected to support beam **177** and move in reciprocating back and forward sliding movement on guide rails **156** with beam **177**, and carriage **173**. Thereby, a movement of motor **135** may move belt **154**, causing longitudinal horizontal movement of transfer paddle **150**.

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[0086] Horizontal movement support frame **149**, and rail support frame **171** may themselves be mounted via spaced vertically oriented mounting plates **178** to a carriage **157**. Carriage **157** may be interconnected to a continuous vertical oriented drive belt **158** driven by vertical motor **159**, and carriage **157** may supported by and on vertical guide rails **161**. Guide rails **161**may be mounted on vertically and longitudinally extending support plate **181**. Support plate **181** may be supported by a plurality frame members **115**'. Drive belt **158** may be supported for movement between a drive wheel **159**' of motor **159** and a lower idler wheel (not visible). Carriage **157** may be configured to slide along vertically oriented (Z - direction) guide rails **161** for stability, in reciprocating upward and downward sliding movement on guide rails **161**. Thereby, a movement of motor **159** may move belt **158**, causing vertical movement of carriage **157**. The vertical movement of carriage **157** results in the vertical movement of horizontal movement support frame **149**, and rail support frame **171**, transfer paddle mounting plate **155**, beam **177** and transfer paddle **150** that are interconnected thereto.

[0087] The co-ordinated operation of motors **153** and **159** by PLC **132** can result in the vertical and longitudinal movement of transfer paddle **150**. Motors **153** and **159** may be selected having a torque strength suitable to slide collated items **102** from collation platform **120** to the input transfer platform **162**. An example suitable motor for both horizontal and vertical movement of the transfer paddle are servo motors such as the model VPL-B**1003**T-PJ**12**AA made by Allen Bradley.

[0088] Transfer apparatus **175** may have an operating longitudinal range of movement for movement of transfer paddle **150** that extends between a downstream edge area of the collation platform **120** to at least the upstream edge area of the input transfer platform **162**. The vertical axis operating range of transfer paddle **150** may be such that the transfer paddle **150** may be positioned in an activated position where the lower transversely extending edge of transfer paddle **150** may be located proximate / close to the upward facing support surface of collation platform **120**, and may be lifted vertically to an upper vertical position that provides transfer paddle **150** clearance to move transversely above and rearwards behind a group of collated items that may be located on collation platform **120**.

[0089] Both motors **153** and **159** can be independently driven in both directions at varying speeds by PLC **132** (FIG **3**) through servo drives. In this regard, both servo motors **153** and **159** may be provided with two separate ports, one for connection to a power line and the other for connection to a communication line to provide communication with the servo drive and PLC **132**. Servo motors **153**, **159** may also have a third input which may provide input for an electric braking mechanism. It should be noted that all of the servo motors described herein may be similarly equipped. Motors **153** and **159** may

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further include encoders that enable PLC **132** to estimate belt position of drive belts **154**, **158**, in real time and thus move transfer paddle **150** both vertically upwards and downwards, as well as backwards and forwards in a longitudinal direction.

[0090] According to some embodiments, transfer paddle **150** may be positioned vertically and horizontally using only motors **153** and **159**. Alternatively, in other embodiments, the transfer paddle may be articulatable on its own in a vertical axis, using a servomotor or a compressed air cylinder.

[0091] Header **16**, topple plate **124** and transfer paddle **150** may move in a co-ordinated movement relationship such as that depicted schematically in FIG. **7**A, as shown in steps (a) to (h). Initiating a cycle of movement, a first row **118** of items may be transferred by co-operative movement of header **116** and positioning of topple plate **124** (position (a) to position (b). The co-ordinated movement / positioning of header **116** and topple plate **124** continues by adding rows **118** of items to form a group **122** on collation platform **120** (position (c)) as header **116** repeatedly adds rows **118** to collation platform **120**, and topple plate will index backwards as each row is added, until a group **122** is formed.

[0092] With a group **122** located on collation platform **120** (position (c)), topple plate **124** will be raised vertically upwards and move backwards to a position behind the group **122** (to position (d) and then to position (e)). Transfer paddle **150** will also move upwards (position (d), and then backwards (position (e)) and then downwards to a position immediately behind the group **122** and in front of topple plate **124** (position (f)). Then transfer paddle **150** can push the group **122** forwards from collating platform **120** onto input transfer platform **162** (from position (f) to position (g)). Thereafter movement rods **200-1**, **200-2** (not shown in FIG. **7**A) can take over the control of movement of the group **122** and engage the front and rear sides of the group of items to move the group away (position (h)).Topple plate **124** will then move longitudinally forward positioning itself to be ready to support another first row **118** that will move onto collation platform **120**. Thereafter, another cycle of movement of header **116**, topple plate **124**, and transfer paddle **150** can commence again (position (a)).

Pedestal Apparatus

[0093] With particular reference now to FIGS. **8**, **9**, **9**A-C and **10**, an example pedestal apparatus **140** is shown. Pedestal apparatus **140** may facilitate / assist with the sheathing of groups **122** of items **102** with erected cases **111**C, as well as the closing of leading and trailing bottom flaps F, G respectively of the erected cases **111**C, as described further hereinafter, in order to be able to interpose the leading and trailing flaps F, G of the erected case, into closed, support positions beneath the group **122** of items **102** that are positioned within the interior storage space **107** of the erected case **111**C. Pedestal apparatus **140** may comprise input transfer platform **162**, a first folding platform **163**, a central loading

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platform **164**, and a second folding platform **165**, each located in series in longitudinal relation to each other (FIGS. **8**, **9** and **10**). Each of input transfer platform **162**, first folding platform **163**, central loading platform **164**, and second folding platform **165** may have upwardly directed support surfaces for supporting items **102** thereon. The positions of support surfaces of first folding platform **163**, central loading platform **164**, and second folding platform **165** may be capable of limited vertical and longitudinal adjustment relative to each other.

[0094] Transversely oriented hinged gate/door **208** may be located between the upstream edge region of input transfer platform **162** and the downstream edge region of collation platform **120**. Gate **208** may be configured for operational movement between a closed position and an open position. In the open position of gate **208**, a substantially smooth, horizontal flat continuous extending support surface between the upper surface of collation platform **120** and the upper surface of input transfer platform **162** is interrupted by gate **208** having been moved downward to provide an opening between the upper surface of collation platform **120** and the upper surface of input transfer platform **162**. In the closed position of gate **208**, a substantially smooth, horizontal flat continuous support surface extends between the upper surface of collation platform **120** and the upper surface of input transfer platform **162** over the upper surface of gate **208** mating with the upper surface of collation platform **120** and the upper surface of input transfer platform **162**.

[0095] Trailing movement rod **200-2** may move from a lowered start position, longitudinally forwards and upwards, through this opening provided when gate **208** is in an open position, between the lowered start position in which trailing movement rod **200-2** does not extend across the upper surfaces of any of gate **208**, input transfer platform **162**, first folding platform **163**, central loading platform **164** or second folding platform **165** to a group engagement position behind the last row of items **102** in a group **122**. When trailing movement rod **200-2** is in a lowered start position, gate **208** may be moved between the open position and the closed position.

[0096] When gate **208** is in the closed position of gate **208**, a substantially smooth, flat uninterrupted surface is provided between the upper surface of collation platform **120** and the upper surface of input transfer platform **162**. In this position, trailing movement rod **200-2** may be either positioned vertically beneath gate **208** in its start position, and the substantially smooth, flat continuous surface between the upper surface of collation platform **120**, gate **208**, and the upper surface of input transfer platform **162** is provided, allowing a collated group to pass over top of the trailing movement rod **200-2**. Alternatively, during operation, trailing movement rod **200-2** may be located above that continuous flat surface, and in an engagement position rearward of a group **122** of items with which it is

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operationally engaging, as described herein. In some embodiments, gate **208** may be connected at both opposite ends by a hinge mechanism and gate **208** may be moved between the open and closed positions under control of PLC **132** by a gate drive mechanism interconnected to gate **208**, which may include a pneumatic piston device with a reciprocating piston arm that may drive gate **208** downwards and upwards between the respective closed and open positions. According to some embodiments, gate **208** may be mounted to a cylinder actuation device to move between the open and closed position, or may. in embodiments, be actuated by a servo drive actuator.

[0097] With particular reference to FIGS. **9**, **18 and 20,** first folding platform **163** and second folding platform **165** may be adjustable up and down in the vertical axis direction using pneumatic piston devices **167-1** and **167-2** that are interconnected thereto, controlled by valves of valve system **332**, operated by PLC **132**, such that each platform surface of first folding platform **163** and second folding platform **165** may have its vertical distance and position adjusted by PLC **132** relative to the surface of the surface of central loading platform **164**, to fulfil the functions described herein. First folding platform **163**, second folding platform **165** and central loading platform **164** may be supported by a pedestal support frame **168**.

[0098] Central loading platform **164** may be supported by one or more platform support plates **195**. Platform support plates **195** may be supported and operable for limited longitudinal rearward and forward movement (Y direction) and may be interconnected to a movement actuator **194** - that may also be for example a pneumatic piston device. Operation of piston device / actuator **194** may be controlled by valves of system **332**, operated by PLC **132** operating air valve system **332**, such that the upper support surface of central loading platform **164** may have its longitudinal distance and position varied to a limited extent relative to the support surfaces of the first folding platform **163** and second folding platform **165** to thereby adjust the size of the longitudinal space/gap **196** between the central loading platform **164** and first folding platform **163**, and the size of the longitudinal space/gap **197** between the central loading platform **164** and second folding platform **165** (FIG. **18**).

[0099] Movement of successive groups **122** of items **102** across pedestal apparatus **140** may be achieved using movement rods **200-1**, **200-2** of rod movement sub-system **203**. Specifically, movement of each collated group **122** of items **102** across components of pedestal apparatus **140** may be facilitated using leading movement rod **200-1** and trailing movement rod **200-2** which can be positioned longitudinally, on longitudinally opposite, front and rearward transverse sides of each group **122** of collated items **102**. Leading movement rod **200-1** and trailing movement rod **200-2** may be each driven

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to move generally longitudinally, independently of each other, and the movement of each may be controlled by PLC **132**.

[00100] FIGS**. 9A-C** depict rod movement sub-system **203** including leading movement rod **200-1** and trailing movement rod **200-2**. In these figures, rod movement sub-system **203** has been isolated from further components of system **100** including (apart from in FIG. **9C**) components of pedestal apparatus **140**, for ease of illustration. Moving rod sub-system **203** may comprise a leading rod movement system **212** and a trailing rod movement system **213**, which may have similar components. Leading rod movement system **212** may facilitate the movement of leading movement rod **200-1** and trailing rod movement system **213** may facilitate the movement of trailing movement rod **200-2**. Leading movement system **212** and trailing movement system **213** may be mounted to components of system frame **115** using mounting blocks **211**.

[00101] Leading rod movement system **212** may comprise a motor **204-1**, a pair of transversely spaced drive chains **202-1**, a plurality of idler wheels / cogwheels **214**, and leading movement rod **200-1**. Similarly, trailing movement system **213** may comprise a motor **204-2**, a pair of laterally spaced drive chains **202-2**, a plurality of idler wheels / cogwheels **214**, and trailing movement rod **200-2**. Motors **204-1**, **204-2** may be servomotors or similar systems configured to receive an input from a PLC **132** to determine a direction to rotatably drive a drive wheel (i.e. clockwise or counter-clockwise). Idler wheels **214** may include bearings and be attached to contact points such that they may rotate freely in both rotational directions. Motors **204-1**, **204-2** may be configured to operate in both directions and varying speeds under control of PLC **132**.

[00102] Leading movement rod **200-1** may be configured to move on its cyclical path suspended between the pair of laterally spaced, longitudinally and vertically running, continuous conveyor chains **202-1**. Conveyor chains **202-1** may each extend and move in a path around a plurality of spaced toothed idler wheels **214**. The paths of each of conveyor chains **202-1** may have a top run path portion **205-1** and side and bottom run path portions. Top run path portions **205-1** may be oriented generally horizontally and longitudinally and generally in the same horizontal plane to each other. Conveyor chains **202-1** may be driven by motor **204-1** that has a drive wheel which is operable to engage directly or indirectly at least one of the conveyor chains **202-1** and drive the transversely spaced pair of conveyor chains **202-1** on their path in both a forward and rearward direction under control of PLC **132**. Movement rod **200-1** may be mounted with mounting blocks **209-1** to, and extend laterally and horizontally between, conveyor chains **202-1**. Movement rod **200-1** may be positioned during operation to move backwards

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and forwards with the movement of chains **202-1** generally along the path of the top run portion **209-1** of the conveyor chains **202-1**.

[00103] Trailing movement rod **200-2** may be configured and driven in a similar manner to leading movement rod **200-1**. Trailing movement rod **200-2** may be configured to move on its path suspended between a first pair of laterally spaced, longitudinally and vertically running, continuous conveyor chains **202-2**. Conveyor chains **202-2** may be spaced laterally outside of conveyor chains **202-1** as depicted in FIGS. **9**A and **9**C. Conveyor chains **202-2** may each extend and move in a path around the plurality of spaced toothed idler wheels **214**. The paths of each of conveyor chains **202-2** may have a top run path portion **205-2** and side and bottom run path portions. The top run path portions **205-2** may be oriented generally horizontally and longitudinally and generally in the same horizontal plane to each other. Conveyor chains **202-2** may be driven by a motor **204-2** that has a drive wheel which is operable to engage directly or indirectly at least one of the conveyor chains **202-2** and drive the pair of conveyor chains **202-2** on their path in both a forward and rearward direction under control of PLC **132**. Movement rod **200-2** may be mounted with mounting blocks **209-2** to, and extend laterally and horizontally between, conveyor chains **202-2**. Movement rod **200-2** may be positioned during operation to move backwards and forwards with the movement of chains **202-2** generally along the path of the top run portion **209-2** of the chain conveyor **202-2**.

[00104] Components of leading rod movement system **212** and trailing rod movement system **213** including pairs of conveyor chains **202-1**, **202-2**, idler wheels **214**, motors **204-1**, **204-2** may be interconnected to, and supported on a pair of longitudinally and vertically extending plates **216**. Plates **216** may be mounted to frame **115** using blocks **211**.

[00105] Movement rods **200-1, 200-2** may be each cylindrical in shape (e.g. circular in cross-sectional shape). In other embodiments, Movement rods **200-1, 200-2** may have cross sectional shapes that are non-circular. In some other embodiments (for example when dealing with relatively light weighted items **102**), in order to engage the leading and trailing sides of a group **122** of items (and an erected case **111**C containing such group of items) the movement rods **200-1, 200-2** may not extend continuously across the entire transverse span, and may have for example have opposed cantilevered rod portions extending inwards towards each other from a support (such as a conveyor chain) at only one end thereof.

[00106] As is illustrated in particular in FIGS. **9**, **9**C and **10**, top run path portions **205-1** and **205-2** of conveyor chains **202-1**, **202-2** respectively may be positioned laterally outward of components of pedestal apparatus **140**. Similar to the bumper members **126**, opposed guide members **206** collation

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platform **120** may extend longitudinally on transversely opposite sides of input transfer platform **162**; first folding platform **163**; central loading platform **164**; and second folding platform **165**. Guide members **206** may also be constructed with metal support frames and having inner support surfaces of a similar low friction, high rigidity material such as UHMW polyethylene. In the longitudinal area of guide members **206** adjacent to central loading platform **164**, the inward facing surface of opposite guide members **206** are spaced further apart than elsewhere along the opposed guide members **206** (e.g. the inward facing surfaces of opposed guide members **206** may be notched for a short longitudinal distance). This additional transverse spacing adjacent to central loading platform **164** assists in providing sufficient room for the erected case **111**C carried by robotic arm **250** to be able to sheath the group **122** of items **102** with an erected case **111C** while the group rests on the central loading platform. In general, the inward facing, spaced surfaces of opposed guide members **206** help ensure the maintenance of the upright positioning and ordered arrangement of the group **122** of collated items **102** during movement over components of pedestal apparatus **140** by movement rods **200-1**, **200-2**. Longitudinally extending, horizontally oriented guide members **206** may be supported by longitudinally spaced, transversely oriented support arms **215** connected to a central movement apparatus **207** that is operable to provide for reciprocating inward and outward movement of guide members **206**, relative to a group **122** of items **102** and an erected case **111C** when positioned near the group, and when being moved to sheath a group with an erected case. Guide members **206** may each be linked to a motor or linear actuator configured to receive an operational input from PLC **132** to move from a first position (directly abutting collated group **122**) to a second position (providing clearance for the erected case **111C**).

[00107] As illustrated in FIG. **9**, a collated group **122** of items **102** is positioned on input transfer platform **162**. Trailing movement rod **200-2** is in an operational engagement position, located longitudinally behind a group **122** of collated items **102** and within or below the opening of gate **208**, with gate **208** in an open position. Leading movement rod **200-1** is in its corresponding start position directly in front of the forward face of a group **122** of collated items **102**. Trailing movement rod **200-2** is in a position or close to a position where it can engage the rearward side of the group **122** and then push the group **122**, resulting in the sliding of the group of items in a forward longitudinal direction from input transfer platform **162**, over first folding platform **162** and onto the central loading platform **164**. Upper support surface of central loading platform **164** may have its longitudinal distance and position selected relative to the support surface of the first folding platform **163** by PLC **132** operating valve system **332** to operate actuator **194**, to adjust the size of the longitudinal space/gap **196** between the

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central loading platform **164** and first folding platform **163** to be sufficiently small to ensure that the items **102** in each group **122** passing from first folding platform **163** to central loading platform **164**, do not have any problems in passing over the gap **196** (i.e. gap **196** is not so large such that when passing over the gap, that one or more items **102** may become dis-oriented so as to disrupt the ordered configuration of the collated group **122**). This is particularly important when trying to load items **102** that have a relatively small dimension in the longitudinal direction.

[00108] Leading movement rod **200-1** and trailing movement rod **200-2** will be configured and positioned sufficiently vertically high enough above the support surfaces of the input transfer platform **162**, first folding platform **162** and central loading platform **164** that the movement rods will engage the group **122** of items **102** in a manner which does not cause them to fall over, or break up the collated group when moved. Leading movement rod **200-1** and trailing movement rod **200-2** (operating in conjunction with side guide members **206**) will be configured and positioned so as to confine the group **122** in the ordered array, and be able to slide the group **122** over the support surfaces while maintaining the integrity of the relative positioning of the items **102** within the group **122.** The vertical positioning of the movement rods **200-1**, **200-2** (and of guide members **206**) may be chosen depending in part on the vertical height and centres of gravity of the items **102**. Leading movement rod **200-1** may thus be positioned and operable to move in synchronized movement with trailing movement rod **200-2**, to hold collated items **102** together during such sliding movement of the group **122** onto central loading platform **164**, to prevent toppling and maintain the grouping formation. Leading movement rod **200-1** may be operated so as to apply a small amount of force in the opposite, rearward direction on collated items **102** to prevent toppling and hold the group **122** in the desired ordered array of items **102**.

[00109] Similarly, movement rods **200-1**, **200-2** may also be configured to move in the opposite rearward direction and to move a group **122** of items therewith also in an opposite, rearward movement. During this operation, leading movement rod **200-1** may provide the necessary force to move the collated items **102** backwards, and trailing movement rod **200-2** may provide similar support to prevent toppling and maintain grouped formation. This rearward movement of a group **122** may be utilized to facilitate the sealing of a lower flap of an erected case **111**C, as described herein.

[00110] Trailing and leading movement rods **200** may each be driven independently under control of PLC **132**. Therefore, PLC **132** will manage conveyor chain movements to ensure each movement rod **200-1**, **200-2** is appropriately moved such that the two movement rods will not interfere with each other's movement.

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[00111] FIG. **9**C is a top view of movement assembly **210**. As can be seen, the individual spaced chains of each pair of drive chains **202-1** and **202-2** may be spaced apart on opposite sides of components of pedestal apparatus **140** a sufficient distance sufficient to allow components of pedestal apparatus **140** to fit therebetween. For illustrative purposes, the components of pedestal apparatus are not shown in this figure. According to some embodiments, the entire pedestal apparatus **140** may be fastened to and suspended within the planar support plates **216**. Thereby, the path of movement rods **200-1**, **200-2** carried by their respective conveyor chains, may sweep under pedestal apparatus **140**. Thus, movement rods **200-1**, **200-2** generally move in one forward, cyclical direction in the path defined by the conveyor chains, apart from some limited, opposite rearward movements, as described herein.

[00112] PLC **132** can provide operational signals to the motors **204-1**, **204-2** of movement rods **200-1**, **200-2** to transport successively, spaced groups **122** of collated items **102** from the input transfer platform **162** across the input transfer platform **162** and the first folding platform **163** to a casing position on the central loading platform **164**. There, leading and trailing movement rods **200-1** and **200-2** can be moved in operational directions a short longitudinal distance apart from the respective rearward and forward sides of the collated group **122** of items. This can provide sufficient clearance (e.g. approximately **0.5**" (**1.27**cm) in each direction) for case sheathing / bottom loading of items as will be described further hereinafter. This movement apart of leading and trailing movement rods **200-1** and **200-2** from the respective rearward and forward sides of the collated group **122** of items (along with the moving apart of guide members 206) from the side surfaces of the collated group 122 may take place after the initial engagement of an erected case 111C with the group as described hereinafter.

[00113] As a group **122** of collated items **102** is being delivered by movement rods **200-1**, **200-2** from the collation platform **120** to central loading platform **164**, a knocked-down, flattened case blank **111**A may have already been converted to an erected case **111C** by robotic arm **250** which can retrieve a flattened blank **111**A delivered to a pick up position from or within blank magazine **251**. As shown in FIG. **11**, a knock-down flattened case blank **111** (such as one described with relation to FIG. **3**), may be retrieved by an end effector **252** of robotic arm **250**. Robotic arm **250** may have a first arm segment **250'** mounted to a robot mounting plate **253**, in a position generally vertically above central loading platform **164**. Mounting plate **253** may in turn be fixedly connected to one or more support frame members **115'**.

[00114] According to some embodiments, magazine **251** containing a stack of knock-down case blanks **111** may be situated within an operating radius / reach of robotic arm **250**. With particular reference to FIGS. **11** and **11**A, an example robotic arm that may be suitable is the FANUC M-**20**iA/**12**A

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Series Robot made by Fanuc Corporation and/or an affiliated company, having a payload of **12** Kg, an arm reach of **2009** mm. Robotic arm **250** be equipped with end effector **252** mounted to the end of a plurality of interconnected arm segments **250'** of robotic arm **250** and which enable end effector **252** to be rotated about six different axes of rotation R**1** to R**6** as illustrated in FIG. **11**A. Robot axes of rotation are dependent upon each other as a result of the specific configuration of the robotic arm **250**. Having a plurality of plurality of arm segments **250'**, **250''**, **250'''** and **250''''** that provide for rotation of an end effector **252** about several axes of rotation provides enhanced flexibility in the path that the end effector **252** can take with a flattened case blank **111**A and in particular with an erected case blank **111**C.

