US011928910B2

(12) **United States Patent**
Jafa et al.

(10) **Patent No.: US 11,928,910 B2**
(45) **Date of Patent: *Mar. 12, 2024**

(54) **LEAN VENDING MACHINE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 167 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/499,675**

(22) Filed: **Oct. 12, 2021**

(65) **Prior Publication Data**

US 2022/0139147 A1 May 5, 2022

Related U.S. Application Data

(63) Continuation of application No. 16/691,060, filed on Nov. 21, 2019, now Pat. No. 11,170,599, which is a (Continued)

(51) **Int. Cl.**
G07F 11/42 (2006.01)
G07F 11/00 (2006.01)
G07F 11/16 (2006.01)

(52) **U.S. Cl.**
CPC ***G07F 11/005*** (2013.01); ***G07F 11/165*** (2013.01); ***G07F 11/42*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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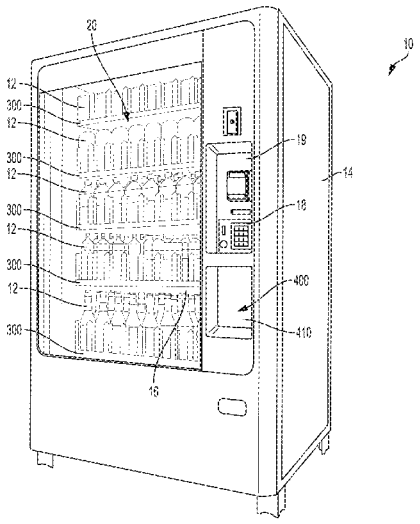
(57) **ABSTRACT**

A vending machine includes two horizontal lead screws, a vertical lead screw, first and second motors, a shelf, a delivery cup, and a delivery area. The first and second motors drive the horizontal lead screws and the vertical lead screw, respectively. The vertical lead screw moves horizontally along the horizontal lead screws. The shelf contains a product and has a movable gate to hold the product on the shelf. The delivery cup moves vertically along the vertical lead screw and has a solenoid and a plunger. The solenoid activates the plunger, which opens the gate to dispense the product onto the delivery cup. An outer door of the delivery area isolates the delivery area from outside the vending machine when closed and provides access to the product from outside the vending machine when open. A mechanical interaction between the delivery cup and the delivery area opens the outer door.

20 Claims, 27 Drawing Sheets



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continuation of application No. 15/382,042, filed on Dec. 16, 2016, now Pat. No. 10,490,014.

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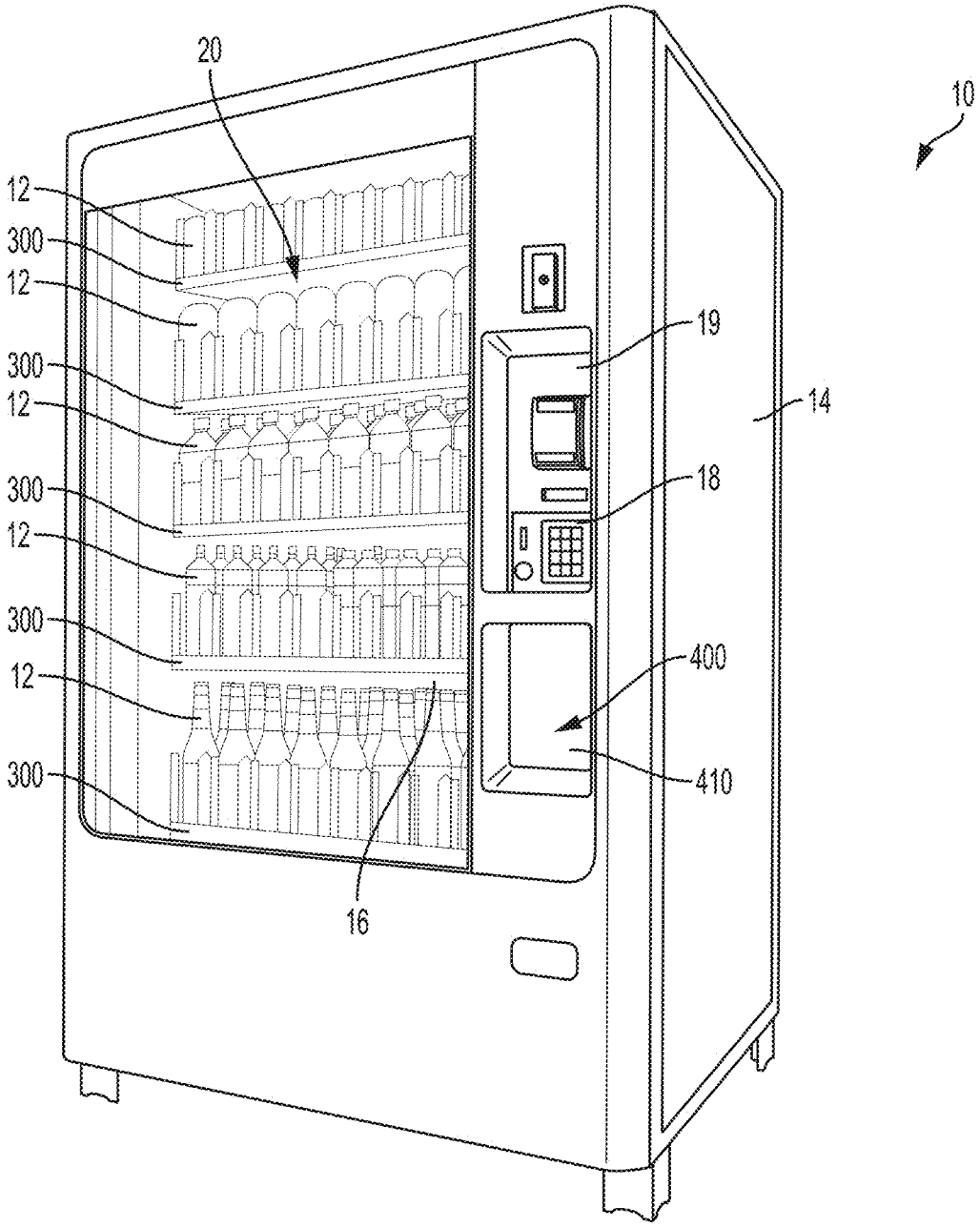


