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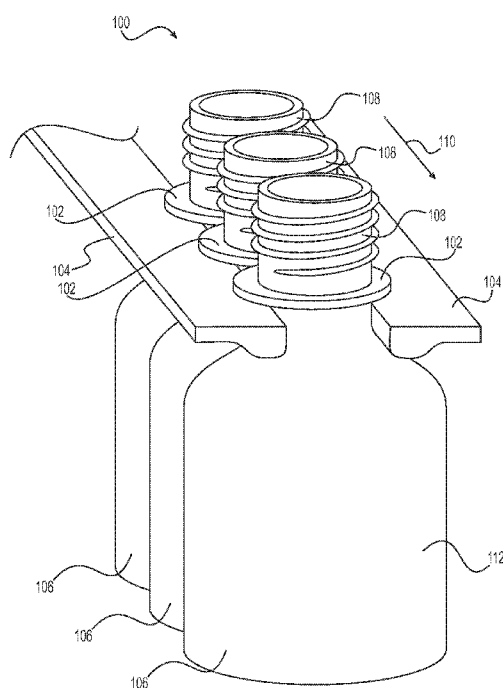


FIG. 1

(57) Abstract: Methods, devices, and systems for unjamming a jammed component of a manufacturing line are described. The methods may include detecting a jammed component and operating an unjamming device to unjam the jammed component. An unjamming device may include a body, a drive mechanism, and an unjamming structure to unjam the jammed component in the manufacturing line. A sensor may detect a jam in a manufacturing line and an unjamming device may unjam a jammed component.

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SYSTEMS, METHODS, AND DEVICES FOR UNJAMMING A MANUFACTURING LINE

FIELD OF THE DISCLOSURE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority to United States Provisional Application No. 62/793,960 filed January 18, 2019, the contents of which is expressly incorporated herein by reference in its entirety.

[0002] The present disclosure relates to a system, method, and device for monitoring and unjamming a manufacturing line. The present disclosure also relates to a system, method, and device for unjamming a container in a manufacturing line.

BACKGROUND

[0003] Manufacturing lines are used to make a wide range of products. In some lines, components, such as containers (including cups, bottles, jars, or other packaging) are transported along the line by a conveyance system. The containers may then be sorted and sent to another line for processing, such as to fill them with foodstuffs, beverages, soaps, cleaning solutions, personal care products, or other consumer or industrial goods.

[0004] Manufacturing lines may be included in any part of the manufacturing process, including container formation, container assembly, sterilization or disinfection of the containers, container transport, or container filling or packaging processes. Many manufacturing lines include a conveyance system that conveys containers within the manufacturing line.

[0005] Conveyance systems move the containers within a single manufacturing line and between manufacturing lines. For example, in some manufacturing lines, containers, such as bottles, jars, or cups, are formed from a preform (such as by blow molding) at the start of the line and then transported to another part of the line for disinfection or filling. In some other manufacturing lines, the blow-molded bottles are grouped and sent to another facility for processing. In other manufacturing lines, pre-formed containers are supplied to the line where they are processed, such as by filling with foodstuffs or other goods.

[0006] FIG. 1 shows an exemplary manufacturing line 100 having containers, such as bottles 106, cups, or jars, which may have a lip or flange 102. In some systems, containers having lip 102 may be transported along rails or guides that supports lip or flange 102 of container 106 during transport, such as rails or guides 104 shown in FIG. 1. In some of these systems, known as air conveyors, pressurized air may be applied against the neck 108 or body 112 of containers 106, which forces the containers to move along the manufacturing line. Many containers proceed in series, one after another, in a direction of travel 110 as each container 106 pushes the preceding container forward along the rails or guides 104.

[0007] Although conveying systems of a manufacturing line, such as air conveying system 200 of FIG. 2, can move a large number of containers 202 from one location to another, they are prone to jamming. FIG. 2 shows an exemplary jam 210 in the manufacturing line when a container 202 becomes skewed on the guides 204, which causes the flange or lip to jam against the guides 204. Such jams cause the containers to slow or stop, which prevents the containers from proceeding in the direction of travel 208 and causes loss of production because no containers are being transported and the manufacturing line ceases operation.

[0008] At present, people are employed to clear jams by walking along manufacturing lines looking for jams. If a jam is spotted, the people jostle the containers until they come free and production continues. Such methods are inefficient and costly. Jams can occur at several locations in the line at once or in close succession. Due to the high frequency of jams, significant losses of production and revenue can result because of the time required to clear each jam and then search for and find other jams. Because manufacturing lines are often very long, even a single jam can take a significant amount of time to clear while the person responsible for clearing it walks along the line looking for the jam and then tries to unjam the system.

[0009] Given the time, expense, and resulting loss of production and revenue associated with manufacturing line jams, it is desirable to have an improved system and method for unjamming manufactured lines.

SUMMARY

[0010] In the following description, certain aspects and embodiments will become evident. It is contemplated that the aspects and embodiments, in their broadest sense, could be practiced without having one or more features of these aspects and embodiments. It is also contemplated that these aspects and embodiments are merely exemplary.

[0011] One aspect of the disclosure relates to an unjamming method. The unjamming method may include detecting a jammed component of a manufacturing line and operating a mechanism to move an unjamming device toward the location of the jammed component. The unjamming device may include an unjamming structure configured to move between an active position and an inactive position. The method may include unjamming the jammed component of

the manufacturing line with the unjamming device when the unjamming structure is in the active position.

[0012] According to another aspect, detecting the jammed component may include detecting whether the motion of a component in the manufacturing line has substantially stopped. According to another aspect, detecting the jammed component may include determining whether a first component is absent at a first location of the manufacturing line for a predetermined period of time. According to another aspect, detecting the jammed component may further include whether a second component is present at a second location of the manufacturing line when the first component is absent at the first location. According to another aspect, the absence of the first component at the first location and the presence of the second component at the second location may indicate that the jammed component is located between the first location and the second location.

[0013] According to another aspect, operating the mechanism may include operating the mechanism to move the unjamming device substantially parallel to the manufacturing line.

[0014] According to another aspect, unjamming the jammed component may include contacting the jammed component with the unjamming structure. According to another aspect, unjamming the jammed component may include contacting a component adjacent to the jammed component with the unjamming structure. According to another aspect, unjamming the jammed component may include contacting a component with the unjamming structure to cause contact with the jammed component, whereby the contact with the jammed component unjams the jammed component.

[0015] According to another aspect, unjamming the jammed component may include moving the unjamming device in a direction substantially opposite to the desired direction of travel of the jammed component during the unjamming step.

[0016] According to another aspect, the method may include moving the unjamming structure to the inactive position after the step of unjamming the jammed component. According to another aspect, the method may include returning the unjamming structure to a resting location after unjamming the jammed component until a second jammed component is detected.

[0017] According to another aspect, unjamming the jammed component may include moving the unjamming structure from the inactive position to the active position. The method may include contacting at least one of the jammed component or a component adjacent to the jammed component with the unjamming structure in the active position. The method may also include moving the unjamming structure to the inactive position.

[0018] According to another aspect, the active position may be configured such that the unjamming structure interferes with an intended travel path of the component in the manufacturing line and the inactive position does not interfere with the intended travel path of the component.

According to another aspect, the method may include operating the mechanism to move the unjamming device, such as, for example, moving the unjamming device a predetermined distance or moving the unjamming device until the unjamming structure contacts a component in the manufacturing line. According to another aspect, the contact with the component in the manufacturing line causes the jammed component to become unjammed.

[0019] According to another aspect, the method may include determining whether a component of the manufacturing line is located near the unjamming device using a component sensor. The method may also include determining the location of the jammed component by determining that a component is not located near the unjamming device. According to another aspect, the method may include determining whether the unjamming device unjammed the jammed component by determining whether a component is near the unjamming device, and, if it is determined that the unjamming device did not unjam the jammed component, sending the unjamming device to unjam the jammed component.

[0020] Another aspect of the disclosure relates to an unjamming device. The unjamming device may include a body, a drive mechanism, and an unjamming structure. The drive mechanism may be configured to move the body. The unjamming structure may be coupled to the body. The unjamming structure may be configured to move between an active position and an inactive position. The unjamming structure may be further configured to unjam a jammed component of a manufacturing line when the unjamming structure is in the active position.

[0021] According to another aspect, the unjamming device may include an actuator configured to move the unjamming structure between the active position and the inactive position. According to some embodiments, the unjamming structure may be configured to move between the active position and the inactive position via a rotational motion. According to another aspect, the unjamming structure may be configured to move between the active position and the inactive position via a linear motion. According to another aspect, the unjamming structure may be configured to move between the active position and the inactive position via a telescoping motion.

[0022] According to another aspect, the drive mechanism may be configured to move the unjamming device substantially parallel to the manufacturing line.

[0023] According to another aspect, a motion of the unjamming structure between the active position and the inactive position may be substantially perpendicular to the manufacturing line. According to another aspect, a motion of the unjamming structure between the active position and the inactive position may be substantially parallel to the manufacturing line.

[0024] According to another aspect, the device may include a tensioning mechanism configured to maintain tension between the unjamming structure and the body. According to another aspect, the tensioning mechanism may be configured to control movement of the unjamming structure relative to the body. According to another aspect, the tensioning mechanism may include a spring affixed to the unjamming structure and the body.

[0025] According to another aspect, the device may include a movement sensor configured to detect movement of the unjamming structure relative to the body. According to another aspect, the movement sensor may include an optical sensor. According to another aspect, the movement sensor may include a switch.

[0026] According to another aspect, a mechanism may be configured to move the unjamming structure between the active position and the inactive position when the movement sensor detects a predetermined movement of the unjamming structure.

[0027] According to another aspect, the unjamming device may include an unjamming sensor configured to detect when the unjamming structure unjams the component in the manufacturing line. According to another aspect, the

unjamming sensor may include a switch configured to detect relative movement between the body and the unjamming structure. According to another aspect, the unjamming sensor may include an optical sensor.

[0028] According to another aspect, the drive mechanism may be configured to move the unjamming device by rotating at least one wheel. According to another aspect, the drive mechanism may be configured to move the unjamming device along at least one of a guide rail, a floor, or the manufacturing line.

[0029] According to another aspect, the jammed component in the manufacturing line may be a packaging container. According to another aspect, the jammed component in the manufacturing line may be a container for foodstuffs or liquids. According to another aspect, the jammed component in the manufacturing line may be a bottle. According to another aspect, the jammed component in the manufacturing line may be a jar. According to another aspect, the jammed component in the manufacturing line may be a cup.

[0030] According to another aspect, the unjamming device may include a controller configured to control an actuator and the drive mechanism. According to another aspect, the actuator may be configured to move the unjamming structure between the active position and the inactive position.

[0031] According to another aspect, the unjamming device may include a controller configured to move the unjamming structure between the active position and the inactive position based on an input from at least one sensor.

[0032] According to another aspect, the controller may be configured to determine the presence of the jammed component in the manufacturing line. According to another aspect, the controller may be configured to activate the drive mechanism to move the unjamming device such that the unjamming structure

contacts a component in the manufacturing line. According to another aspect, the contacted component may include the jammed component in the manufacturing line. According to another aspect, the contacted component may include a component adjacent to the jammed component. According to another aspect, the contacted component may include a component that causes contact with the jammed component.

[0033] According to another aspect, the unjamming device may include a measuring device configured to detect a distance moved by the unjamming device. According to another aspect, the measuring device may include an optical sensor, a line, or an encoder.

[0034] According to another aspect, the unjamming device may include a component sensor configured to determine whether a component of the manufacturing line is located near the unjamming device. According to some aspects, the determination of whether a component is located near the unjamming device may be used to determine the location of a jammed component. According to some aspects, the determination of whether a component is located near the unjamming device may be used to determine whether the unjamming device unjammed a jammed component and, if it is determined that the unjamming device did not unjam the jammed component, to send the unjamming device to unjam the jammed component.

[0035] Another aspect of the disclosure relates to a system for unjamming a manufacturing line. According to another aspect, the system may include at least one sensor and at least one unjamming device. According to another aspect, the at least one sensor may be configured to detect a jam in a manufacturing line. According to another aspect, the unjamming device may include a body, a

mechanism, and an unjamming structure. According to another aspect, the mechanism may be coupled to the body. According to another aspect, the mechanism may be configured to move the body. According to another aspect, the unjamming structure may be coupled to the body. According to another aspect, the unjamming structure may be configured to unjam a jammed component in the manufacturing line.

[0036] According to another aspect, the at least one sensor may include a plurality of sensors configured to detect the jam. According to another aspect, the plurality of sensors may be configured to detect the jam by determining whether a first component is present at a first location. According to another aspect, the plurality of sensors may be configured to detect the jam by determining whether a second component is absent at a second location.

[0037] According to another aspect, the at least one sensor may be configured to detect whether a component in the manufacturing line is absent at a location for a predetermined time. According to another aspect, the at least one sensor may be configured to detect a speed of a jammed component in the manufacturing line that indicates the jammed component

[0038] According to another aspect, the system may include a controller configured to receive a signal from the at least one sensor indicating a jam and to control the mechanism to move the unjamming device to unjam the jammed component in the manufacturing line.