[00115] In the illustrated embodiment, arm segment **250'** may be rotatable about a longitudinal axis R**1** that extends along a centre longitudinal axis of arm segment **250'**. Arm segments **250'** and **250''** may be pivoted relative to each other about a pivot mechanism having an axis of rotation R**2**. Arm segment **250''** may be rotatable about a longitudinal axis R**3** that extends along a centre longitudinal axis of arm segment **250''**. Arm segments **250''** and **250'''** may be pivoted relative to each other about a pivot mechanism having an axis of rotation R**4**. Arm segments **250'''** and **250''''** may be pivoted relative to each other about a pivot mechanism having an axis of rotation R**5**. Arm segment **250'''** may also be rotatable about a longitudinal axis R**6** that extends along a centre longitudinal axis of arm segment **250'''**.

[00116] According to some embodiments, the robotic arm **250** may be operable in five or less axes of rotation and still achieve a path for a specific configuration of erected case blank **111C** to bottom load a group of items of specific configuration. However, as described herein, a **5** or **6** axes robot is preferably used for the bottom loading sequence to provide a particularly desirable path of end effector **252**, and an erected case **111**C held by the end effector. Modifications to the movement path and position of the robotic arm **250** may be made to accommodate a specific determined number of axes of rotation.

[00117] End effector **252** may have a first arm **254**A and a second arm **254**B. First arm **254**A may be rotatable relative to second arm **254**B. While second arm **254**B may be attached in a fixed position relative to robot arm segment **250'''** to which it is attached, first arm portion **254**A may be operable to rotate about an axis R**7** (see FIG. **12**). An actuating mechanism **261** which may be a Rotary Compressed Air Cylinder or a Servo Actuated Device may be provided to facilitate rotation of first arm **254**A relative to second arm **254**B under control of PLC **132**.

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[00118] Each of first arm **254**A and **254**B may be provided with suction cups **313**, **312** respectively. Vacuum forces may be generated at the suction cups in a variety of ways including providing hoses delivering pressurized air to vacuum generators mounted on the end effector, with the vacuum generators interconnected to the suction cups **313**, **312**. Electronic valves (not shown) that are part of a valve system **332** (FIG. **2**) under the control of PLC **132** may be provided to control the flow of pressurized air to the vacuum generators and thus to control the vacuum at suction cups **313**, **312** including being able to turn on and off the vacuum generated at the suction cups. Arm **254**B of end effector **252** may have a plurality of hollow suction rods **327** with a generally square rectangular shape and peripheral flanged openings, each receiving a suction cup **312**. It should be noted that while many types of suction cups **312**, **313** may be employed on the end effector **252**, a preferred type of suction cup is the model B**40**.**10**.**04**AB made by Piab. Each suction cup **312**, **313** may connected to an outlet from a vacuum generator. The vacuum generator may be any suitable vacuum generator device such as for example the model VCH**12**-**016**C made by Pisco. Vacuum generators each have an inlet interconnected to a hose (not shown) that can carry pressurized air from an air compressor or other vacuum source to the vacuum generator. The vacuum generator converts the pressurized air supplied to the inlet port into a vacuum at one of the outlet ports. That vacuum outlet port is interconnected to a suction cup **312**, **313** so that the suction cup can have a vacuum force. A solenoid valve device that is part of valve system **332** may be interposed along the pressurized air channel running between each vacuum generator and the source of pressurized air. The solenoid valve device may for example be a model CPE**14**-M**1**BH-**5**L-**1/8** made by Festo.Valve system **332** is in electronic communication with PLC **132** and controlled by PLC **132**. In this way PLC **132** can turn on and off the supply of vacuum force to the suction cups **312**, **313**.

[00119] Robotic arm **250**, with end effector **252** ,under control of PLC **132**, may be operable for successively picking up knock-down case blanks **111A** located at the case blank pick up position in magazine **251**, opening the blanks **111A** to form an erected case **111C** and moving the erected case **111**C towards the central loading platform **164**. When a group **122** of collated items **102** is located at the central loading platform **164**, robotic arm **250** may manipulate the path of the end effector **252**, and the erected case **111**C held by the end effector, to sheath the group **122** of items resting on central loading platform **164** of pedestal apparatus **140**.

[00120] According to some embodiments, magazine **251** holding the knock down blanks may be configured to lift the stack of blanks to an operating height, such that the topmost blank is always in a specific position. According to other embodiments, the end effector **252** may be equipped with an electronic eye sensor such as the model **42**KL-D**1**LB-F**4** made by ALLEN BRADLEY. The electronic eye

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sensor may be configured to detect the position of the top-most blank **111**A, and generate signals for the PLC **132** to follow a specific path for movement of the robotic arm **250**.

[00121] The end effector **252** may engage with a blank **111**A. The end effector is then raised vertically in the Z-direction, lifting blank **111**A. In consequence of this operations (as shown in FIG **12**), the blank begins to open-up (blank **111**B) as arm **254**A is rotated relative to arm **254**B.

[00122] As end effector **252** continues to move vertically upwardly, arm **254**A of end effector **252** may be activated by the actuator, to ensure the knock-down blank 111A is opened to have a substantially right-angle cross section. According to some embodiments, arm **254**A may also be equipped with a suction cup head system **313** as previously described. With the case blank opened to a partially opened form **111**B (FIG. **12**) to a fully erected form of case **111**C, panel A of the sleeve (seen in FIG **13**) abuts arm **254**A of the end effector **252**.

[00123] A fully opened, erected case **111**C (having a configuration as shown in FIG. **3**C) may be moved by end effector **252**, from the position shown in FIG. **13** to (i) a preloading position above central folding platform **164**, then to (ii) to a loading commencement position shown in FIGS. **14**, **15**, and **24A**, then to (iiii) a fully engaged position as shown in FIG. **24B**, and then to (iv) a fully loaded position as shown in FIGS. **16** and **24C**, with the group **122** of items fully located within the bounds of storage space **107** of erected case **111C.** In this fully loaded position (iv)**,** the erected case **111C** has been placed over the group **122** of collated items **102** while the group **122** is positioned on central loading platform **164** and the movement rods **200-1, 200-2** and guide members **206** are in retracted positions.

[00124] Prior to end effector **252** moving an erected case **111C** to the loading commencement position (ii), to commence a loading sequence of movement of erected case **111C** with the group of items **122**, upper support surface of central loading platform **164** may have its longitudinal distance and position adjusted relative to the support surface of the first folding platform **163** and second folding platform **165** by PLC **132** to thereby adjust the size of the longitudinal space/gaps **196, 197** between the central loading platform **164** and first and second folding platforms **163, 165** to be sufficiently large to ensure that bottom leading and trailing flaps F, G of erected case **111C** can be brought vertically down through the gaps **196, 197**, when the erected case **111C** sheaths the group **122** of items **102** as they are supported on the support surface of central loading platform **164.** PLC **132** can take into account any such adjustment when positioning end effector **252** of robotic arm **150** in the loading commencement position (ii) shown in FIGS. **14**, **15**, and **24A**.

[00125] According to embodiments where the robotic arm **250** has a plurality arm segments and a corresponding plurality of axes of rotation, the case **111C** can be placed in the pre-loading position and

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orientation (i) generally above central loading platform **164** and at a vertical distance sufficiently above the uppermost surface of the items in the group **122** to be loaded. However, in the initial pre-loading position (i), no portion of the bottom edges of any of the bottom flaps J, K, F, G may be vertically below the top surface of the items. This initial pre-loading position (i) allows the group **122** of items to be moved onto the central loading platform **164** with sufficient clearance to avoid contact with any items and / or cause any bottom flaps to become misaligned with their respective side panels.

[00126] Once a group **122** of items **102** is correctly longitudinally positioned on central loading platform **164**, the case **111C** may be moved by end effector **152** under control of PLC **132** from the preloading position (i) above central folding platform **164**, to the loading commencement position (ii) shown in FIGS. **14**, **15**, and **24A**. At this loading commencement position, the case **111**C may have a tilt angle (see FIG. **15**) in its angle of approach to a group **122** of items **102**. Prior to sheathing a group **122** with an erected case **111**C, the case at the loading commencement position (ii) may be held by end effector **252** with both a transverse tilt angle about a longitudinal Y direction axis relative to the vertical axis Z (i.e. the angle α towards the X axis) and a longitudinal tilt angle about a transverse X direction axis relative to the vertical axis Z (i.e. the angle β towards the Y axis). Tilt angles α and β may each range from **5** degrees to **20** degrees, dependent on the constructed case **111C**, dimensions of the collated items **122** and the approach path determined by PLC **132**. The angles α and β may be determined for the constructed case **111**C to approach collated items **122** having a combined tilt angle comprising angles both α and β.

[00127] End effector **252** may move case **111C** to a loading commencement position proximate to the group **122** with tilt angles α and β and may have a bottom corner **1111A** of case **111C** (FIG **24A**) positioned very close to, and possibly making slight contact with, a corresponding top corner area **122A** of the group **122** of items **102.** The inward facing surfaces of bottom flaps K and G at the corner region of bottom corner **1111A** may be directly facing and possibly contact edge surface at the corner **122A** of the group **122**.

[00128] It should also be noted that bottom flaps J,K F, G may be joined to their respective panels A-D, in a manner such that when panels A-D are titled at a tilt angle, flaps J,K F, G remain in a respective planar relationship to the respective side panel and remain at the same tilt angle(s) as the panels A-D (i.e. the joint has a certain degree of resistance to rotation / stiffness and can resist the forces/torque about the joint result from inertia based on the movement of the robotic arm **250** acting on the tilted flaps).

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[00129] Tilting erected case **111**C may allow for a side flap K of the bottom flaps of opened case **111**C to be vertically lower than the opposite side flap J, as shown in the position of FIGS. **14** and **15**. Thus, the bottom edge of flap K may be in a position that it will not catch upon the top neck surface or other top surface regions of the outside row of items **102** This tilting angle may allow for the transverse positioning of the bottom edge of opposite flap J to have an appropriate transverse clearance distance **199** (FIG. **15**) from the top neck regions of the inside row of items **102** and thus can also avoid the bottom edge of flap J from catching on the neck region / closure of an item.

[00130] End effector **252** may then commence to rotate / pivot the case **111C** substantially about the bottom corner **122A**, such that the diagonally opposite bottom corner **1111B** of the case will be moved in a generally arced path towards the corresponding diagonally opposite top corner **1111B** of the group **122**. During this pivoting movement, the case **111C** will eventually reach the position shown in FIG. **24B** where the diagonally opposite bottom corner **1111B** of the case is positioned directly adjacent / proximate to the corresponding diagonal top corner **1111B** of the group **122** and all four bottom corners of the erected case lie in a horizontal, longitudinally and transversely extending plane. The bottom plane defined by the bottom edges of the bottom flaps F, J, G, K, will have become parallel to, if not co-planar with, a horizontal plane defined by a top surface plane of the group **122** of items. This arced movement of the case corner **1111B** , pivoting around corner **1111A**, and in the pivoting diagonal planar movement of the bottom plane defined by the bottom edges of the bottom flaps, towards a horizontal plane defined by the top surface plane of the group of items, allows for easier sheathing of the collated items. To accomplish this pivoting movement of the case, robotic arm **250** may cause effector **252** to be rotated about a plurality of the multiple axes **R1** to **R6** (FIG. 11A), including axes **R5** and **R6** in order to reduce angles α and angle β to approximately zero.

[00131] It should be noted that a six rotational axis robotic arm 250 is particularly useful for system 100 as it provides a high degree of flexibility in the path that that the end effector can take during operation, including in the path used in moving the erected case **111**C through the loading sequence positions (i) to (iv). Having a six rotational axis robot is also useful in providing flexibility in movement when handling cases of different dimensions, when system 100 needs to be re-configured for handling cases of different dimensions.

[00132] During the movement of case **111C** from the loading commencement position shown in FIGS. **14**, **15**, and **24A**, to the fully engaged position as shown in FIG. **24B**, leading and trailing movement rods **200-1** and **200-2** may co-operate with side guide members **206** to securely hold the group **122** of items **102** together by maintaining contact / engagement with the sides of the group. Thus, while this

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initial loading sequence takes place, the group of items may continue to be held in a tight configuration by the movement arms **200-1, 200-2** at the front and rear faces of group, and by the guide members **206** on the side faces of the group.

[00133] The movement apart of leading and trailing movement rods **200-1** and **200-2** from the respective rearward and forward sides of the collated group **122** of items (along with the moving apart of guide members **206**) from the sides of the collated group 122 may take place after erected case **111C** has reached the fully engaged position (iii) as shown in FIG. **24B** but before the erected case is moved to the fully loaded position (iv).

[00134] For the next sequence of movement to the fully loaded position, additional space for end effector **252** to move the erected case **111**C vertically downwards over the group **122** of items may be provided by PLC **132** operating central movement apparatus **207** to move longitudinally extending, horizontally oriented guide members **206** outwards a short distance (for example in the range of **2** to **9** inches relative to a group **122** of items **102** when positioned on the central loading platform **164)**.

[00135] Next, the robotic arm may move the end effector **252** and the case **111**C held by the end effector from the fully engaged position (iii) vertically downwards (parallel to axis Z) in order to fully sheath the group **122** of items **102** with the erected case **111**C. In this fully loaded position (iv) shown in FIG. **24C**, the group **122** of items is located entirely within the interior storage space **107** of the erected case **111C** and the side flaps J and K (along with leading and trailing flaps F and G) are all positioned below the item support surface of central loading platform **164**.

[00136] In other embodiments, erected case **111C** may in the loading commencement position shown in be angled at an angle α in the opposite angular direction to the vertical, in such a manner that main side flap J is initially, when in the preloading position, positioned vertically lower than opposite side flap K, and case **111C** is in the opposite angular position about axis Z to the orientation shown in FIG. **15** and then the arced movement described above may be between opposite diagonal bottom corners of the case 111C and the top surface corners of the group **122**.

[00137] As shown in FIG. **16** and **17**, when the storage space **107** of erected case **111C** holds the group **122** of collated items **102**, end effector **252** of robotic arm **250** may be disengaged by PLC **132** by operating electronic valves to turn off the suction cup engagement of cups **312**, **313** with case **111C**. thus releasing the case 111C from end effector 252. Robotic arm 250 will then move away, and return to the blank magazine 251 and be ready to engage a new case blank. Also, once end effector **252** has moved the erected case **111C** vertically downwards over the group **122** of items to the fully loaded position (iv), a further input may be provided by PLC **132** operating central movement apparatus **207** to

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move longitudinally extending, horizontally oriented guide members **206** inwards again a short distance (for example in the range of **2** to **9** inches relative to a group **122** of items **102** and the case **111C** containing the same Thus, guide members **206** can again provide side support for movement of the erected case **111C** containing the group **122** of items **102** during the training and leading bottom flap movements described hereinafter.

[00138] Turning to FIG **18** and **19**, leading and trailing, bottom flaps F and G respectively of an erected case **111**C may be folded about their joints with panels A and C respectively, via horizontal, longitudinal movements across the pedestal apparatus **140**. It should be noted that in FIGS. **18** and **19**, the upper flaps E, I, H and L have been omitted for clarity. Also, in FIG. **19**, panel K has also been omitted for clarity. First folding platform **163** and second folding platform **165** may be adjustable up and down in the vertical axis using pneumatic piston devices **167-1** and **167-2** that are interconnected thereto, controlled by valves of system **332**, operated by PLC **132**, such that each platform surface of first folding platform **163** and second folding platform **165** may adjust its vertical distance and position relative to the surface of the surface of central loading platform **164**, to fulfil the functions described hereinafter.

[00139] First folding platform **163**, second folding platform **165** and central loading platform **164** may be supported by a pedestal support frame **168**. As referenced above, the entire pedestal apparatus **140** may be fastened to and suspended within the planar support plates **216** so that movement rods **200-1**, **200-2** carried by their respective conveyor chains, may sweep under pedestal apparatus **140**.

[00140] PLC **132** may provide signals to valve system **332**, to control movement of piston device **194** such that the upper support surface of central loading platform **164** may have its longitudinal distance and position adjusted relative to the support surfaces of the first folding platform **163** and second folding platform **165** to thereby adjust the size of the longitudinal space/gap **196** between the central loading platform **164** and first folding platform **163**, and the size of the longitudinal space/gap **197** between the central loading platform **164** and second folding platform **165** (FIG. **18**) to facilitate the bottom flap F, G, folding sequences described hereinafter.

[00141] Movement rods **200-1**, **200-2** may move into contact with and engage with the forward and rearward exterior surfaces of respectively, leading panel A and trailing panel C, of erected case **111**C. Trailing movement rod **200-1** is able to apply a force to the exterior surface of panel C to slide the erected case **111**C containing a group of items (illustrating only a single leading row **102-1** and a single trailing row **102-2** in FIG. **19**). By moving the opened case **111**C right / longitudinally forward using movement rods **200-1**, **200-2** together in tandem (i.e. towards second folding platform **165**), leading flap F is folded inwardly onto the top surface of second folding platform **165** beneath the row of bottles **102-**

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1, this motion being assisted by ramp **306**r. At the same time, trailing flap G is folded outwardly onto the top of central loading platform **164** being deflected upwards with the assistance of ramp **310**r. This motion is illustrated between steps S**1900** and S**1910** in FIG. **19**.

[00142] Next, first folding platform **163** and second folding platform **165** are raised under control of PLC **132** so their top support surfaces are at a position slightly higher than the support surface of central loading platform **164** (with the surface of second folding platform **165** being raised slightly more than the surface of first folding platform **163**). According to some embodiments, the first folding platform **163**, second folding platform **165** and central loading platform **164** may all be similar in size. Movement rods **200**-**1** and **200**-**2** then shift the case **111C** back to the left / rearward (i.e. onto central loading platform **164**) as illustrated in step S**1920**.

[00143] As is apparent in S**1920**, as the open and loaded case **111C** shifts back onto the central loading platform **164**, the trailing minor flap G is folded back vertically downwards to substantially its starting orientation, perpendicular to the item support surfaces of the platforms of pedestal apparatus **140**. This folding action is effected by the leading edge of trailing flap G, catching ramp **308**r of first folding platform **163** -- due to the surface of first folding platform **163** having been raised to a position above the surface of central loading platform **164** -- and being directed / deflected downwards. Leading flap F is located between the top surface of central loading platform **164** and the bottom surface of the leading row of bottles **102**-**1**.

[00144] Next, second folding platform **165** is lowered by control of PLC **132** to a position where its support surface is slightly below the support surface of central loading platform **164** (approximately **0.5**") and the movement rods **200**-**1** and **200**-**2** under control of PLC **132** shift case **111**C rearwards towards the first folding platform **163**, as shown in S**1930**. During this shift onto the first folding platform **163**, trailing flap G is deflected upwards and folded onto the top surface of first folding platform **163** beneath the trailing row of bottles **102**-**2**, this motion being assisted by ramp **308**r such that the opened case **111**C and its minor flaps F, G, reach the position shown in S**1930**. In this position, trailing flap G is now also folded horizontally inwards and is perpendicular relative to the vertical side walls of the opened case **111**C. Trailing flap G is located between the top surface of first folding platform **163** and the bottom surface of the trailing row of bottles **102**-**2**.

[00145] In the final movement in the sequence, second folding platform **165** is moved under control of PLC **132**, so that its support surface is in a slightly raised position higher the support surface of central loading platform **164** (approximately **0.5**") and movement rods **200**-**1** and **200**-**2** shift case **111**C forward again to be completely on the surface of the central loading platform **164** such that during the shift

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forward, the trailing flap G is maintained in a horizontal position and the leading edge of trailing flap G catches ramp **310**r of central loading platform **164**.

[00146] Thus, as shown in S**1940**, when the opened case **111**C and bottles **102**-**1**, **102**-**2** contained therein are again centrally located on the support surface of central loading platform **164**, leading flap F and trailing flap G have been both folded horizontally inwards and are perpendicular relative to the vertical side walls of the opened case **111**C. Leading flap F is located between the top surface central loading platform **164** and the bottom surface of the leading row of bottles **102**-**1**. Trailing flap G is located between the top surface of central loading platform **164** and the bottom surface of the trailing bottles **102**-**2**. The result is that now the flaps F and G have both been moved into an operationally closed supporting position beneath the rows of bottles **102**-**1**, **102**-**2**.

[00147] Variations of the foregoing sequential movements of case **111**C and flaps F, G, relative to the first folding platform **163**, central loading platform **164** and second folding platform **165** are possible. For example, in a first movement of case **111**C effected by movement rods **200**-**1**, **200**-**2**, case **111**C may be moved backwards onto first folding platform **163** a sufficient rearward distance to place trailing flap G between the bases of rearward row(s) of items and the surface of the folding platform **163**. This may be assisted by the leading edge of flap G catching ramp 308r. This movement may also cause leading flap F to become angled upwards from the vertical downwards direction, and outwards.

[00148] In a second movement of case **111**C effected by movement rods **200**-**1**, **200**-**2**, case **111**C may be moved forwards, back onto central loading platform **164**, allowing leading flap F to drop down. Platform **163** may have been raised sufficiently relative to central platform **164** to ensure trailing flap G catches ramp **310r** and is positioned between the bases of rearward row(s) of items and the surface of the central loading platform **164** during this forward movement.

[00149] In a third movement of case **111**C effected by movement rods **200**-**1**, **200**-**2**, case **111**C may be moved forwards from central loading platform **164** onto second folding platform **165**, allowing leading flap F to be folded upwards and inwards. Platform **165** may have been lowered sufficiently relative to central loading platform to ensure trailing flap G catches ramp **306r** and moves between the bases of rearward row(s) of items **102** and the support surface of the second folding platform **165** during this forward movement. After this movement, the result is that now the flaps F and G have both been moved into an operationally closed supporting position beneath the rows of bottles **102**-**1**, **102**-**2**.

[00150] Turning now to FIG. **20**, after having bottom flaps F and G, moved to the closed position the collated items **102** having been bottom-loaded into the case **111**D, the movement rods **200**-**1**, **200**-**2** may re-engage case **111**D to move case **111**D containing the collated items **102** in storage space **107** to a

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platform **172** of an output conveyor **170**, where the case **111**D is handed off to output conveyor **170** for further processing. A linear actuator may be affixed to central loading platform **164**. This linear actuator may bring collated items closer to robotic arm **250**, and reduce the gap between the central loading platform **164** and either of first folding platform **163** and second folding platform **165**.

[00151] To review the overall movement of movement rods 200-1, 200-2 (with particular reference to FIGS. **9** and **9A-C**), the movement rods **200-1** and **200-2** will receive a group **122** of collated items delivered from collation platform **120** by transfer paddle **150**. Movement rods **200-1** and **200-2** are moved by pairs of continuous looped conveyor chains **202-1, 200-2**. Movement rods **200-1** and **200-2** primarily move in a single cyclical direction (i.e. across the surface and clockwise as shown in FIG. **9**). Once each movement rod **200-1**, **200-2** reaches the downstream end edge area of the pedestal apparatus **140**, the movement rods will return and are cycled back to their start positions to await the next group **122** of items **102** to be loaded into a case. In the illustrated embodiment, chains **202-1, 202-2** each form loops extending about a physical perimeter of the pedestal apparatus **140** (i.e. above and below). As shown, returning to the start positions is facilitated by movement rods **200-1**, **200-2** traversing with the chains in a cyclical path direction below the pedestal apparatus **140**, until they have returned to their starting positions. Once there, the entire process of engagement / dis-engagement with a group **122** of items **102** may be repeated. In the illustrated embodiment, throughout this cycle of movements, the leading movement rod **200-1** remains ahead of the trailing rod **200-2**.