FIG. 1

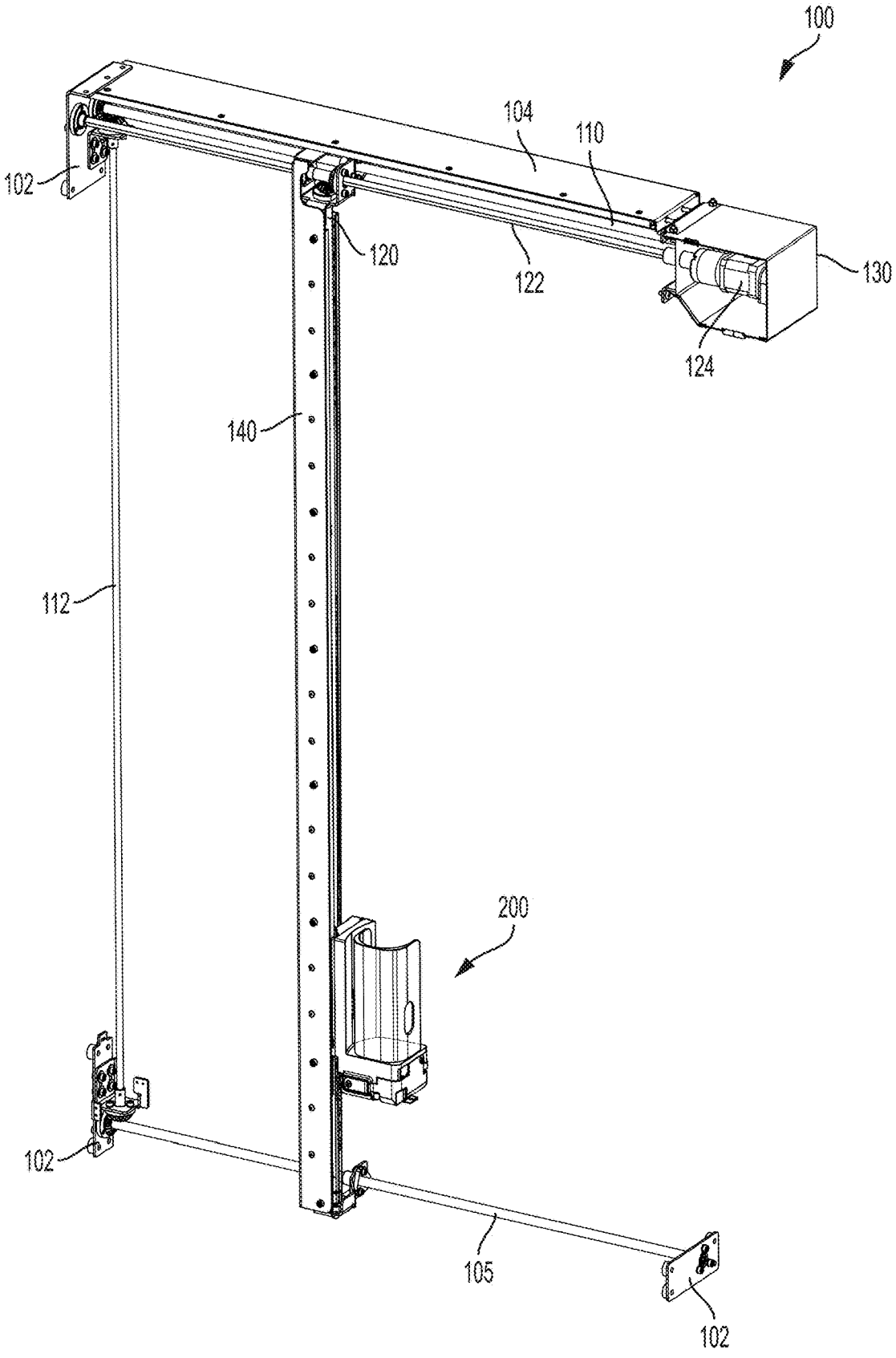


FIG. 2

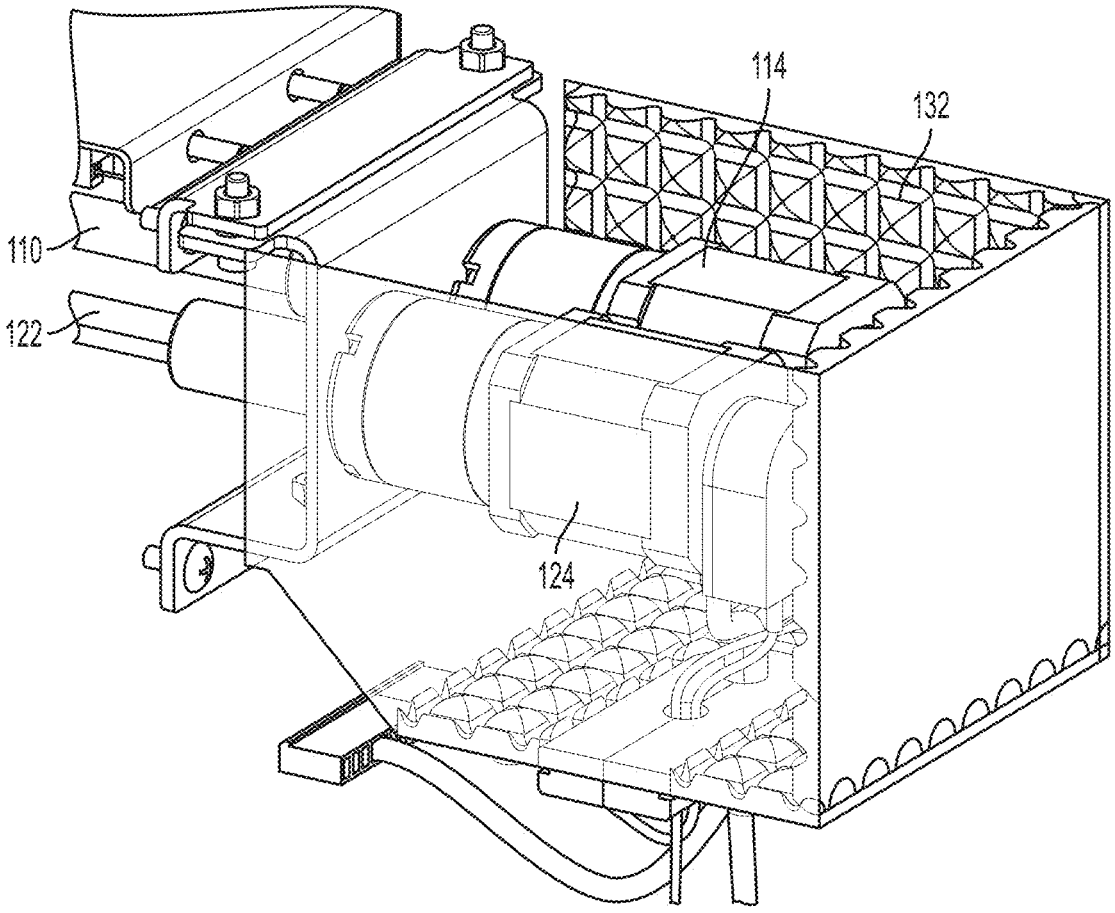


FIG. 3

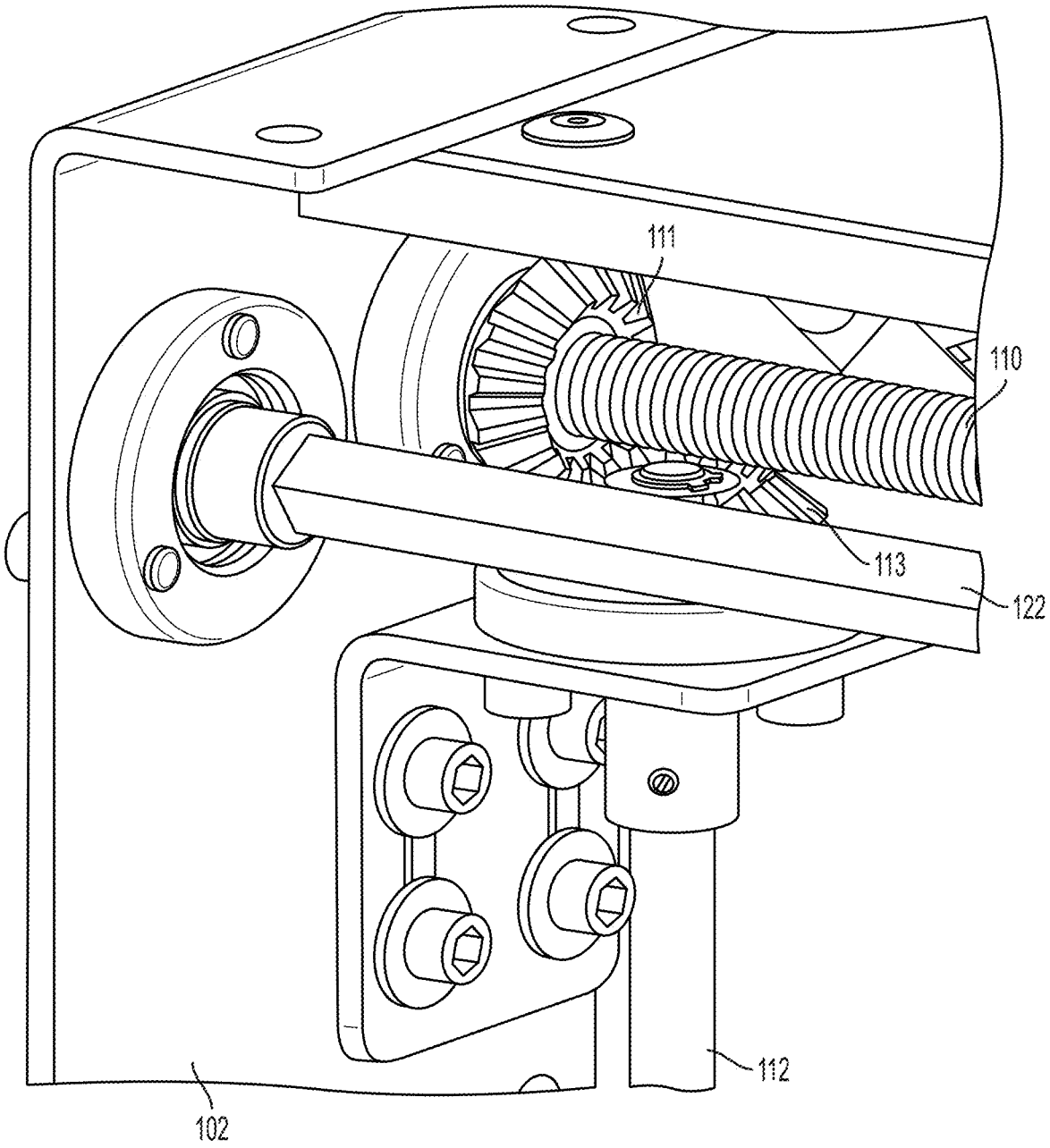


FIG. 4

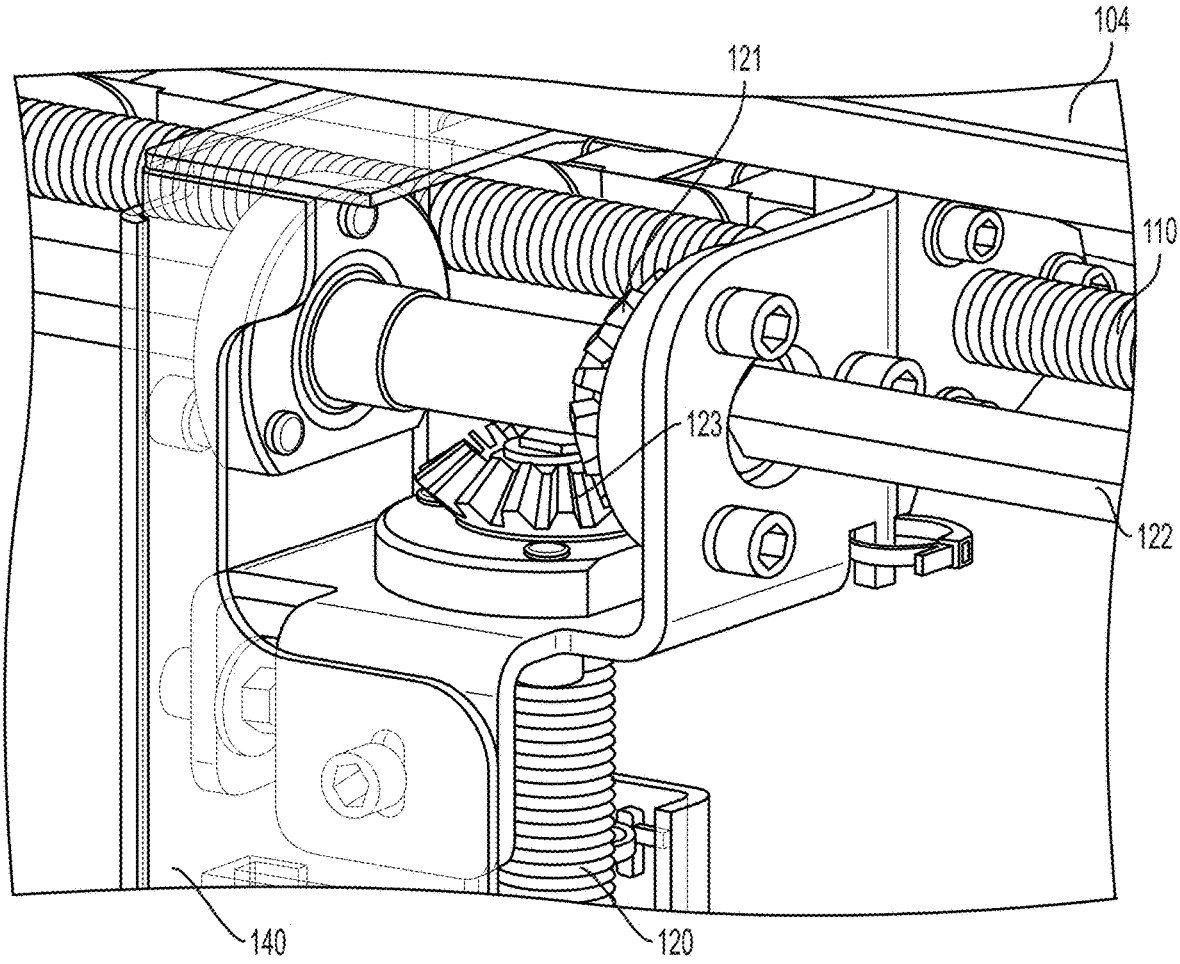
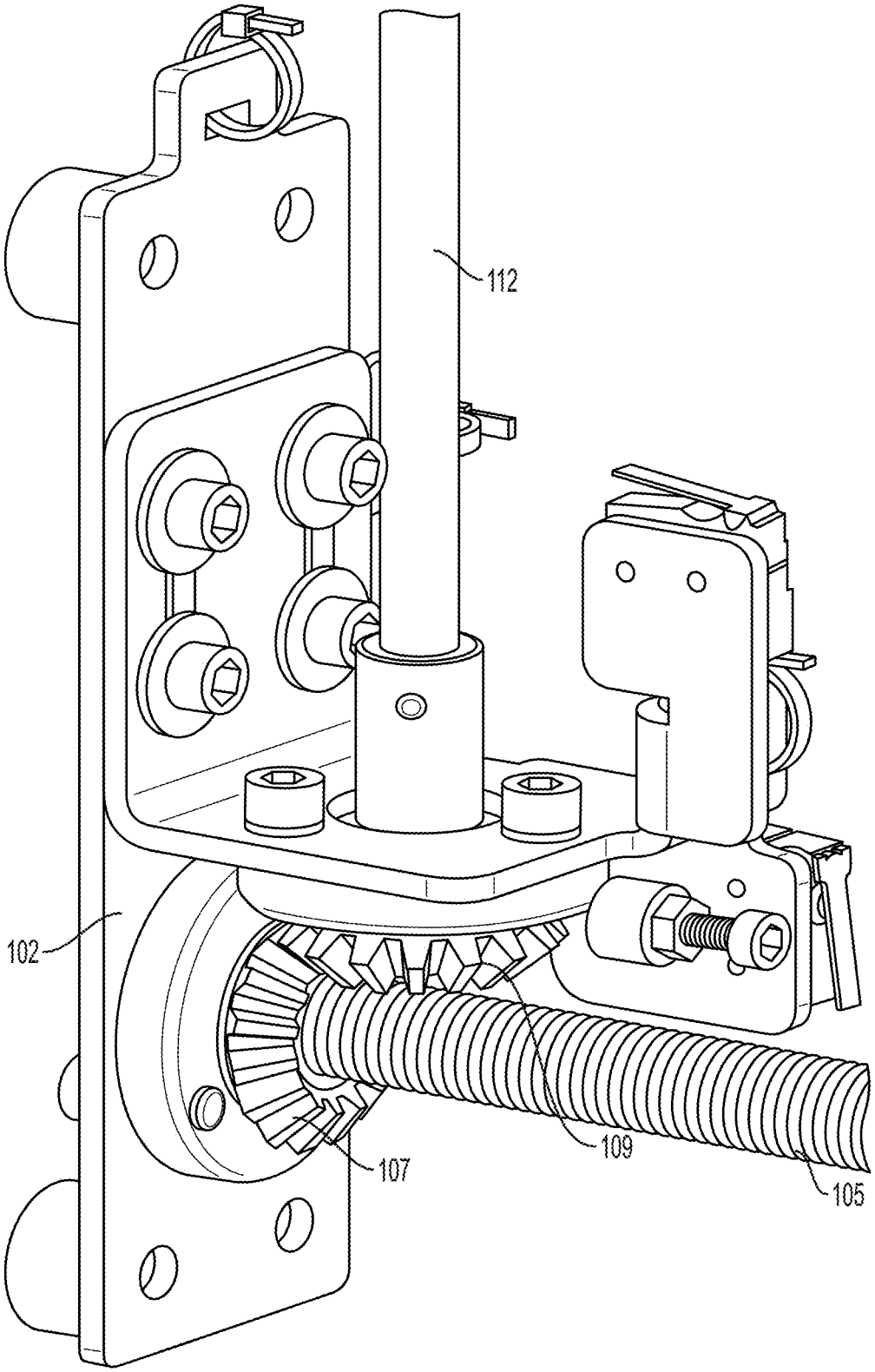


FIG. 5



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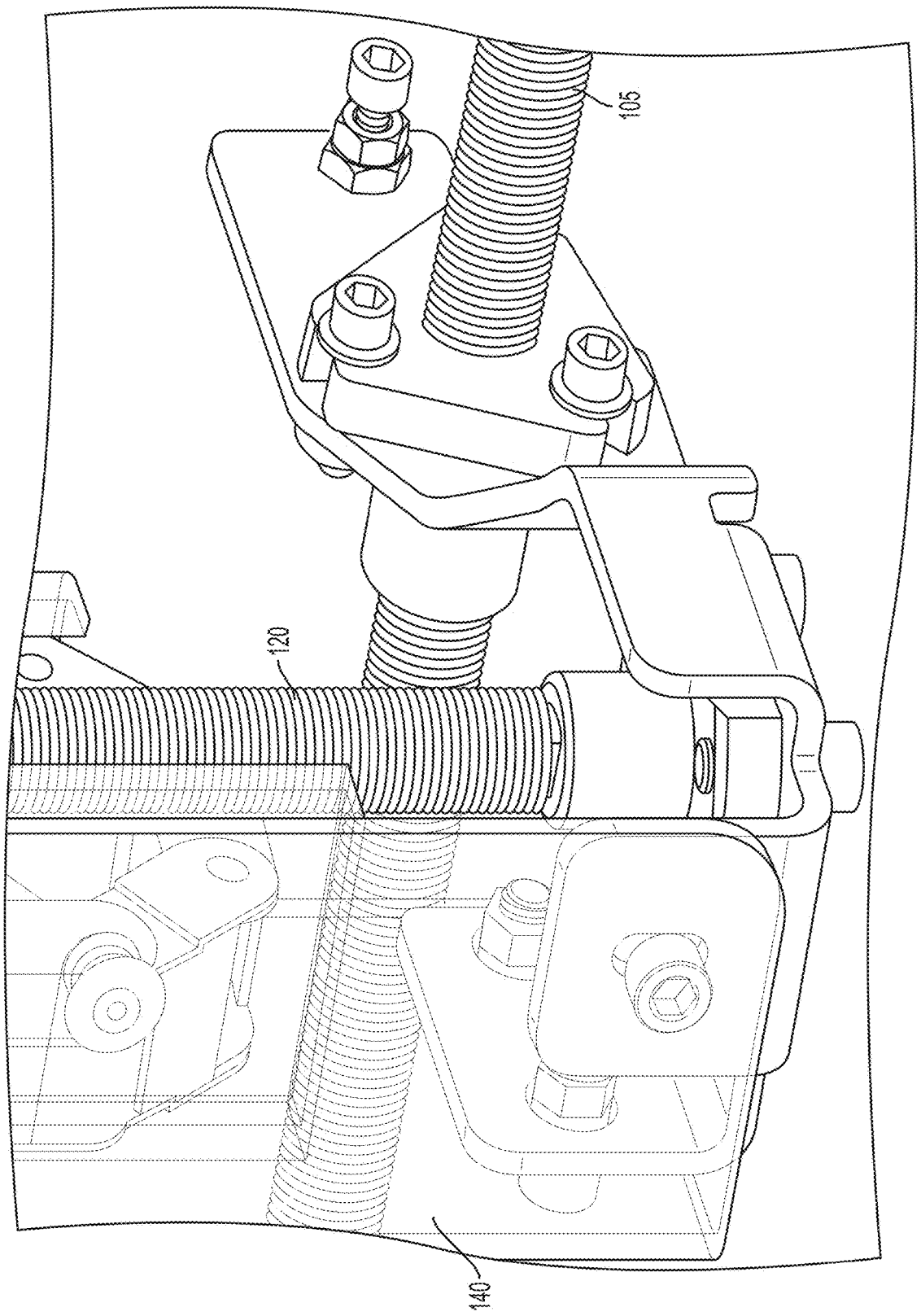

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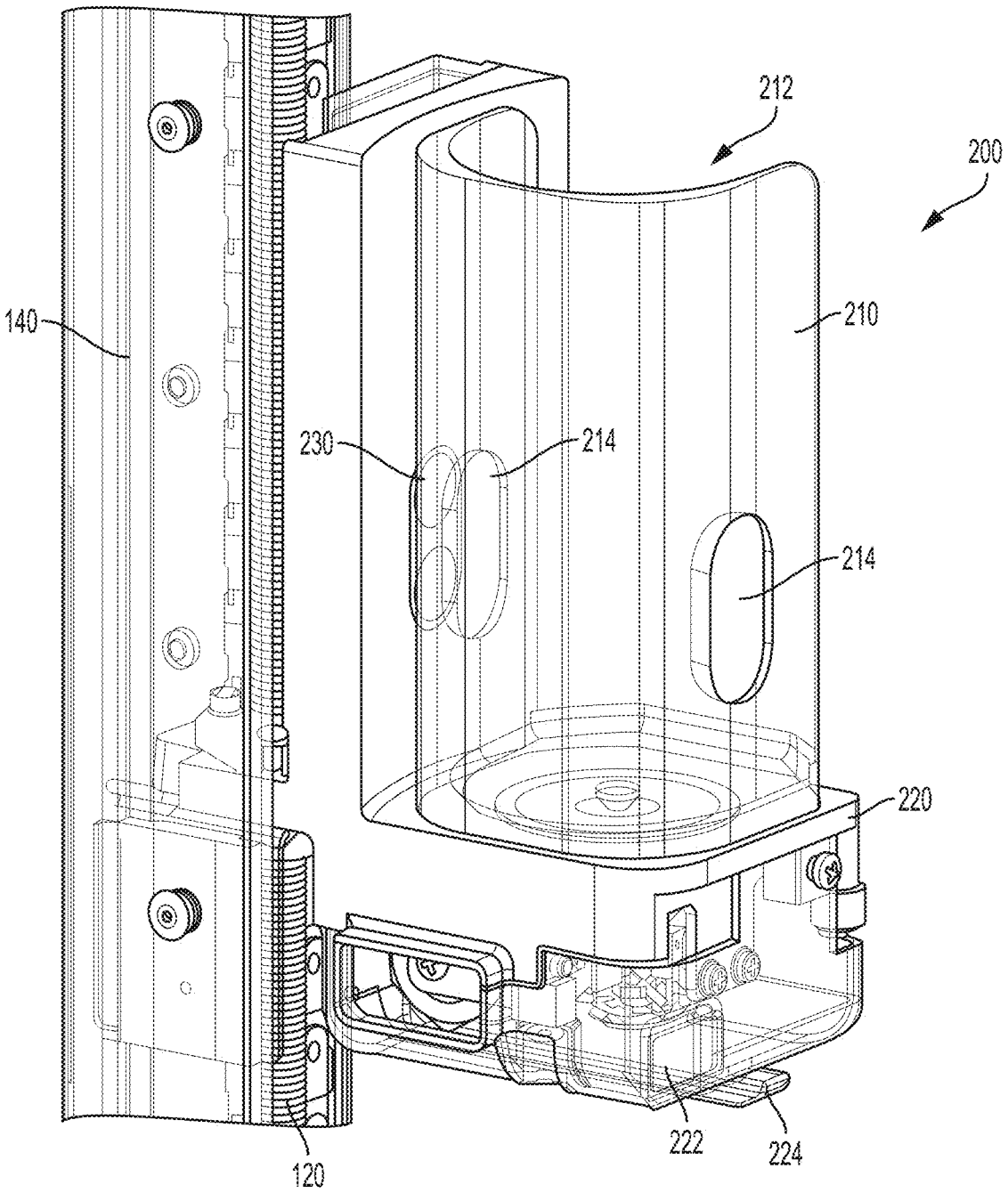