[0039] According to another aspect, the at least one unjamming device may include a plurality of unjamming devices. According to another aspect, each of the plurality of unjamming devices may be configured to unjam a predetermined segment of the manufacturing line.

[0040] According to another aspect, at least one unjamming device may include a plurality of unjamming devices configured to unjam a corresponding plurality of predetermined segments of the manufacturing line such that at least two of the predetermined segments overlap.

[0041] According to another aspect, the system may include a controller. According to another aspect, the at least one unjamming device may include a plurality of unjamming devices. According to another aspect, the controller may be configured to determine one unjamming device of the plurality of unjamming devices to unjam the jammed component.

[0042] According to another aspect, the at least one unjamming device may be configured to return to a resting position after the unjamming device unjams the unjammed component.

[0043] According to another aspect, the manufacturing line may include an air conveyor configured to transport a plurality of components along the manufacturing line. According to another aspect, the jammed component may be a component jammed in the air conveyor.

[0044] According to another aspect, the system may include a component sensor configured to determine whether a component of the manufacturing line is located near the unjamming device. A processor may be configured to use the determination of whether a component is located near the unjamming device to determine the location of a jammed component. The processor may be configured to use determination of whether a component is located near the unjamming device to determine whether the unjamming device unjammed a jammed component and, if it is determined that the unjamming device did not unjam the jammed component, to send the unjamming device to unjam the jammed component.

[0045] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several exemplary embodiments and together with the description, serve to outline principles of the exemplary embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] FIG. 1 shows an exemplary embodiment of components of a manufacturing line.

[0047] FIG. 2 shows an exemplary jammed component in a manufacturing line.

[0048] FIG. 3 shows an exemplary embodiment of an unjamming method.

[0049] FIG. 4 shows exemplary method steps for detecting a jammed component.

[0050] FIG. 5 shows exemplary method steps for unjamming a jammed component.

[0051] FIG. 6A shows a front view of an exemplary embodiment of an unjamming device.

[0052] FIG. 6B shows a side cross-sectional view of an exemplary embodiment of an unjamming device.

[0053] FIG. 6C shows an isometric view of an exemplary embodiment of an unjamming device.

[0054] FIG. 6D shows a bottom view of an exemplary embodiment of an unjamming device.

[0055] FIG. 6E shows a simplified isometric view of a portion of an exemplary drive mechanism of an exemplary unjamming device.

[0056] FIG. 7A shows a simplified exemplary embodiment of an unjamming device.

[0057] FIG. 7B shows a simplified exemplary embodiment of an unjamming device.

[0058] FIG. 7C shows a simplified exemplary embodiment of an unjamming device.

[0059] FIG. 8A shows a top view of an exemplary system for unjamming manufacturing line.

[0060] FIG. 8B shows a side view of an exemplary system for unjamming manufacturing line.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0061] Reference will now be made in detail to exemplary embodiments shown in the accompanying drawings.

[0062] Exemplary disclosed embodiments include devices, systems, and methods for unjamming a jammed component in a manufacturing line. For example, in some embodiments, an unjamming device includes a body, a drive mechanism, and an unjamming structure. The unjamming device may be used in a method or system for unjamming the jammed component. The disclosed embodiments reduce costs or complexity associated with unjamming the manufacturing line when compared to traditional processes by reducing the down time or lost processing time associated with clearing jams in the manufacturing line by previously known methods.

[0063] The disclosed embodiments may be used to unjam components, such as bottles, jars, cups, or other containers having a lip or flange, travelling in a manufacturing line. In some embodiments, the manufacturing line includes a conveying system, such as an air conveyor. Exemplary methods of unjamming a jammed component are described with reference to FIGS. 3-5. Exemplary unjamming devices and systems for unjamming a jammed component are described with reference to FIGS. 6-8. It is contemplated that the exemplary unjamming devices and systems may, in some embodiments, be used to perform the methods disclosed in FIGS. 3-5.

[0064] FIG. 3 shows an exemplary embodiment of a method 300 of unjamming a manufacturing line. At step 302, a jammed component of a manufacturing line is detected. According to some embodiments, the jammed component may be detected using one or more sensors as described further below. At step 304, a mechanism operates to move an unjamming device. The unjamming device may include a body, a drive mechanism, and an unjamming structure. In some embodiments, the unjamming structure may be configured to move between an active position and an inactive position. At step 306, the unjamming device unjams the jammed component of the manufacturing line. Unjamming the jammed component may include contacting the jammed component with the unjamming structure of the unjamming device. For example, when the jammed component is contacted by the unjamming structure, the unjamming structure may cause the jammed component to move or jostle in a way that unjams the jammed component. In some exemplary embodiments, when a lip or flange of a container is wedged or caught in the manufacturing line, contact from the unjamming device may move the jammed component in such a way to free the lip or flange, thereby freeing the

component and restoring the motion of the components in the manufacturing line. According to some embodiments, unjamming the jammed component may include contacting a component adjacent to the jammed component. According to some embodiments, unjamming the jammed component may include contacting a component that causes contact with the jammed component. For example, when the component adjacent to the jammed component is contacted, it may swing or press against the jammed component, thereby jostling the jammed component and causing it to unjam. When the jammed component includes a lip or flange of a container wedged or caught in the manufacturing line, the contact from the adjacent component may jostle the jammed component in a way that frees the lip or flange, thereby freeing the jammed component and restoring the motion of the components in the manufacturing line. In some embodiments, after unjamming the jammed component, the unjamming device may return to a resting location, as shown in step 308.

[0065] FIGS. 4 and 5 show exemplary method steps of detecting a jammed component and unjamming the jammed component respectively.

[0066] FIG. 4 shows exemplary method steps of a method 400 of detecting a jammed component. In some embodiments, some or all of the steps of method 400 may be used in step 302 of method 300. At step 402, it is determined whether a first component is present at a first location of the manufacturing line. In some embodiments, if the component is detected, the method proceeds to step 404 where it is determined whether a second component is present at a second location of the manufacturing line. The second location may be farther downstream in the direction of travel of the components in the manufacturing line. When a component is detected at both locations, the method may continue to monitor one or both locations until a

component is not detected at one or both locations. When a component is detected at the first location, but not at the second location, it may indicate that a jam has occurred. Steps 402 and 404 may either be continuous or discontinuous in their detection. Continuous detection may continually receive signals from a sensor indicating whether a component is present at the location. Discontinuous measurements may occur at intervals, such as every one, two, or three seconds. At step 406, the method determines whether a predetermined time has passed. If the predetermined time has passed, the method may determine that a jam has occurred and send an unjamming device to unjam the manufacturing line at step 408.

[0067] In some embodiments, step 402 may be omitted, such that the method 400 only determines whether a component of the manufacturing line is present at one location. If the component is absent at this location, it indicates that a jam occurred prior to the monitored location. In such embodiments, an unjamming device may be sent to unjam the jammed component if no component is detected at the monitored location.

[0068] In some embodiments, step 406 may be omitted. In such embodiments, the unjamming device may be sent to unjam the jammed component when the absence of the component is detected at step 404. Such embodiments may be useful when measurements are discontinuous. In such embodiments, if a component is not detected at the location for a predetermined number of measurements, for example, two or three measurements, the method may determine that a jam has occurred and send an unjamming device to unjam the manufacturing line.

[0069] In some embodiments, the detecting a jammed component may also include one or more fault detection steps (not shown). Faults may lead to false

jam detection due to interruptions or errors from external sources, such as misalignment of a detection sensor, a loss of electrical power, malfunctioning sensors, malfunctioning conveying systems, or intentional stoppage of the manufacturing line. If a fault is detected, an alert may be sent to an operator to address the fault.

[0070] Operating a mechanism to move the unjamming device, such as at step 304 of FIG. 3, may be accomplished by any method or process by which the unjamming device traverses at least a portion of the manufacturing line to arrive at the location of the jammed component so that the unjamming device can unjam the jammed component. For example, in some embodiments, the unjamming device may include a drive mechanism. Some exemplary drive mechanisms include a drive mechanism that is part of the unjamming device, such as wheels, tracks, or other traction components that move the unjamming device along a floor, guide rails, or the manufacturing line itself. In other embodiments, the drive mechanism may include a mechanism external to the unjamming device that provides motion for the unjamming device, such as, for example, a pulley system or line system by which a motor or pulley moves a line attached to the unjamming device, thereby causing the unjamming device to traverse along the manufacturing line to unjam the jammed component.

[0071] According to some embodiments, the unjamming device may be moved along a path substantially parallel to the manufacturing line. In some embodiments, the unjamming device may be moved in a direction opposite the intended travel direction of the components of the manufacturing line when it is sent to unjam a jammed component. In such embodiments, the unjamming device may travel along the manufacturing line, for example, along a guide rail, against the

intended flow of components until the unjamming device reaches the jammed component when it unjams the jammed component. Such embodiments may be advantageous because the unjamming device will traverse the manufacturing line but will not cause further jams because the path of the unjamming device will be clear until it reaches the jammed component.

[0072] FIG. 5 shows an exemplary embodiment of a method 500 of unjamming a jammed component. In some embodiments, some or all of the steps of method 500 may be used in step 306 of method 300. In some embodiments, at step 502, a processor, controller, or other device may determine whether an unjamming structure of an unjamming device is in an active position. If the unjamming structure is not in an active position, method 500 may proceed to step 504, where the unjamming structure is moved to an active position. Subsequent to step 504, or if the unjamming structure is already in an active position at step 502, the method proceeds to step 506 where the unjamming device is moved to contact a component of the manufacturing line to unjam a jammed component. In some embodiments, the unjamming structure may contact the jammed component, such as a jammed bottle or jar, to dislodge the jammed component, thereby unjamming it and resuming the flow of the components in the manufacturing line. In some embodiments, the unjamming structure may contact a component adjacent to the jammed component of the manufacturing line. In such embodiments, the unjamming structure causes the adjacent component to move, contacting the jammed component, thereby dislodging it and resuming the flow of the components. It is also contemplated that the unjamming structure may contact a component two or more components away from the jammed components, provided that that contact causes the jammed component

to dislodge, thereby unjamming it and resuming the flow of the components in the manufacturing line.

[0073] According to some embodiments, at step 508, after the unjamming device unjams the manufacturing line, the unjamming structure is moved to an inactive position. The inactive position may be any position that is different from the active position that does not substantially interfere with the motion of the components in the manufacturing line. Exemplary embodiments of active and inactive positions are described further below. In some embodiments, the unjamming structure may be actively moved from the active to the inactive position, such as through the use of an actuator, servo, motor, or other mechanism. In some embodiments, the unjamming structure may be passively moved to the inactive position. Passive movement from the active position to the inactive position may occur, for example, when contacting the component to unjam the jammed component imparts a motion to the unjamming structure sufficient to move the unjamming structure to the inactive position without being assisted by an actuator or servo. For example, contact with the component to unjam the manufacturing line may apply a force sufficient to rotate the actuator structure to the inactive position, such as illustrated in FIG. 7A, without assistance from an actuator.

[0074] According to some embodiments, steps 502 and/or step 504 may occur prior to step 304 of FIG. 3. In some embodiments, steps 304 and 506 may be the same step. In such embodiments, a jam may be detected at step 302 of FIG. 3. It may be then determined whether the unjamming structure is in an active position at step 502. If the unjamming structure is not in an active position, it may be moved to the active position as described in step 504. A mechanism may then move the unjamming device to unjam the jammed component as described in step 304. The

unjamming device may then unjam the jammed component, such as by contacting the jammed component or a component adjacent to the jammed component, as described in step 506. It is therefore contemplated that steps described in FIGS. 4 and 5 may occur in different variations to accomplish the method disclosed in FIG. 3.

[0075] FIGS. 6A-6E show views of an exemplary embodiment of an unjamming device 600. FIG. 6A shows a front view of exemplary unjamming device 600. FIG. 6B shows a cross-sectional view of unjamming device 600 taken along plane B-B of FIG. 6A. FIG. 6C shows an isometric view of unjamming device 600. Unjamming device 600 may include a body 602, a drive mechanism 604, and an unjamming structure 606. In some embodiments, drive mechanism 604 may be configured to move body 602, such as long rail or guide 626. In some embodiments, unjamming structure 606 may be coupled to body 602. In some embodiments, unjamming structure 606 may be configured to move between an active position and an inactive position.

[0076] In general, an active position may be a position in which unjamming structure 606 is configured to interfere with an intended travel path of the components of the manufacturing line. An inactive position may be a position in which unjamming structure 606 is configured such that it will not substantially interfere with an intended travel path of the components of the manufacturing line. For example, when unjamming device 600 is operated to unjam a jammed component, such as a jammed bottle, unjamming structure 606 may be positioned in the active position and unjamming device 600 be moved along the manufacturing line until unjamming structure 606 contacts a component, such as the jammed bottle or a bottle adjacent to the jammed bottle, thereby dislodging the jammed component, unjamming the system, and resuming the motion of the components in the

manufacturing line. Unjamming device 600 may then be moved to an inactive position so that the now-unjammed components can continue traveling along the manufacturing line and not contact unjamming structure 606, because such contact while the components are moving could cause further jams.