[00152] In other embodiments, the movement rods **200-1** and **200-2** may be alternatively operated without the use of a chain loop extending around such a perimeter. For example, movement rods **200-1** and **200-2** may be configured to only traverse across a top surface, and return to the initial point by moving counter clockwise. Movement rods **200-1** and **200-2** may further alternatively be positioned extending from a vertical drivetrain and may be configured to optionally articulate in and out of the path of collated items **122**.

[00153] Each collated group **122** will be transferred from collation platform **120** via transfer paddle **150**. Each group **122** will have a leading face (i.e. a front or first row) and trailing face (i.e. a back or last row). Transfer paddle **150** will shift the entire collated group **122** by applying force to the back row. This will translate across the entire collated group **122**, shifting all individual items **102**. As the front row reaches the downstream end region of input transfer platform **162**, it will meet and be engaged by leading movement rod **200-1**, positioned at a cycle start position above and at the downstream end region of input transfer platform **162**. Trailing movement rod **200-1** will be positioned in its cycle start position below input transfer platform **162**, at a longitudinal downstream position that allows the

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collated items **122** (still being moved by the transfer paddle **150**), to move downstream on surfaces of collation platform **120** and input transfer platform **162**, until the back row of the group **122** has crossed over the gate **208** and is positioned onto the input transfer platform **162**. Once there, the trailing movement rod **200-2** moves from its cycle start position below gate **208**, after gate **208** is opened, to an operational engagement position where it meets and engage with the back row of collated group **122**. Once both movement rods **200-1** and **200-2** have engaged with the front and back rows of the collated group **122** respectively, the movement rods **200-1** and **200-2** may be used to move together in tandem to translate the collated group to the central loading platform **164**.

[00154] There, at some point prior to or during the case loading sequence, movement arms **200-1** and **200-2** will temporarily move in opposite directions from the collated group, providing between **0.5**" to **2**" of space for the collated group to be sheathed with a constructed case **111**C by robotic arm **250** as described above.

[00155] After the collated group has been sheathed with constructed case **111**C, movement arms **200-1** and **200-2** will both move in their respective directions towards front and rear faces of the panels of the erected and loaded case **111**C, and may move as previously described to fold bottom minor flaps. Once this bottom leading and trailing flap F, G folding and closing has occurred, the movement arm **200-2** will push the constructed case **111**C to the output conveyor **170**. This final movement for the constructed case **111C** to be delivered to the output conveyor **170**, requires the leading movement arm **200-1** to move out of the way of the constructed case **111**C. In the illustrated embodiment, as the case approaches the output conveyor **170**, movement arm **200-1** will begin its movement on its return path potion to return to its start position, moving below the sealing pedestal **140**, and eventually through gate **208**. Similarly, once the case has been received by output conveyor **170**, the trailing movement arm **200-2** will traverse the same return path, and will stop at its cycle start position before moving through gate **208** and gate **208** will then be or have been moved into a closed position.

Output Folding and Sealing Conveyor

[00156] FIG. **21** and **22** are a top and bottom view of output conveyor **170**, respectively. Output conveyor **170** may be configured to receive, from the sealing platform, a case **111D** having bottom leading and trailing flaps F, G respectively, folded with a group **122** of items **102** held within interior storage space **107** defined by panels A-D of the case. Next the remaining bottom side flaps J and K can be closed, which is made relatively straightforward, since leading and trailing flaps F and G are already closed, and provide support surfaces for holding items **102** within interior space **107** of case **111**D. In

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some embodiments where the top flaps were not closed previously, system **100** can also close the top flaps E, I, H and L. Additionally, the case typically needs to be sealed in a manner that seals the group **122** of items **102** within the storage space **107** of case **111**D.

[00157] Output conveyor **170** may comprise a generally horizontal and longitudinally extending support plate with a low friction support surface, and a pair of side-mounted, transversely spaced vertically oriented side conveyor drive belts **174-1** and **174-2** that extend longitudinally, and are operable to engage the exterior surfaces of side panels B and D and drive case **111**D through the remaining folding and sealing apparatuses. The spacing of conveyor drive belts **174-1** and **174-2** may be easily adjustable to vary the transverse distances therebetween, to enable cases with different width dimensions to be processed by the output conveyor **170**. Conveyor drive belts **174-1** and **174-2** may be provided with high-friction case contact surfaces at a specific width corresponding to a width dimension of the case **111**D. Conveyor drive belts **174-1** and **174-2** may be operable to engage side panels B and D of the case **111**D and move the case **111**D in a forward longitudinal and horizontal direction (Y). Conveyor drive belts **174-1** and **174-2** may be driven to move continuously. Similar to the infeed conveyor **104**, output conveyor belts **174-1** and **174-2** may be driven by suitable motors **176-1** and **176-2** such as a DC motor or a variable frequency drive motor controlled through a DC motor drive (sold by Oriental under model AXH-**5100**-KC-**30**) by PLC **132**. Output conveyor **170** may be configured to close the remaining open bottom flaps (flaps K, J) of case **111**D and all the top flaps (flaps E, I , H, L).

[00158] Top leading/trailing flap rails **402** may be situated on a frame of system **100**. Top leading/trailing flap rails **402** may have a configuration that includes a pair of side-by-side, transversely spaced, downward angled portions **402**-r leading to a single, horizontal portion **402**-p. As the output conveyor **170** transports a case **111**D past top flap rails **402**, the leading flap E will be folded inwards by first angled portion **402**-r and held in place by horizontal portion **402**-p. Concurrently, with the top minor flap leading portion being folded by rails **402**, an overhead kicker rod device **404** driven by a servomotor **406** controlled by PLC **132** may rotate / articulate, folding the trailing flap H forward, so that it will subsequently be also engaged by first angled portion **402**-r of flap rails **402**, and then also be held in place in a closed position by horizontal portion **402**-pbe Servomotor **406** may receive operational instructions from PLC **132**. Once both leading and trailing top flaps E and H, are closed, these flaps may be maintained in a closed position by a generally flat and thin, longitudinally extending compression plate **408**.

[00159] With reference now to FIG **22**, bottom side flaps J, K may also be folded using bottom rails **410**, positioned on an underside of the output conveyor platform. Bottom rails **410** may be two

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generally tubular shapes (i.e. an elongated rounded rod or tube). The rails **410** may formed having two portions, the first portion **410**-r being a downstream, inwardly angled input portion configured to contact the flaps J, K, and a second portion **410**-p of the tubes narrowing to an individual point. As output conveyor**170** transports the case **111**D along the first portion **410**-r of bottom rails **410**, bottom flaps J, K may be moved inward alongside the angle of the rail portion **410**-r. At the nexus of first portion **410**-r and second portion **410**-p, the bottom flaps will be fully closed.

[00160] Returning to FIG. **21**, a similar top flap rail **412** may be employed to fold the top side flaps I, L through the movement of the case by the output conveyor **170**. The rails **412** may be formed having two portions, the first portion **412**-r being an angled downstream, inwardly angled input portion configured to contact flaps I, L, and a second portion **412**-p of the tubes narrowing to an individual point. As output conveyor **170** transports the case along the first portion **412**-r of top flap rails **412**, top flaps I, L may be moved inward alongside the angle of the portion. At the nexus of first portion **412**-r and second portion **412**-p, the top flaps I, L will fully close and the case will have traversed outside of the compression plate. It should be noted that these folding apparatuses may be able to process a variety of different sized cases without adjustment. However, the components of these folding apparatuses may also be mounted to the frame **115** in a manner that there positioning can be readily adjusted to accommodate different sized cases.

[00161] After top and bottom major flaps have been folded, the case may be then sealed at both top and bottom ends along their top and longitudinal central flaps joints, using a sealing mechanism **420**. Sealing mechanism may have a top portion **420**-t comprising a tape wheel **422**-t. Tape wheel **422**-t may be driven by a motor and configured to hold a supply of tape adhesive. Top portion **420**-t may further include and seal the top of the case. A corresponding bottom portion of the sealing mechanism may also include a bottom tape wheel **422**-b also driven by a motor and configured to also hold a supply of sealing tape. According to some embodiments, top portion and bottom portion of sealing mechanism may be a tape applicator, configured to apply a strip of tape across the top side flaps and bottom side flaps, sealing the case completely. Similarly, the top and bottom sealing mechanisms may be able to process a variety of different sized cases without adjustment. However, the components of these mechanisms may also be mounted to the frame **115** in a manner that there positioning can be readily adjusted to accommodate different sized cases. Conveyor drive belts **174**-**1** and **174**-**2** may drive the cases **111**D past the upper and lower tape wheels, **422**-t, **422**-b, thus sealing the top and bottom central joints. The sealed cases are then discharged from output conveyor **170** for further handling.

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[00162] Components of system **100**, and parts thereof, that are described herein, may generally be made from generally available materials. For example, some components or parts thereof, may be made of suitable metals such as steel and/or aluminium, as will be evident to a person skilled in the art, when reading the present disclosure.

Method

[00163] Turning now to FIG. **23**, a flow-chart diagram describing a method M**1000** of filling and sealing cases is illustrated. The method may be performed using system **100** described herein.

[00164] At step S**100**, an input flow of items (such as items **102**) is received (such as from an input / infeed conveyor **104**). The input flow of items may be received in a single line to a transfer station.

[00165] At step S**200**, subgroups / rows of items are transferred from the input flow to a collating station to form a collated group. This may be facilitated for example by transfer apparatus **112** including header **116** and topple plate **124**. Topple plate **124** may be moved as the items are being transferred to the collating station by repeated pushing movements of header **116**. The topple plate may be moved in co-ordinated movement with the header **116**. The topple plate may ensure that the collated rows do not topple over throughout the addition of new collated rows by the header to the collating station. According to some embodiments, the topple plate is moved synchronously and at a similar speed to the header. Alternatively, the topple plate may be moved a predefined distance in advance of the header being actuated.

[00166] At step S**300**, a collated group is transferred from the collating station to pedestal apparatus at a casing area/station. The transfer may be done using another transfer apparatus, such as transfer paddle **150**. The transfer apparatus may move to a first position behind the collated items on the collation platform at the collating station and slide the group of collated items to an input transfer platform of the pedestal apparatus.

[00167] At step S**400**, using engaged movement rods, the collated group is transported to a loading platform of the pedestal apparatus. Movement rods may include a trailing movement rod and a leading movement rod, that are individually controllable in the forwards and backwards longitudinal (Y) direction. The leading movement rod such as rod **200-1**, may abut a leading edge of the collated group, and the trailing rod **200-2** may abut the rearward edge of the group. Through moving both rods in co-ordinated movement together, the movement rods may position collated items on a case loading platform.

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[00168] In step S**500-1** – the movement rods disengage from contact with, and are spaced from, the rearward and forward edges of the group of items. This may be done by the trailing and leading movement rods moving in opposite longitudinal directions away from the collated group.

[00169] In S**500-2** (which may have occurred during any of steps S**200**, S**300** or S**400**) a robot (such as robotic arm **250**) selects a blank from a magazine and erects a flat case blank **111**A to form an erected case **111**C.

[00170] At step S**600**, the collated group may be sheathed with an erected case. According to some embodiments, this may be performed using a robotic arm **250** having configured to pick up a knock-down blank, and lift and open the blank using an end effector equipped with a suction portion. The robotic arm may approach the collated group of items from an attack angle having a tilt about the Y, Z, or X axis, allowing for bottom flaps to remain open and provide clearance space for sheathing of the group by the erected case.

[00171] At step S**700**, the movement bars may re-engage with the sheathed collated group. This may be performed by the trailing and leading movement rods moving close enough to abut the collated items having a sheathed open-tube blank thereon.

[00172] At step S**800**, using the movement bars and pedestal apparatus, the leading and trailing bottom case flaps may be folded. The movement arms re-engage with contact on the erected case, now containing the group of items in the storage space of the case and move the case forward and rearward in relation to the pedestal apparatus. Pedestal apparatus may include left and right platforms, wherein each portion may include a ramp portion and a flat portion. Each of left and right portion may be linearly actuated in a vertical axis to allow left and right portion to be above or below the central portion. Using the method as described with relation to FIG. **19**, the bottom minor flaps may be folded under the individual items.

At step S**900**, the bottom side flaps and all top case flaps may be closed. This may be performed by delivering the case to an output conveyor. The output conveyor may be configured to transport the case across a first rail to close the top leading and trailing flaps and a kicker arm actuated by a servomotor configured to assist in closing the top trailing minor flap. The top minor flaps may be held in place by a compression plate. Then, top rails and bottom rails may be employed to close the top and bottom side flaps. Once closed, the folded case may be fed through a top and bottom case joint sealer, configured to apply a strip of tape or adhesive to the top or bottom of the case along the exposed central flaps joints on the top and bottom of the case.

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[00173] It is expected that in some embodiments, system **100** may be capable of erecting, loading, and sealing in the range of approximately 10 cases per minute, and possibly about 15 cases per minute or more, depending upon configuration of the specific cases, items / group of items, and specific component of system **100**.

[00174] Of course, the above described embodiments are intended to be illustrative only and in no way limiting. The described embodiments of carrying out the invention are susceptible to many modifications of form, arrangement of parts, details and order of operation. The invention, rather, is intended to encompass all such modification within its scope, as defined by the claims.

[00175] Selected embodiments of the present invention may be used in a variety of fields and applications. Other features, modifications, and applications of the embodiments described here may be understood by those skilled in the art in view of the disclosure herein.

[00176] It will be understood that any range of values herein is intended to specifically include any intermediate value or sub-range within the given range, and all such intermediate values and sub-ranges are individually and specifically disclosed.

[00177] The word "include" or its variations such as "includes" or "including" will be understood to imply the inclusion of a stated integer or groups of integers but not the exclusion of any other integer or group of integers.

[00178] It will also be understood that the word "a" or "an" is intended to mean "one or more" or "at least one", and any singular form is intended to include plurals herein.

[00179] It will be further understood that the term "comprise", including any variation thereof, is intended to be open-ended and means "include, but not limited to," unless otherwise specifically indicated to the contrary.

[00180] When a list of items is given herein with an "or" before the last item, any one of the listed items or any suitable combination of two or more of the listed items may be selected and used.

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WHAT IS CLAIMED IS:

1. A system of loading cases with items, the system comprising:

- an item delivery apparatus operable to deliver a plurality of items to a transfer station;

- a collation platform operable to support a group of items;

- a pedestal apparatus operable to support the group of items;

- a first transfer apparatus operable to transfer a plurality of items from said item delivery apparatus at said transfer station, to said collation platform, to form the group of items on said collation platform;

- a second transfer apparatus operable to transfer the group of items from said collation platform to said pedestal apparatus;

- at least one movement rod operable to be driven in longitudinal movement by a rod movement drive apparatus;

- a case movement apparatus located proximate said pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a group of items located on said pedestal apparatus with an erected case;

- wherein in operation:

    (a) said item delivery apparatus delivers a plurality of items to said transfer station;

    (b) said first transfer apparatus transfers a plurality of items from said item delivery apparatus at said transfer station, to said collation platform, to form a group of items on said collation platform;

    (c) said second transfer apparatus transfers said group of items from said collation platform to said pedestal apparatus;

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(d) said at least one movement rod engages said group of items and moves said group of items to a loading position on said pedestal apparatus;

(e) said at least one movement rod dis-engages from said group of items said group of items at said loading position on said pedestal apparatus;

(f) said case movement apparatus moves an erected case to sheath said group of items located at said loading position on said pedestal apparatus.

2. A system as claimed in claim 1 wherein in operation, (e) overlaps in time with (f).

3. A system as claimed in claim 1 wherein said at least one movement rod comprises first and second movement rods and wherein in operation said first movement is a trailing movement rod that engages a rearward side of said group of items and said second movement rod is a leading movement rod that engages a forward side of said group of items. and wherein said trailing and leading rod move in tandem contact with said group of items to move said group items to said loading position on said pedestal apparatus

4. A system as claimed in claims 1, 2 or 3 wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable to engage with, and release, a case.

5. A system as claimed in claim 4, wherein said end effector is mounted to a multi-segment arm of said robot arm and said end effector is operable to rotate about several axes of rotation provided by said multi-segment arm.

6. A system as claimed in claim 4, wherein said end effector is operable to rotate about at least six separate axes of rotation.

7. A system as claimed in any one of claims 3 to 6, wherein said end effector is operable to engage a flattened case blank and open said flattened case blank into an erected case that is suitably configured to sheath said group of items.

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8. A system as claimed in any one of claims 3 to 7, wherein said items are each supported on a base portion in a generally vertically upright orientation, and wherein end effector is operable to move said erected case in a path to sheath said group of items, said path having a tilted path position in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

9. A system as claimed in claim 8, wherein in said tilted path position said erected case is tilted from a vertical axis by a tilt angle in the range of 5 to 20 degrees from the vertical.

10. A system as claimed in claim 9 wherein said tilt angle is a transverse tilt angle.

11. A system as claimed in claim 9 wherein said tilt angle is a longitudinal angle.

12. A system as claimed in claim 9 wherein said tilt angle comprises both a transverse tilt angle and a longitudinal tilt angle each in the range of 5 to 20 degrees from the vertical.

13. A system as claimed in any one of claim 8 to 12 wherein end effector is operable to move said erected case on said from said tilted path position by pivoting said erected case about a first bottom corner of case such that a diagonally opposite corner of case moves in an arced path portion, to an case engagement position.

14. A system as claimed in claim 13 wherein when in operation, said end effector moves said erected case in said arced path portion, to said case engagement position, a bottom plane defined by bottom edges of a plurality of bottom flaps of sad erected case, will become parallel to a horizontal plane defined by a top surface plane of the group of items

15. A system as claimed in any one of claims 8 to 13, wherein said erected case has a plurality of bottom flaps, and when said erected case is angled at said tilt angle, a first side flap is positioned below a top surface of said group of items.

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16. A system as claimed in claim 15 and when said erected case is angled at said tilt angle, as second side flap of said erected case, opposite to said first side flap, is also positioned below said top surface of said group of items.

17. A system as claimed in claims 13 or 14, wherein said path of said end effector has a vertical path portion such that robotic arm is operable to move said erected case vertically downward from said case engagement position to a fully loaded position.

18. A system as claimed in any one of claims 8 to 12, wherein said path of said end effector has a vertical path portion and wherein while said group of items is at said loading position, said end effector changes the tilt angle to zero from said tilted path portion to said vertical path portion.

19. A system as claimed in claim 18 wherein during said vertical path portion, said erected case is moved vertically downward to locate said group of items within a storage space of said erected case.

20. A system as claimed in any one of claims 2 to 19, wherein the pedestal apparatus further comprises: a first folding platform; a second folding platform; and a central loading platform located between said first folding platform and said second loading platform; and wherein in operation, after (f), then (g) wherein said first and second movement rods re-engage said group of items said group of items at said loading position on said central loading platform, and move said case and said group of items held therein, in forward and rearward movements over said first folding platform, said central loading platform and second folding platform to thereby close a trailing bottom flap and a leading bottom flap of said case, to support positions between said group of items and said pedestal apparatus.

21. A system as claimed in claim 20, wherein the first folding platform and the second folding platform are located on opposite longitudinal sides of the central loading platform.

22. A system as claimed in claim 21 wherein each of said first folding platform and said second folding platform, comprise a ramp portion at a proximal side to the central loading platform and a flat portion at a distal side of the central loading platform.

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23. A system as claimed in any one of claims 2 to 22 wherein said first and second movement rods are generally oriented to and extend in a direction generally transverse direction and said first and second movement rods move forwards and backwards in a longitudinal direction of movement.

24. A system as claimed in any one of claims 20 to 23, wherein said system is operable such that after (g), then (h) wherein said first and second movement rods move said erected case to a flap folding apparatus, said flap folding apparatus is operable to close the bottom side flaps of said erected case.

25. A system as claimed in claim 24 wherein said erected case has a plurality of top flaps and said flap folding apparatus is operable to close said plurality of top flaps of said erected case.

26. A system as claimed in claim 24 or 25, wherein said system further comprises a flap sealing apparatus operable to seal the top flaps and bottom flaps of said erected case.

27. A system as claimed in any one of claims 1 to 26, further comprising a gate apparatus operable between (1) a closed position wherein said trailing movement rod is positioned at a start position beneath said support surface of said pedestal apparatus and an opening in a support surface of said pedestal apparatus is closed by said gate such that said group of items can pass from said collation platform, over said gate and onto said pedestal apparatus; and (ii) an open position which allows at least a trailing movement rod of said first and second rods to move from said starting position, through said opening in said support surface of said pedestal apparatus to an engagement position behind a group of items on said pedestal apparatus.

28. A system as claimed in any one of claims 1 to 27, wherein the first transfer apparatus comprises a header configured to actuate from a first position to a second position, wherein the first position allows for a collated row of individual items to move in front of header, and wherein in the second position the header pushes a plurality of items from the input delivery apparatus to the collation platform.

29. A system as claimed in claim 28 wherein said first transfer apparatus further comprises a topple plate configured to move in co-ordinated movement with said header, said topple plate operable to

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assist in maintaining said plurality of items in an upright orientation during movement from said input delivery apparatus to said collation platform.

30. A system as claimed in any one of claim 1 to 29, wherein the second transfer apparatus comprises a transfer paddle apparatus operable to move said group of items from said collation platform to said collation platform.

31. A system as claimed in any one of claim 1 to 29, wherein the second transfer apparatus comprises a transfer paddle apparatus operable to slide said group of items from a support surface of said collation platform onto a support surface of said pedestal apparatus.

32. A system as claimed in any one of clams 1 to 31, further comprising transversely spaced, opposed guide members positioned to support opposed longitudinal sides of said plurality of items when said plurality of items are being transferred by said first transfer to said collation platform, to form a group of items on said collation platform.

33. A system as claimed in any one of claims 1 to 31, further comprising transversely spaced, opposed guide members positioned to support opposed longitudinal sides of said group of items when said group of items are being transferred by said second transfer apparatus from said collation platform to said pedestal apparatus.

34. A system as claimed in any one of claims 1 to 33 further comprising an output conveyor configured to receive the case from the pedestal apparatus.

35. A system of loading cases with items, the system comprising:

- a case movement apparatus located proximate a pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a plurality of items located on said pedestal apparatus with an erected case;

- wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable to engage with, and release, a case;

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- wherein said plurality of items are each supported on a base portion in a generally vertically upright orientation, and wherein end effector is operable to move said erected case in a path to sheath said plurality of items, said path having a tilted path position in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

36. A system as claimed in claim 35, wherein said end effector is mounted to a multi-segment arm of said robot arm and said end effector is operable to rotate about several axes of rotation provided by said multi-segment arm.

37. A system as claimed in claims 35 or 36, wherein said end effector is operable to rotate about at least six separate axes of rotation.

38. A system as claimed in any one of claims 35 to 37, wherein said end effector is operable to engage a flattened case blank and open said flattened case blank into an erected case that is suitably configured to sheath said group of items.

39. A system as claimed in any one of claims 35 to 38, wherein in said tilted path position said erected case is tilted from a vertical axis by a tilt angle in the range of 5 to 20 degrees from the vertical.