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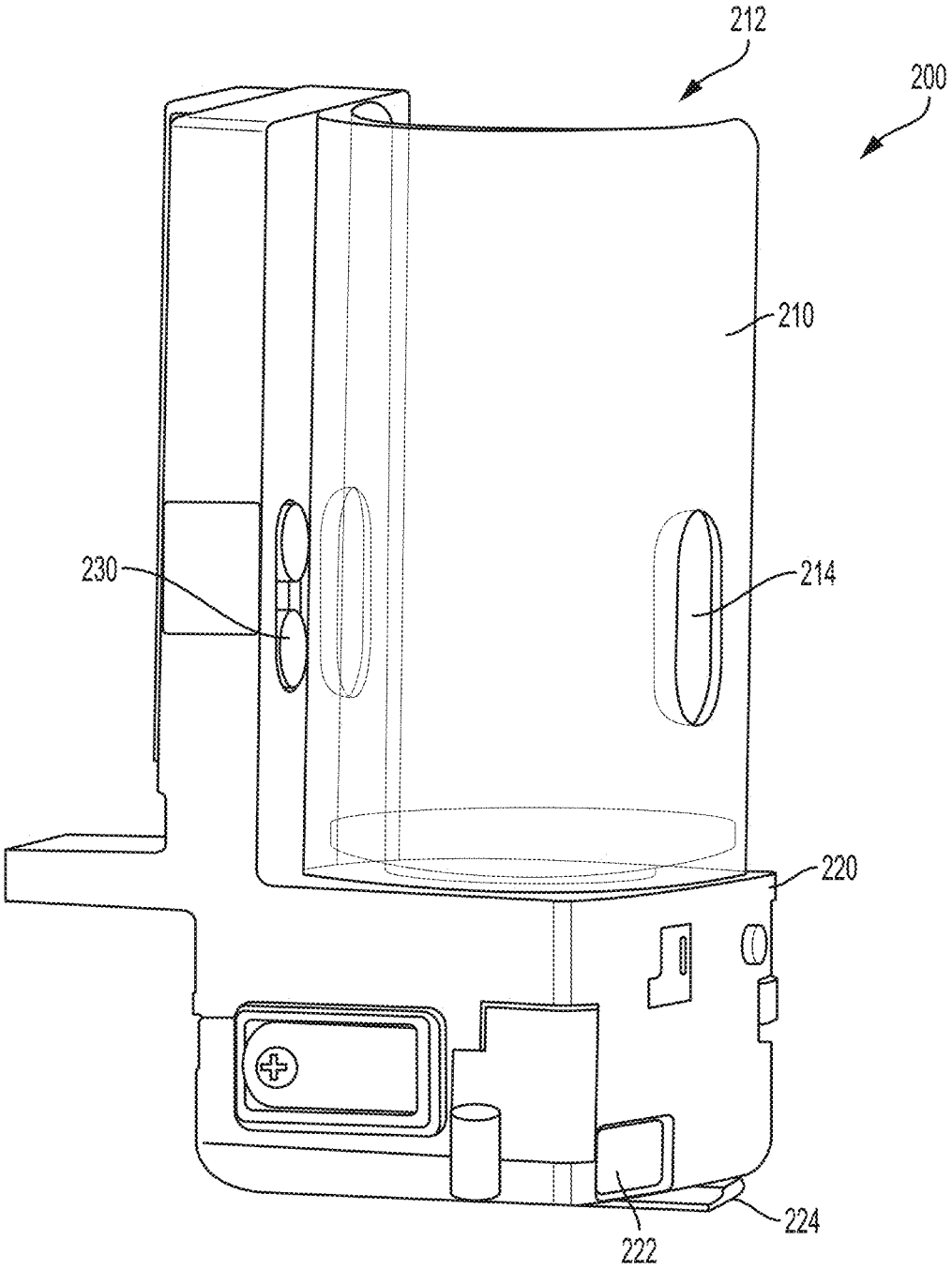

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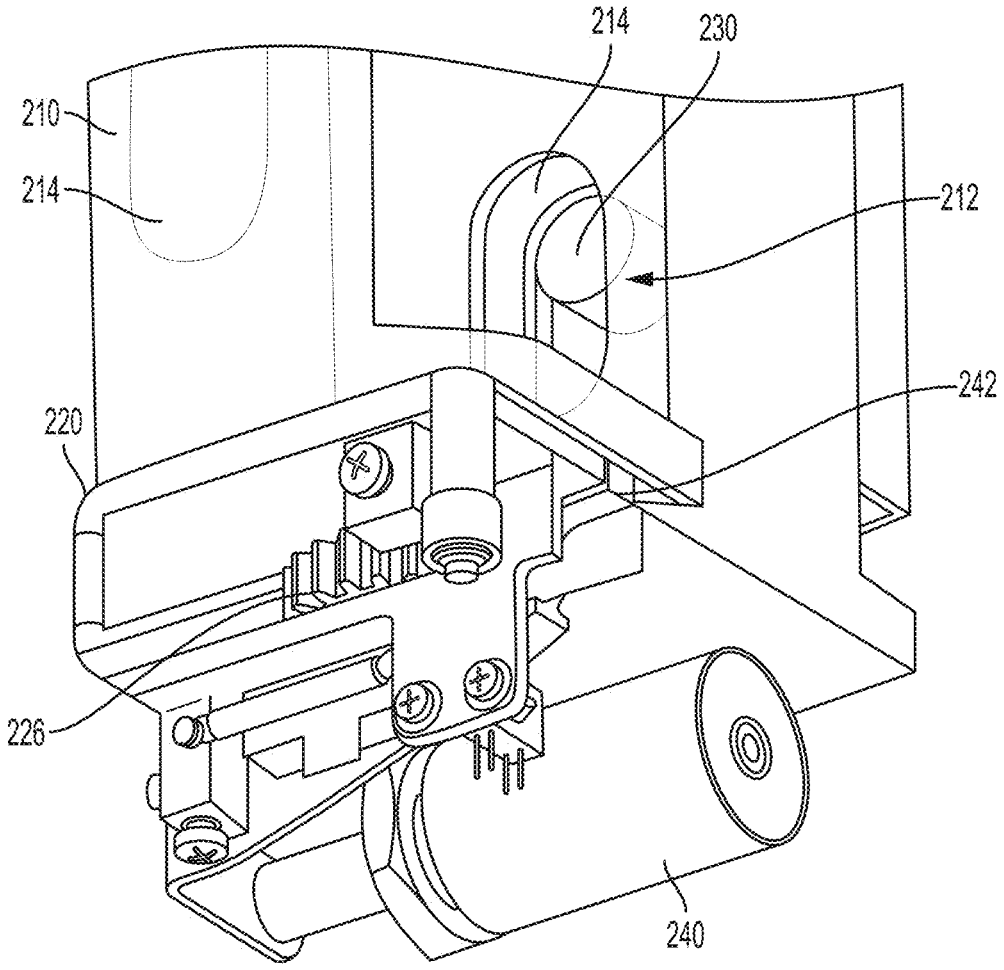

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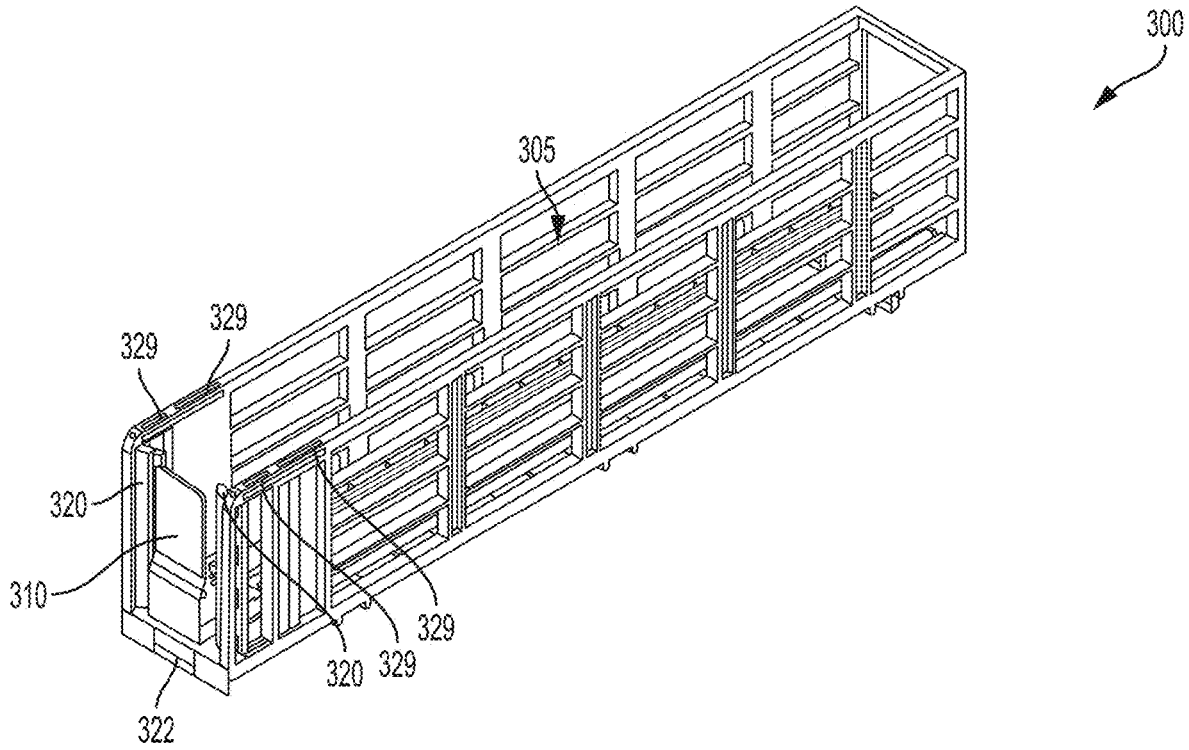

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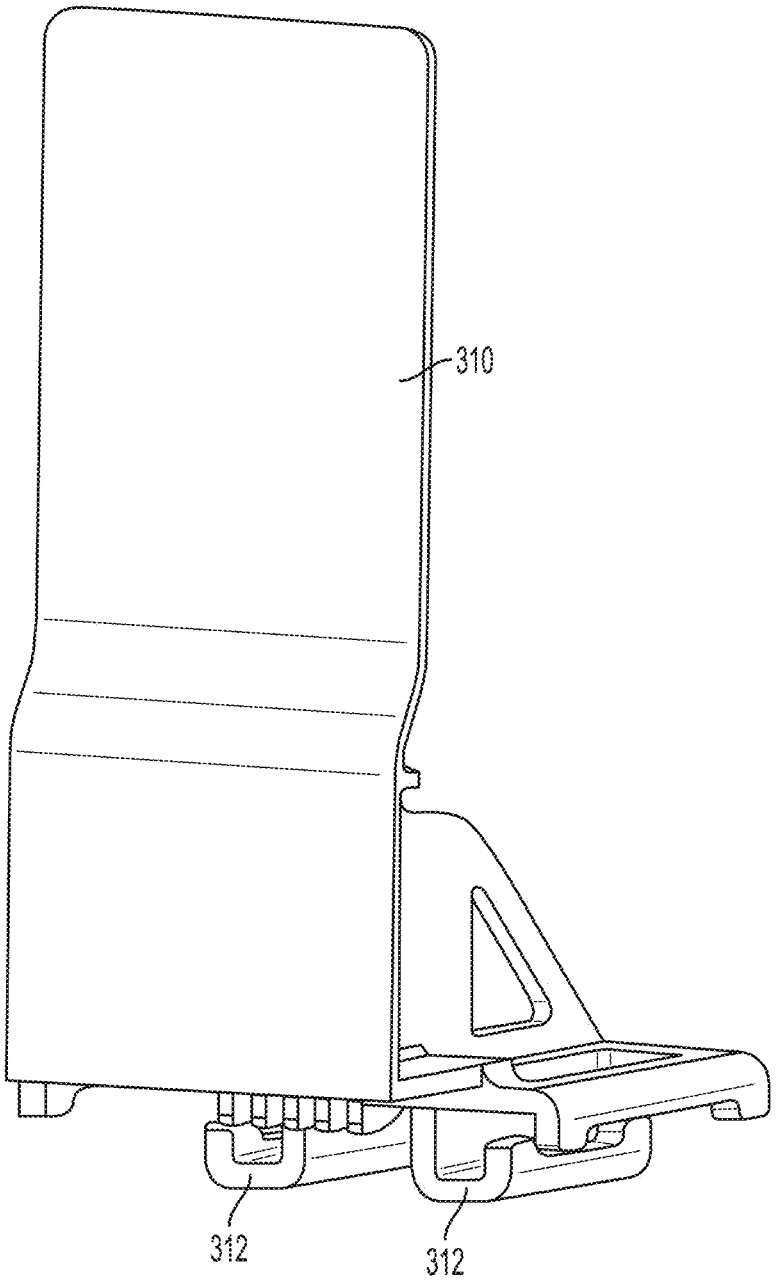

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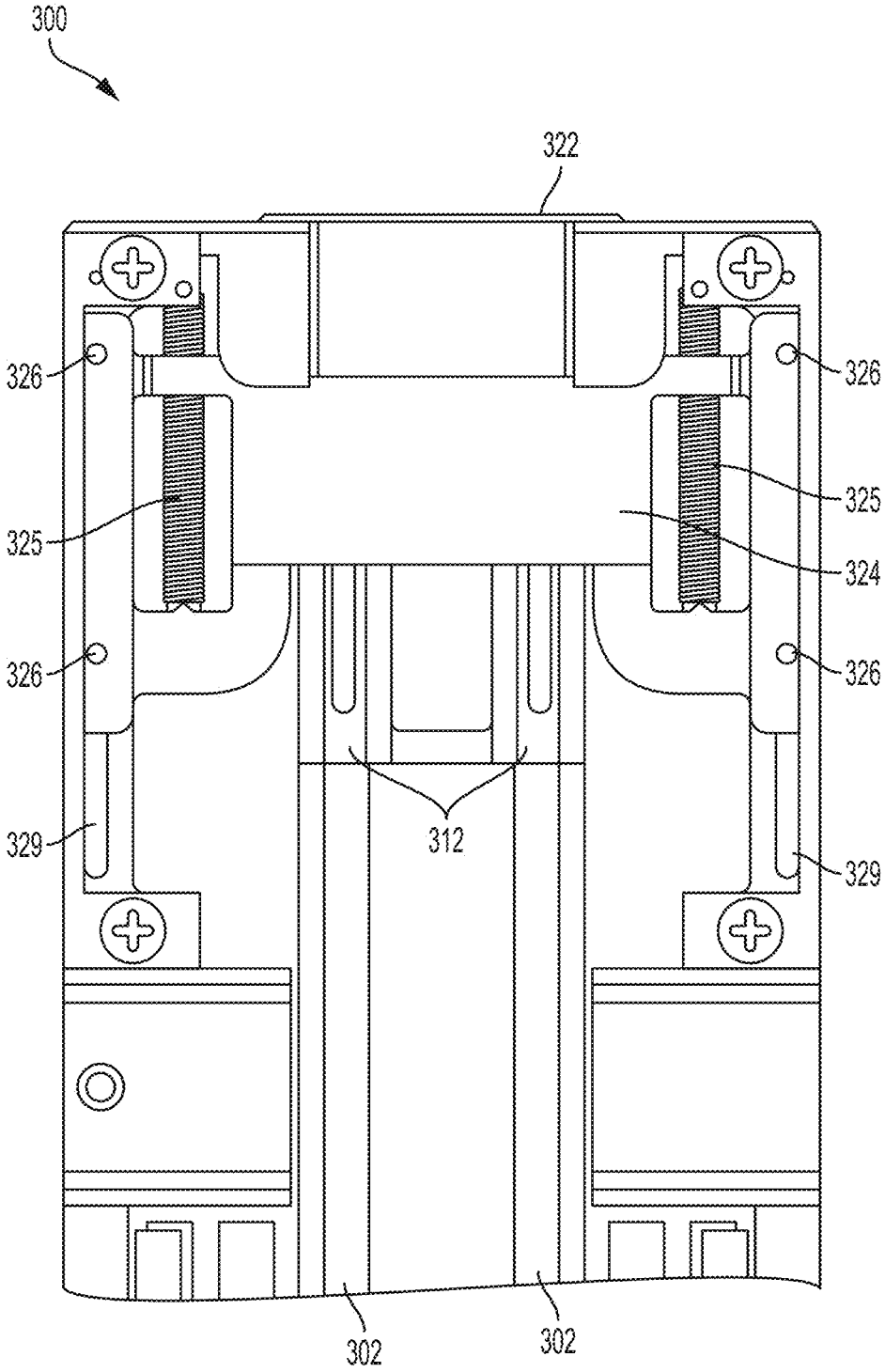