[0077] FIGS. 7A-7C show non-limiting examples of active and inactive positions of unjamming structure 606. FIGS. 7A-7C show simplified unjamming devices 600 including body 602 and unjamming structure 606. Other components of unjamming devices 600 have been omitted to facilitate clarity of the description.

[0078] In FIG. 7A, unjamming structure 606 is shown in active position 702, which interferes with travel path or direction of travel 701 of component 700. When unjamming structure 606 is in active position 702 of FIG. 7A, it is configured to such that it may contact a component 700 of the manufacturing line. Component 700 may be a component of a manufacturing line that is the jammed component or may be a component adjacent to the jammed component. When unjamming structure 606 contacts component 700, it unjams the manufacturing line by freeing the jammed component and thereby restoring motion to the components of the manufacturing line. For example, if component 700 is the jammed component, unjamming structure 606 may jostle component 700 to unjam it, and component 700 may then continue moving in direction of travel 701. If component 700 is adjacent to the jammed component, when unjamming structure 606 contacts component 700, it causes component 700 to jostle the jammed component, thereby unjamming the manufacturing line such that component 700 and the previously-jammed component continue moving in travel direction 701. When unjamming structure 606 contacts component 700, unjamming structure 606 rotates to inactive position 704 about axis 706. When unjamming structure 606 is in inactive position 704 of FIG. 7A, it may be

configured such that unjamming structure 606 does not substantially interfere with the travel path or direction of travel 701 of component 700 of the manufacturing line. In this way, the movement from active position 702 to inactive position 704 clears travel path 701 so that the components 700 can continue traveling in the manufacturing line without interruption.

[0079] FIG. 7B shows another embodiment in which unjamming structure 606 may move between active position 708 and inactive position 710 via a telescopic motion. As shown in FIG. 7B, when unjamming structure 606 is in active position 708, it is configured to be extended such that it may contact component 700 of the manufacturing line and when unjamming structure 606 is in inactive position 710, it is telescoped down such that may not contact component 700 of the manufacturing line, which moves in direction of travel 701 after the jam is cleared.

[0080] FIG. 7C shows a top-down view of another embodiment in which unjamming structure 606 may move between active position 712 and inactive position 714 via a linear motion, for example, substantially perpendicular to direction of travel 701 of component 700. For example, unjamming structure 606 may be configured to move along tracks or sliders 716 between active position 712 and inactive position 714. As shown in FIG. 7C, when unjamming structure 606 is in active position 712, it is configured to such that it may contact component 700 of the manufacturing line and when unjamming structure 606 is in inactive position 714, it has been moved out of the travel path 701 of component 700 such that unjamming structure 606 may not contact component 700, which moves in direction of travel 701 after the jam is cleared.

[0081] As shown in FIGS. 6A-6C, an actuator 608 may be operatively connected to unjamming structure 606 and configured to move unjamming structure 606 between the active position and the inactive position. An “actuator” includes any device for moving or controlling another object. For example, actuator 608 may provide a rotational motion of FIG. 7A and may include any device that is configured to rotate unjamming structure 606 between active position 702 to inactive position 704. In another embodiment, actuator 608 may provide a telescoping motion of FIG. 7B and may include any device that is configured to cause unjamming structure 606 to move between active position 708 to inactive position 710. In another embodiment, actuator 608 may provide a linear motion of FIG. 7C and may include any device that is configured to linearly move unjamming structure 606 between active position 712 to inactive position 714. The movement of unjamming structure 606 may also include any combination of rotational, linear, and telescopic motions between the active and inactive positions.

[0082] In the embodiments shown in FIGS. 7A-7C, unjamming device 600 travels in a direction opposite direction of travel 701 of component 700 to unjam the manufacturing line. As also shown in FIGS. 7A-7C, the unjamming device is located below components 700, such as beneath the bottles in an air conveyor system. In some embodiments, unjamming device 600 may be located next to or above the travel path of the components in the manufacturing line, rather than below it. In embodiments when unjamming device is located adjacent to the travel path of component 700, unjamming structure 606 of FIG. 7A may rotate about a vertical axis rather than about horizontal axis 706 shown in FIG. 7A.

[0083] In some embodiments, the unjamming device 600 may include a support structure 610 between actuator 608 and unjamming structure 606. In some embodiments, support structure 610 may limit the movement of unjamming structure 606 to prevent it moving past the active position. In some embodiment, support structure 610 may support unjamming structure 606 and prevent it from becoming damaged or deformed through repeated use or movement between the active position and the inactive position.

[0084] As shown in FIGS. 6A-6C, in some embodiments, support structure 610 may be part of unjamming structure 606. In other embodiments, support structure 610 may be part of body 602. According to some embodiments, body 602 may perform the same functions as support structure 610.

[0085] In some embodiments, a movement sensor 618 may be configured to detect a movement of unjamming structure 606 to determine whether unjamming structure 606 has contacted a component of the manufacturing line to unjam the jammed component of the manufacturing line. According to some embodiments, movement sensor 618 may determine the relative motion between unjamming structure 606 and support structure 610 or body 602. In some embodiments, movement sensor 618 may include a switch that determines the separation of two contacts, for example, a first contact 620 located on support structure 610 or body 602 and a second contact located on unjamming structure 606. In some embodiments, movement sensor 618 may measure the electrical or magnetic contact between contact 620 of body 602 and contact 622 of unjamming structure 606. If the contact is broken or falls between a predetermined threshold, a processor, controller, or other device (not shown) may determine that unjamming structure 606 has contacted a component of the manufacturing line. In some embodiments,

movement sensor 618 determines the movement of unjamming structure 606 and a processor or controller may receive a signal from movement sensor 618 and may send a signal to actuator 608 to move unjamming component 606 between the active position and the inactive position. In some embodiments, movement sensor 618 may include an optical sensor or switch. In some embodiments, movement sensor 618 may include a plurality of sensors.

[0086] According to some embodiments, a tensioning mechanism 624 may be configured to maintain tension between actuator structure 610 or body 602 and unjamming structure 606. Tensioning mechanism 624 may be configured to apply a force that maintains contact between contact 620 of support structure 610 or body 602 and contact 622 of unjamming structure 606. Tensioning mechanism may, for example, maintain electrical or magnetic contact between contact 622 of unjamming structure 606 from breaking contact with contact 620 of support structure 610 or body 602 during movement of unjamming device 600. By maintaining this contact, tensioning mechanism 624 may prevent false positives indicating that unjamming structure 606 has contacted a component of the manufacturing line when the motion is instead due to the movement of unjamming device 600.

[0087] According to some embodiments, tensioning mechanism 624 may include a spring, such as shown in FIGS. 6A- 6C. In some embodiments, tensioning mechanism 624 may include a magnet that applies magnetic force to maintain the position of unjamming structure 606. In some embodiments, tensioning mechanism 624 may include a snap joint that applies frictional force to maintain the position of unjamming structure 606. The snap joint may include a cantilever hook on the unjamming structure 606 and a housing on the body 602 or support structure 610. In some embodiments, tensioning mechanism 624 may include a hook and loop

fastener that applies adhesive force to maintain the position of unjamming structure 606.

[0088] Unjamming device 600 may include drive mechanism 604. In some embodiments, drive mechanism 604 may include a motor 605. In the embodiment shown in FIGS. 6A-6E, drive mechanism 604 includes a pulley 612. In some embodiments, pulley 612 may be configured to impart motion to one or more wheels 614 via a chain or belt 616. In other embodiments, drive mechanism 604 may be configured to impart motion to at least one wheel 614 via a gear system. In some embodiments, a gear system may be used to impart motion from drive mechanism 604 to at least one wheel 614. In some embodiments, wheels 614 may be configured to move unjamming device 600 by moving unjamming device 600 along a rail 626. For example, rail 626 may include slots or grooves 628 and wheels 614 may be configured to move unjamming device 600 along rail 626 using slots or grooves 628. As shown in FIGS. 6D and 6E, chain or belt 616 may rest in slot or groove 628 and pass from wheels 614 around pulley 612, such that when pulley 612 rotates, it causes wheels 614 to rotate along belt 616, causing unjamming device 600 to travel along rail 626. In some embodiments, belt 616 may include teeth to provide better traction along one or both of pulley 612 and wheels 614. In other embodiments, wheels 614 may be configured to move unjamming device 600 by moving unjamming device 600 on a floor. In some embodiments, wheels 614 may be configured to move unjamming device 600 by moving unjamming device 600 along a guide, such as a guide rail. In some embodiments, drive mechanism 604 may be configured to move unjamming device 600 along a magnetic rail system.

[0089] According to some embodiments, unjamming structure 606 may be configured to passively move between the active position and the inactive position

when contacting a component to unjam the manufacturing line. For example, unjamming structure 606 may be held in the active position via magnetic force between unjamming structure 606 and support structure 610 or body 602. When unjamming structure 606 contacts a component of the manufacturing line to unjam the jammed component, the contact may overcome the magnetic force and cause unjamming structure 606 to move to the inactive position by the force of the contact. In some embodiments, axis 706 of FIG. 7A may include a bearing with a sufficiently low coefficient of friction to permit unjamming structure 606 to rotate between active position 702 and inactive position 704 when unjamming structure 606 contacts component 700. In other embodiments, passive motion of unjamming structure 606 may be controlled by a locking mechanism that maintains unjamming structure 606 in the active position until it contacts the component of the manufacturing line such that the contact overcomes the locking force and causes unjamming structure 606 to move to the inactive position.

[0090] In some embodiments, unjamming device 600 may include a controller (not shown) configured to provide commands or signals to control the operation of one or more of unjamming structure 606, drive mechanism 604, actuator 608, or any other component of unjamming device 600.

[0091] According to some embodiments, the controller may be located separate from unjamming device 600 and may be in communication with unjamming device 600 through a data connection, such as a wired or wireless data connection.

[0092] In some embodiments, the controller may be configured to operate drive mechanism 604. For example, the controller may be configured to control the speed, direction, acceleration, deceleration, and other movement functions of unjamming device 600 using drive mechanism 604. Such operation may include

controlling one or more of a drive system, a speed control system, a braking system, or a steering system. In some embodiments, the controller may be configured to operate actuator 608 to move unjamming structure 606 from the active position to the inactive position or from the inactive position to the active position. In some embodiments, the controller may be configured to receive information or inputs from movement sensor 618 and, based on that information, control the position of unjamming structure 606.

[0093] According to some embodiments, the controller may be configured to receive inputs or information from one or more unjamming sensors that detect when unjamming structure has unjammed the jammed component of the manufacturing line. In some embodiments, the unjamming sensor may include the movement sensor 618. In some embodiments, the unjamming sensor may include a sensor that measures the speed of components of the manufacturing line. In some embodiments, the unjamming sensor may include a sensor that detects the movement of components of the manufacturing line or the presence or absence of components of the manufacturing line. The movement, presence, or absence of the components at one or more locations in the manufacturing line may indicate whether a component has become jammed and/or whether the manufacturing line has become unjammed.

[0094] In some embodiments, drive mechanism 604 may be configured to move unjamming device 600 substantially parallel to the manufacturing line. In some embodiments, the movement of the unjamming structure between the active position and the inactive position may be substantially parallel to the manufacturing line, such as, for example, the rotation shown in FIG. 7A. In some embodiments, the movement of the unjamming structure between the active position and the inactive

position may be substantially perpendicular to the manufacturing line, such as, for example, the telescoping motion shown in FIG. 7B or the linear motion shown in FIG. 7C.

[0095] In some embodiments, unjamming device 600 may include a measuring device (not shown) configured to measure a distance that unjamming device 600 has traveled along the manufacturing line to unjam the manufacturing line. In some embodiments, the measuring device may include a line or belt connected to body 602 and an external structure, such that the measuring device measures the distance based on the length of the line. In some embodiments, the measuring device may include an encoder. For example, the encoder may determine the number of revolutions or the amount of rotation of a motor, a pulley, a wheel, or other rotating component of unjamming device 600 and, based on the number of revolutions or amount of rotations, determine the distance traveled by unjamming device 600. In some embodiments, the measuring device may include an optical sensor, such as, for example, a laser-based sensor, photoelectric sensor, optical sensor, or reflective sensor, that determines when unjamming device 600 traverses a particular segment of the manufacturing line.

[0096] FIGS. 8A and 8B show an exemplary system 800 for detecting and unjamming a jammed component of a manufacturing line 802. FIG. 8A shows an exemplary top-down view of system 800 and FIG. 8B shows an exemplary side view of system 800. System 800 may be configured to automatically detect jammed component(s) in a manufacturing line and to dispatch one or more unjamming devices to unjam the jammed component(s).