40. A system as claimed in claim 39 wherein said tilt angle is a transverse tilt angle.

41. A system as claimed in claim 39 wherein said tilt angle is a longitudinal angle.

42. A system as claimed in claim 39 wherein said tilt angle comprises both a transverse tilt angle and a longitudinal tilt angle each in the range of 5 to 20 degrees from the vertical.

43. A system as claimed in any one of claims 35 to 42 wherein end effector is operable to move said erected case on said from said tilted path position by pivoting said erected case about a first bottom corner of case such that a diagonally opposite corner of case moves in an arced path portion, to an case engagement position.

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44. A system as claimed in claim 43 wherein when in operation, said end effector moves said erected case in said arced path portion, to said case engagement position, a bottom plane defined by bottom edges of a plurality of bottom flaps of sad erected case, will become parallel to a horizontal plane defined by a top surface plane of the group of items
45. A system as claimed in any one of claims 35 to 44, wherein said erected case has a plurality of bottom flaps, and when said erected case is angled at said tilt angle, a first side flap is positioned below a top surface of said group of items.

46. A system as claimed in claim 45 and when said erected case is angled at said tilt angle, as second side flap of said erected case, opposite to said first side flap, is also positioned below said top surface of said group of items.

47. A system as claimed in claims 43 or 44, wherein said path of said end effector has a vertical path portion such that robotic arm is operable to move said erected case vertically downward from said case engagement position to a fully loaded position.

48. A system as claimed in claim 35, wherein said path of said end effector has a vertical path portion and wherein while said group of items is at said loading position, said end effector changes the tilt angle to zero from said tilted path portion to said vertical path portion.

49. A system as claimed in claim 48 wherein during said vertical path portion, said erected case is moved vertically downward to locate said group of items within a storage space of said erected case.

50. A system of loading cases with items, the system comprising:

- longitudinally spaced first and second movement members operable to be driven in longitudinal movement by a movement drive apparatus;

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- a case movement apparatus located proximate a pedestal apparatus, said case movement apparatus operable to move an erected case in a path that sheaths a group of items located on said pedestal apparatus with an erected case;

- wherein in operation:

    (a) said first and second movement members, engage said group of items and move said group of items to a loading position on said pedestal apparatus;
    (b) said first and second movement members, dis-engage from said group of items when said group of items are at said loading position on said pedestal apparatus;

    (c) said case movement apparatus moves an erected case to sheath said group of items located at said loading position on said pedestal apparatus.

51. A system as claimed in claim 50, wherein said first and second movement members comprise first and second movement rods that generally extend in a transverse direction and said first and second movement rods are operable to engage rearward and forward transverse sides of said group of items in order to move said group of items to said loading position on said pedestal apparatus.

52. A system as claimed in claim 51 wherein when in operation said first and second movement rods engage rearward and forward transverse sides of said group of items, said first and second movement rods slide said group of items over at least one upper support surface of said pedestal to said loading position.

53. A system as claimed in 52, wherein said system is operable such that after (c), then (d) wherein said first and second movement rods engage with said erected case move said erected case to a flap folding apparatus, said flap folding apparatus operable to close the bottom side flaps of said erected case.

54. A system as claimed in claim 53 wherein in operation, when closing at least a leading bottom flap and a trailing bottom flap, said first and second movement rods move backwards and forwards in a longitudinal direction of movement relative to a plurality of support surfaces of said pedestal

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apparatus, said support surfaces being configured and operable to facilitate the closing of the leading and trailing bottom flaps during said backwards and forwards movement of said first and second movement rods.

55. A system as claimed in claim 54 wherein in operation, when closing at least a leading bottom flap and a trailing bottom flap, said first and second movement rods first move backwards and thereafter move forwards in a longitudinal direction of movement relative to said plurality of support surfaces of said pedestal apparatus.
56. A method of loading cases with items comprising:

    (a) delivering a plurality of items to said transfer station;

    (b) transferring a plurality of items at said transfer station, to a collation platform, to form a group of items on said collation platform;

    (c) transferring said group of items from said collation platform to a pedestal apparatus;

    (d) engaging said group of items with transversely oriented trailing and leading movement rods and moving said group of items longitudinally to a loading position on said pedestal apparatus;

    (e) dis-engaging said leading and trailing movement rods from said group of items while said group of items are at said loading position on said pedestal apparatus;

    (f) sheathing said group of items located at said loading position on said pedestal apparatus with an erected case.

57. A method as claimed in claim 56 wherein:

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- a case movement apparatus is located proximate said pedestal apparatus, and said case movement apparatus moves an erected case in a path that sheaths a plurality of items located on said pedestal apparatus with an erected case;

- wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable that engages with, and releases, a case

58. A method as claimed in claim 57 wherein said plurality of items are each supported on a base portion in a generally vertically upright orientation, and wherein end effector moves said erected case in a path to sheath said plurality of items having a tilted path portion in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

59. A method of loading cases with items, the method comprising:

- moving an erected case with a case movement apparatus in a path that sheaths a plurality of items located on a pedestal apparatus with an erected case;

- wherein said case movement apparatus comprises a multi-axis robot arm having an end effector operable to engage with, and release, a case;

- wherein said plurality of items are each supported on a base portion in a generally vertically upright orientation;

- and wherein said end effector moves said erected case in a path to sheath said plurality of items, said path having a tilted path portion in which while said erected case is located proximate to said group of items, said erected case is tilted from a vertical axis.

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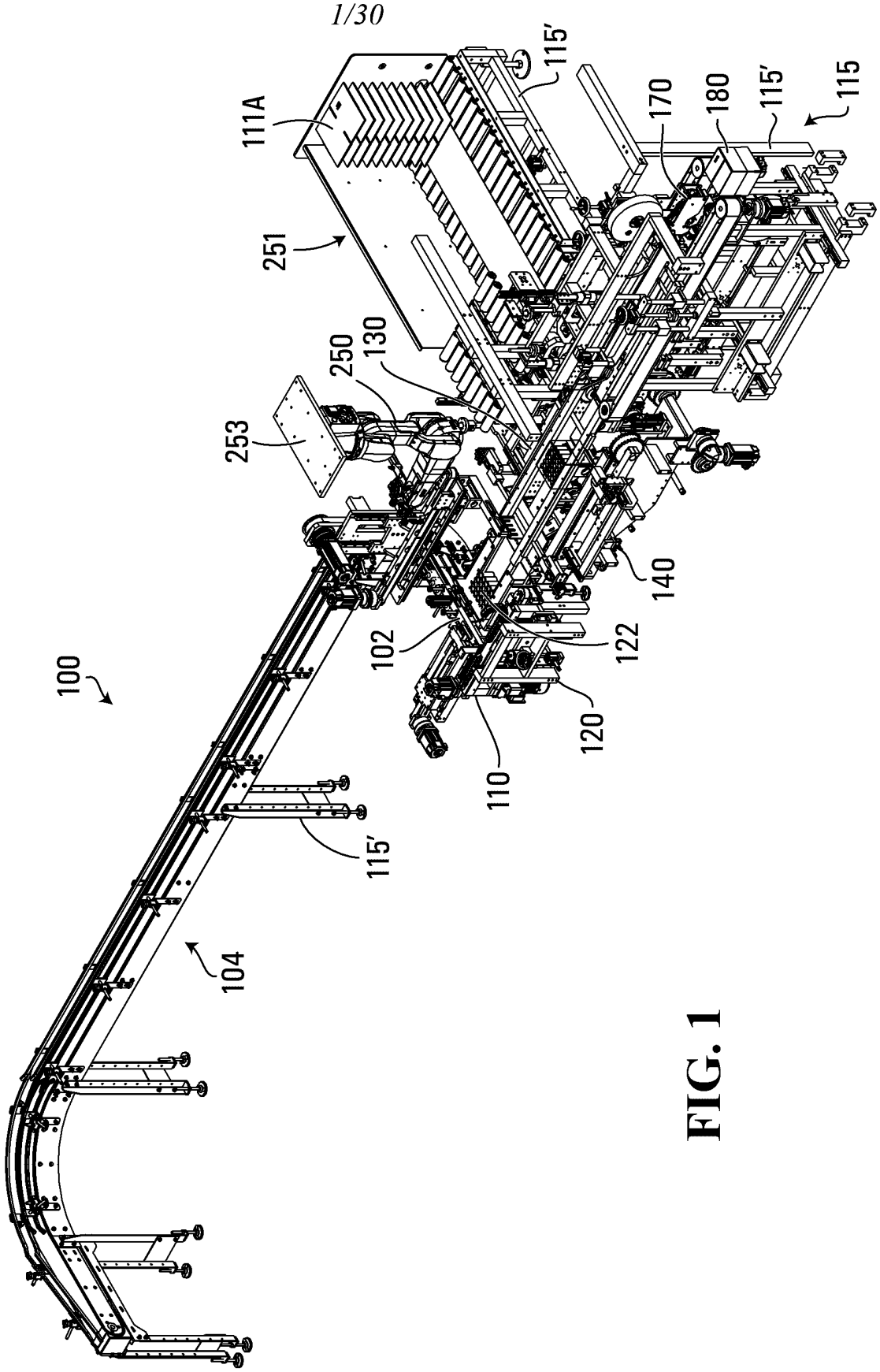

FIG. 1

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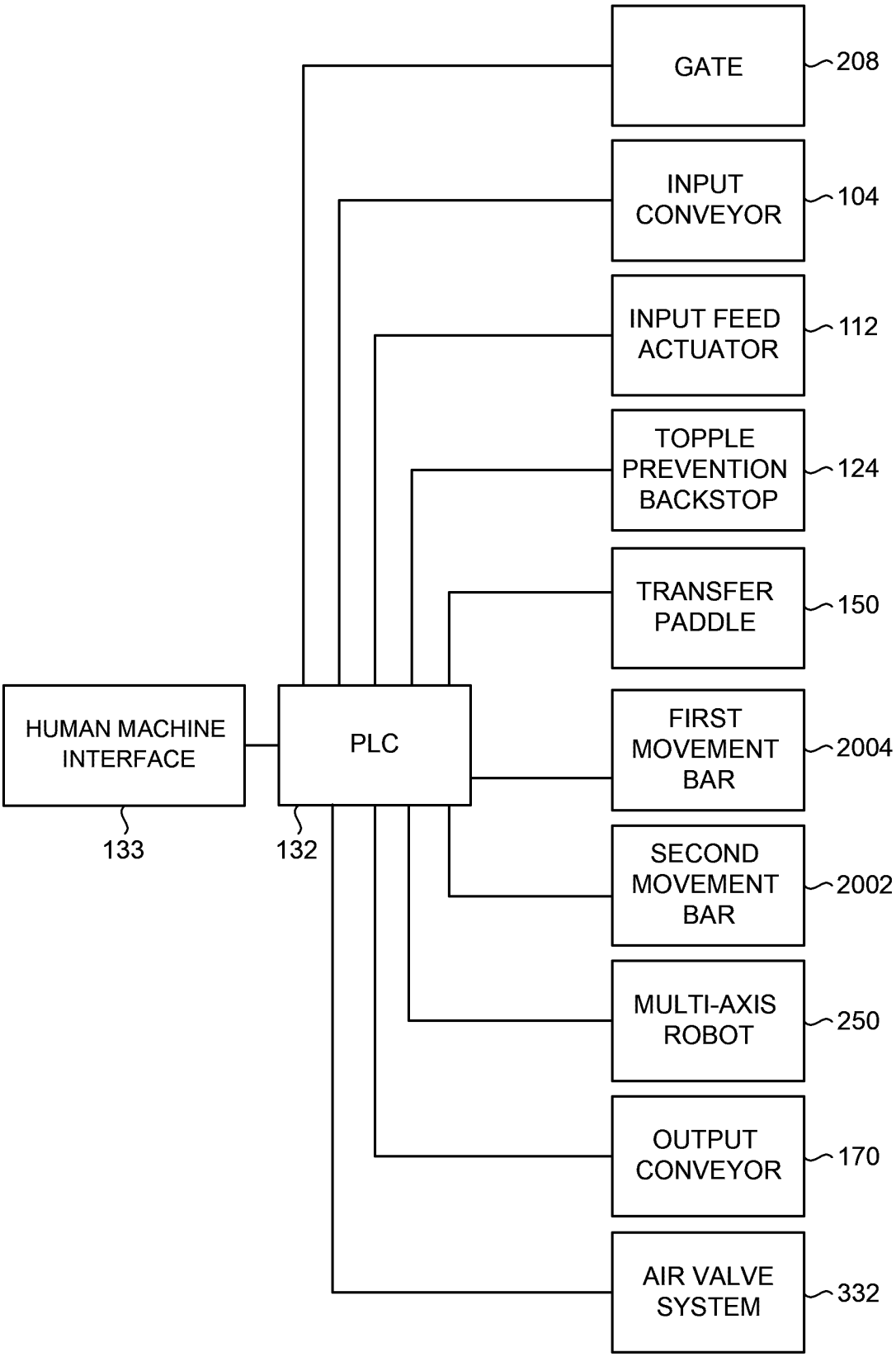

FIG. 2

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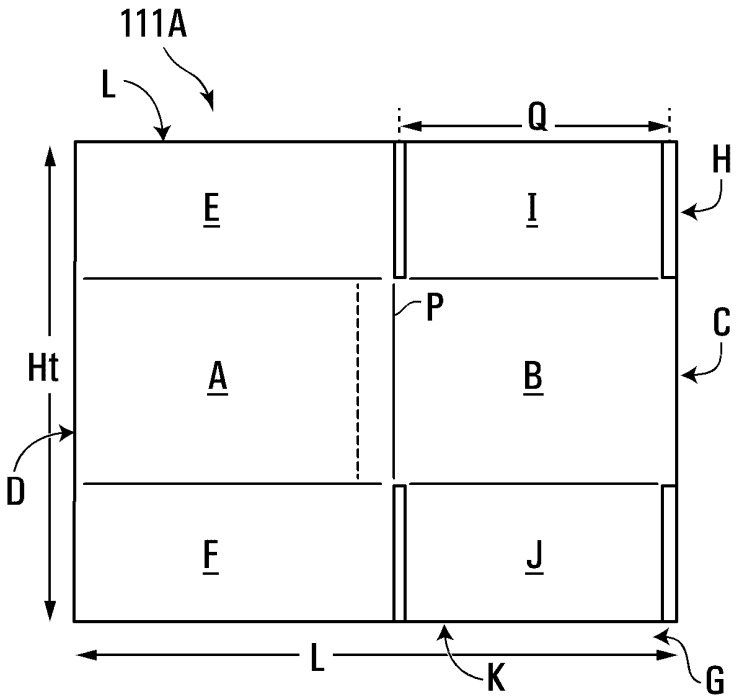

FIG. 3A

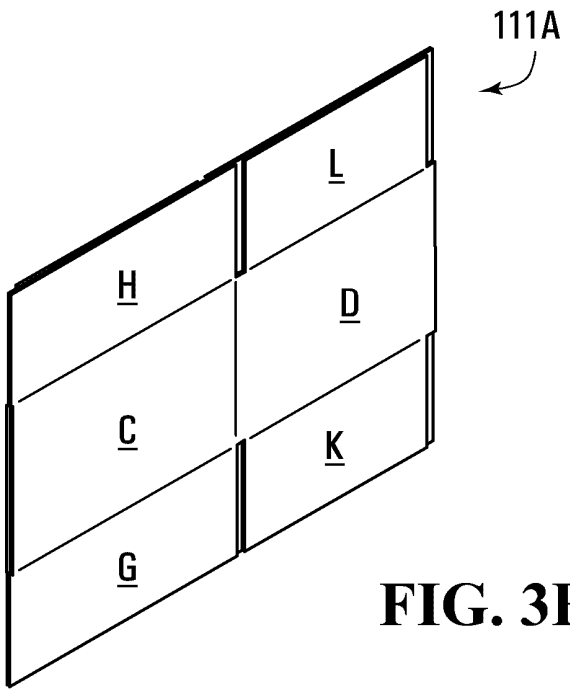

FIG. 3B

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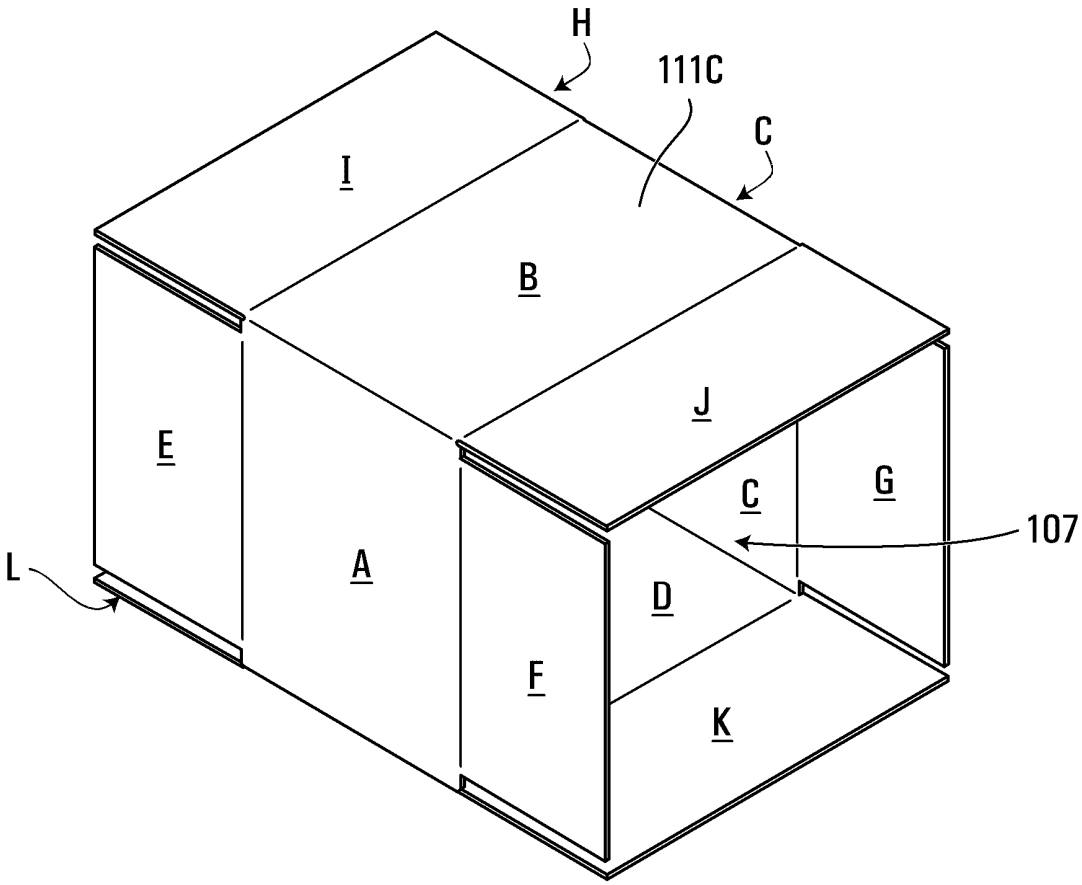

FIG. 3C

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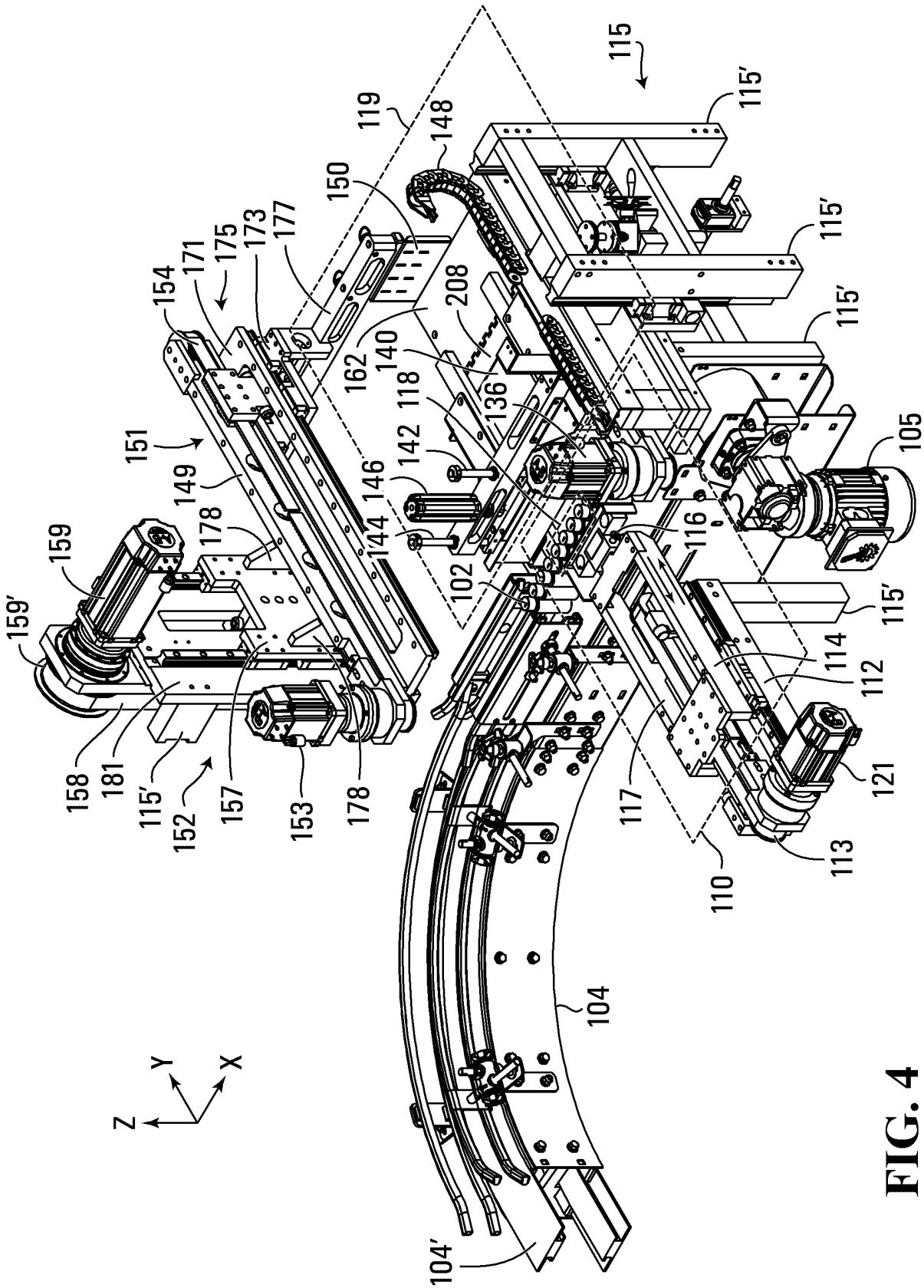