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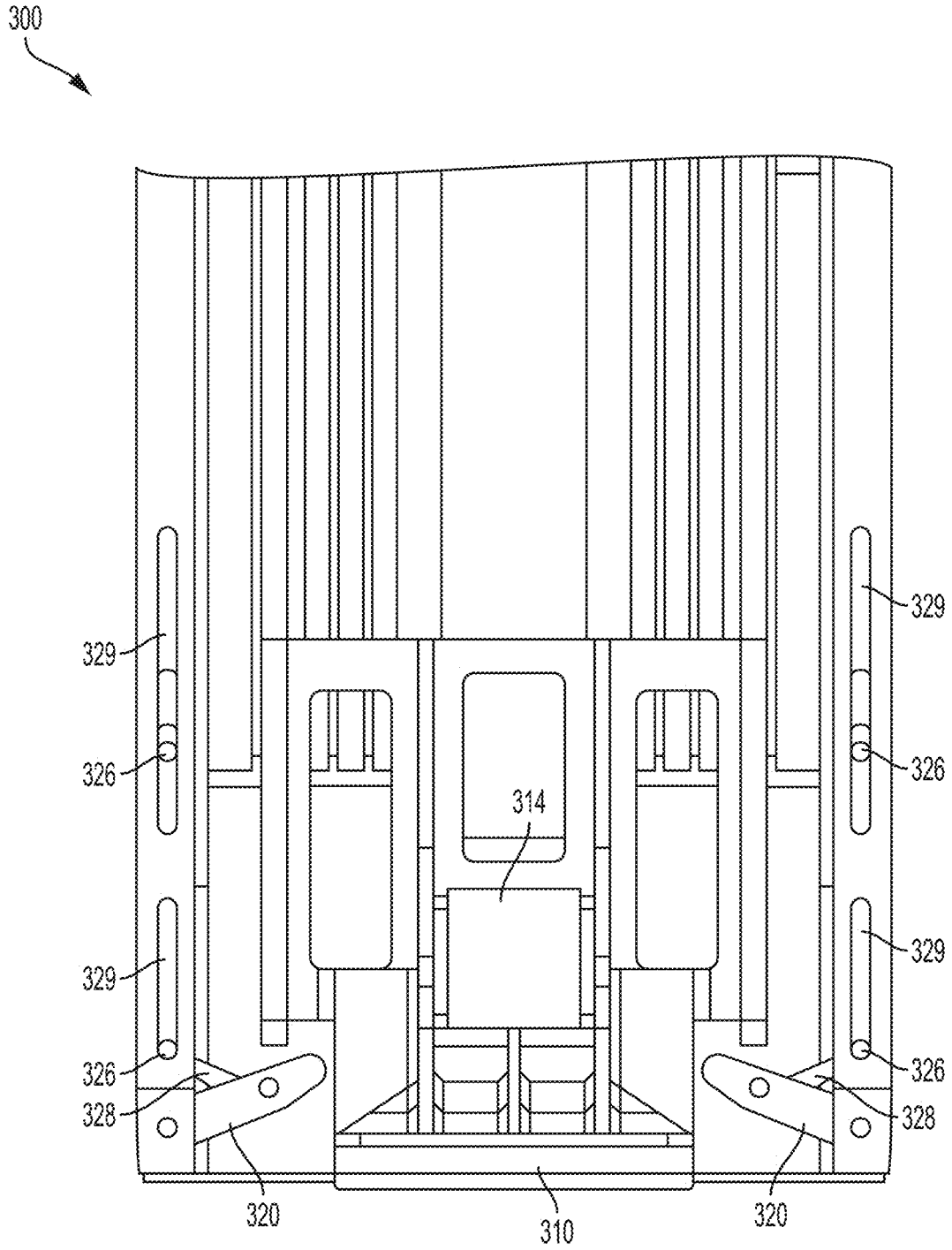