[0097] Exemplary system 800 includes one or more sensors 802, for example, sensors 802a-802d, along manufacturing line 804. Manufacturing line 804 may include an air conveyor system for processing, transporting, or producing components 806, which move in intended travel direction 801 when manufacturing line 804 is in operation. In some embodiments, components 806 may be bottles, jars, cups, or other container, having a lip or flange that is supported by rails or guides 805 during conveyance. During operation, components 806 may become jammed, which stops operation of manufacturing line 804. As shown in FIGS. 8A and 8B, component 806a represents a jammed component and component 806b represents a component adjacent to the jammed component. Exemplary jammed component 806a has become skewed such that it is locked on guides 805, thereby preventing component 806a from moving along manufacturing line 804. This jam causes the remaining components 806 to also cease moving, which results in loss of production. The jam must be cleared before production can resume, and the lost production time results in a loss of product output and revenue.

[0098] In some embodiments, system 800 may detect jammed component 806a using sensors 802. In the exemplary embodiment of FIGS. 8A and 8B, sensors 802 detect whether a component 806 is present at corresponding locations 808.

[0099] For example, sensor 802a is configured to detect whether a component 806c is present at location 808a. Sensors 802b, 802c, and 802d are configured to detect whether any component 806 is present at locations 808b, 808c, and 808d, respectively. In some embodiments, sensors 802 may include an optical sensor configured to detect the presence or absence of components 806, for example, based on reflected optical scattering back to sensor 802. In some embodiments, sensors 802 may detect the presence or absence of components 806

at locations 808 based on whether a container 806 obstructs an optical path to a receiver on the opposite side of the travel path of containers 806. In some embodiments, an optical sensor may include an infrared sensor or laser.

[0100] In some embodiments, system 800 detects jammed component 806a based on sensor 802b determining that no component is present at location 808b. In this way, system 800 determines that a jam has occurred prior to location 808b. A controller (not shown) may determine that the jam has occurred and may send an unjamming device 600b to unjam manufacturing line 804, as described above, by contacting jammed component 806a or adjacent component 806b with an unjamming structure.

[0101] In some embodiments, a plurality of sensors 802 may be configured to detect jammed component 806a. For example, sensors 802a and 802b may detect jammed component 806a determining whether a component 806c is present at a first location 808a using sensor 802a. Sensor 802b may detect whether a second component present at a second location 808b. If component 806c is present at first location 808a and no component is present at second location 808b, then system 800 may be configured to determine that manufacturing line 804 is jammed and jammed component 806a is located between first location 808a and second location 806b. A controller (not shown) may determine that the jam has occurred between locations 808a and 808b and may send an unjamming device 600b to unjam manufacturing line 804, as described above, by contacting jammed component 806a or adjacent component 806b with an unjamming structure.

[0102] In some embodiments, detecting jammed component 806a may include determining that a component is absent at a location, for example, location 808b for a predetermined time as part of determining whether a jam has occurred.

By waiting for a predetermined period of time before determining that a jam has occurred, system 800 may not make an incorrect determination, for example, if the jam clears itself or if there is a substantial gap in components 806 during processing.

[0103] In some embodiments, system 800 may include a controller (not shown) configured to receive one or more signals from sensors 802 indicating jammed component 806a. The controller may be configured to operate an unjamming device 600 to unjam jammed component 806a in manufacturing line 804.

[0104] According to some embodiments, system 800 may include a plurality of unjamming devices 600. FIG. 8B, for example, shows four unjamming devices 600a-600d. In some embodiments, each unjamming device 600 may be configured to unjam a respective segment 812 of manufacturing line 804. As shown in FIGS. 8A and 8B, the plurality of unjamming devices 600a-600d are configured to unjam a plurality of segments 812a-812d, respectively. Segment 812a, for example, corresponds to the segment of manufacturing line 804 preceding location 808a. Segment 812b corresponds to the segment of manufacturing line 804 between location 808a (for example, sensor 802a) and location 808b (for example, sensor 802b). Segments 812c and 812d correspond to the segments of manufacturing line 804 between locations 808b and 808c and between locations 808c and 808d, respectively. As shown in FIG. 8B, the plurality of unjamming devices 600a-600d may be located at a resting location, such as locations 808a-808d, respectively, while manufacturing line 804 is operating normally. The corresponding unjamming structure of unjamming devices 600a-600d may be placed in inactive position 702 when they are not being used to unjam manufacturing line 804. When unjamming structure is in inactive position 702, it lies below the interference line 814 of

components 806 and, therefore, will not interfere with the normal operation of manufacturing line 804.

[0105] When system 800 detects jammed component 806a, the controller may send a signal to one of unjamming devices 600 to unjam manufacturing line 804. For example, in FIG. 8B, because jammed component 806a is located in segment 812b, the controller may send unjamming device 600b to unjam jammed component 806a. In this exemplary embodiment, the controller may send a signal for unjamming device 600b to move the unjamming structure from inactive position 702 to active position 704. When the unjamming structure is in active position 704 a portion of the unjamming structure lies above travel line 814 of components 806 and, therefore, will interfere with the components as it travels along manufacturing line 804. The controller may then send an instruction or command to move unjamming device 600b in direction 803 toward the jam, such as along guide 816. In some embodiments, direction 803 may be substantially opposite intended travel direction 801 of components 806. As unjamming device 600b traverses segment 812b along guide 816, it contacts a component of the manufacturing line, which jostles jammed component 806a, thereby unjamming manufacturing line 804. For example, as shown in FIG. 8B, unjamming device 600b may contact adjacent component 806b with the unjamming structure (shown in phantom), which causes adjacent component 806b to jostle jammed component 806a, thereby unjamming component 806a and allowing components 806 to continue traveling in intended travel direction 801, which resumes operation of manufacturing line 804. As shown in phantom 600b of FIG. 8B, when unjamming device 600b contacts adjacent component 806b, the unjamming structure moves to inactive position 702, which lies below the interference line 814 of components 806 and, therefore, will not interfere with the

unjammed operation of manufacturing line 804. The controller may then send a signal or instruction to return unjamming device 600b to its resting location at location 808b.

[0106] Although FIG. 8B shows the unjamming device contacting adjacent component 806b to unjam manufacturing line 804, other embodiments may contact jammed component 806a to unjam manufacturing line 804. Similarly, although FIG. 8B describes exemplary active position 704 and inactive position 702, which may correspond to the embodiments shown in FIG. 7A, some embodiments may use variations of unjamming structures and/or active or inactive positions, such as, for example, the embodiments described with reference to FIGS. 7B and/or 7C, to unjam manufacturing line 804. Furthermore, although FIG. 8B shows unjamming devices 600 located below the interference line 814, in some embodiments unjamming devices 600 may be configured to travel adjacent to or above components 806.

[0107] In some embodiments, each of the plurality of unjamming devices 600 may be configured to unjam a predetermined segment 812 of manufacturing line 804. In some embodiments, segments 812 may not overlap. In some embodiments, segments 812 may overlap such that the controller may send either of the unjamming devices corresponding to the overlapping segment to unjam a component in the overlapping segment of manufacturing line 804.

[0108] According to some embodiments, the one or more sensors for detecting a jammed component may be configured to detect the speed of the components moving along the manufacturing line. For example, when the system (such as a controller) determines that the one or more components has stopped moving, substantially stopped moving, or that the speed of one or more components

has dropped below a predetermined threshold, the system may determine that a jam has occurred and may send an unjamming device to unjam the jammed component. Sensors for detecting the speed of the components in the manufacturing line may be used as an alternative to, or in addition to, sensors for detecting the presence or absence of components at locations of the manufacturing line, as described above. Similarly, other sensors for determining whether a jam has occurred may be employed by the contemplated system.

[0109] According to some embodiments, the system may include one or more unjamming sensors configured to detect when the unjamming structure unjams the jammed component in the manufacturing line. In some embodiments, the one or more unjamming sensors may be a movement sensor, such as movement sensor 618. In some embodiments, the one or more unjamming sensors may be one or more sensors that detect that the components in the manufacturing line have begun moving again. The unjamming sensors, may, for example, be configured to perform functions similar to sensors 802 to detect the whether one or more components are present or absent at locations of the manufacturing line or to detect the speed of one or more components of the manufacturing line and thereby determine if the jam has been cleared.

[0110] According to some embodiments, system 800 may be configured to detect multiple jams in manufacturing line 804 and may dispatch a plurality of unjamming devices 600 to unjam the jammed components.

[0111] According to some embodiments, the unjamming device may include a component sensor, such as, for example, an optical or ultrasonic sensor, to detect whether a component of the manufacturing line is located near the unjamming device. For example, when the unjamming device is located below the components,

as shown in FIG. 8B, the component sensor may be directed upwards to detect components above the unjamming device. If, after the system attempts to unjam the line, the component sensor does not detect components above the unjamming device (indicating that the system has been unjammed), a processor or controller may be configured to send a signal to the unjamming device to attempt to unjam the jammed component again. In some embodiments, the component sensor may be used to control certain unjamming devices. For example, rather than sending unjamming device 600B of FIG. 8B to unjam the jammed component, the system may determine that unjamming device 600a is closer to the jam. The system may then send unjamming device 600a to unjam the jammed component. A component sensor (not shown) may detect whether components are located above unjamming device 600a as it travels towards jammed component 806a. When the component sensor determines that no components are above unjamming device 600a, it will determine that it has passed the jam and may then follow any of the unjamming procedures to unjam the jammed component.

[0112] According to some embodiments, the system may include an interface, such as a bluetooth interface to a mobile or portable electronic device, or an interface to a computer. The system may gather information related to the status of the system and provide it to the interface for display to system operators. Such information may include, for example, information about the status of the unjamming devices, whether any faults have occurred in the system, how many jams a particular unjamming device has cleared. In some embodiments, the interface may be able to query unjamming devices within a given range, such as through a bluetooth connection, to gather information about a specific unjamming device. In some embodiments, the operator may be able to send commands to the queried

unjamming device to, for example, clear a fault or test the operation of particular parts of the unjamming device.

[0113] Other embodiments of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.

WHAT IS CLAIMED IS:

1. An unjamming device comprising:
a body;
a drive mechanism configured to move the body; and
an unjamming structure, the unjamming structure being configured to move
between an active position and an inactive position,
wherein the unjamming structure is configured to unjam a jammed component
of a manufacturing line when the unjamming structure is in the active
position.
2. The unjamming device of claim 1, further comprising an actuator
configured to move the unjamming structure between the active position and the
inactive position.
3. The unjamming device of claim 1, wherein the unjamming structure is
configured to move between the active position and the inactive position via a
rotational motion.
4. The unjamming device of claim 1, wherein the unjamming structure is
configured to move between the active position and the inactive position via a linear
motion.
5. The unjamming device of claim 1, wherein the unjamming structure is
further configured to move between the active position and the inactive position via a
telescoping motion.

6. The unjamming device of claim 1, wherein the drive mechanism is configured to move the unjamming device substantially parallel to the manufacturing line and a motion of the unjamming structure between the active position and the inactive position is substantially perpendicular to the manufacturing line.

7. The unjamming device of claim 1, wherein the drive mechanism is configured to move the unjamming device substantially parallel to the manufacturing line and a motion of the unjamming structure between the active position and the inactive position is substantially parallel to the manufacturing line.

8. The unjamming device of claim 1, further comprising a tensioning mechanism configured to maintain tension between the unjamming structure and the body.

9. The unjamming device of claim 8, wherein the tensioning mechanism is further configured to control movement of the unjamming structure relative to the body.

10. The unjamming device of claim 8, wherein the tensioning mechanism comprises a spring affixed to the unjamming structure and the body.

11. The unjamming device of claim 1, further comprising a movement sensor configured to detect movement of the unjamming structure relative to the body.

12. The unjamming device of claim 11, wherein a mechanism is configured to move the unjamming structure to the inactive position when the movement sensor detects a predetermined movement of the unjamming structure.

13. The unjamming device of claim 11, wherein the movement sensor comprises an optical sensor.

14. The unjamming device of claim 11, wherein the movement sensor comprises a switch.

15. The unjamming device of claim 1, wherein the drive mechanism is configured to move the unjamming device by rotating at least one wheel.

16. The unjamming device of claim 1, wherein the drive mechanism is configured to move the unjamming device along at least one of a guide rail, a floor, or the manufacturing line.

17. The unjamming device of claim 1, wherein the jammed component in the manufacturing line comprises a bottle.

18. The unjamming device of claim 1, further comprising a controller configured to control an actuator and the drive mechanism, wherein the actuator is configured to move the unjamming structure between the active position and the inactive position.

19. The unjamming device of claim 1, further comprising a controller configured to move the unjamming structure between the active position and the inactive position based on an input from at least one sensor.

20. The unjamming device of claim 19, wherein the controller is further configured to:

determine the presence of the jammed component in the manufacturing line;

and

activate the drive mechanism to move the unjamming device such that the unjamming structure contacts a component in the manufacturing line.

21. The unjamming device of claim 1, further comprising a measuring device configured to detect a distance moved by the unjamming device.

22. The unjamming device of claim 21, wherein the measuring device comprises an optical sensor, a line, or an encoder.

23. The unjamming device of claim 1, further comprising a component sensor configured to determine whether a component of the manufacturing line is located near the unjamming device.