FIG. 4

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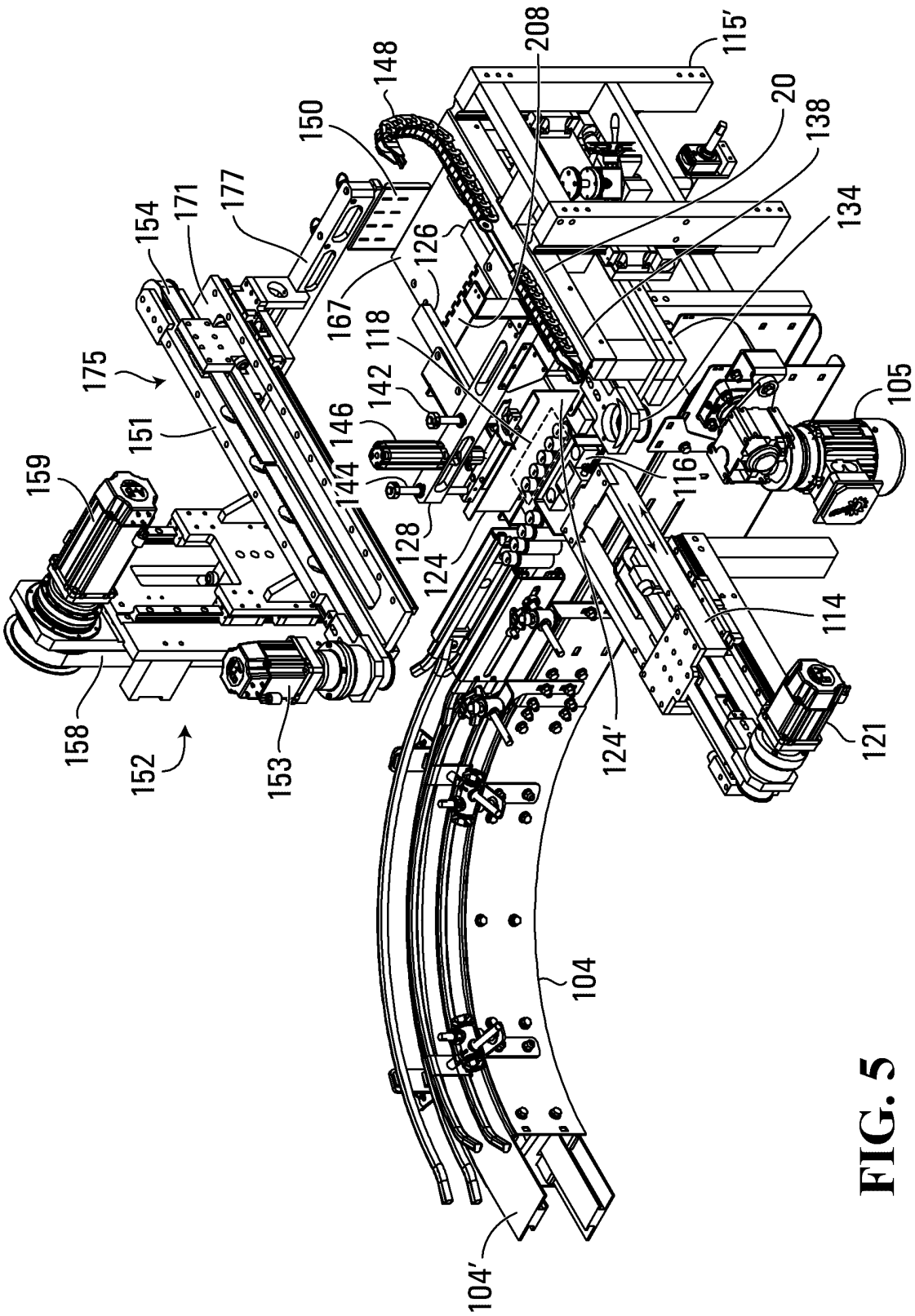

FIG. 5

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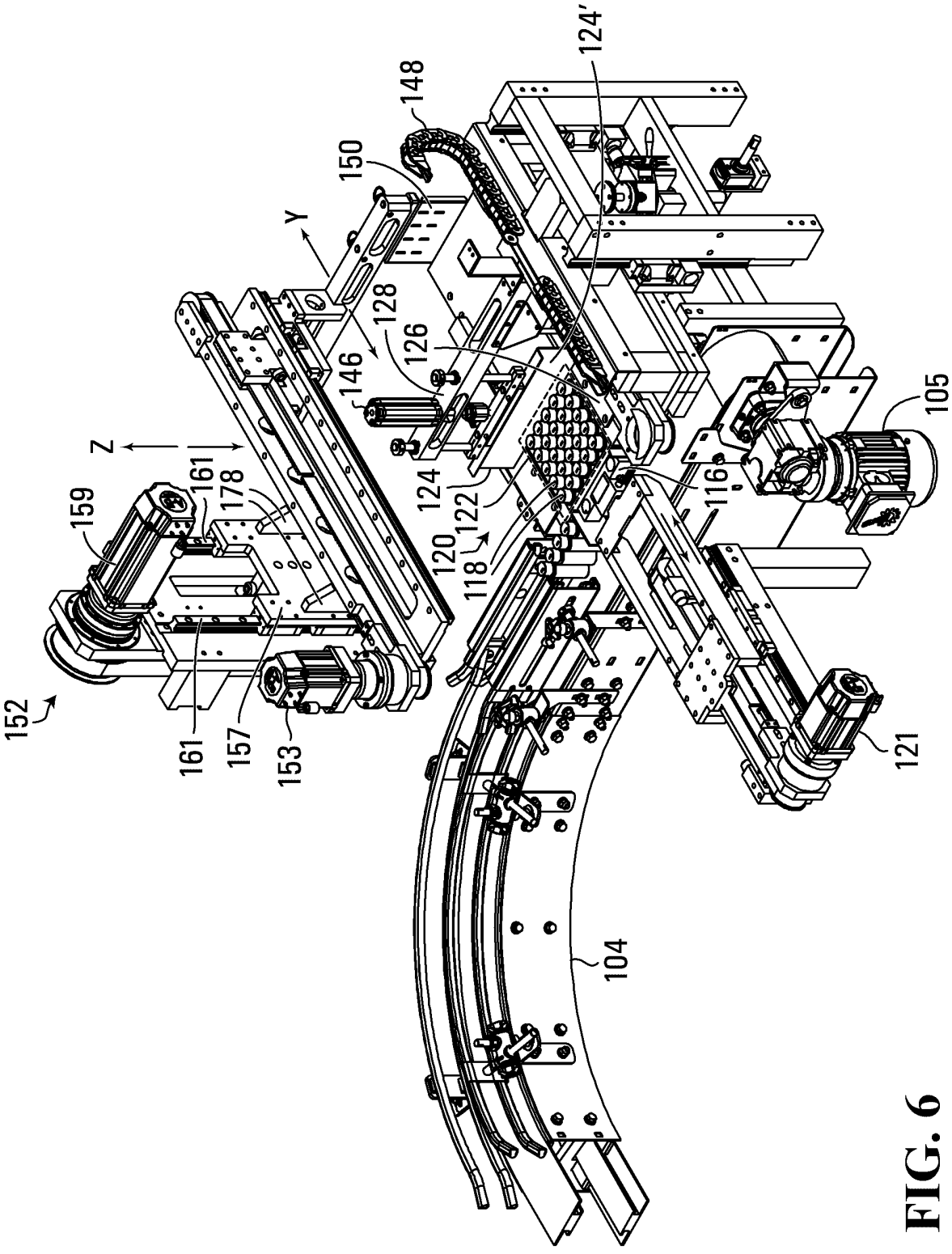
124'
148
150
Y
128
126
146
105
Z
161
178
159
124
122
116
120
118
152
161
157
153
121
104

FIG. 6

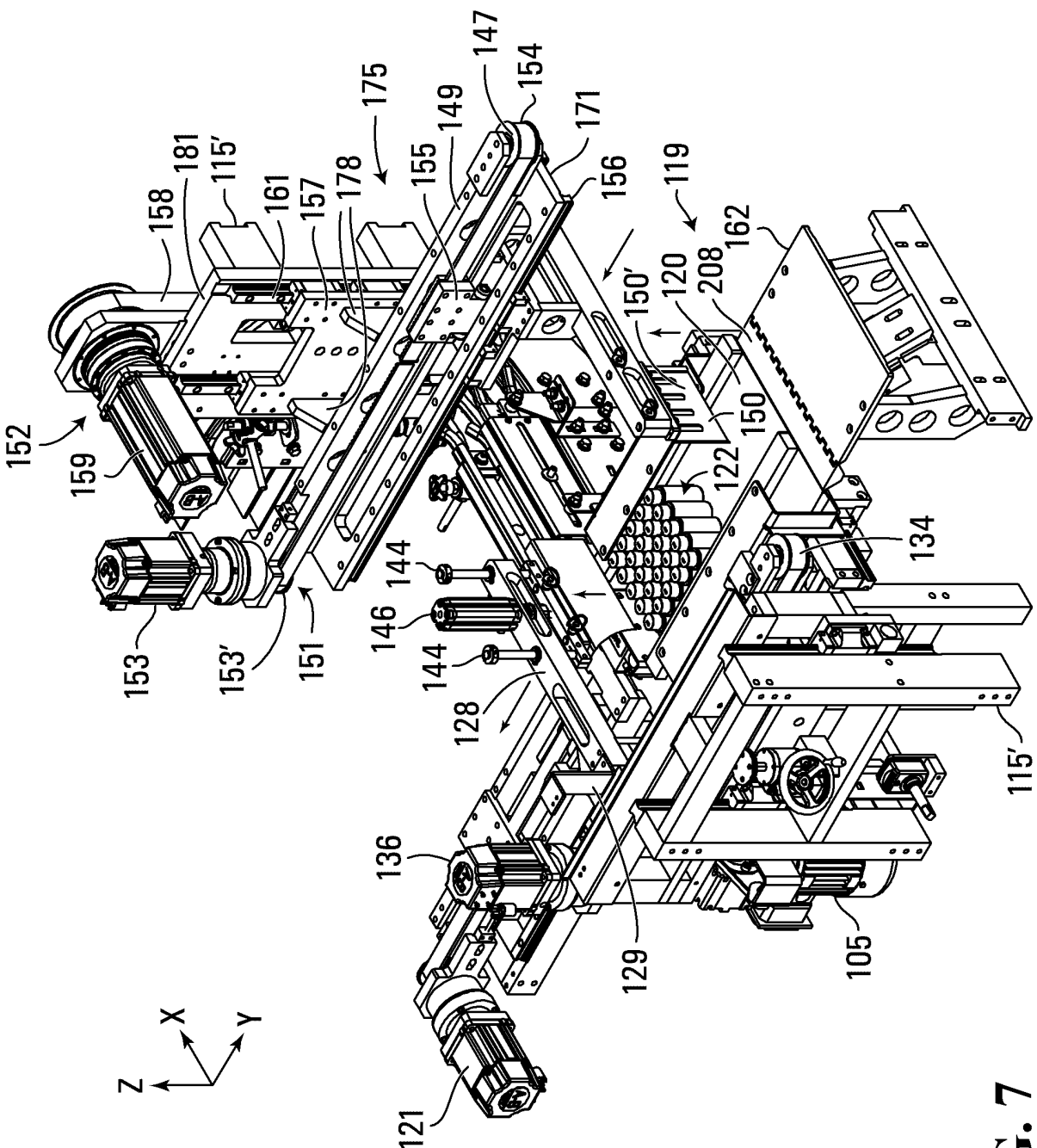

FIG. 7

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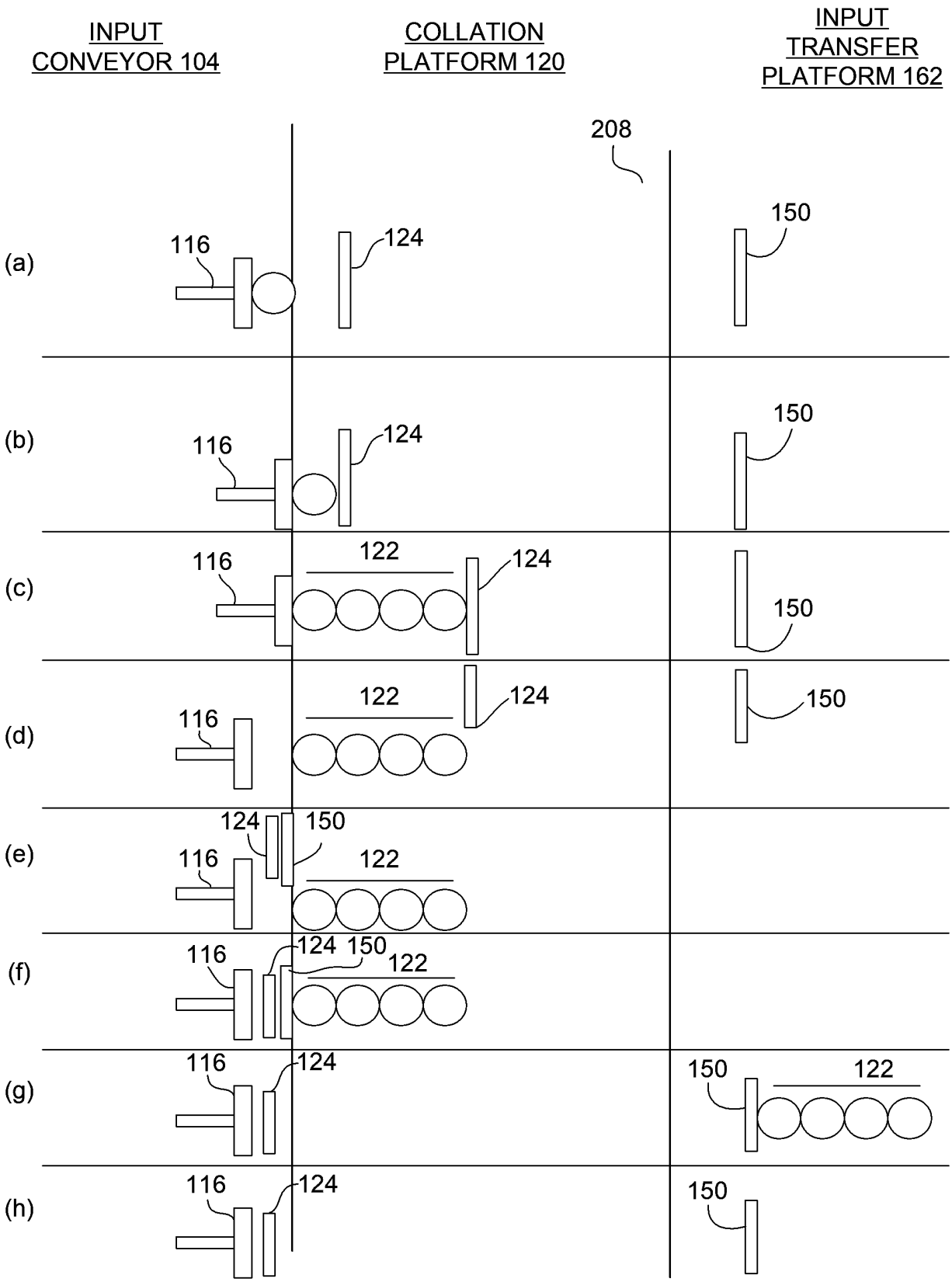
INPUT CONVEYOR 104
COLLATION PLATFORM 120
INPUT TRANSFER PLATFORM 162
208
(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
116
122
124
150

FIG. 7A

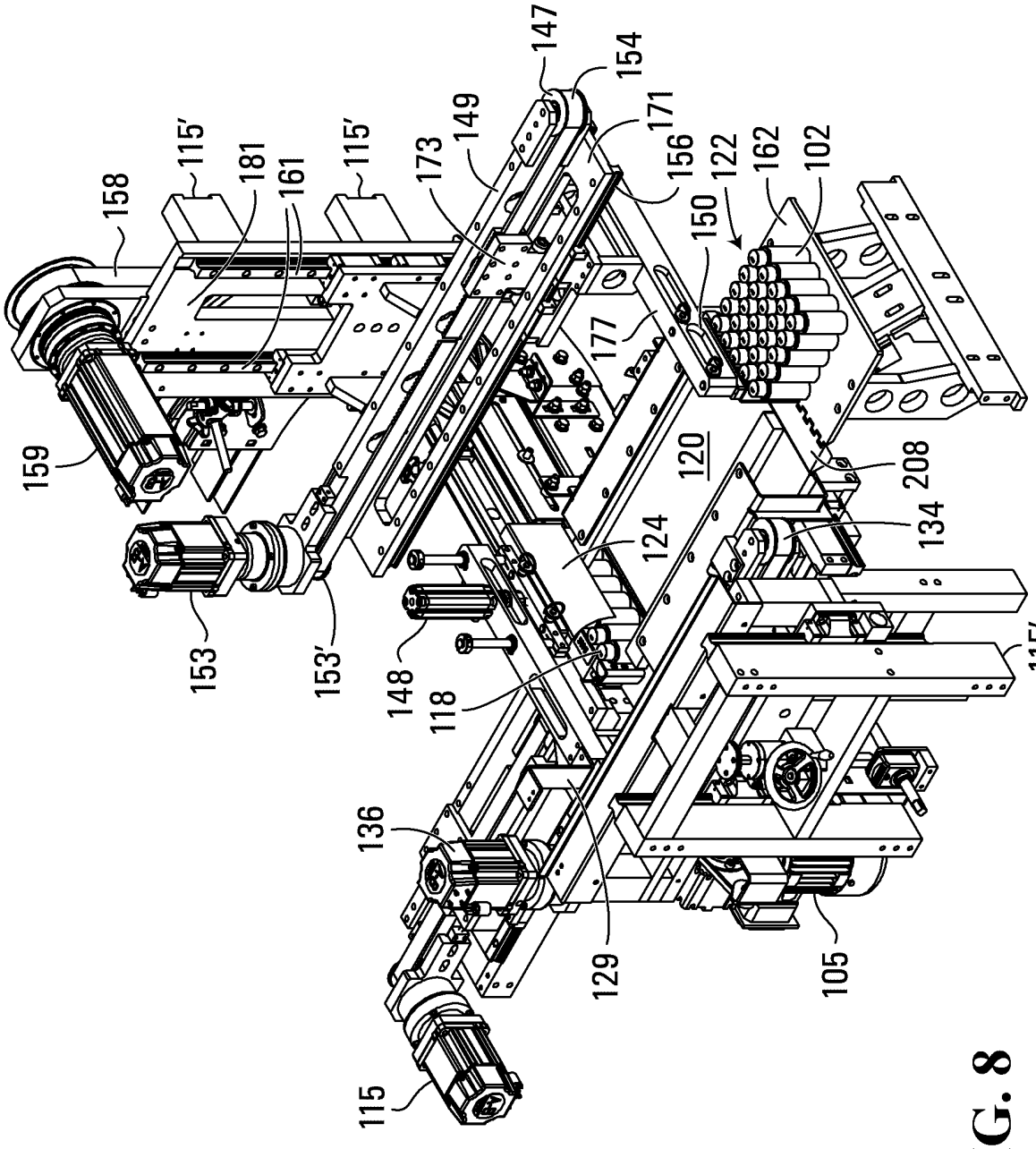

FIG. 8

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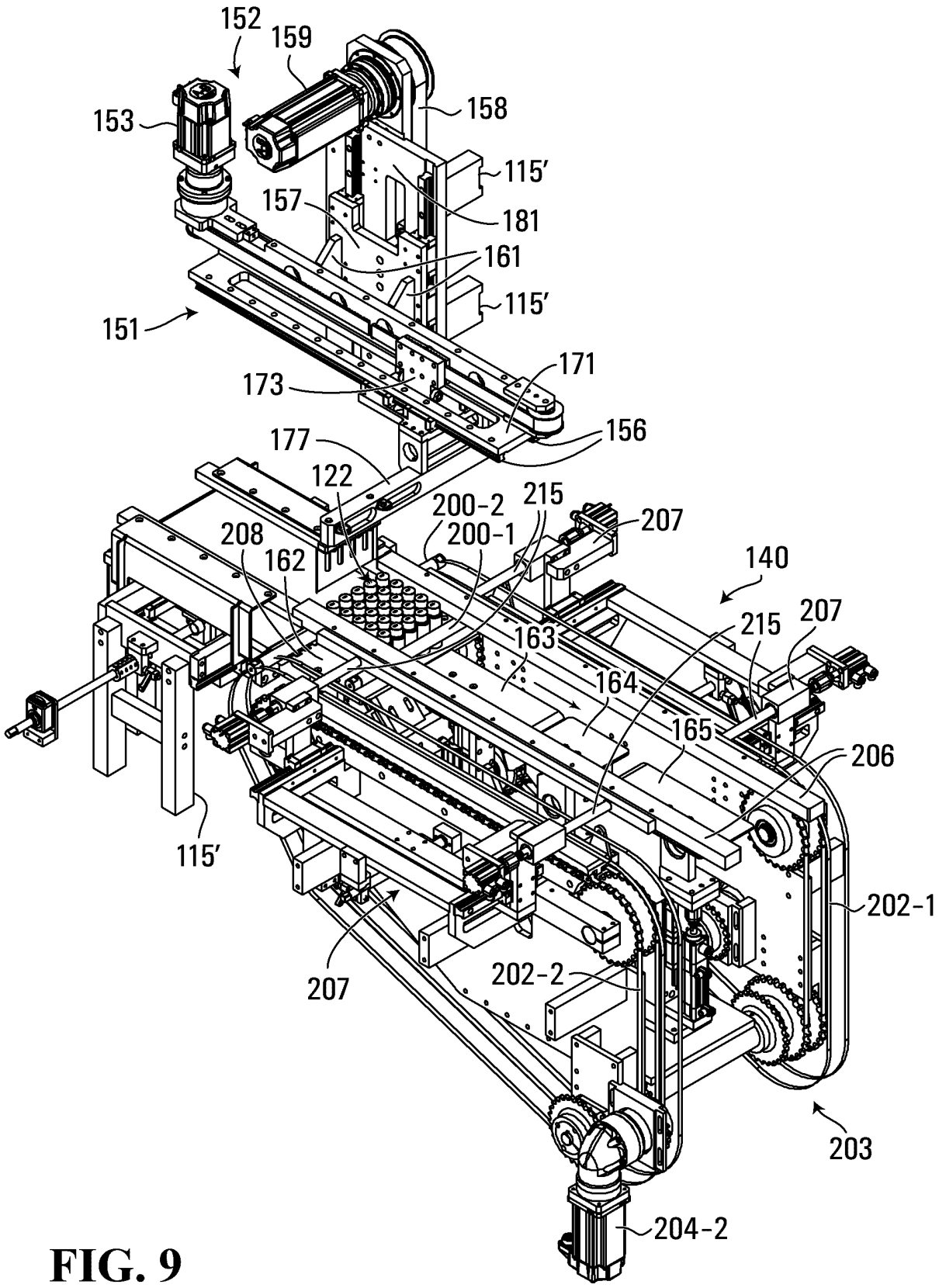