FIG. 14

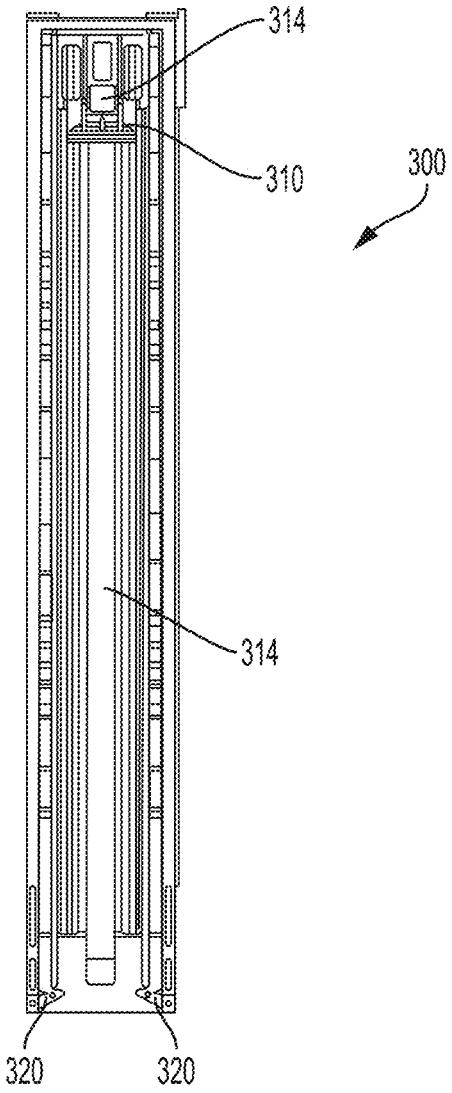


FIG. 15

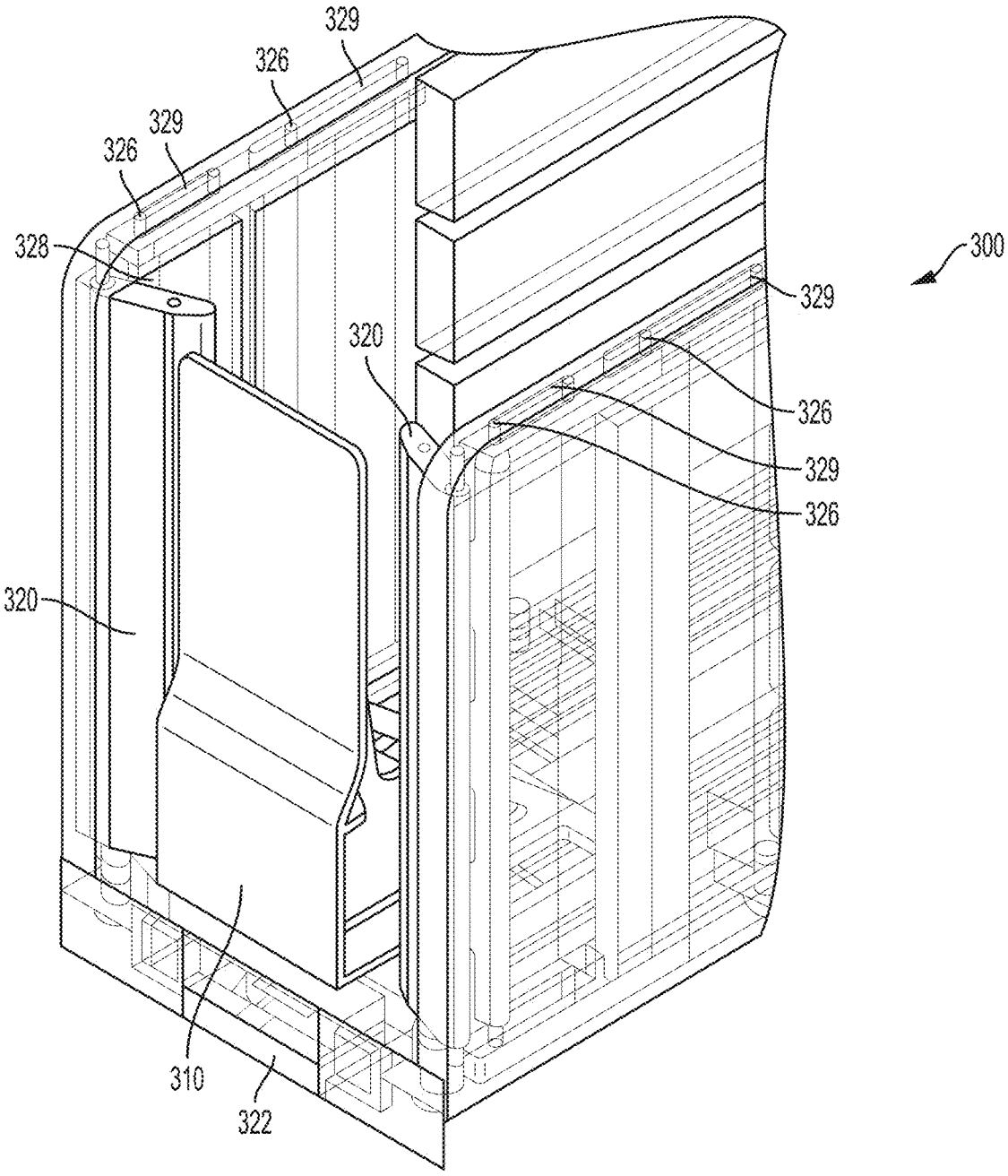


FIG. 16

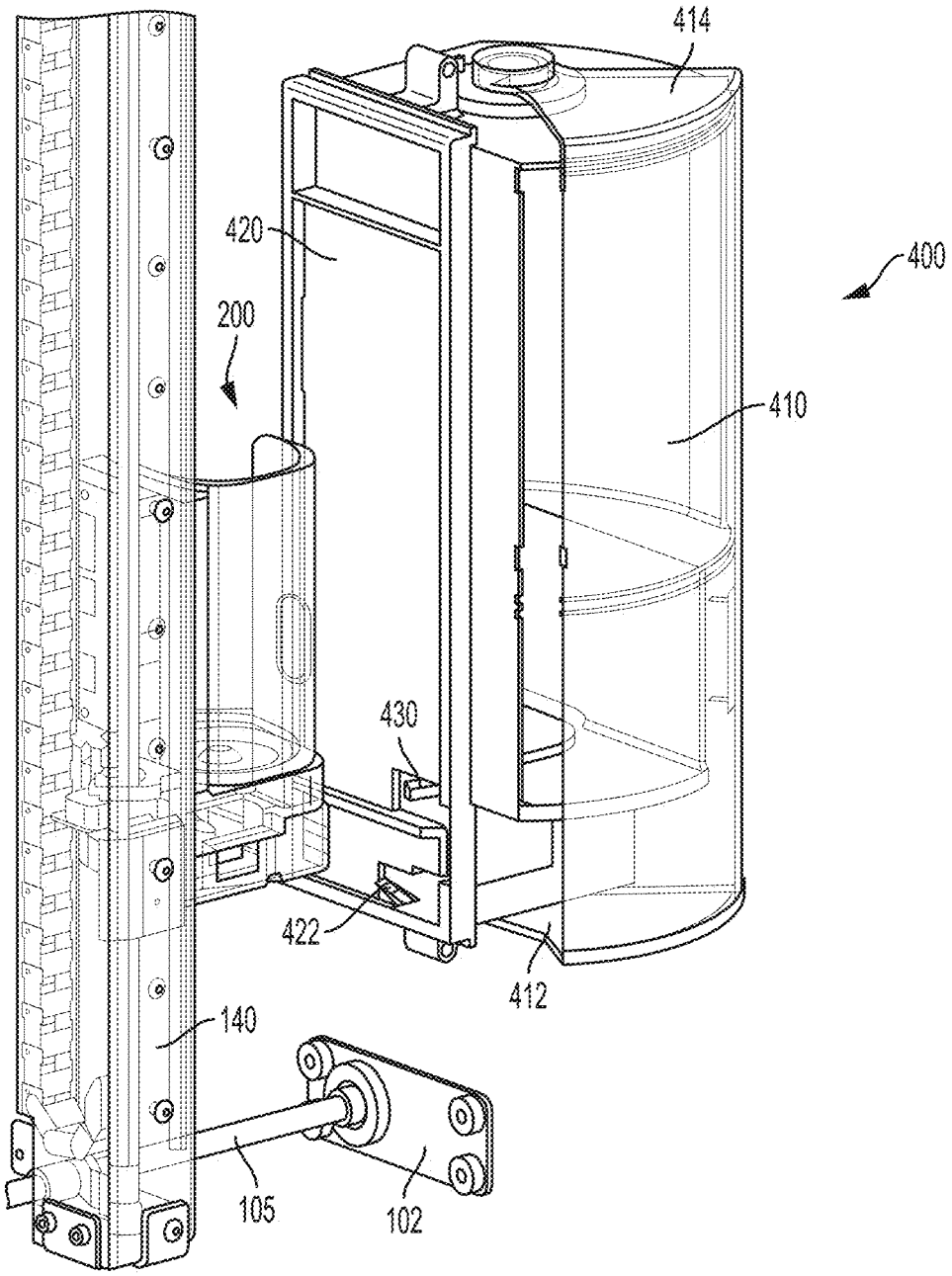


FIG. 17

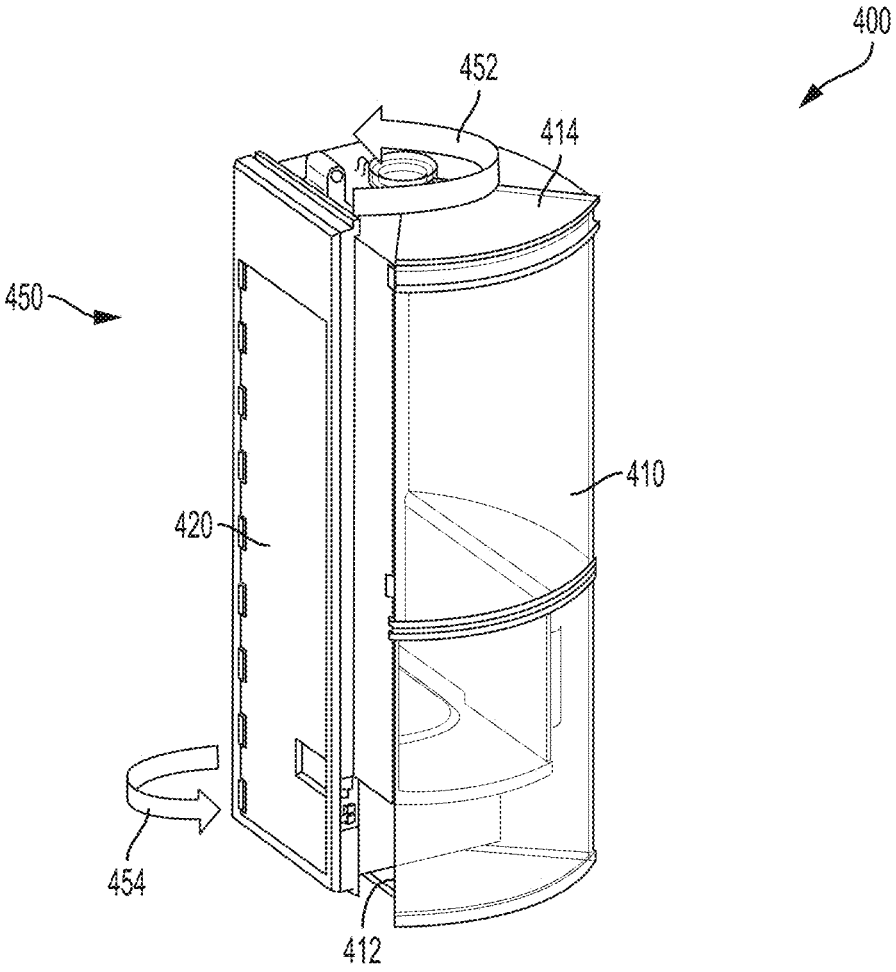


FIG. 18A

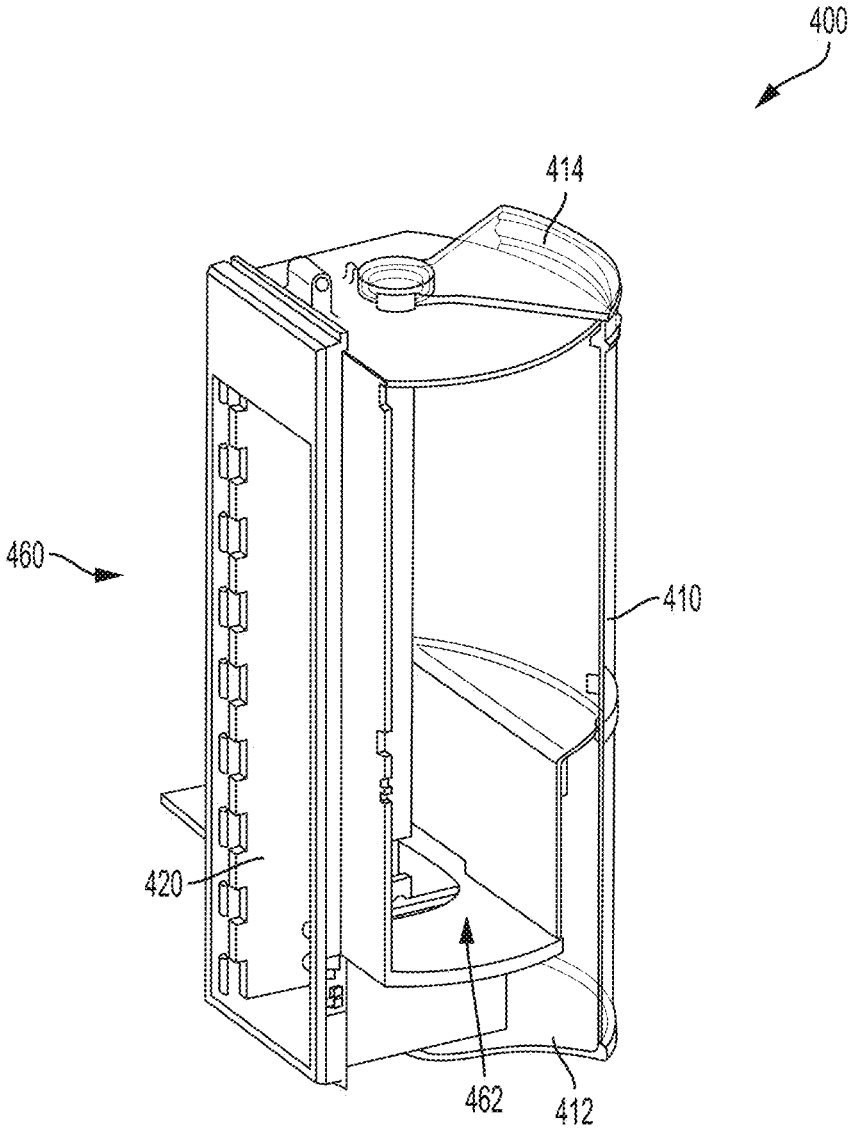


FIG. 18B

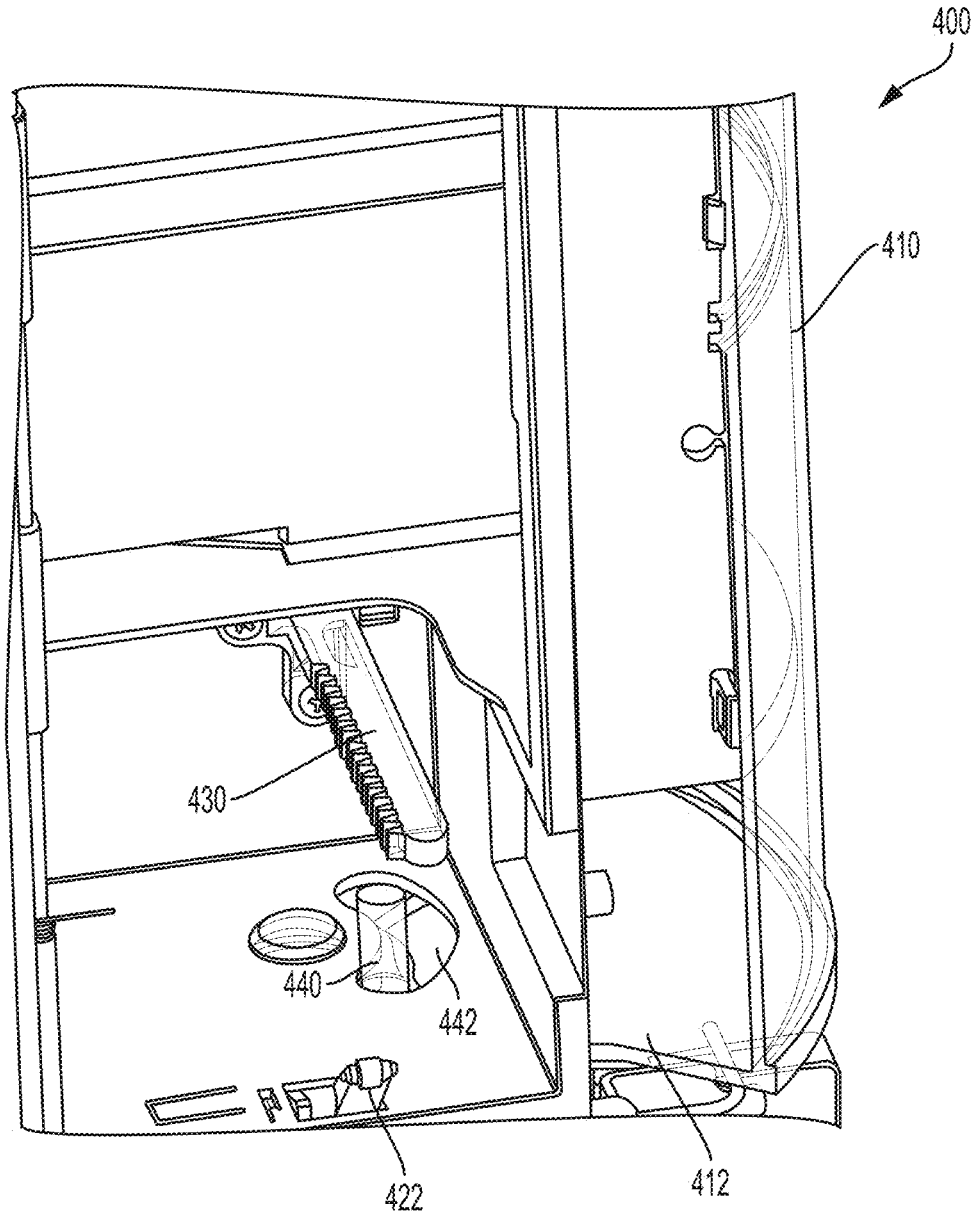


FIG. 19

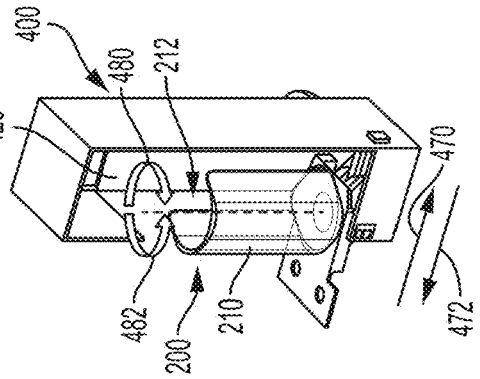


FIG. 20D

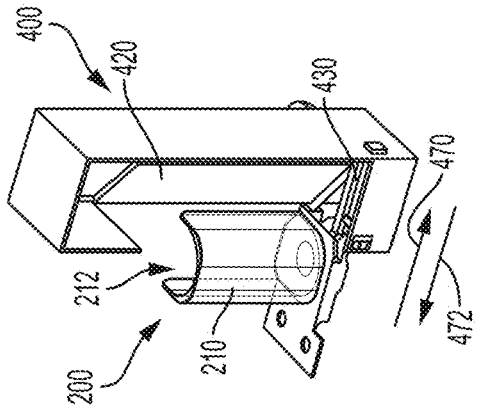
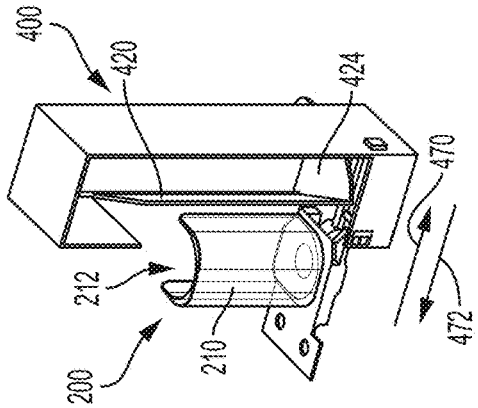


FIG. 20C



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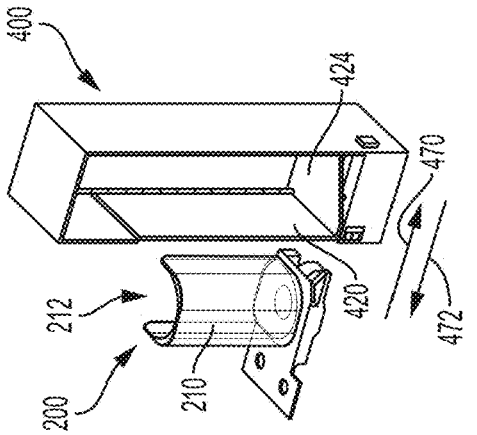