24. An unjamming method comprising:

detecting a jammed component of a manufacturing line;

operating a mechanism to move an unjamming device toward the location of the jammed component, wherein the unjamming device comprises an

unjamming structure configured to move between an active position and an inactive position; and
unjamming the jammed component in the manufacturing line with the unjamming device when the unjamming structure is in the active position.

25. The method of claim 24, wherein detecting the jammed component comprises detecting whether the motion of a component in the manufacturing line has substantially stopped.

26. The method of claim 24, wherein detecting the jammed component comprises determining whether a first component is absent at a first location of the manufacturing line for a predetermined time.

27. The method of claim 26, wherein detecting the jammed component further comprises determining whether a second component is present at a second location of the manufacturing line when the first component is absent at the first location.

28. The method of claim 24, wherein operating the mechanism comprises operating the mechanism to move the unjamming device substantially parallel to the manufacturing line.

29. The method of claim 24, wherein unjamming the jammed component comprises contacting the jammed component with the unjamming structure.

30. The method of claim 24, wherein unjamming the jammed component comprises contacting a component adjacent to the jammed component with the unjamming structure.

31. The method of claim 24, wherein unjamming the jammed component comprises contacting a component with the unjamming structure to cause contact with the jammed component, whereby the contact with the jammed component unjams the jammed component.

32. The method of claim 24, wherein unjamming the jammed component comprises moving the unjamming device in a direction substantially opposite to the desired direction of travel of the jammed component during the unjamming step.

33. The method of claim 24, further comprising moving the unjamming structure from the active position to the inactive position after the step of unjamming the jammed component.

34. The method of claim 24, further comprising returning the unjamming structure to a resting location after unjamming the jammed component until a second jammed component is detected.

35. The method of claim 24, wherein unjamming the jammed component comprises:

moving the unjamming structure from the inactive position to the active position;

contacting at least one of the jammed component or a component adjacent to the jammed component with the unjamming structure in the active position; and
moving the unjamming structure to the inactive position.

36. The method of claim 24, wherein the active position is configured such that the unjamming structure interferes with an intended travel path of the components in the manufacturing line and the inactive position does not interfere with the intended travel path of the components.

37. The method of claim 24, wherein operating the mechanism to move the unjamming device comprises at least one of:

moving the unjamming device a predetermined distance, or
moving the unjamming device until the unjamming structure contacts a component in the manufacturing line.

38. The method of claim 24, further comprising:

determining whether a component of the manufacturing line is located near the unjamming device using a component sensor,
determining whether the unjamming device unjammed the jammed component, and
if it is determined that the unjamming device did not unjam the jammed component, sending the unjamming device to unjam the jammed component.

39. A system for unjamming a manufacturing line comprising:
at least one sensor configured to detect a jam in a manufacturing line; and
at least one unjamming device comprising:
a body;
a mechanism configured to move the body; and
an unjamming structure, wherein the unjamming structure is configured
to unjam a jammed component in the manufacturing line.

40. The system of claim 39, wherein the at least one sensor comprises a plurality of sensors configured to detect the jam by determining whether a first component is present at a first location and a second component is absent at a second location.

41. The system of claim 39, wherein the at least one sensor is configured to detect whether a component in the manufacturing line is absent at a location for a predetermined time.

42. The system of claim 41, further comprises a controller configured to receive a signal from the at least one sensor indicating the jam and to control the mechanism to move the unjamming device to unjam the jammed component in the manufacturing line.

43. The system of claim 39, wherein the at least one sensor is configured to detect a speed of the jammed component in the manufacturing line that indicates the jam.

44. The system of claim 39, wherein the at least one unjamming device comprises a plurality of unjamming devices, wherein each of the plurality of unjamming devices is each configured to unjam a predetermined segment of the manufacturing line.

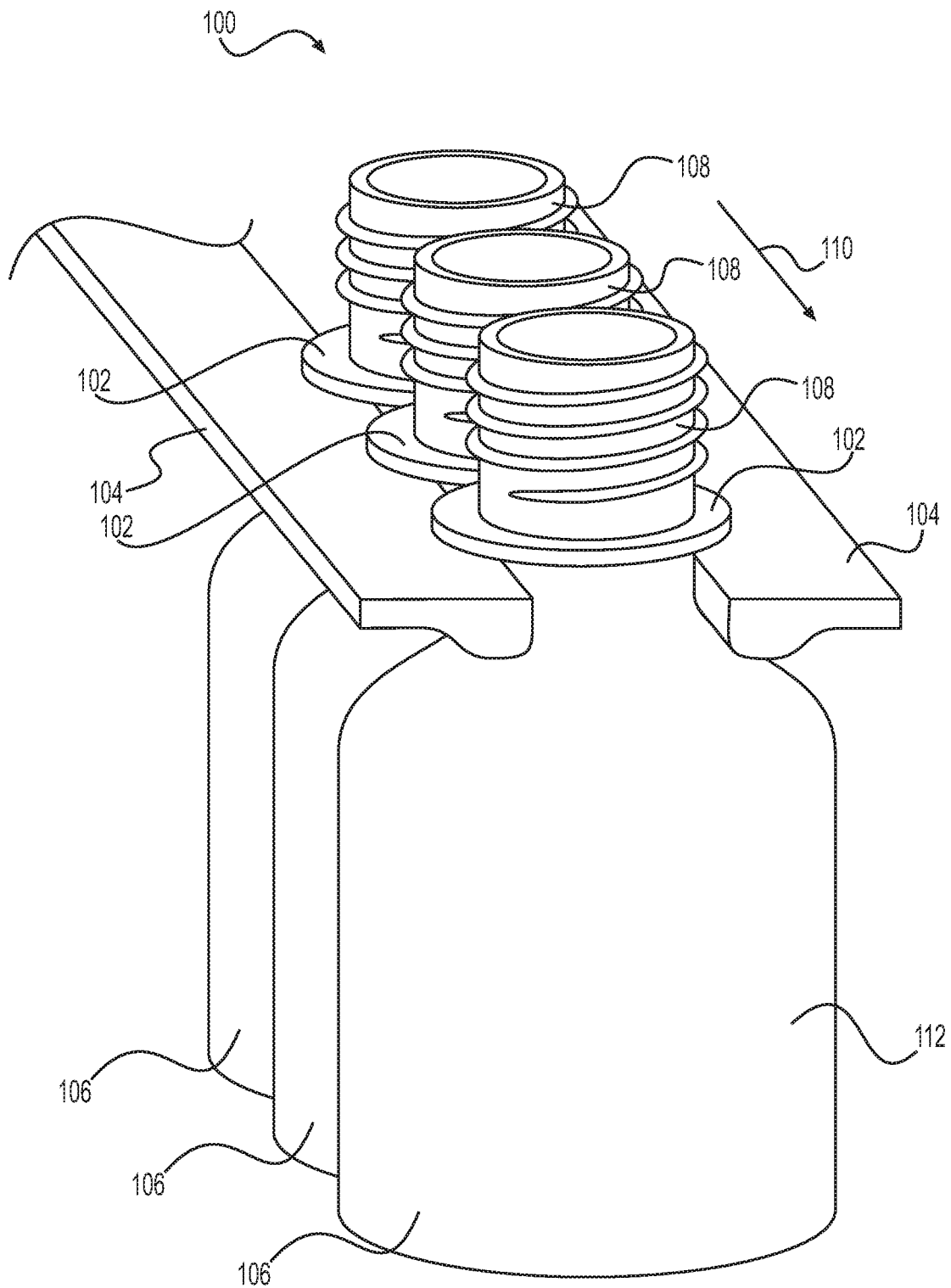
45. The system of claim 39, wherein at least one unjamming device comprises a plurality of unjamming devices configured to unjam a corresponding plurality of predetermined segments of the manufacturing line such that at least two of the predetermined segments overlap.

46. The system of claim 39, further comprising a controller;
wherein the at least one unjamming device comprises a plurality of
unjamming devices, and
wherein the controller is configured to determine one unjamming device of the
plurality of unjamming devices to unjam the jammed component.

47. The system of claim 39, wherein the at least one unjamming device is configured to return to a resting position after the unjamming device unjams the jammed component.

48. The system of claim 39, wherein the manufacturing line comprises an air conveyor configured to transport a plurality of components along the manufacturing line.

49. The system of claim 39, further comprising:
a component sensor configured to determine whether a component of the
manufacturing line is located near the unjamming device;
wherein the processor is configured to determine whether the unjamming
device unjammed the jammed component and, if it is determined that the
unjamming device did not unjam the jammed component, configured to
send the unjamming device to unjam the jammed component.