FIG. 9

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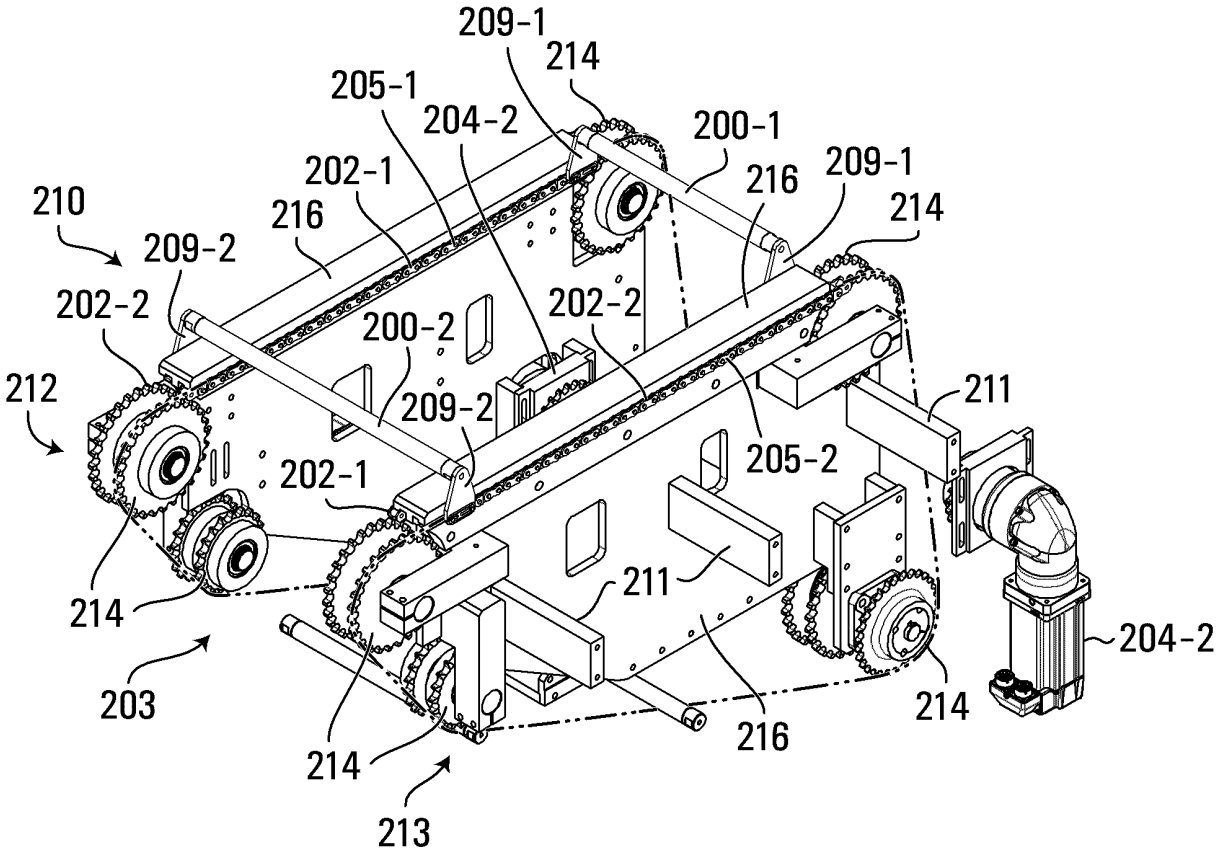

FIG. 9A

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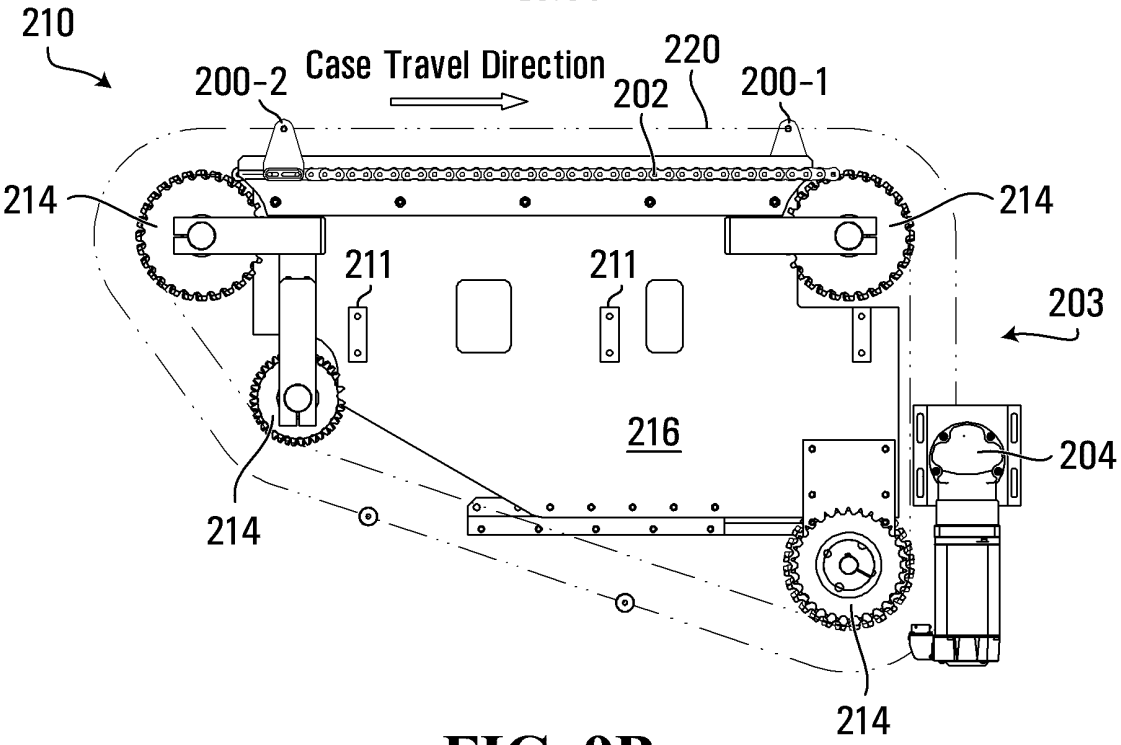

FIG. 9B

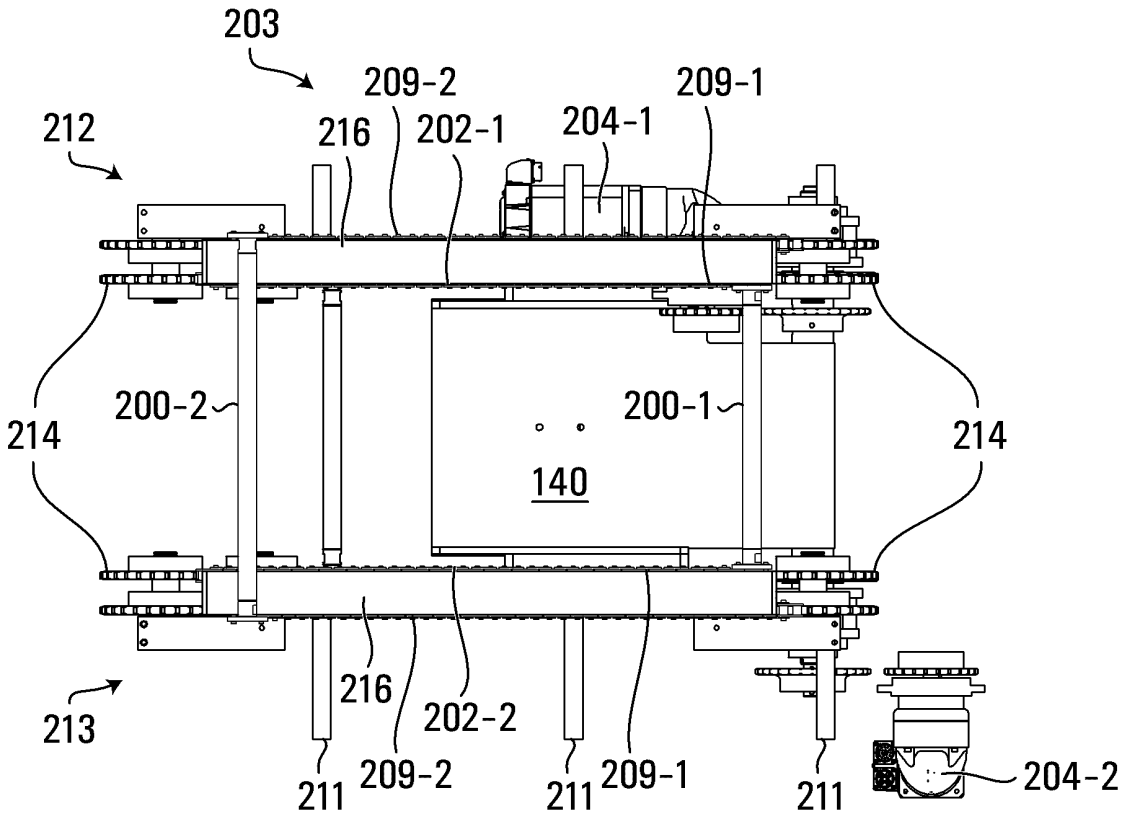

FIG. 9C

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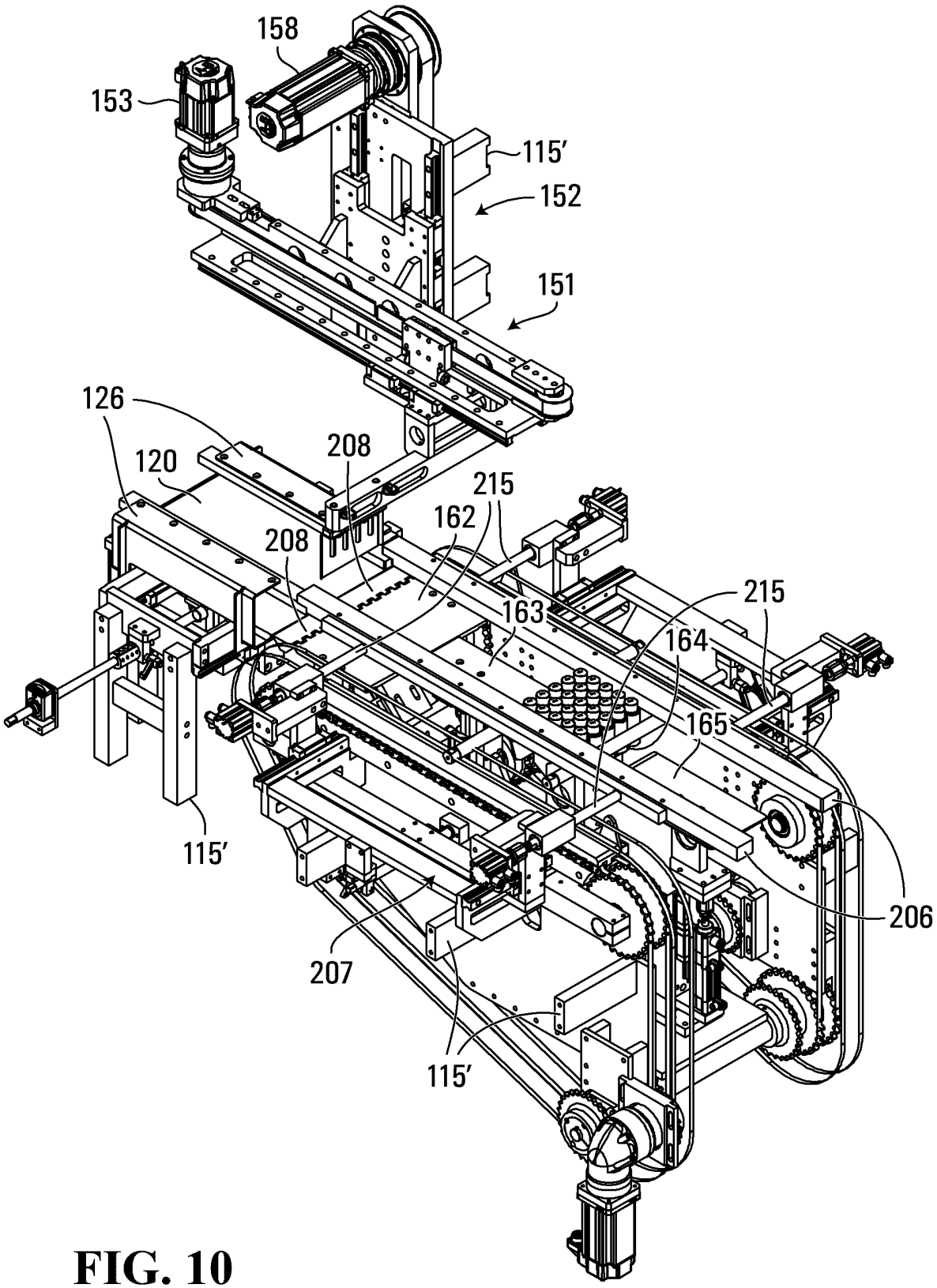

FIG. 10

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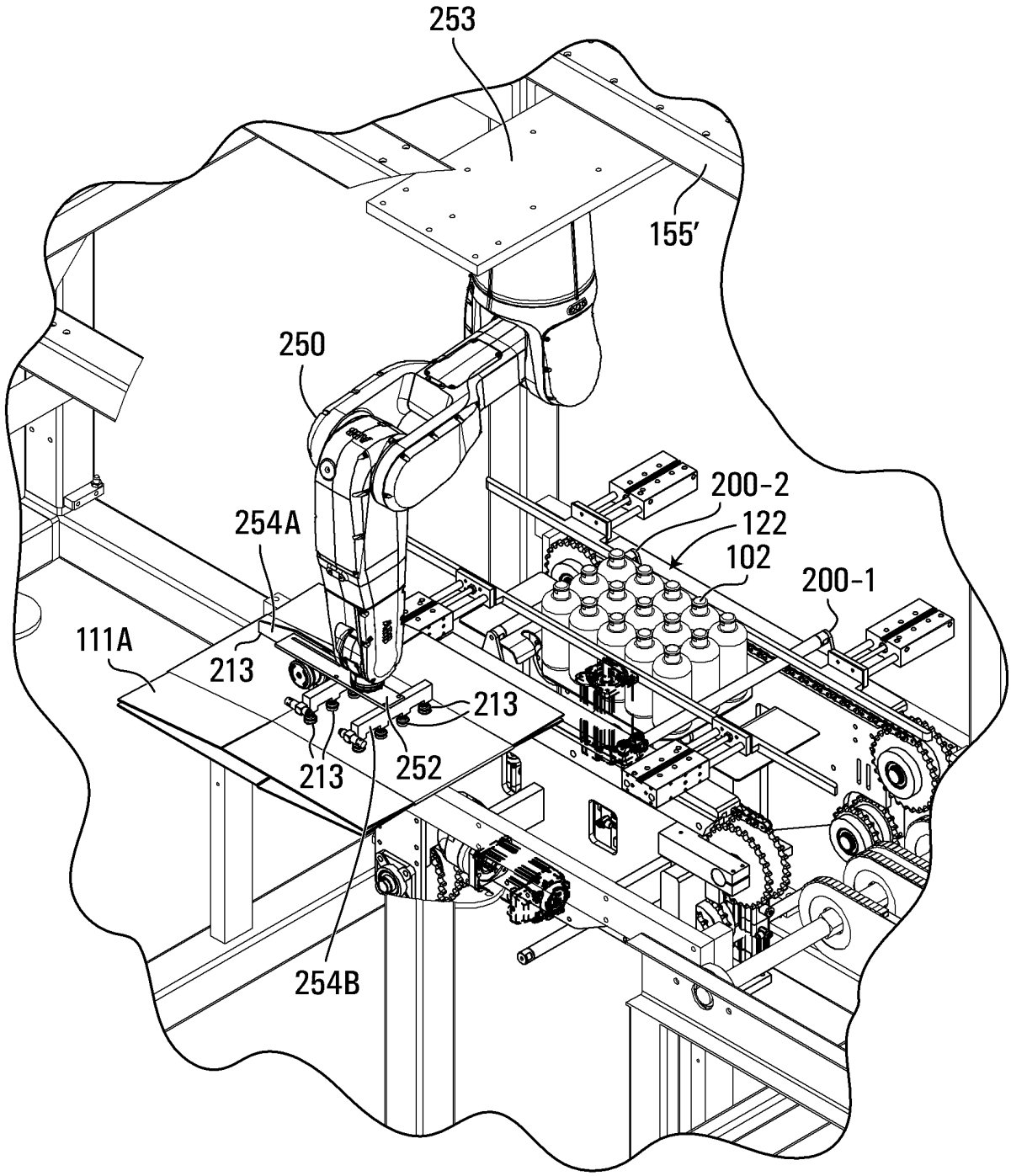

FIG. 11

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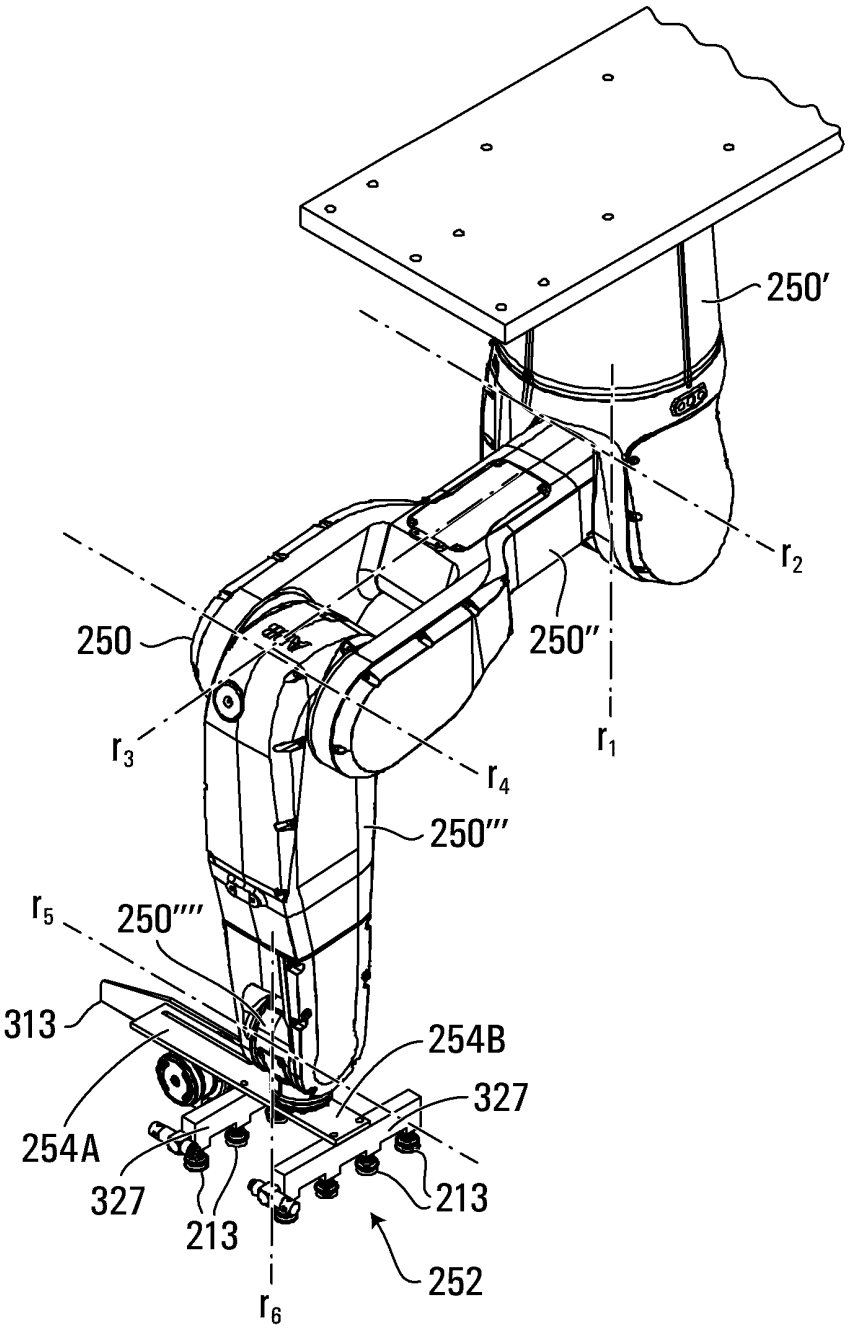

FIG. 11A

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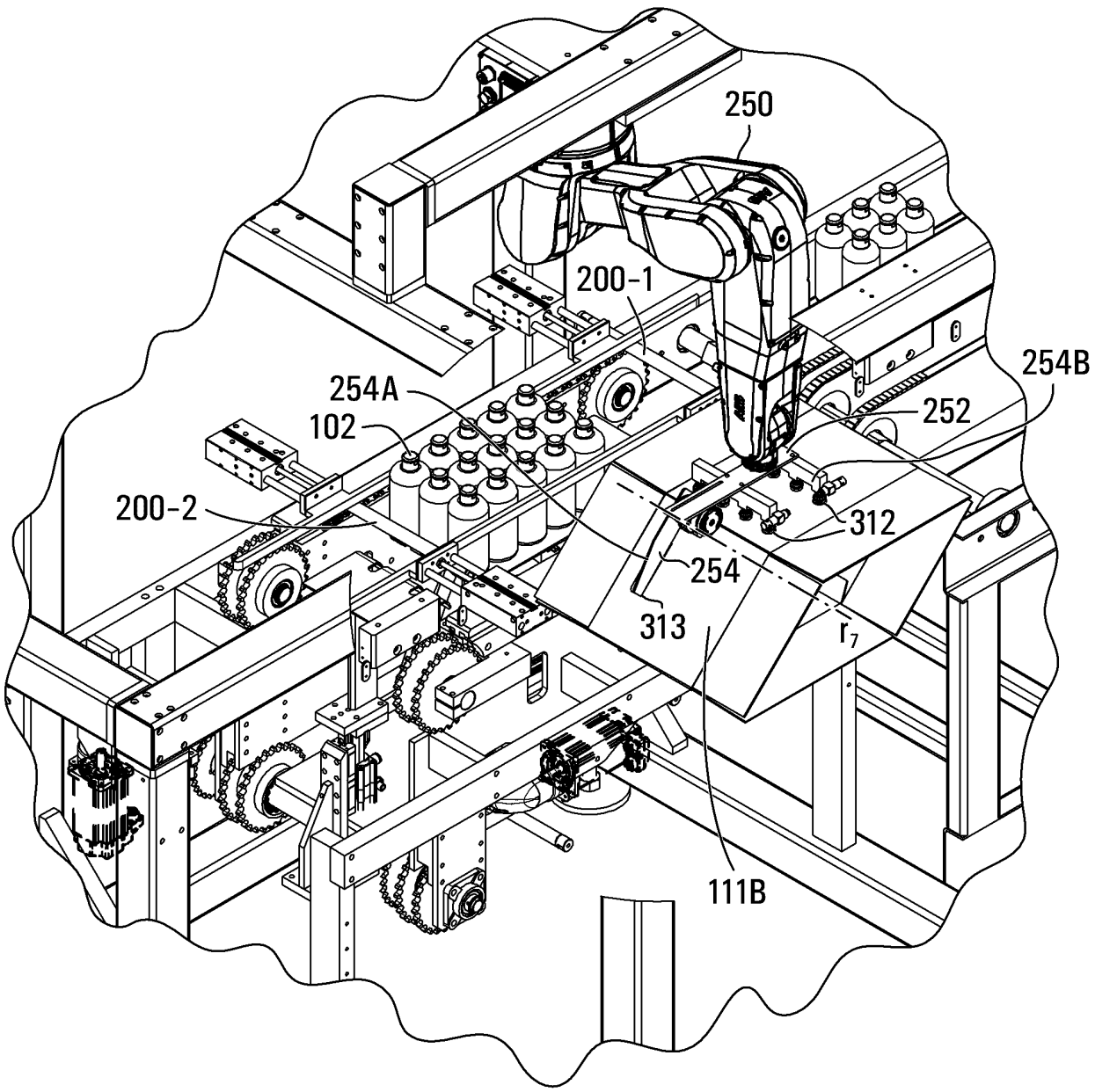