FIG. 20A

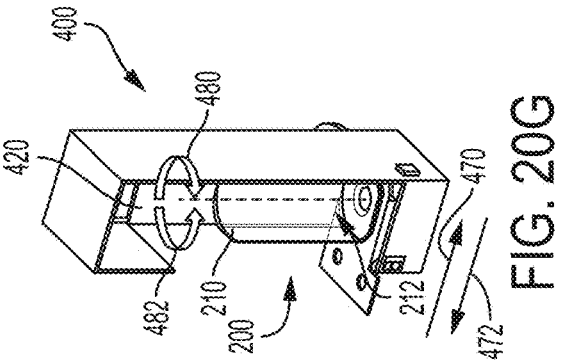

FIG. 20G

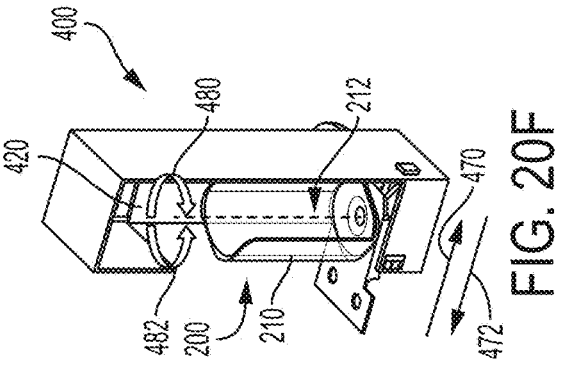

FIG. 20F

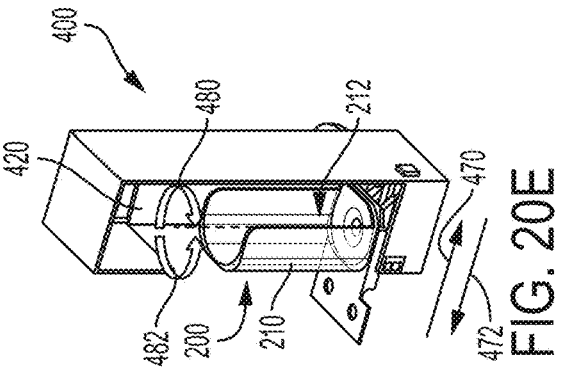

FIG. 20E

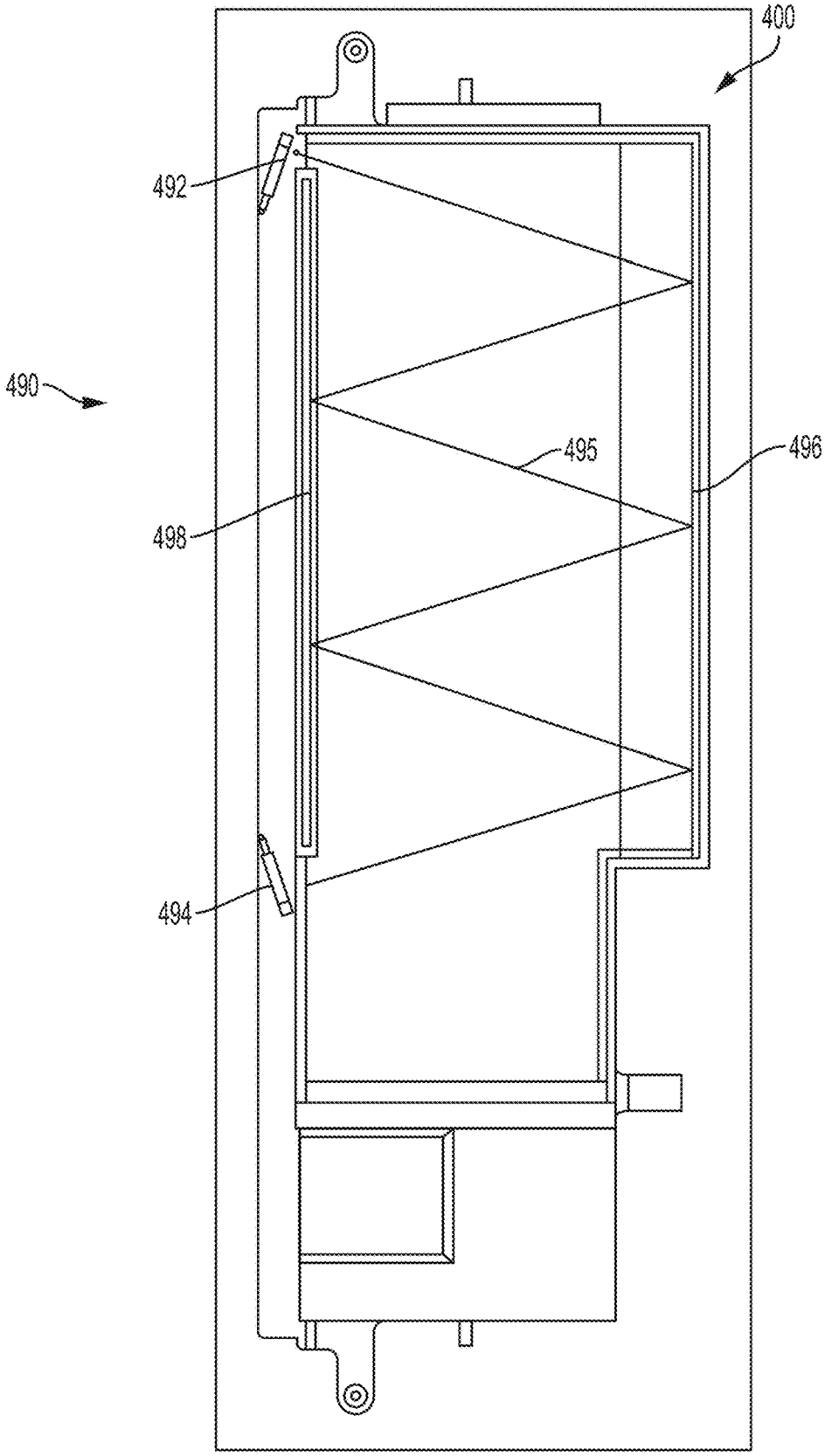

FIG. 21

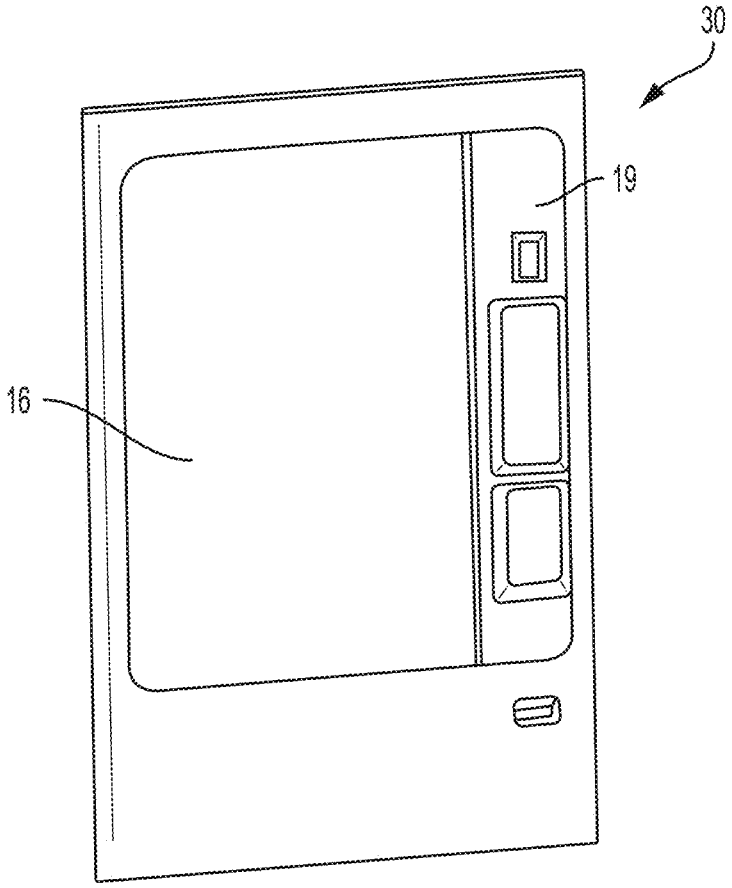

FIG. 22

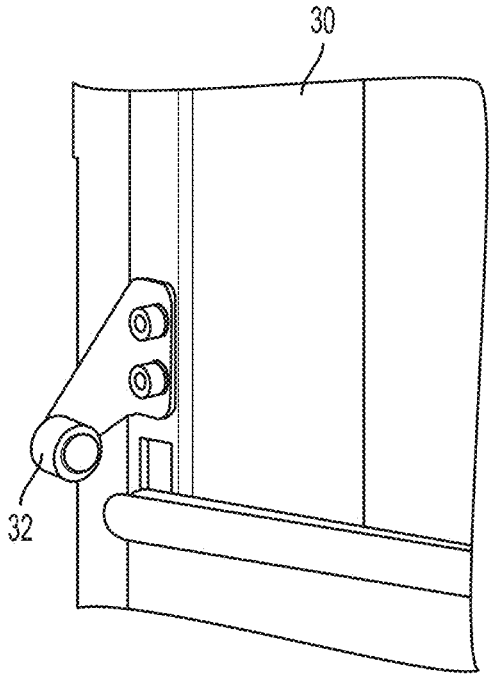

FIG. 23

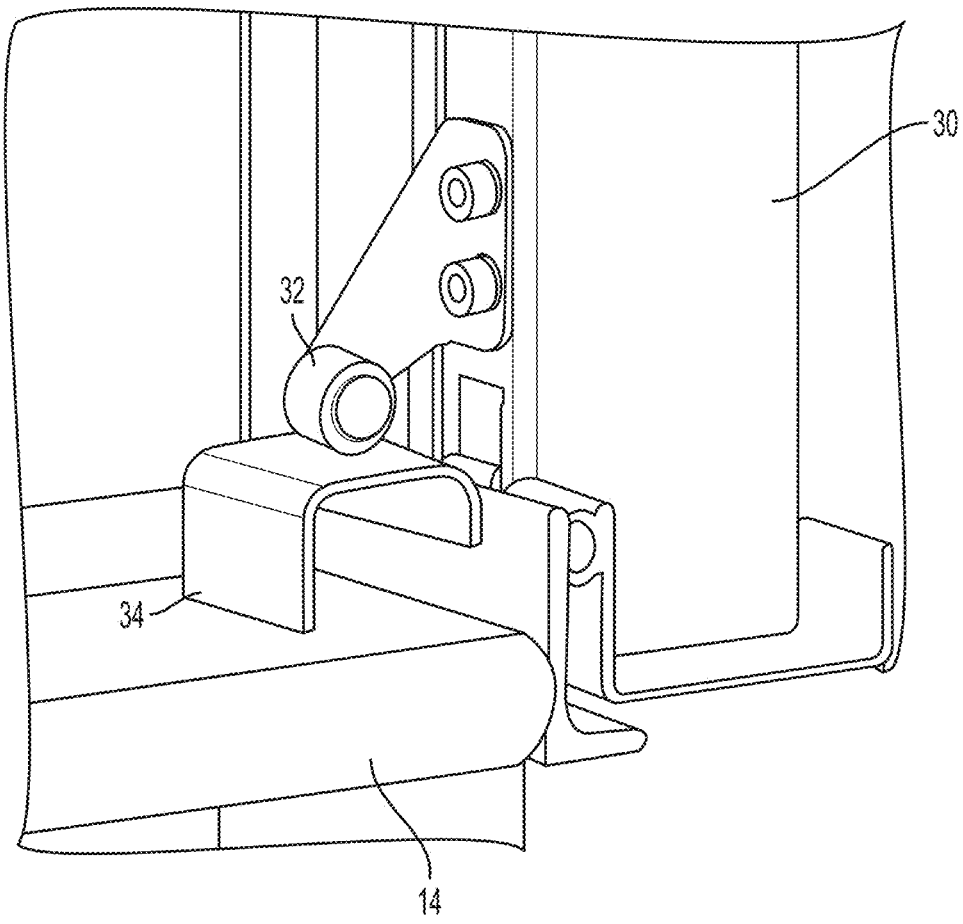

FIG. 24

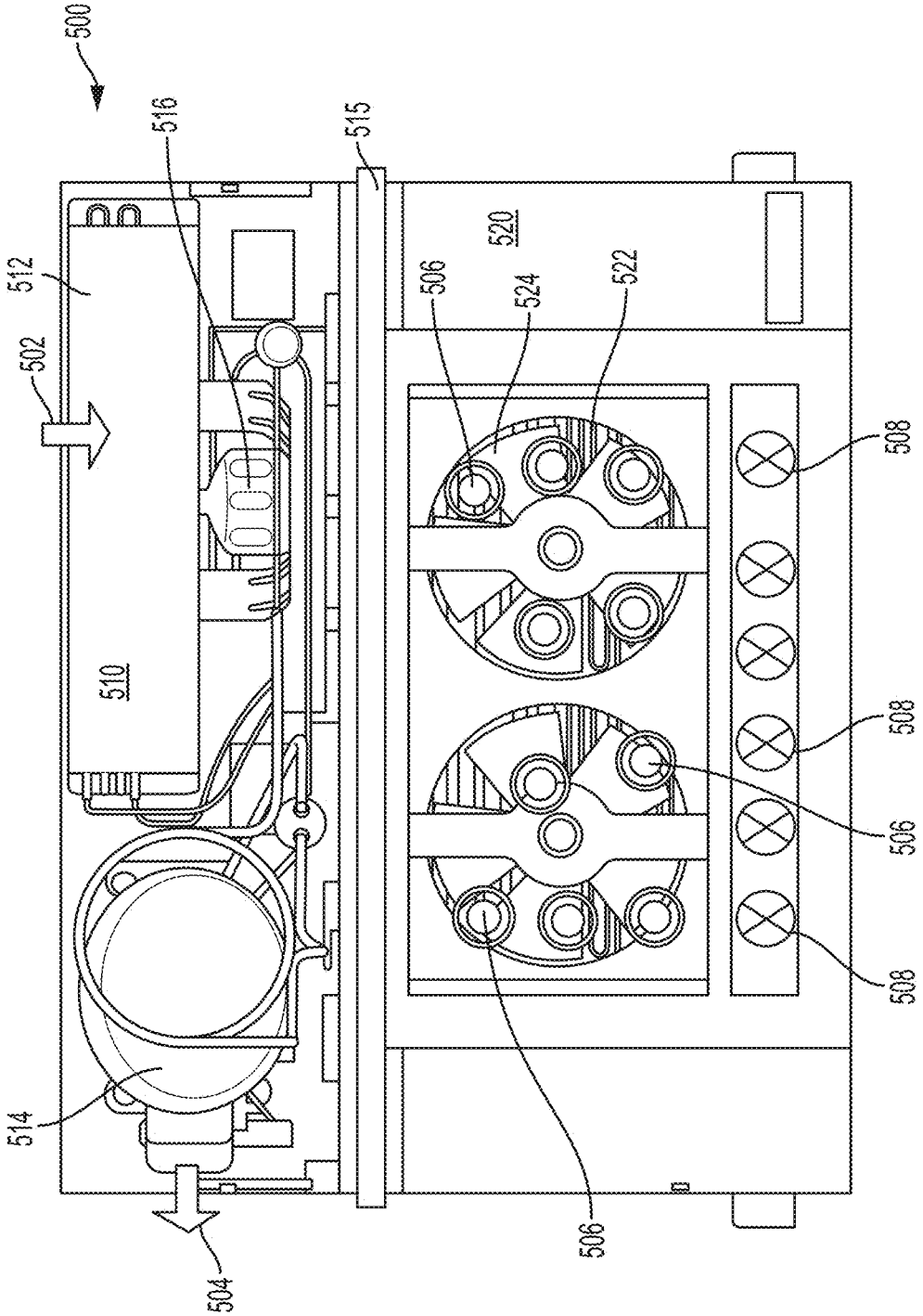
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FIG. 25

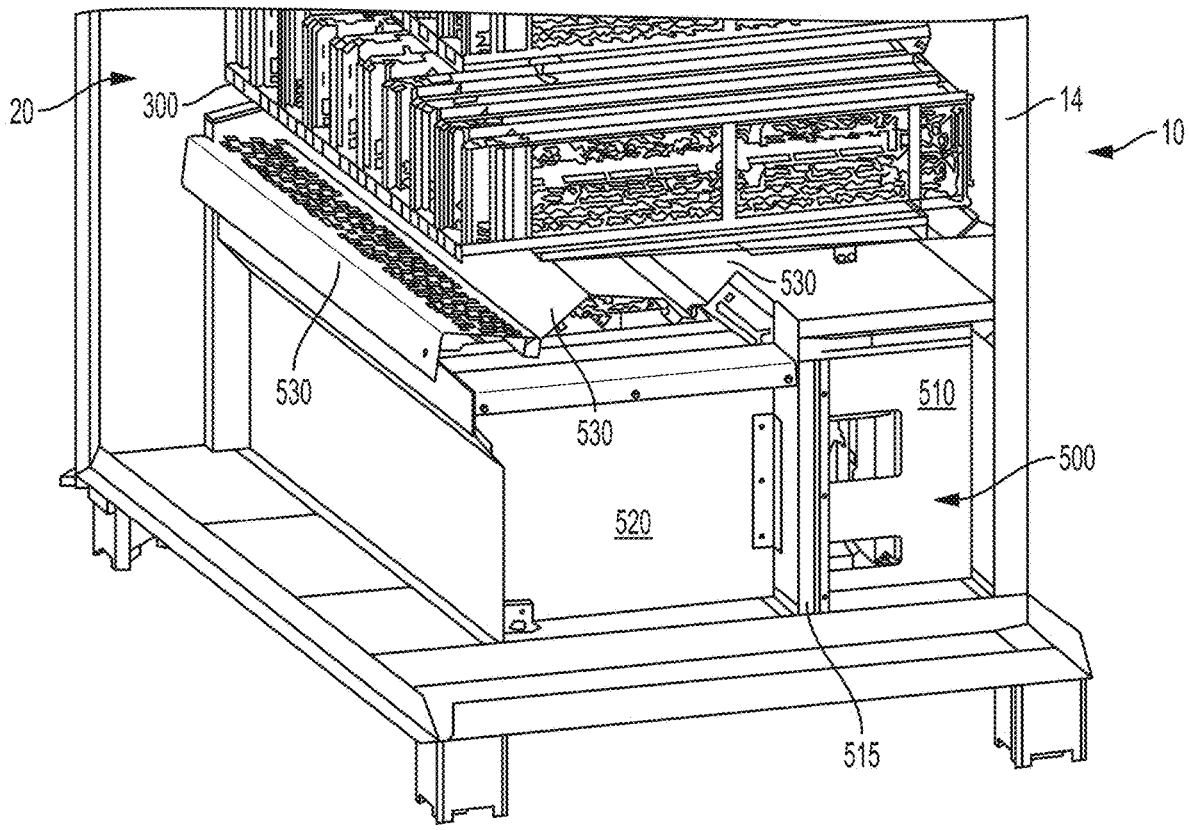

FIG. 26

LEAN VENDING MACHINE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 16/691,060, filed Nov. 21, 2019, which is a continuation of U.S. patent application Ser. No. 15/382,042, filed Dec. 16, 2016, the disclosures of which are each incorporated herein in their entireties by reference thereto.

BACKGROUND

Field

Embodiments of the present invention relate generally to vending machines, and more specifically to vending machines that present vending products to consumers without dropping the vending products.

Background

Vending machines are used to store and deliver products (e.g., beverages in bottles, cans, boxes, etc.) to consumers. Conventional vending machines often deliver the products by dropping the products into a pick-up space where the consumer opens a hinged door, for example, to retrieve the product. Other vending machines do not drop the products, but these vending machines require high levels of service and maintenance.

BRIEF SUMMARY OF THE INVENTION

In some embodiments, a vending machine includes two horizontal lead screws, first and second motors, a vertical lead screw, a shelf, a delivery cup, and a delivery area. In some embodiments, the first motor is coupled to and drives the two horizontal lead screws. In some embodiments, the vertical lead screw moves horizontally along the two horizontal lead screws. In some embodiments, the second motor is coupled to and drives the vertical lead screw. In some embodiments, the shelf contains a vending product and has a movable gate that holds the vending product on the shelf. In some embodiments, the delivery cup is coupled to the vertical lead screw and moves vertically along the vertical lead screw. In some embodiments, the delivery cup has a solenoid and a plunger. In some embodiments, the solenoid activates the plunger and the plunger opens the gate to dispense the vending product onto the delivery cup. In some embodiments, the delivery area has an outer door. In some embodiments, the outer door isolates the delivery area from an exterior of the vending machine when in a closed position and provides access to the vending product from the exterior of the vending machine through an opening when in an open position. In some embodiments, a mechanical interaction between the delivery cup and the delivery area moves the outer door to the open position.