**FIG. 1**

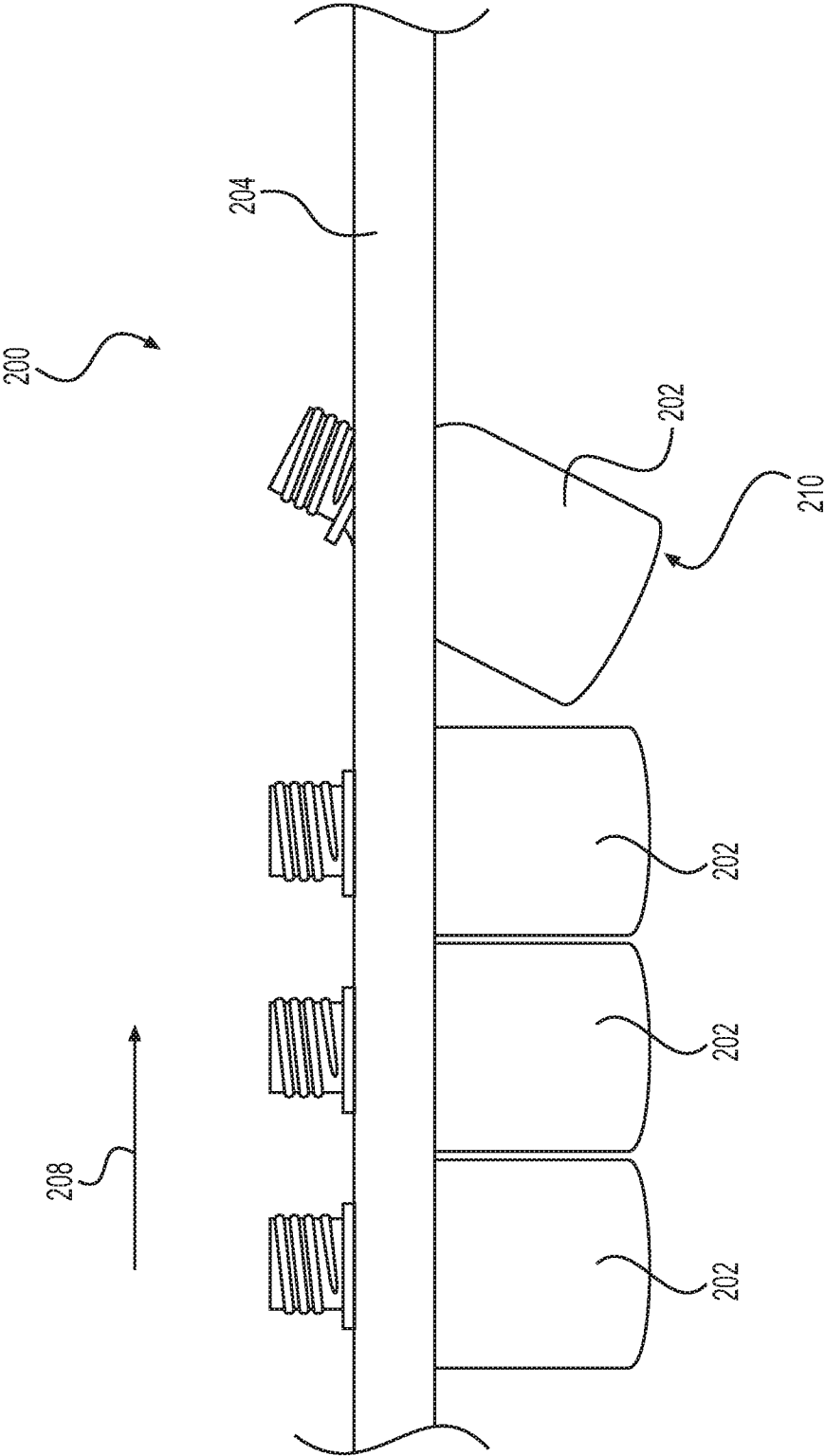
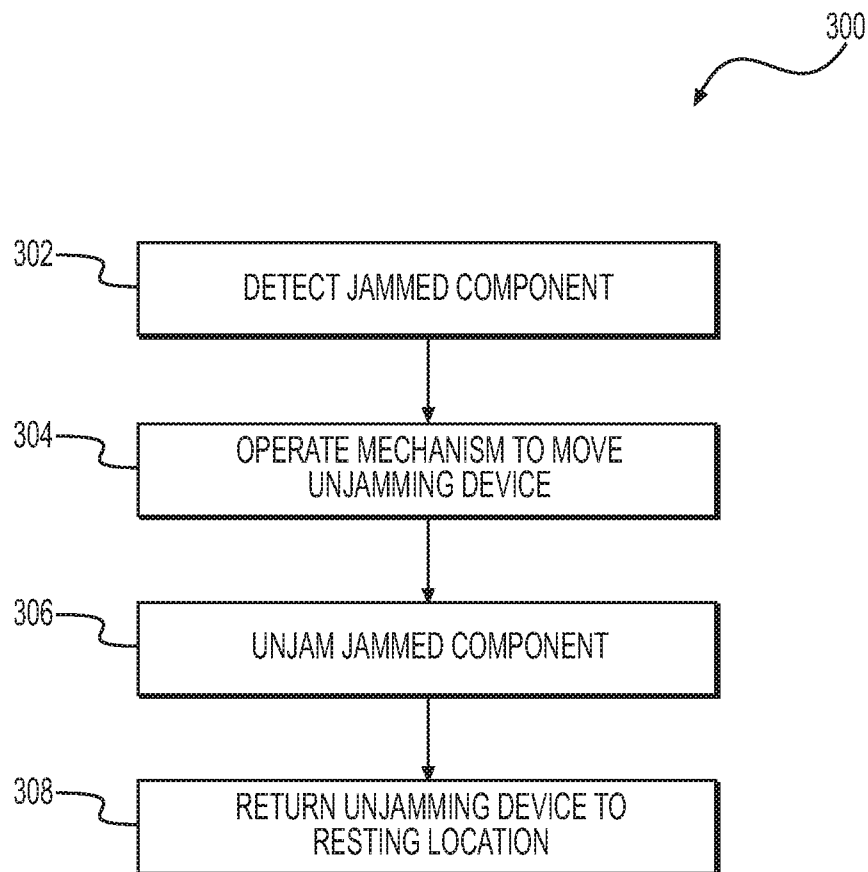
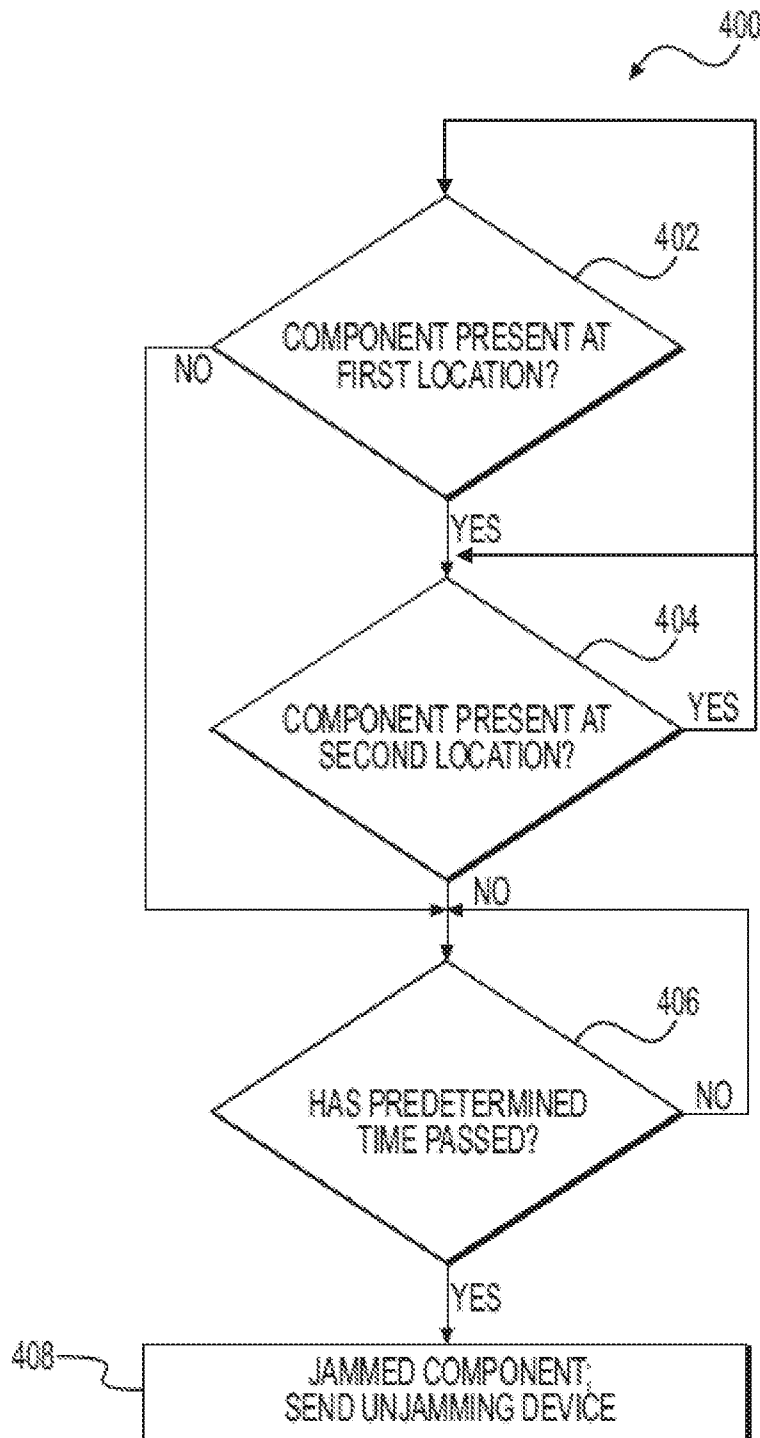
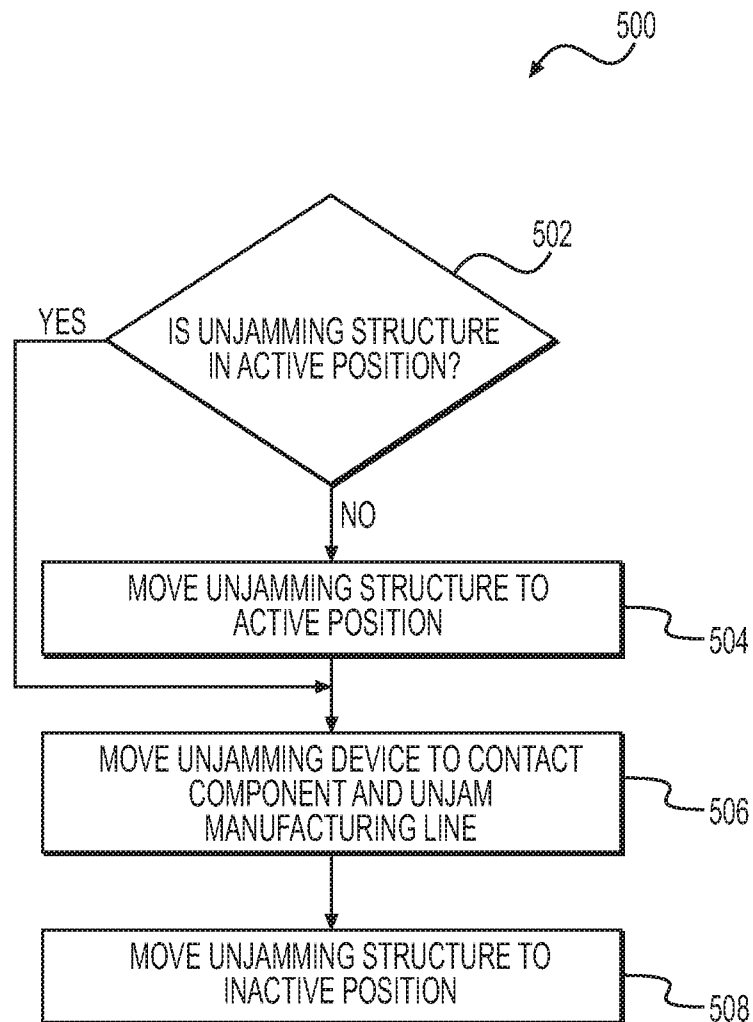
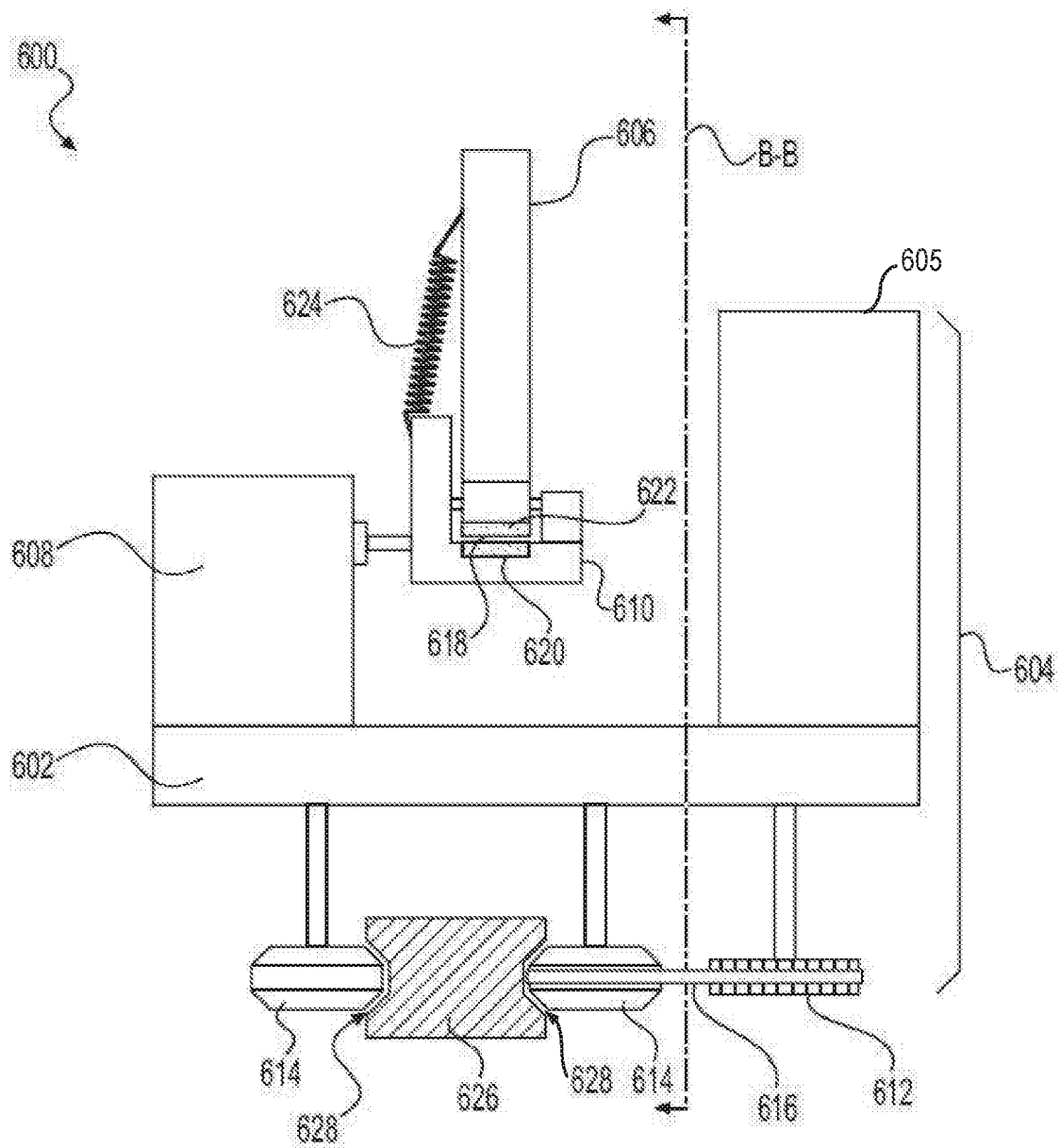