FIG. 12

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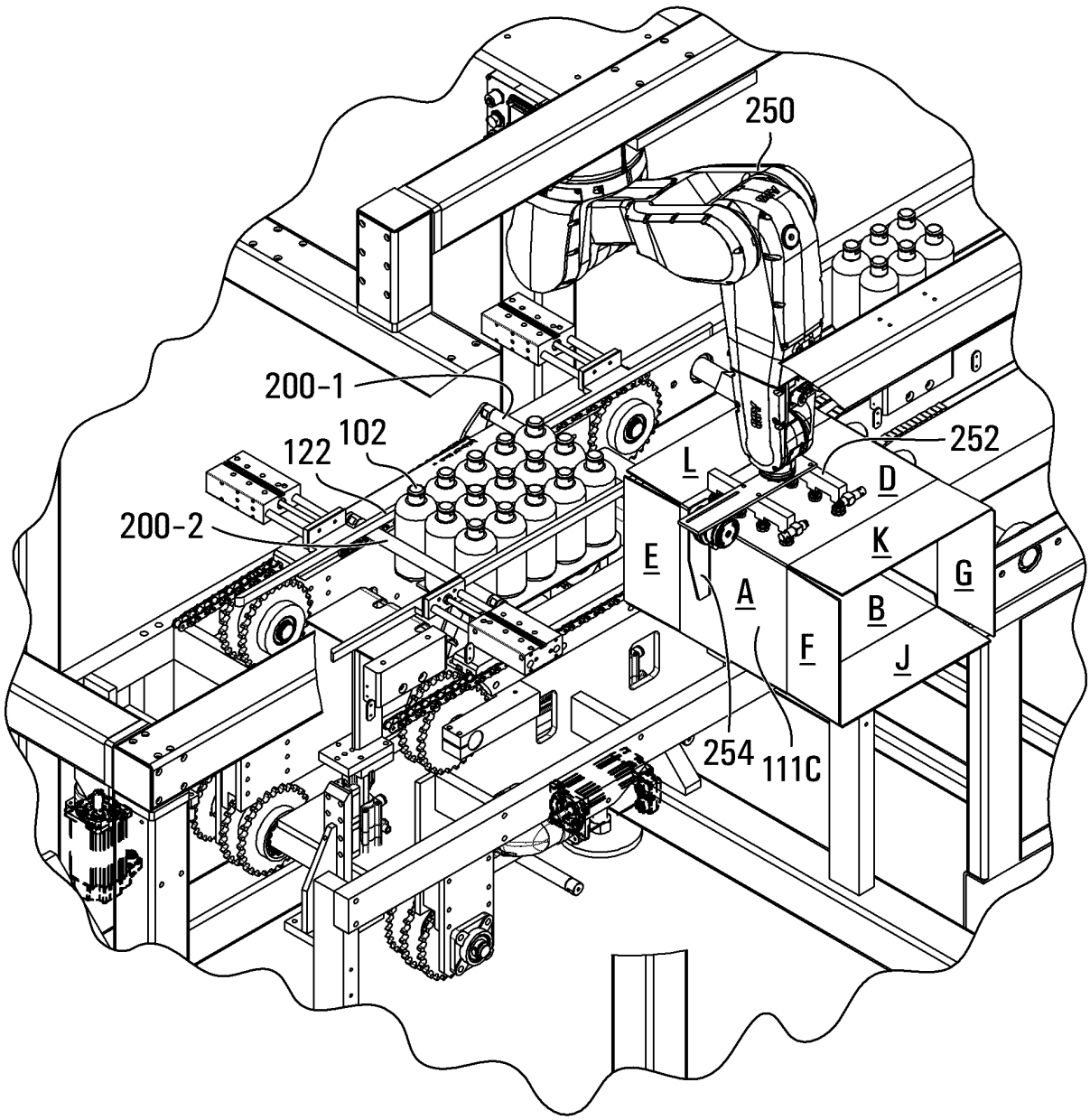

FIG. 13

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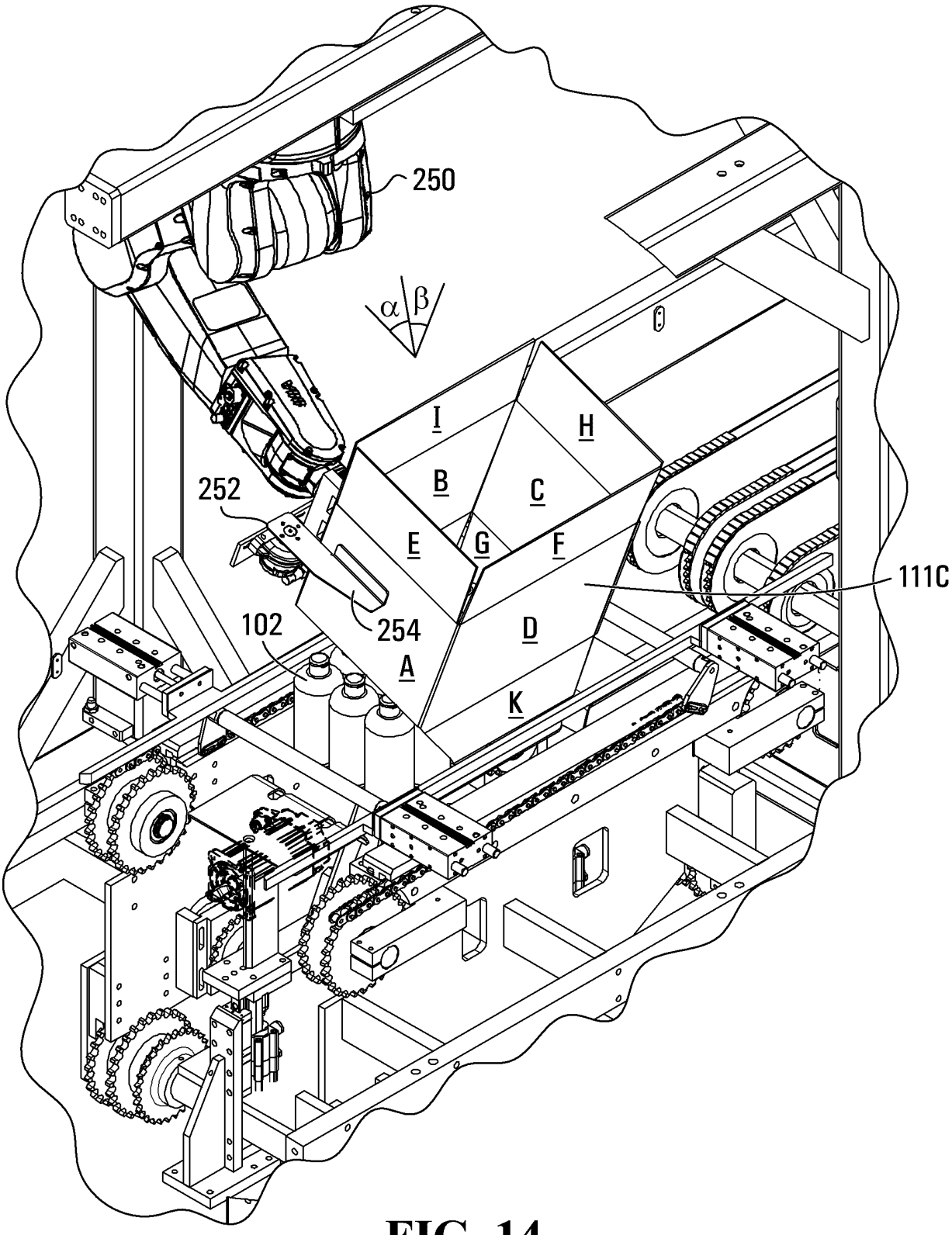

FIG. 14

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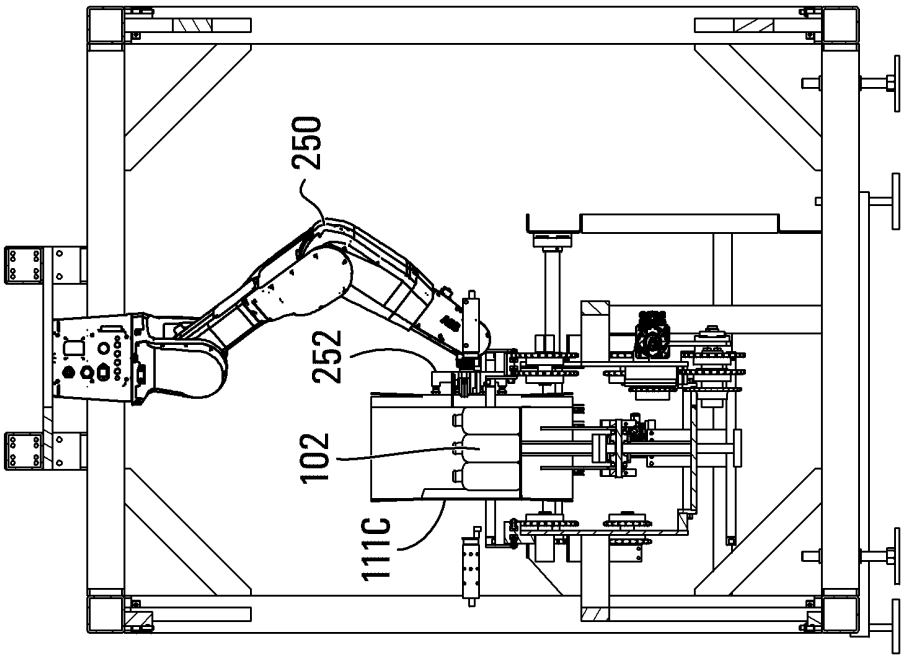

FIG. 16

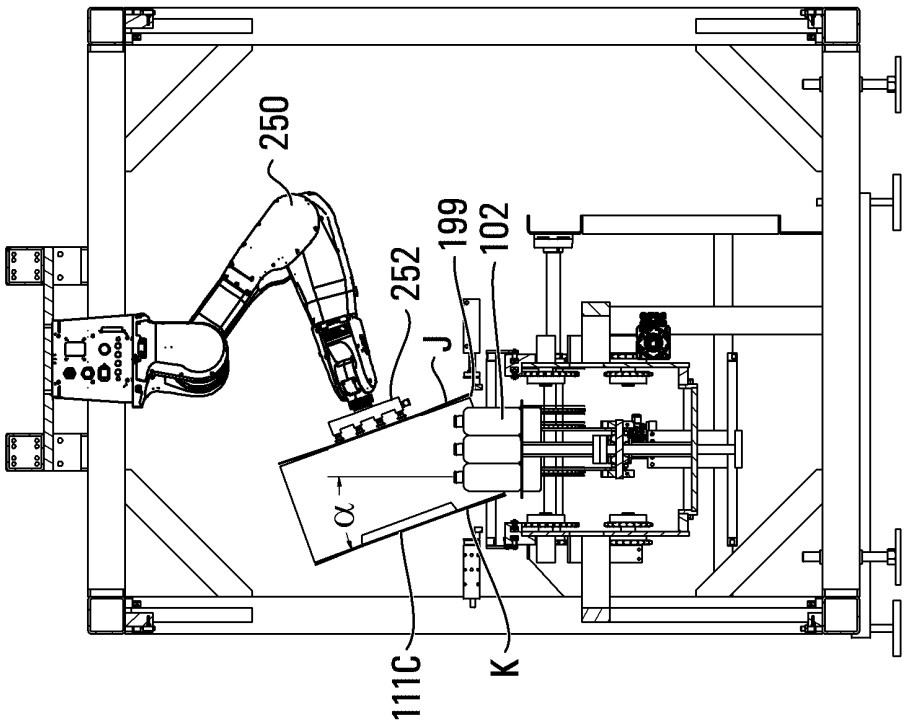

FIG. 15

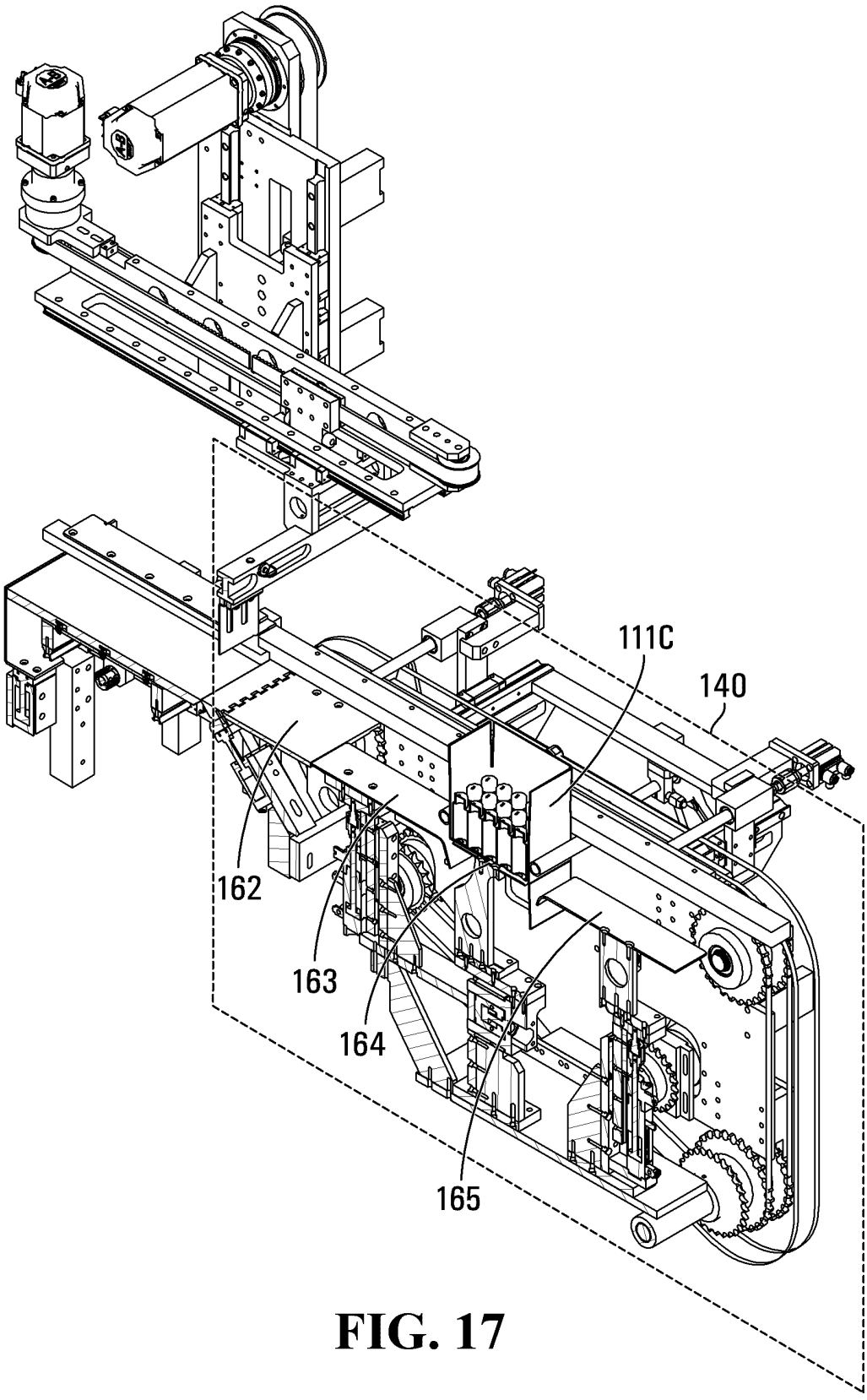

FIG. 17

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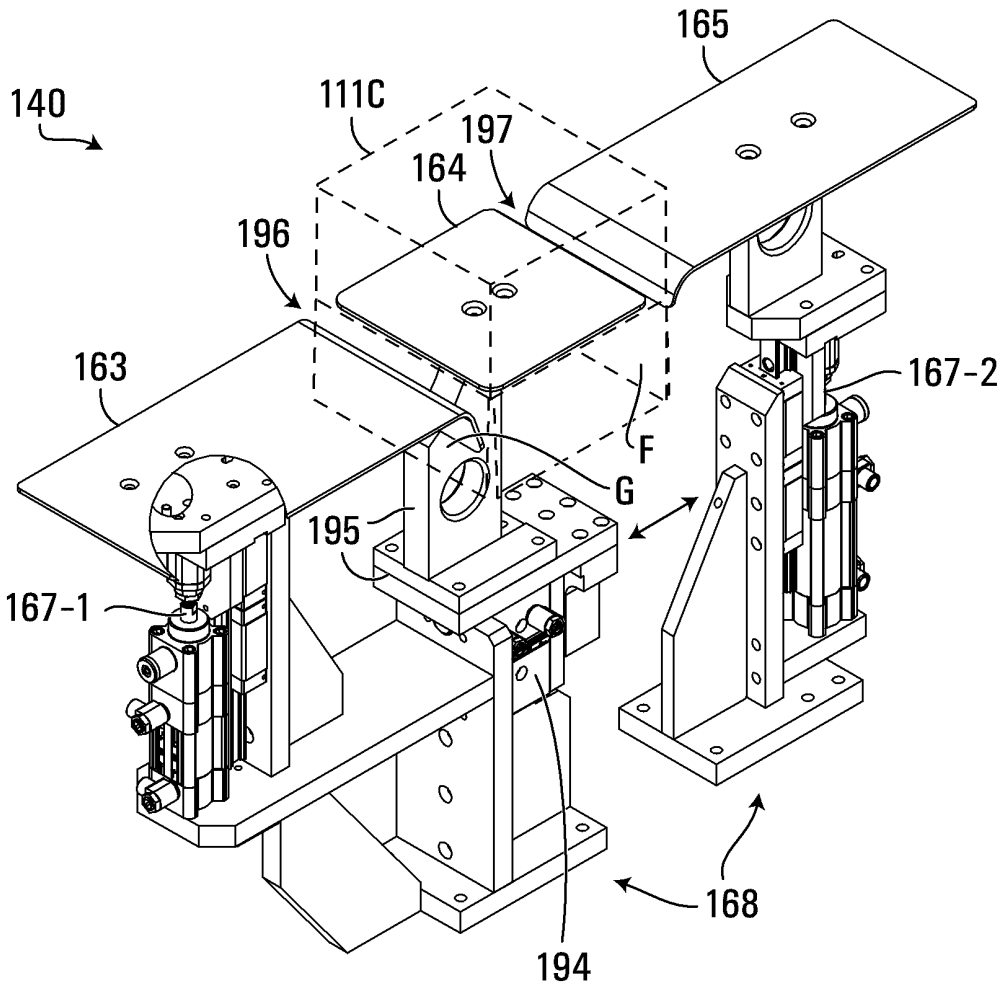

FIG. 18

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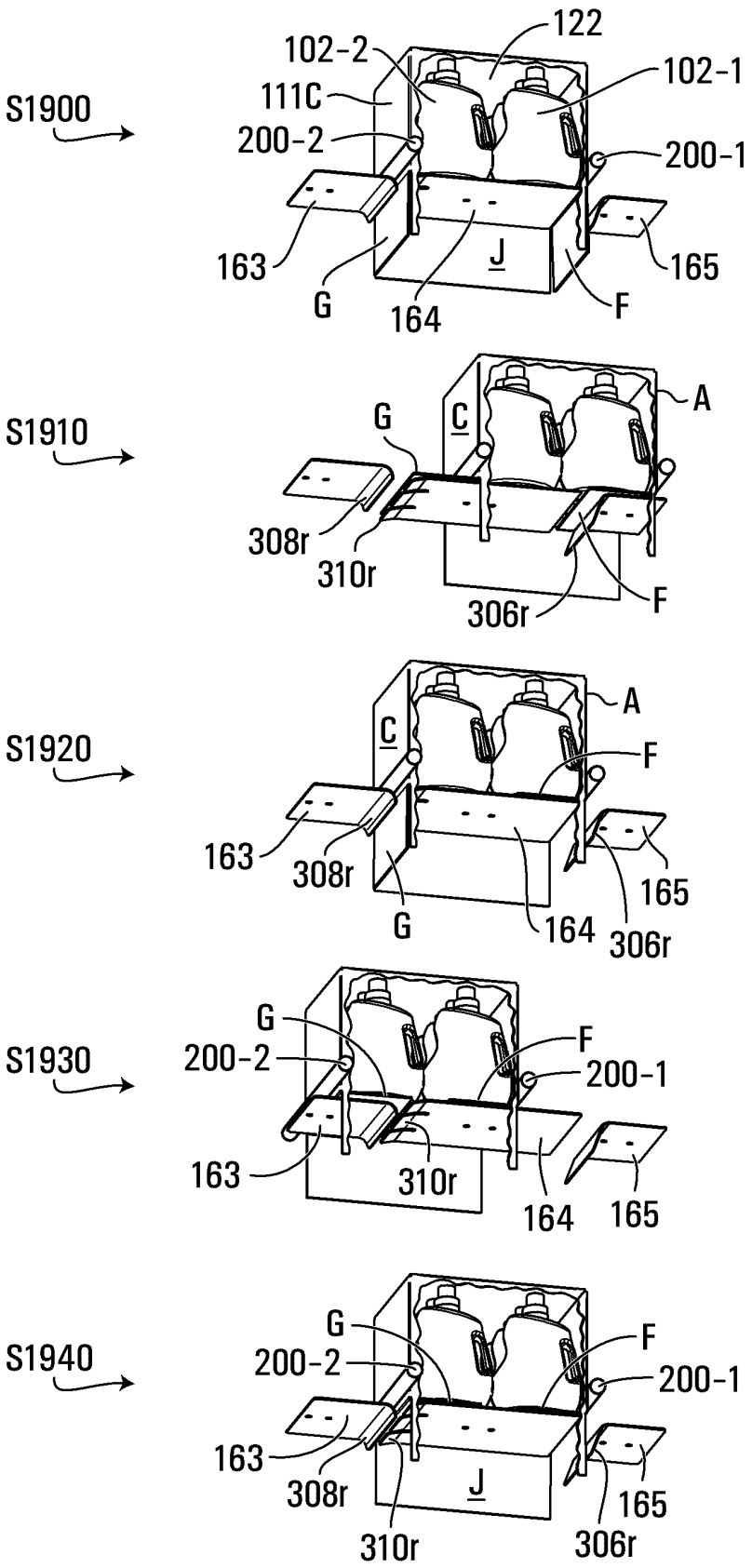