In some embodiments, the first motor is disposed adjacent to the second motor. In some embodiments, the first and second motors are disposed outside of a storage space of the vending machine. In some embodiments, the vending machine includes a transparent front panel.

In some embodiments, the delivery cup includes a receptacle having an open side that faces the shelf and receives the vending product. In some embodiments, the mechanical interaction between the delivery cup and the delivery area rotates the delivery cup so that the open side aligns with the opening. In some embodiments, the mechanical interaction rotates the delivery cup and opens the outer door simultaneously. In some embodiments, the vending machine also includes a rack and a pinion gear. In some embodiments, the mechanical interaction comprises an interaction between the rack and the pinion gear.

In some embodiments, the gate comprises two side gates mechanically linked to a front plate. In some embodiments, the plunger pushes the front plate to open the two side gates. In some embodiments, the vending machine also includes a spring that closes the two side gates. In some embodiments, the vending machine also includes an optical sensor that detects when the gate is completely opened and provides a signal to the solenoid.

In some embodiments, the shelf is flat. In some embodiments, the vending machine also includes an ultrasound sensor disposed on the delivery cup. In some embodiments, the ultrasound sensor detects a vending product within the delivery cup.

In some embodiments, a vending machine includes an exterior body, a storage space within the exterior body, a delivery system, and a delivery area. In some embodiments, the storage space stores a vending product. In some embodiments, the delivery system is movable in an X-direction and a Y-direction. In some embodiments, the delivery system has a receptacle with an open side and a pinion gear mechanically linked to the receptacle. In some embodiments, the delivery area has a rack, an outer door, and a projection mechanically linked to the outer door and protruding through a slot. In some embodiments, the outer door isolates the delivery area from outside the exterior body in a closed position and provides access to the vending product from outside the exterior body in an open position. In some embodiments, a surface of the delivery system pushes the projection along the slot as the delivery system moves the vending product into the delivery area, thereby moving the outer door from the closed position to the open position. In some embodiments, the rack interacts with the pinion gear as the delivery system moves the vending product into the delivery area, thereby rotating the receptacle so that the open side faces an opening formed when the outer door is in the open position.

In some embodiments, the slot is curved and the outer door moves in a rotating manner. In some embodiments, the vending machine also includes an inner door between the delivery area and the storage space. In some embodiments, the delivery system mechanically opens the inner door.

In some embodiments, a method for vending a product to a consumer from a vending machine includes moving a delivery cup to align the delivery cup with a shelf containing the product, opening a gate of the shelf by activating a solenoid for a timed pulse, receiving the product into the delivery cup, and moving the delivery cup into a delivery area such that the product is presented in an upright manner to the consumer. In some embodiments, moving the delivery cup into the delivery area mechanically opens an outer door to allow access to the delivery area and mechanically rotates the delivery cup to provide the consumer access to the product. In some embodiments, the vending machine includes a transparent front panel.

In some embodiments, the method also includes closing the gate with a spring after the timed pulse. In some embodiments, the timed pulse allows only one product to be dispensed from the shelf. In some embodiments, the method also includes unlocking and opening an inner door to the delivery area.

In some embodiments, the method also includes removing the delivery cup from the delivery area after the product is removed by the consumer. In some embodiments, removing the delivery cup from the delivery area closes the outer door and closes and locks the inner door. In some embodiments, the transparent front panel comprises glass.

Further features and advantages of embodiments of the invention, as well as the structure and operation of various embodiments of the invention, are described in detail below with reference to the accompanying drawings. It is noted that the invention is not limited to the specific embodiments described herein. Such embodiments are presented herein for illustrative purposes only. Additional embodiments will be apparent to a person skilled in the relevant art(s) based on the teachings contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

The accompanying drawings, which are incorporated herein and form part of the specification, illustrate embodiments of the present invention and, together with the description, further serve to explain the principles of the invention and to enable a person skilled in the relevant art(s) to make and use the invention.

FIG. **1** shows a perspective view of a vending machine according to some embodiments.

FIG. **2** shows a perspective view of a delivery system for a vending machine according to some embodiments.

FIG. **3** shows a close-up view of a portion of a delivery system for a vending machine according to some embodiments.

FIG. **4** shows a close-up view of a portion of a delivery system for a vending machine according to some embodiments.

FIG. **5** shows a close-up view of a portion of a delivery system for a vending machine according to some embodiments.

FIG. **6** shows a close-up view of a portion of a delivery system for a vending machine according to some embodiments.

FIG. **7** shows a close-up view of a portion of a delivery system for a vending machine according to some embodiments.

FIG. **8** shows a perspective view of a delivery cup for a vending machine according to some embodiments.

FIG. **9** shows a perspective view of a delivery cup for a vending machine according to some embodiments.

FIG. **10** shows an interior view of a portion of a delivery cup for a vending machine according to some embodiments.

FIG. **11** shows a perspective view of a shelf for a vending machine according to some embodiments.

FIG. **12** shows a perspective view of a product pusher for a vending machine according to some embodiments.

FIG. **13** shows a bottom view of a shelf for a vending machine according to some embodiments.

FIG. **14** shows a top view of a shelf for a vending machine according to some embodiments.

FIG. **15** shows a top view of a shelf for a vending machine according to some embodiments.

FIG. **16** shows a perspective view of a shelf for a vending machine according to some embodiments.

FIG. **17** shows a perspective view of a delivery area for a vending machine according to some embodiments.

FIG. **18**A shows a perspective view of a delivery area for a vending machine in a closed configuration according to some embodiments.

FIG. **18**B shows a perspective view of a delivery area for a vending machine in an open configuration according to some embodiments.

FIG. **19** shows an interior view of a delivery area for a vending machine according to some embodiments.

FIGS. **20**A-**20**G show an operation of a delivery cup entering a delivery area of a vending machine according to some embodiments.

FIG. **21** shows a front view of a delivery area of a vending machine according to some embodiments.

FIG. **22** shows a perspective view of a door for a vending machine according to some embodiments.

FIG. **23** shows a partial interior view of a door for a vending machine according to some embodiments.

FIG. **24** shows a partial interior view of a door for a vending machine according to some embodiments.

FIG. **25** shows a top view of a refrigeration unit for a vending machine according to some embodiments.

FIG. **26** shows a perspective view of a refrigeration unit within a vending machine according to some embodiments.

Features and advantages of the embodiments will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like reference characters identify corresponding elements throughout.

DETAILED DESCRIPTION OF THE INVENTION

The present invention(s) will now be described in detail with reference to embodiments thereof as illustrated in the accompanying drawings. References to "one embodiment", "an embodiment", "an exemplary embodiment", etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

Vending machines are used to store and deliver products (e.g., beverages in bottles, cans, boxes, etc.) to consumers. Conventional vending machines often deliver the products by dropping the products into a pick-up space where the consumer opens a hinged door, for example, to retrieve the product. However, seeing and/or hearing the product drop can be unpleasant for the consumer. In addition, dropping some products (e.g., carbonated drinks) may cause the product to be volatile when opened. Presenting the product to the consumer, rather than dropping the product, would improve the quality of the product and result in a better user experience.

While some vending machines do not drop products, these vending machines require high levels of service and maintenance. Thus, it is desirable to provide a vending machine that presents the product to the consumer but reduces the complexity of other vending machines (i.e., a lean vending machine). Furthermore, it is desirable for the vending machine to accommodate products of a variety of shapes (e.g., cylindrical, square) and sizes, while also providing simple product loading.

Accordingly, in some embodiments, a lean vending machine comprises a storage system, a delivery system, and a delivery area. These components interact with each other

to dispense, transport, and present vending products to consumers without any dropping. In some embodiments, the interactions are primarily mechanical, thus reducing the complexity of the vending machine and reducing the need for service and maintenance.

In some embodiments, the storage system is modular. In some embodiments, the storage system comprises one or more shelves. In some embodiments, the plurality of shelves forms a grid of product storage areas. In some embodiments, each shelf is configured to dispense vending products. For example, each shelf may include a mechanism to dispense vending products, such as a spring-loaded product pusher. As another example, each shelf may be angled downward so that gravity assists and/or pulls vending products out of the shelf. In some embodiments, each shelf is flat. In some embodiments, each shelf comprises a gate that keeps the vending products on the shelf until the vending machine is ready to dispense the vending product.

In some embodiments, the delivery system comprises an X-Y mechanism and a delivery cup. In some embodiments, the X-Y mechanism moves the delivery cup in an X-direction and a Y-direction, allowing the delivery cup to be positioned next to a shelf to receive a vending product and then relocated to the delivery area to present the vending product to the consumer. In some embodiments, the X-Y mechanism includes lead screws and nut assemblies.

In some embodiments, the delivery cup is coupled to the X-Y mechanism and comprises a platform for supporting the vending product. In some embodiments, the delivery cup communicates with the shelf. In some embodiments, the delivery cup communicates with the shelf to properly locate the delivery cup. In some embodiments, the delivery cup interacts with the shelf to open the gate, allowing for one of the vending products to be dispensed onto or into the delivery cup. For example, the delivery cup may include an actuator to open the gate. In some embodiments, the delivery cup opens the gate by use of a solenoid activating a plunger.

In some embodiments, the delivery area comprises a retrieval location for the consumer to retrieve the vending product. In some embodiments, the delivery area comprises an outer door that isolates the delivery area from outside the vending machine. In some embodiments, the delivery cup mechanically interacts with the delivery area as the delivery cup enters the delivery area to provide the consumer with access to the vending product, thus presenting the vending product to the consumer. In some embodiments, the mechanical interaction rotates the delivery cup, opens an inner door, unlocks an inner door, and/or opens an outer door of the delivery area. In some embodiments, the mechanical interaction comprises an interaction between a pinion gear and a rack. In some embodiments, the mechanical interaction comprises an interaction between a pushing surface and a projection protruding through a slot. In some embodiments, the mechanical interaction comprises an interaction between a projection and a locking mechanism. In some embodiments, the mechanical interaction comprises a force directly on the inner door.

The vending products may include drinks, such as bottled water, energy drinks, carbonated soft drinks, milks, juices, sports drinks, etc., as well as food, such as chips, granola bars, energy bars, sandwiches, ice cream bars, candy, and other snacks. The vending products may be packaged in different sizes, shapes, and styles. Thus, while beverages are primarily discussed herein, the principles disclosed apply to other types of vending products as well. The lean vending machines disclosed herein may be used in any setting (e.g., school campuses, stores, malls, offices, etc.).

These and other embodiments are discussed below with reference to the figures. However, those skilled in the art will readily appreciate that the detailed description given herein with respect to these figures is for explanatory purposes only and should not be construed as limiting.

In some embodiments, vending machine **10**, as shown, for example, in FIG. **1**, comprises an exterior body **14**. Exterior body **14** may be made from a plurality of pieces (such as side panels, a rear panel, a front panel, a top panel, or a bottom panel) or may be structured by any method known in the art without departing from the invention. In some embodiments, vending machine **10** includes a front panel **16**. In some embodiments, front panel **16** is transparent. In some embodiments, front panel **16** is glass (e.g., single- or double-paned). In some embodiments, front panel **16** is transparent plastic. In some embodiments, front panel **16** is sized and shaped to allow consumers to see vending products **12** stored within vending machine **10**.

In some embodiments, vending machine **10** comprises a user interface **18**. In some embodiments, user interface **18** comprises a keypad and/or a touch screen, which may be used, for example, to select a desired vending product **12** or enter information (such as a PIN). In some embodiments, user interface **18** comprises payment mechanisms. For example, user interface **18** may include one or more of a currency reception area (e.g., bill and/or coin slot), a card reader (e.g., for reading credit cards, debit cards, ID cards, etc. by swiping), and contactless payment mechanisms (e.g., mechanisms based on RFID, QR codes, NFC, Bluetooth, etc.). In some embodiments, user interface **18** comprises payment return mechanisms, such as a bill and/or a coin return. In some embodiments, user interface **18** is disposed adjacent to front panel **16**. In some embodiments user interface **18** is surrounded by a plastic cover **19**.

In some embodiments, vending machine **10** is used to vend one or more vending products **12**. In some embodiments, vending products **12** may each be the same type of product (e.g., bottled water). In some embodiments, vending machine **10** may include a variety of vending products **12** (e.g., bottled water, different flavors of soft drinks, juices, etc.).

In some embodiments, vending machine **10** includes a storage space **20**. For example, storage space **20** may be located within exterior body **14**. In some embodiments storage space **20** comprises the space visible through front panel **16**. In some embodiments, vending machine **10** stores vending products **12** within storage space **20**. For example, vending machine **10** may store vending products **12** on a plurality of shelves **300** within storage space **20**. In some embodiments, each shelf **300** may be dedicated to a particular type of vending product **12**.

In some embodiments, vending machine **10** comprises a delivery area **400**. In some embodiments, delivery area **400** is configured to present vending products **12** to consumers. In some embodiments, delivery area **400** is surrounded by plastic cover **19**. In some embodiments, delivery area **400** is disposed adjacent to (e.g., below) user interface **18**. In some embodiments, delivery area **400** comprises an outer door **410**. When closed, outer door **410** may isolate delivery area **400** from outside vending machine **10**.

In some embodiments, as shown, for example, in FIG. **2**, vending machine **10** comprises a delivery system **100** to transport vending products **12** from shelves **300** to delivery area **400**. In some embodiments, delivery system **100** is disposed between front panel **16** and shelves **300**. In some embodiments, delivery system **100** comprises an X-Y mechanism and a delivery cup **200**. In some embodiments,

the X-Y mechanism of delivery system **100** is configured to move delivery cup **200** to any position in its plane within storage space **20**, thus allowing delivery cup **200** to be positioned adjacent to any of the plurality of shelves **300** and to be positioned in delivery area **400**.

In some embodiments, the X-Y mechanism of delivery system **100** is attached to vending machine **10** via supporting brackets **102**. In some embodiments, supporting brackets **102** may be disposed in the corners of the X-Y mechanism. In some embodiments, the X-Y mechanism comprises supporting bar **104**, which provides additional support to secure the X-Y mechanism within vending machine **10**. In some embodiments, supporting bar **104** may be disposed near the top of vending machine **10**.

In some embodiments, the X-Y mechanism of delivery system **100** comprises a system of lead screws and nut assemblies. In some embodiments, a nut assembly comprises a component (e.g., a bracket) that attaches a lead screw to the element that will be moved along the lead screw (e.g., delivery cup **200**, another lead screw, etc.). The component may be threaded on an interior portion so that as the lead screw rotates, the component moves along the lead screw.

In some embodiments, the X-Y mechanism comprises a bottom horizontal lead screw **105**, a top horizontal lead screw **110**, and a vertical lead screw **120**. In some embodiments, bottom horizontal lead screw **105** is disposed near the bottom of vending machine **10**. In some embodiments, bottom horizontal lead screw **105** is disposed below the bottom of front panel **16** to be out of the consumer's sight. In some embodiments, top horizontal lead screw **110** is disposed near the top of vending machine **10**. In some embodiments, top horizontal lead screw **110** is disposed above the top of front panel **16** to be out of the consumer's sight. In some embodiments, top horizontal lead screw **110** is coupled to and driven by a motor **114** (see FIG. **3**). In some embodiments, motor **114** is disposed within a motor box **130**. In some embodiments, motor **114** comprises a DC motor. In some embodiments, bottom horizontal lead screw **105** is also coupled to and driven by motor **114**. In some embodiments, bottom horizontal lead screw **105** is coupled to motor **114** indirectly.