FIG. 2

**FIG. 3**

**FIG. 4**

**FIG. 5**

**FIG. 6A**

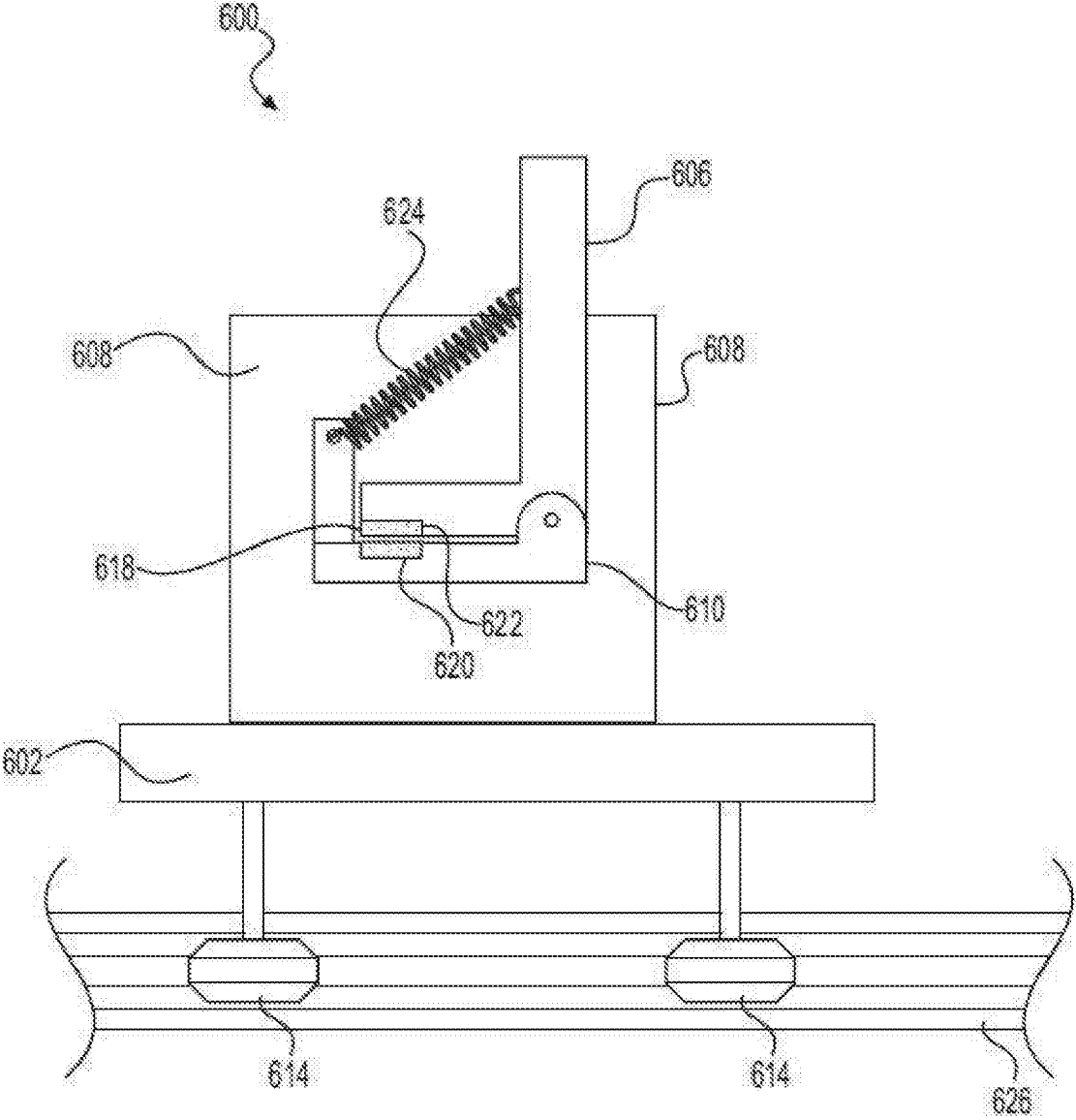
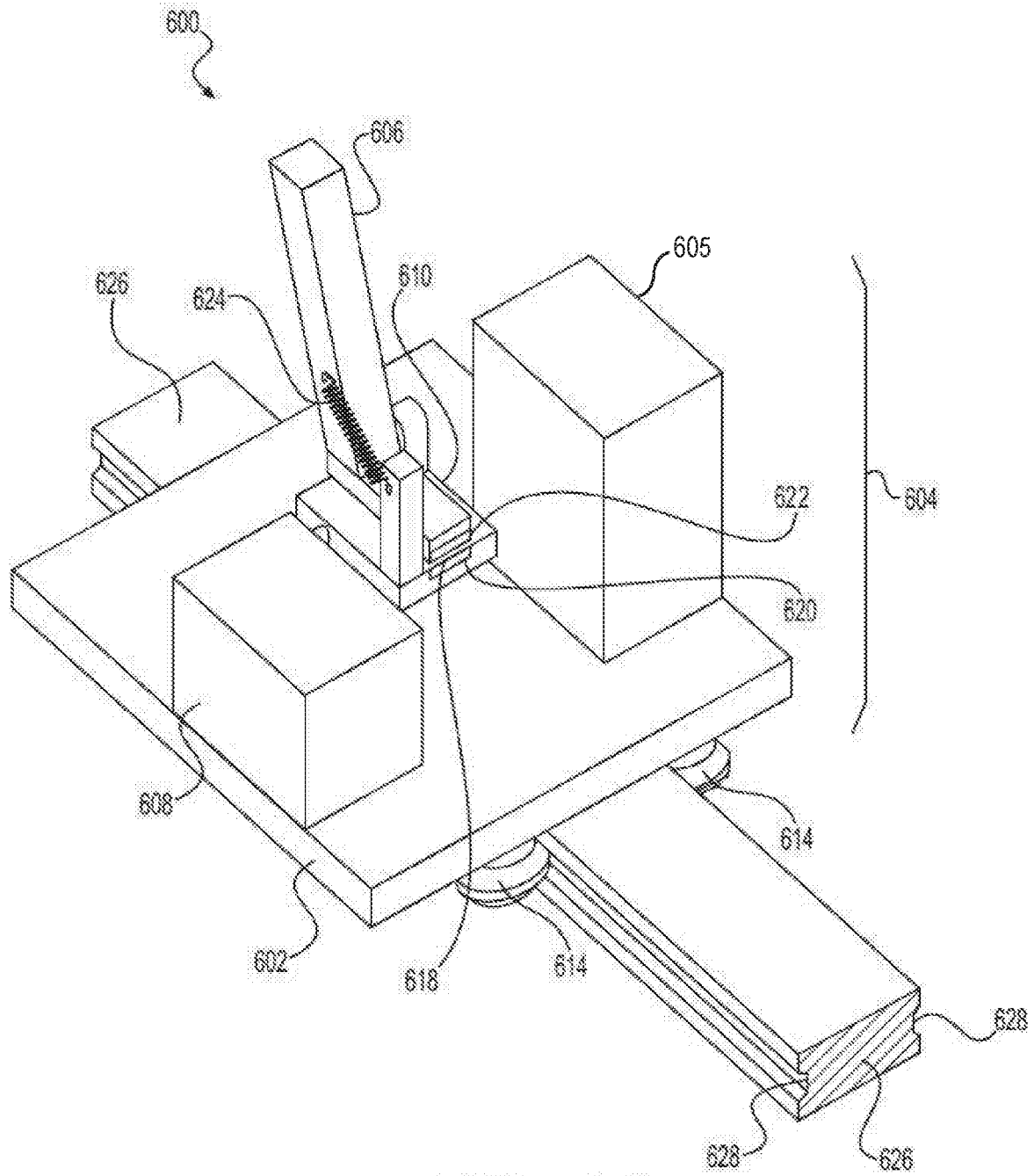