FIG. 19

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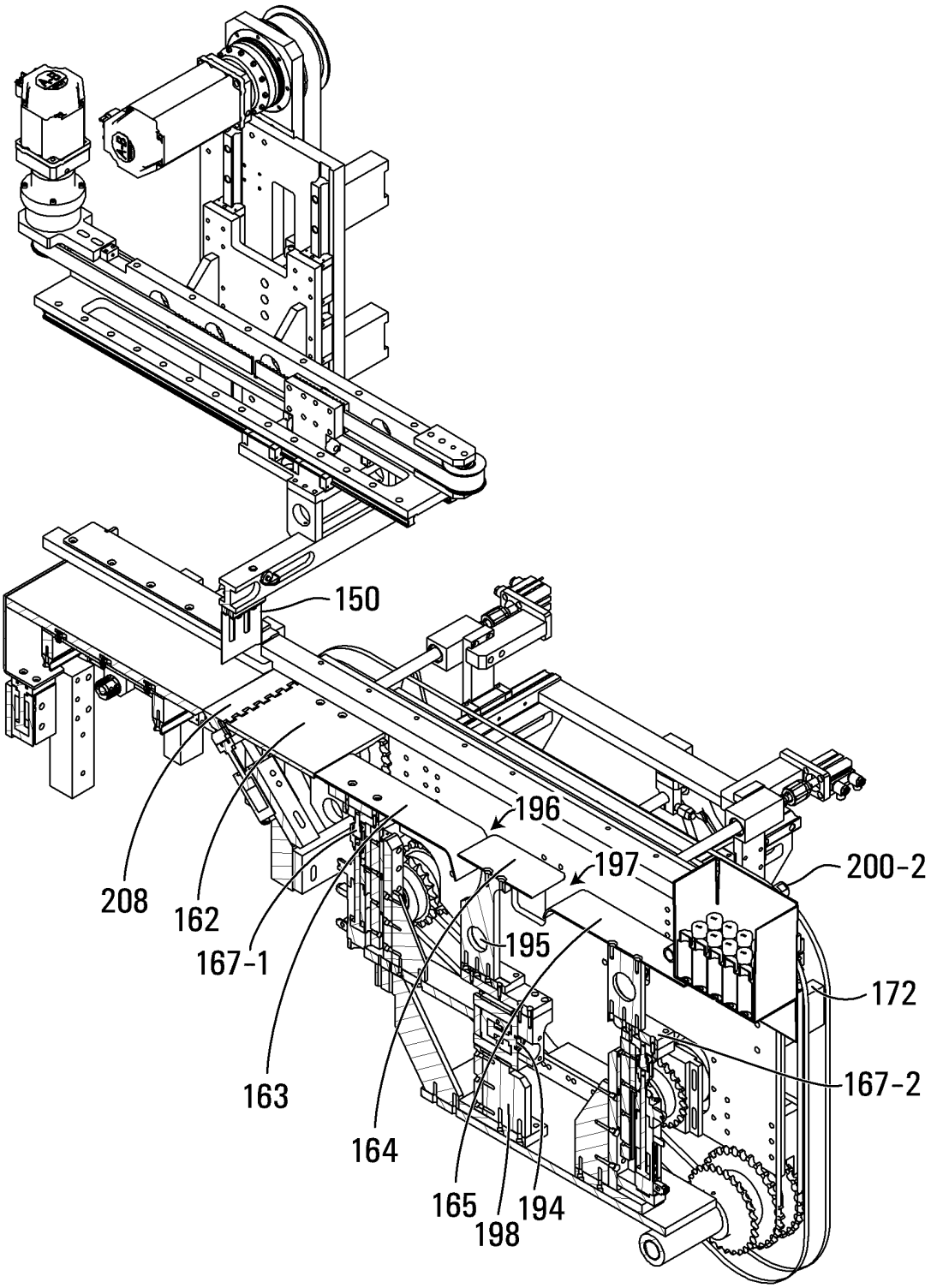


FIG. 20

Date Reçue/Date Received 2021-02-12

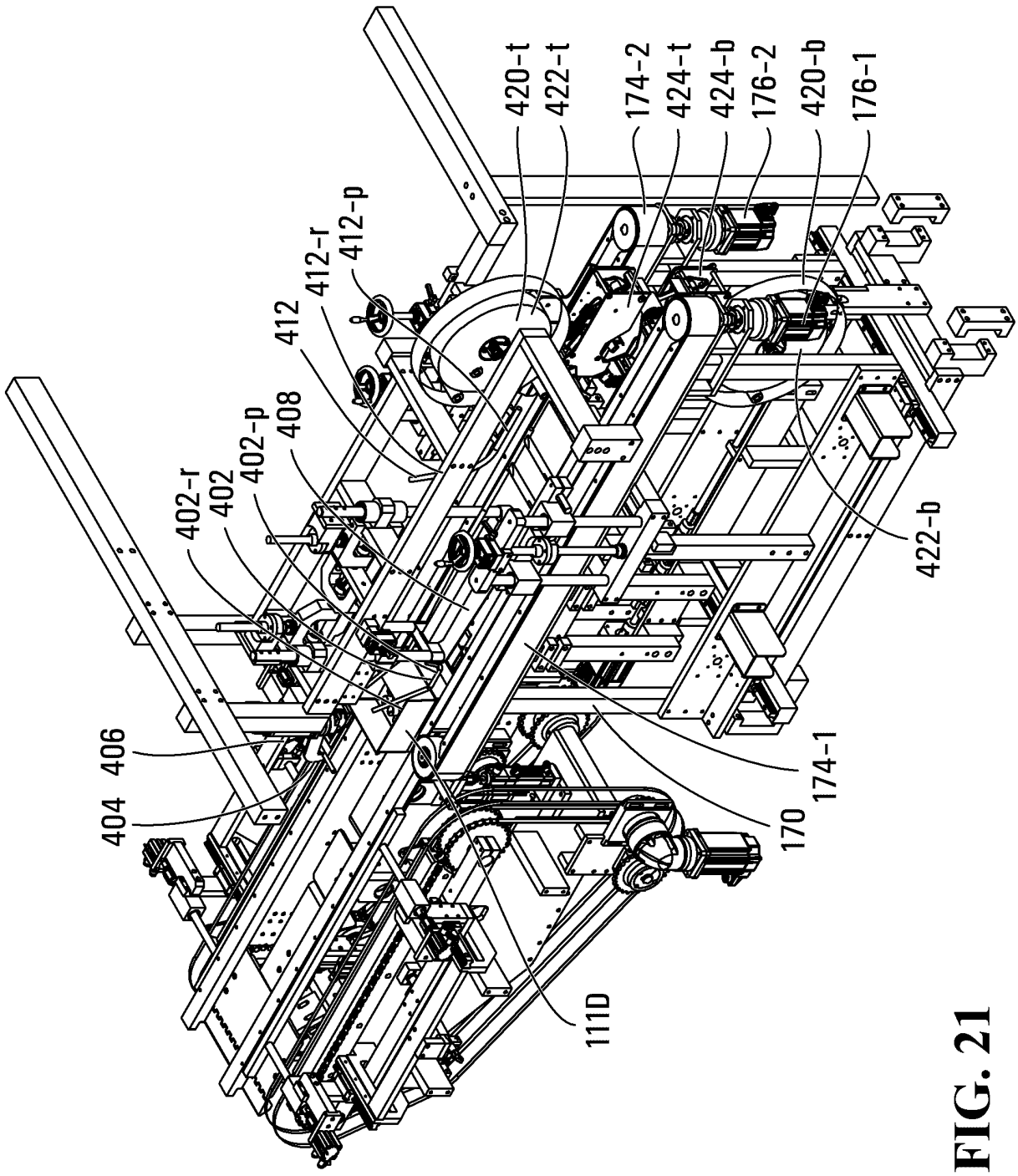


FIG. 21

Date Reçue/Date Received 2021-02-12

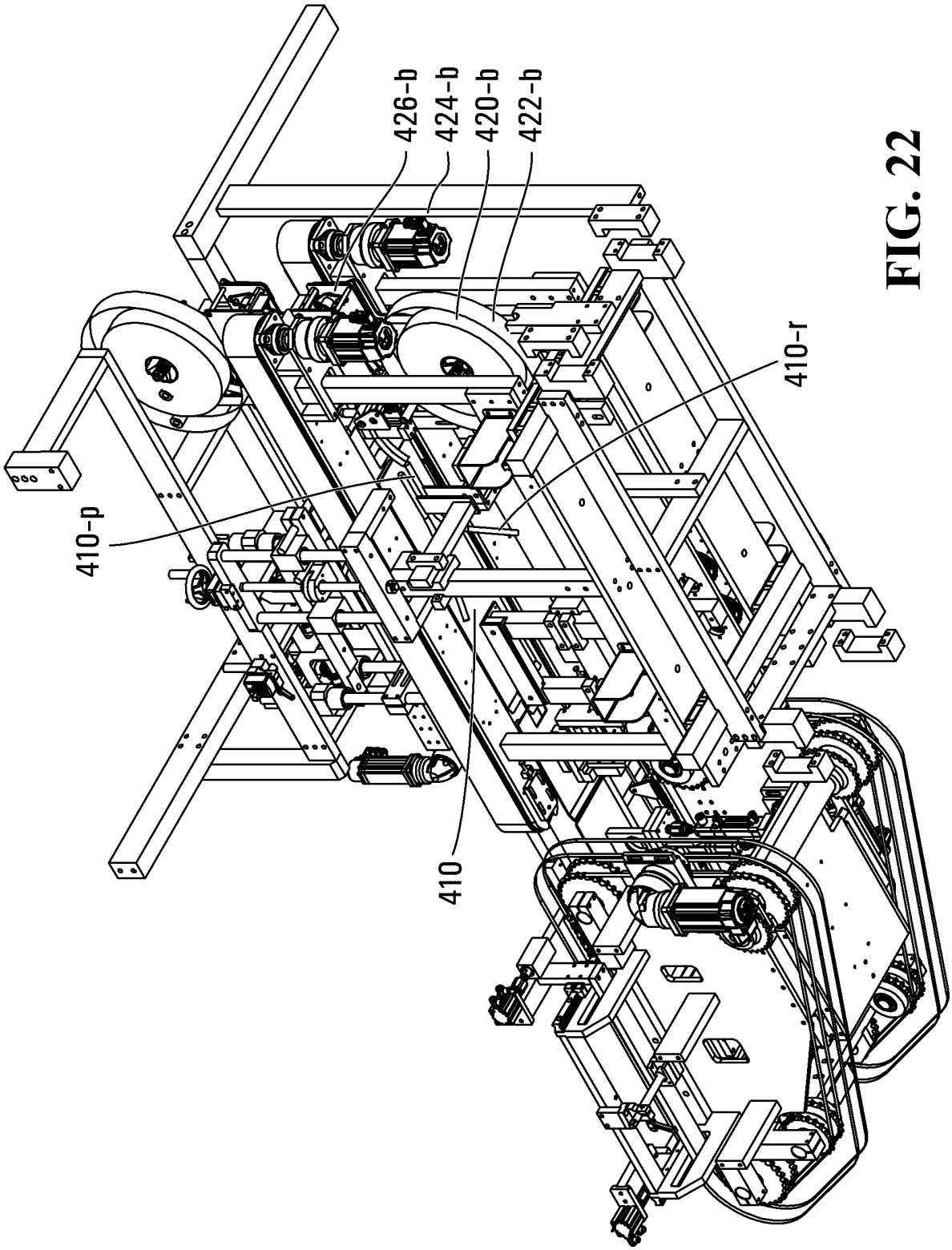


FIG. 22

Date Reçue/Date Received 2021-02-12

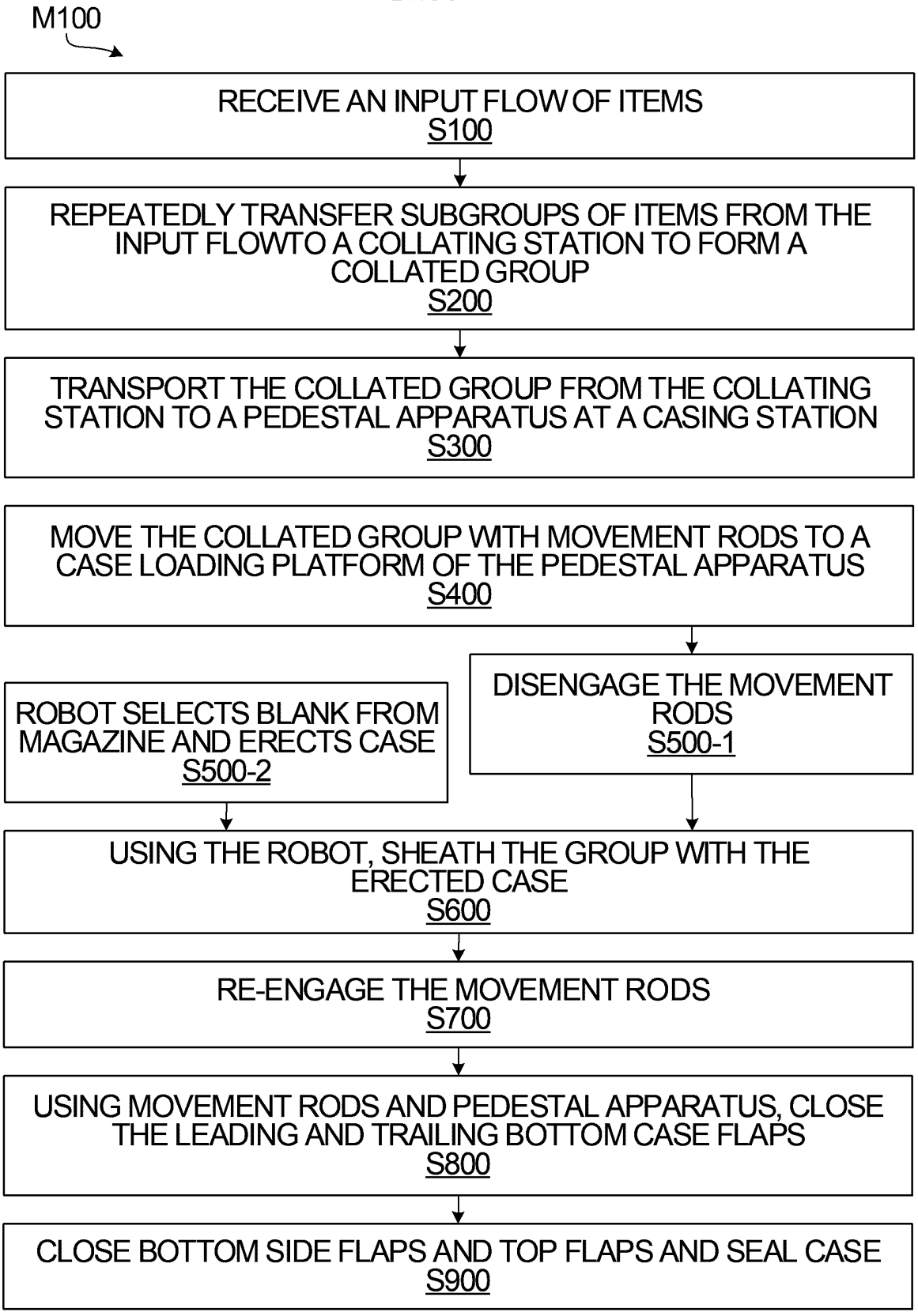


FIG. 23

Date Reçue/Date Received 2021-02-12

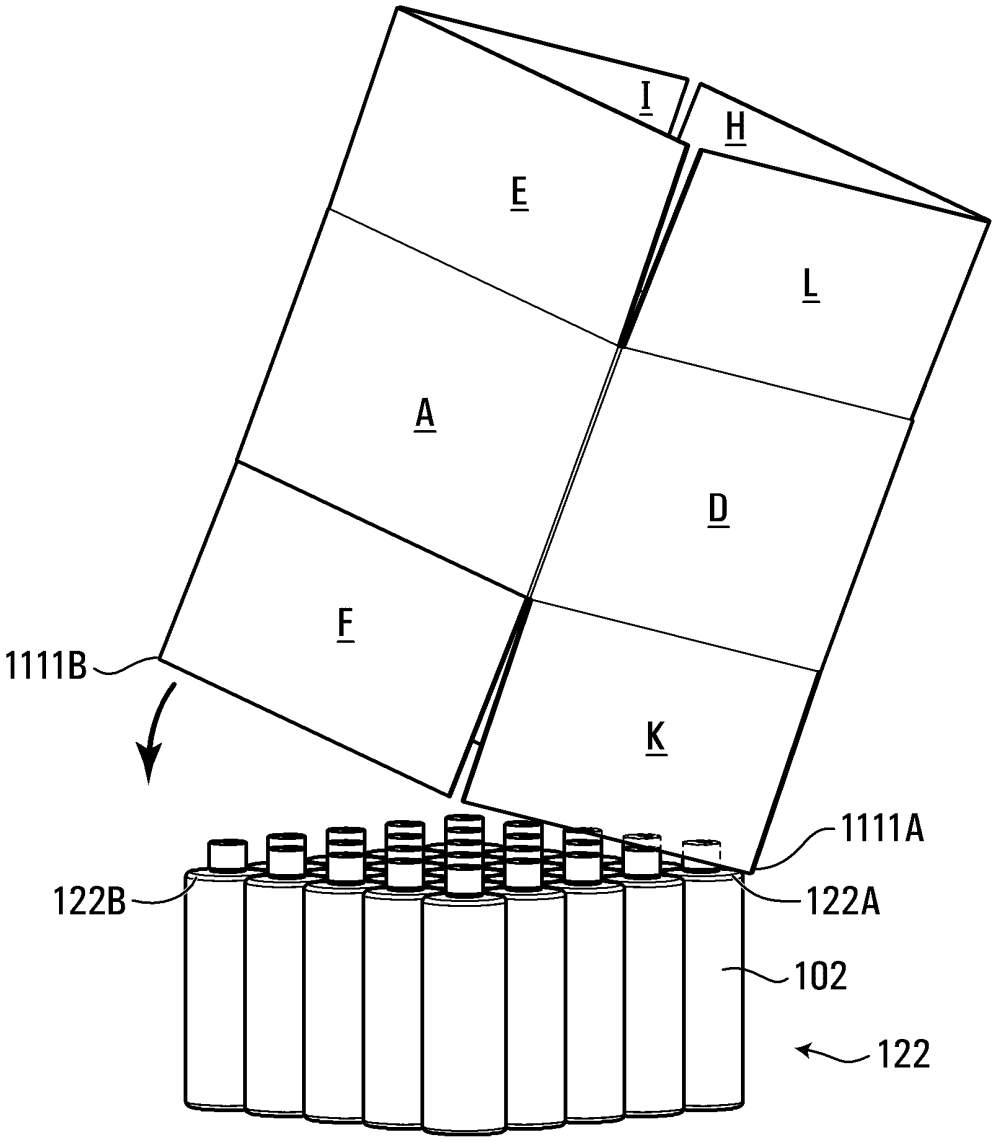


FIG. 24A

Date Reçue/Date Received 2021-02-12

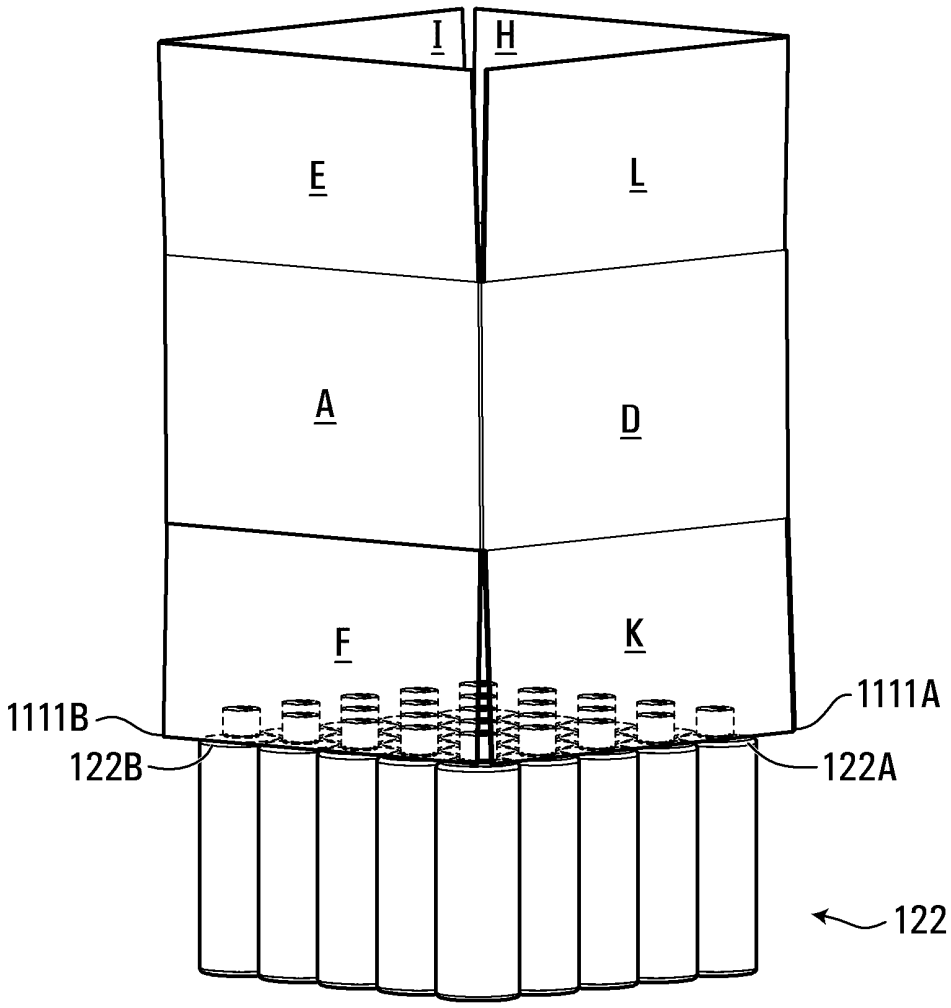
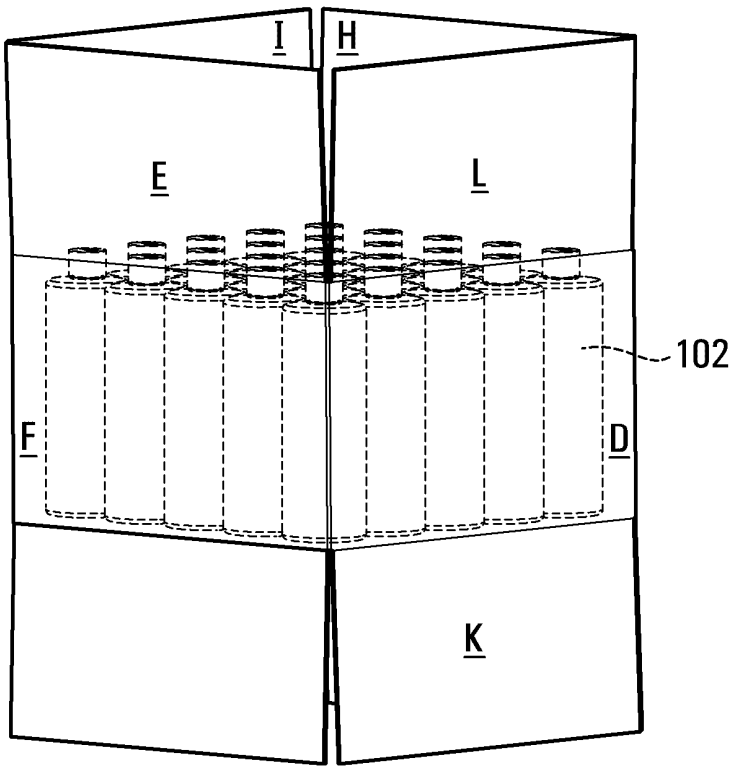


FIG. 24B

Date Reçue/Date Received 2021-02-12



(iv)

FIG. 24C

Date Reçue/Date Received 2021-02-12