FIG. 6B

**FIG. 6C**

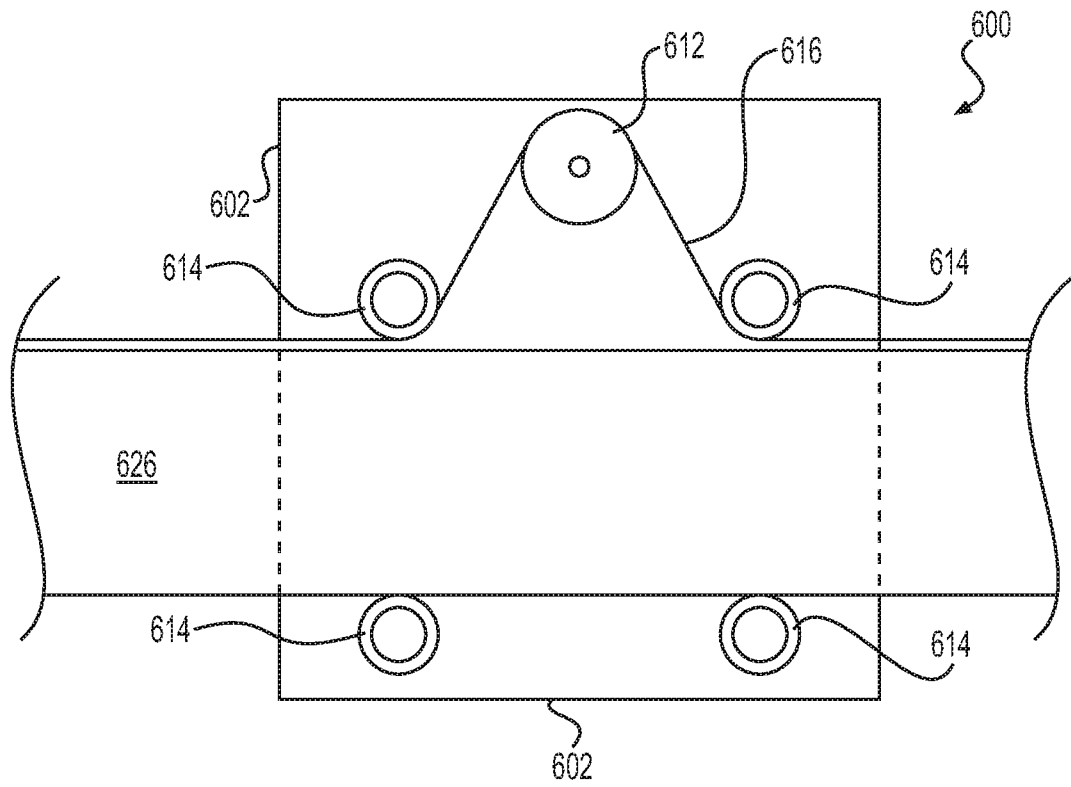


FIG. 6D

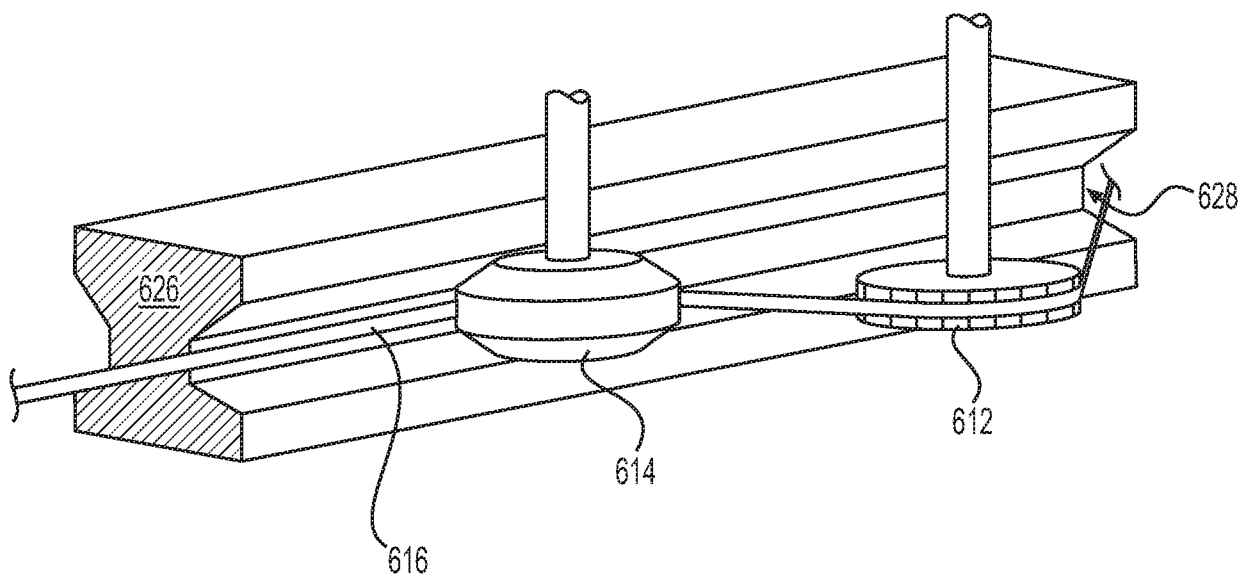


FIG. 6E

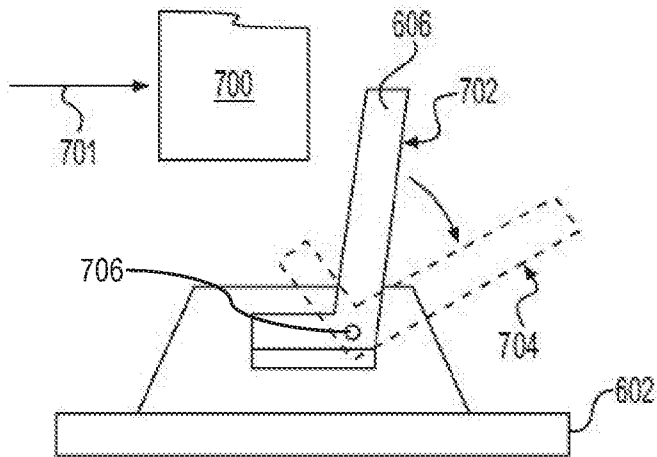


FIG. 7A

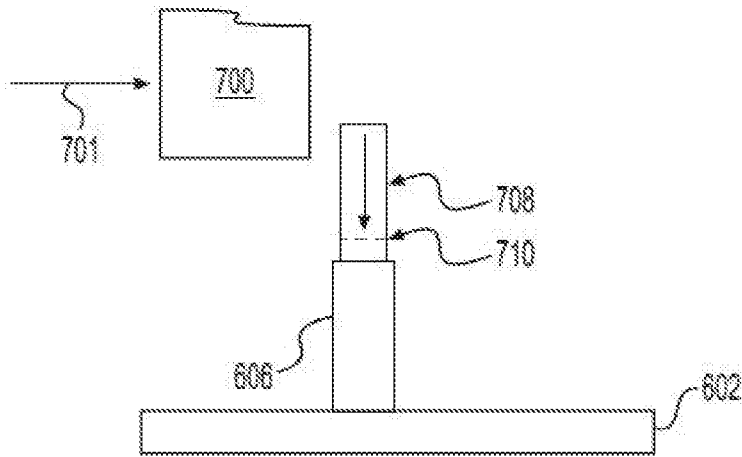


FIG. 7B

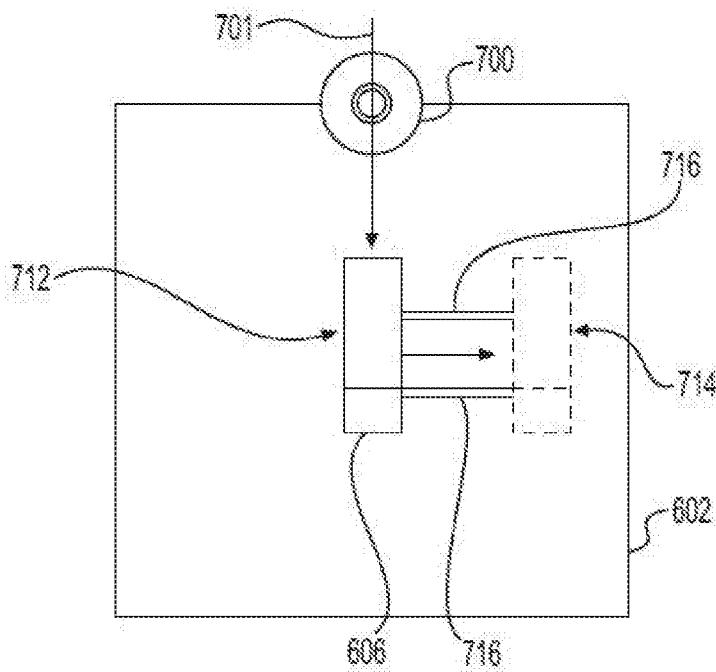


FIG. 7C

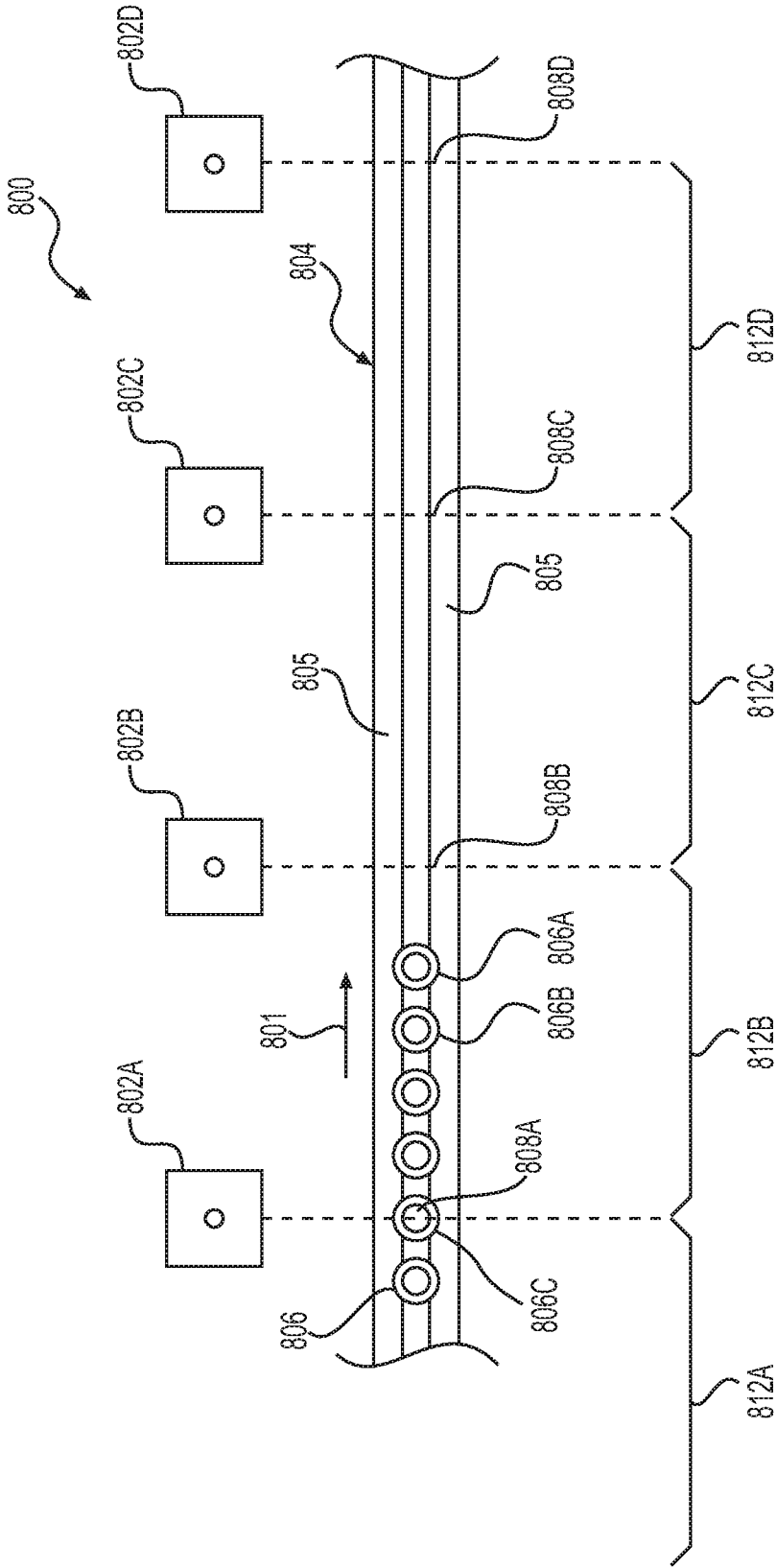
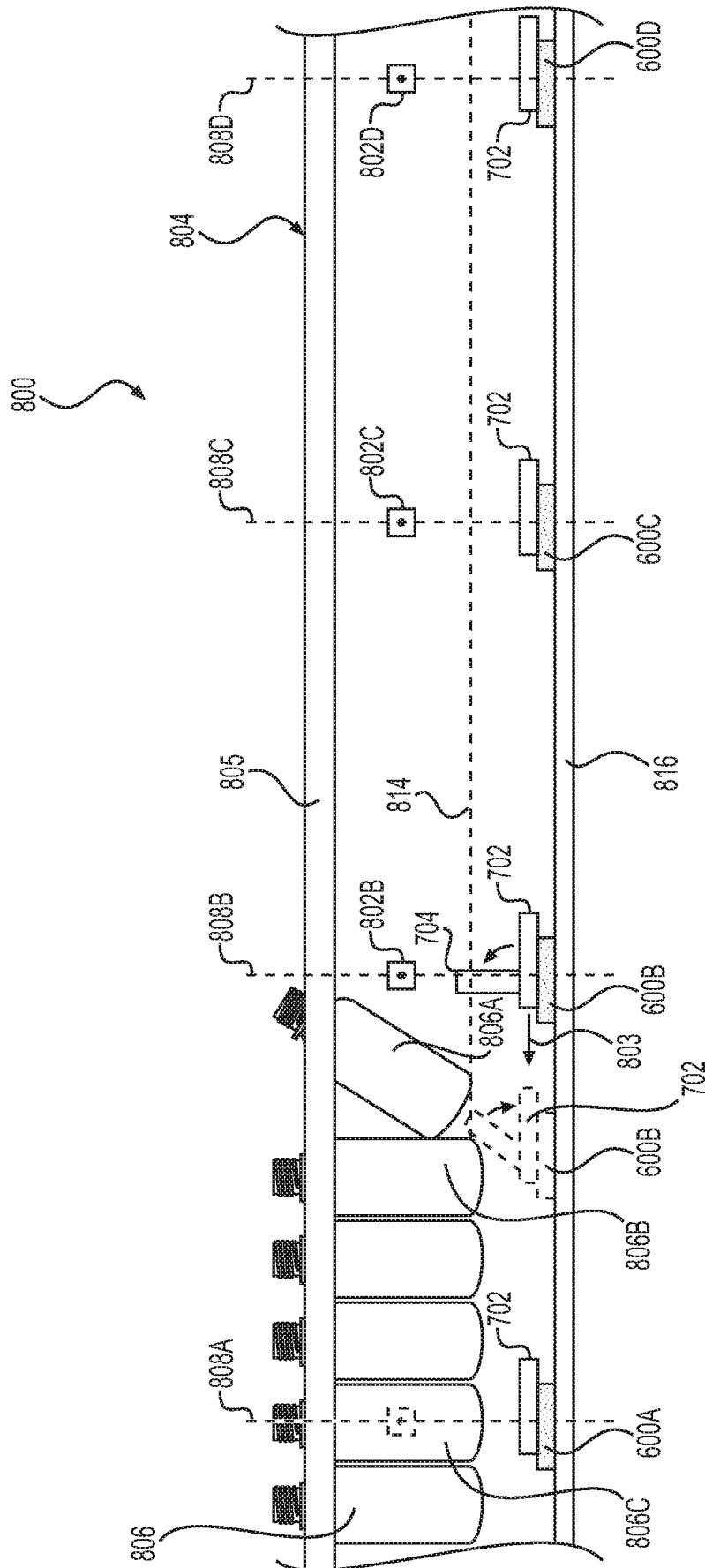


FIG. 8A

**FIG. 8B**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US20/13779

A. CLASSIFICATION OF SUBJECT MATTER

IPC - B65G 43/08, 47/24, 51/03 (2020.01)

CPC - B65G 43/08, 47/24, 51/035

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 5,135,014 A (BESWICK F) 04 August 1992; column 4, lines 35-45; column 5, lines 15-25; column 8, lines 45-68	1-5, 7-9, 15-18 --- 19, 20, 24, 28-33, 35, 37 --- 6, 10-14, 21, 22, 38
X --- A	US 6,685,401 B1 (DE ALMEIDA RODRIGUES C et al.) 03 February 2004; figure 3; column 5, lines 25-30; column 7, lines 35-65	1, 23 --- 26, 27, 38
X --- Y --- A	US 6,488,449 B1 (LAQUAY F et al.) 03 December 2002; column 7, lines 45-55; column 8, lines 1-25	24, 25, 34, 36 --- 19, 20, 24, 28-33, 35, 37 --- 6, 26, 27, 38
A	US 2010/0269602 A1 (DAMIKOLAS G) 28 October 2010; entire document	1-38

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

23 March 2020 (23.03.2020)

Date of mailing of the international search report

14 MAY 2020

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

Authorized officer

Shane Thomas

Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US20/13779

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Continued Within the Next Supplemental Box

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
Group I: Claims 1-38

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2013779

-***-Continued from Box No. III Observations where unity of invention is lacking-***-

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-38 are directed toward: an unjamming device and an unjamming method comprising: operating a mechanism to move an unjamming device toward the location of the jammed component.

Group II: Claims 1-23 and 39-49 are directed toward: an unjamming device and a system for unjamming a manufacturing line comprising: at least one sensor.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I include: an unjamming device and an unjamming method comprising: operating a mechanism to move an unjamming device toward the location of the jammed component, which are not present in Group II.

The special technical features of Group II include: an unjamming device and a system for unjamming a manufacturing line comprising: at least one sensor configured to detect a jam in a manufacturing line, which are not present in Group I.

The common technical features of Groups I and II are: an unjamming device comprising: a body; a drive mechanism configured to move the body; and an unjamming structure, the unjamming structure being configured to move between an active position and an inactive position, wherein the unjamming structure is configured to unjam a jammed component of a manufacturing line when the unjamming structure is in the active position.

These common technical features are disclosed by US 5,135,014 A (BESWICK). Beswick discloses an unjamming device comprising: a body (219; figures 7, 8); a drive mechanism (227, 233, 235, collectively) configured to move the body (carriage 219 mounted on wheels 221 is moved via lever 227, cam follower 233 and cam 235 rotated by the axle of the conveyor 35; column 8, lines 45-68); and an unjamming structure (214), the unjamming structure being configured to move between an active position and an inactive position (beam 214 is moved back and forth, i.e. between an active position and an inactive position, to unjam bottles 27; column 8, lines 45-60), wherein the unjamming structure is configured to unjam a jammed component of a manufacturing line when the unjamming structure is in the active position (beam 214 is moved back and forth to unjam bottles 27 (jammed component), i.e. in the active position, moving along lanes 193 (manufacturing line); column 8, lines 45-60).

Since the common technical features are previously disclosed by the Beswick reference, the common features are not special and so Groups I and II lack unity.