In some embodiments, the motion of top horizontal lead screw **110** is transmitted to bottom horizontal lead screw **105** via a transmission bar **112**. For example, as shown in FIG. **4**, a transmission gear **111** may be coupled to top horizontal lead screw **110** and a transmission gear **113** may be coupled to transmission bar **112**. Transmission gear **111** may engage transmission gear **113** so that when top horizontal lead screw **110** rotates, transmission bar **112** also rotates. As shown in FIG. **6**, a transmission gear **109** may be coupled to transmission bar **112** and a transmission gear **107** may be coupled to bottom horizontal lead screw **105**. Transmission gear **109** may engage transmission gear **107** so that when transmission bar **112** rotates, bottom horizontal lead screw **105** also rotates. In some embodiments, top horizontal lead screw **110** and bottom horizontal lead screw **105** rotate at the same speed. For example, the gear ratio between transmission gear **111** and transmission gear **113** may be 1:1 and the gear ratio between transmission gear **109** and transmission gear **107** may also be 1:1. In some embodiments, transmission bar **112** is disposed at a side of vending machine **10** opposite from delivery area **400**. In some embodiments, transmission bar **112** is disposed to the left of front panel **16** to be out of the consumer's sight.

In some embodiments, vertical lead screw **120** is coupled to top horizontal lead screw **110** and bottom horizontal lead screw **105**, as shown, for example, in FIGS. **5** and **7**, with a nut configuration such that vertical lead screw **120** moves along top horizontal lead screw **110** and bottom horizontal lead screw **105** as top horizontal lead screw **110** and bottom horizontal lead screw **105** rotate. In some embodiments, vertical lead screw **120** is coupled to a motor **124** (see FIGS. **2-3**). In some embodiments, vertical lead screw **120** is coupled to motor **124** indirectly via a transmission bar **122**. For example, as shown in FIG. **5**, a transmission gear **121** may be coupled to transmission bar **122** and a transmission gear **123** may be coupled to vertical lead screw **120**. Transmission gear **121** may engage transmission gear **123** so that when transmission bar **122** rotates, vertical lead screw **120** also rotates. In some embodiments, transmission bar **122** is disposed adjacent to top horizontal lead screw **110**. Thus, in some embodiments, transmission bar **122** is disposed above the top of front panel **16** to be out of the consumer's sight. In some embodiments, transmission bar **122** is square.

In some embodiments, motor **124** is disposed adjacent to motor **114**. In some embodiments, motor **124** is disposed within motor box **130**. In some embodiments, motor **124** comprises a DC motor. In some embodiments, motor box **130** comprises insulation **132** as shown in FIG. **3** with motor box **130** removed. In some embodiments, insulation **132** may reduce the noise of motors **114** and **124** heard by consumers. In some embodiments, motor box **130** is disposed out of the consumer's sight. For example, motor box **130** may be disposed in an upper right corner (i.e., to the right and/or above the edges of front panel **16**. Thus, in some embodiments, motor box **130** may be disposed outside of storage space **20**. In some embodiments, motors **114** and **124** are controlled by a controller. For example, motors **114** and **124** may receive signals from the controller to move delivery cup **200** in a certain amount in the X-direction and a certain amount in the Y-direction. The signals from the controller may be based on a selection of a particular vending product **12** by the consumer via user interface **18**. The controller may be a single controller that controls both motors **114** and **124** or it may be two separate controllers that separately control motors **114** and **124**.

In some embodiments, a support beam **140** is coupled to vertical lead screw **120**. In some embodiments, support beam **140** operates to provide additional structural support to vertical lead screw **120**. In some embodiments, support beam **140** operates to conceal portions of the X-Y mechanism to be out of the consumer's sight (e.g., vertical lead screw **120**, electrical connections, brackets, etc.).

In some embodiments, delivery cup **200** of delivery system **100** is coupled to vertical lead screw **200**, as shown, for example, in FIGS. **2** and **8**, with a nut configuration such that delivery cup **200** moves along vertical lead screw **120** as vertical lead screw **120** rotates. Thus, delivery cup **200** may move in a Y-direction as vertical lead screw **120** rotates and in an X-direction (along with vertical lead screw **120** and support beam **140**) as top horizontal lead screw **110** and bottom horizontal lead screw **105** rotate. Thus, delivery cup **200** can be precisely and reliably positioned at any of the shelves **300** and at delivery area **400** based on signals received by the controller that controls motors **114** and **124**. In some embodiments, other types of X-Y mechanisms may be used instead of a system of lead screws and nut assemblies to precisely locate delivery cup **200**.

In some embodiments, delivery cup **200** is configured to receive vending product **12** from shelves **300** and transport vending product **12** to delivery area **400**. In some embodiments, delivery cup **200** is configured to interact with shelves **300**. In some embodiments, delivery cup **200** may

communicate with shelf **300** and vice versa. For example, shelf **300** may send a signal to delivery cup **200** indicating that delivery cup **200** has arrived at a proper location. As another example, delivery cup **200** may send a signal to shelf **300** that delivery cup **200** is ready to receive vending product **12**. Signals between delivery cup **200** and shelf **300** may utilize, for example, RFID, NFC, or Bluetooth technologies. In some embodiments, delivery cup **200** may include an actuator that causes shelf **300** to dispense vending product **12**. In some embodiments, the actuator comprises a mechanical actuator.

In some embodiments, delivery cup **200** is configured to interact with delivery area **400**. In some embodiments, the interaction between delivery cup **200** and delivery area **400** allows a consumer to easily access vending product **12** within delivery area **400**. In some embodiments, the interaction between delivery cup **200** and delivery area **400** opens outer door **410**. In some embodiments, delivery cup **200** is configured to mechanically interact with delivery area **400**. In some embodiments, the mechanical interaction between delivery cup **200** and delivery area **400** causes outer door **410** to open. In some embodiments, the mechanical interaction between delivery cup **200** and delivery area **400** results in movement of other components of delivery area **400** and/or delivery cup **200** that provides the consumer with better access to vending product **12**. In some embodiments, the mechanical interaction between delivery cup **200** and delivery area **400** effectively presents vending product **12** to the consumer.

In some embodiments, as shown, for example, in FIGS. **8-10**, delivery cup **200** comprises a receptacle **210** and a platform **220**. In some embodiments, receptacle **210** is transparent, allowing consumers to see vending product **12** as it is transported to delivery area **400**. In some embodiments, receptacle **210** has an open side **212**. In some embodiments, open side **212** is configured to face shelves **300**. In some embodiments, receptacle **210** is configured to rotate relative to platform **220**. For example, as described more fully below, receptacle **210** may rotate **180** degrees as it enters delivery area **400** so that open side **212** faces towards the consumer, thus facilitating the consumer's access to vending product **12**.

In some embodiments, platform **220** supports receptacle **210**. In some embodiments, platform **220** comprises features that facilitate the consumer's access to vending product **12**. These features may include a pushing surface **222**, a projection **224**, and/or a pinion gear **226** (see FIG. **10**). In some embodiments, pushing surface **222** may open outer door **410**, as described more fully below. In some embodiments, projection **224** may unlock an inner door **420** of delivery area **400**, as described more fully below. In some embodiments, pinion gear **226** may interact with a rack **430** of delivery area **400** to rotate receptacle **210**, as described more fully below. Thus, in some embodiments, pinion gear **226** is coupled to receptacle **210** so that the rotation of pinion gear **226** is tied to the rotation of receptacle **210**.

In some embodiments, delivery cup **200** comprises a sensor **230** to sense whether vending product **12** is within delivery cup **200** (i.e., sensor **230** can sense the presence or absence of vending product **12** within delivery cup **200**). In some embodiments, sensor **230** comprises an ultrasound sensor. In some embodiments, receptacle **210** comprises holes **214** to facilitate sensing of vending product **12** by sensor **230**. In some embodiments, receptacle **210** comprises two holes **214** on opposite sides so that sensor **230** can sense when vending product **12** is received from shelf **300** (i.e., before rotating 180 degrees) and can sense when vending product **12** is removed by the consumer in delivery area **400** (i.e., after rotating 180 degrees).

In some embodiments, movements of delivery cup **200** may be based on sensor **230** sensing vending product **12** (or the absence thereof). For example, delivery cup **200** may stay in delivery area **400** until it senses the absence of vending product **12** (indicating that the consumer has retrieved vending product **12**). As another example, delivery cup **200** may stay by shelf **300** until it senses vending product **12** (indicating that vending product **12** is ready to be transported to delivery area **400**). In some embodiments, different types of sensors may be used, in the same or in different locations, in place of sensor **230**. For example, a pressure sensor may be used to sense the presence of vending product **12** by the weight of receptacle **210** and anything therein.

In some embodiments, delivery cup **200** comprises features that facilitate the dispensing of vending product **12** from shelves **300**. For example, as discussed above, delivery cup **200** and shelf **300** may send signals to communicate that delivery cup **200** is properly positioned relative to shelf **300**. In some embodiments, delivery cup **200** may comprise an actuator. In some embodiments, the actuator may send a signal for shelf **300** to dispense vending product **12**. In some embodiments, the signal may be sent via RFID, NFC, or Bluetooth technologies. In some embodiments, the actuator may comprise a mechanical actuator. In some embodiments, the actuator comprises a solenoid **240** and a plunger **242**, as shown, for example, in FIG. **10**. In some embodiments, solenoid **240** activates plunger **242**. In some embodiments, when plunger **242** is activated, plunger **242** interacts with shelf **300**, as described more fully below, to allow shelf **300** to dispense one vending product **12** into delivery cup **200**. In some embodiments, solenoid **240** activates plunger **242** for a timed pulse.

In some embodiments, as shown, for example, in FIG. **11**, shelf **300** comprises a product storage area **305**, a product pusher **310**, and a gate **320**. While FIG. **11** only shows one shelf **300**, vending machine **10** may contain a plurality of shelves **300**. In some embodiments, shelves **300** are modular. In some embodiments, shelves **300** may be positioned in a grid (i.e., adjacent shelves **300** in a row and multiple rows of shelves **300** arranged vertically). In some embodiments, product storage area **305** is configured to receive a variety of vending products **12** having different shapes and sizes. In some embodiments, vending products **12** are loaded into product storage area **305** by pushing vending products against product pusher **310** and through gate **320**.

In some embodiments, product pusher **310** is configured to slide along shelf **300** via sliding members **312**, as shown, for example, in FIG. **12**. In some embodiments, as shown, for example, in FIG. **13**, sliding members **312** may slide along rails **302** of shelf **300**. As shown in FIG. **12**, product pusher **310** may be biased to a front portion of shelf **300**. When vending products **12** are inserted into product storage area **305**, product pusher **310** is pushed towards the back of shelf **300**. In some embodiments, product pusher **310** is spring-loaded, thus tending to push vending product **12** out of product storage area **305**. For example, product pusher **310** may be biased to a front portion of shelf **300** with spring **314** (see FIGS. **14-15**). In some embodiments, spring **314** comprises a constant force spring. When product pusher **310** is at the front of shelf **300**, spring **314** may be entirely rolled up. As vending products **12** are inserted into product storage area **305**, product pusher **310** is pushed back, thus unrolling spring **314**. Unrolled spring **314** exerts a force on product pusher **310**, which pushes on vending products **12**. In some

embodiments, shelf **300** is flat or horizontal, for example, shelf **300** may be parallel relative to the floor or to a base vending machine **10**. In some embodiments, shelf **300** is angled down toward delivery cup **200** (i.e., toward the front of vending machine **10**). Thus, gravity may also exert a force on vending products **12** to move them out of product storage area **305**.

In some embodiments, gate **320** operates to hold vending products **12** within product storage area **305**. In some embodiments, gate **320** comprises two side gates **320** (see FIGS. **11**, **14-16**). Gates **320** may be sized based on the smallest vending product **12** to be stored in vending machine **10**. Thus, gates **320** may hold any size vending product **12** within product storage area **305**. In some embodiments, two side gates **320** are disposed at a side of shelf **300**. For example, one side gate **320** may be disposed on each side of shelf **300**. In some embodiments, two side gates **320** extend only partially inward from each side of shelf **300**. In some embodiments, shelf **300** comprises a sensor, such as an optical sensor, to determine the size of vending product **12** within product storage area **305**.

In some embodiments, gates **320** are hinged. In some embodiments, gates **320** are spring-loaded into a closed position. For example, springs **325**, as shown, for example, in FIG. **13**, may be included with shelf **300** to keep gates **320** in a closed position. In some embodiments, gates **320** are mechanically linked to front plate **322**, bottom plate **324**, and side rods **326** (see FIGS. **13** and **16**). In some embodiments, front plate **322** is disposed at the bottom of the front side of shelf **300** facing delivery cup **200**. In some embodiments, front plate **322** is configured to be pushed into shelf **300**. In some embodiments, plunger **242** of delivery cup **200** is configured to push front plate **322** into shelf **300**. In some embodiments, as front plate **322** is pushed in, bottom plate **324** and side rods **326** are also pushed back. In some embodiments, side rods **326** slide within slots **329**. In some embodiments, a link **328** connects side rods **326** with gate **320**. Accordingly, as side rods **326** slide back within slot **329**, link **328** is pulled back, thus swinging gate **320** open.

In some embodiments, as soon as front plate **322** is released, front plate **322** returns to its original position due to the force exerted by springs **325**. In some embodiments, gates **320** stay open only long enough for one vending product **12** to be dispensed from shelf **300**. In some embodiments, the timed pulse of solenoid **240** is long enough to allow one vending product **12** to dispense from shelf **300**. In some embodiments, the length of time of the timed pulse is varied and may be based on the size of vending product **12**. In some embodiments, the length of time of the timed pulse is the same for each vending product **12**, regardless of size. In some embodiments, the timed pulse is less than one second (e.g., 0.2-0.5 seconds). In some embodiments, shelf **300** comprises an optical sensor configured to sense when gates **320** are entirely open. In some embodiments, the optical sensor is configured to send a signal to solenoid **240**. In some embodiments, the timed pulse begins when solenoid **240** receives a signal that gates **320** are entirely open. Similar timing or timed pulses may occur in embodiments where the actuator is not a solenoid and plunger configuration.

In some embodiments, after delivery cup **200** receives vending product **12** from shelf **300**, delivery cup **200** transports vending product **12** to delivery area **400**. In some embodiments, delivery area **400** comprises the area where consumers may retrieve vending product **12**. In some embodiments, as shown, for example, in FIG. **17**, delivery area **400** comprises outer door **410** and inner door **420**.

In some embodiments, outer door **410** comprises a door that isolates delivery area **400** from an exterior of vending machine **10** when outer door **410** is closed (i.e., in a closed configuration **450** (see FIG. **18**A)). In some embodiments, when outer door **410** is opened (i.e., in an open configuration **460** (see FIG. **18**B)), an opening **462** is formed, allowing consumers access to delivery area **400** so that vending product **12** can be retrieved. In some embodiments, outer door **410** moves from closed configuration **450** to open configuration **460** by mechanical interaction with delivery cup **420**. In some embodiments, outer door **410** slides open. In some embodiments, outer door **410** rotates open. In some embodiments, outer door **410** opens in direction **452**, as shown in FIG. **18**A. In some embodiments, outer door **410** comprises a bottom plate **412** and a top plate **414**. In some embodiments, bottom plate **412** and top plate **414** connect outer door **410** to delivery area **400** by a rotatable attachment. In some embodiments, the attachment is spring-loaded to bias outer door **410** to be in closed configuration **450**.

In some embodiments, as shown, for example, in FIG. **19**, bottom plate **412** includes a projection **440** that protrudes into delivery area **400**. In some embodiments, projection **440** protrudes through a slot **442**. In some embodiments, slot **442** is curved. In some embodiments, pushing surface **222** of delivery cup **200** is configured to push projection **440** along slot **442**. In some embodiments, as projection **440** moves along slot **442**, outer door **410** opens.

In some embodiments, as shown, for example, in FIG. **19**, rack **430** is disposed within delivery area **400** in a fixed manner. In some embodiments, pinion gear **226** of delivery cup **200** is configured to interact with rack **430** as delivery cup **200** enters delivery area **400**. The teeth of rack **430** may engage with the teeth of pinion gear **226**, thus rotating pinion gear **226** as delivery cup **200** continues to move into delivery area **400**. In some embodiments, the rotation of pinion gear **226** rotates receptacle **210**, thus presenting vending product **12** to the consumer. In some embodiments, the interaction between pinion gear **226** and rack **430** and the interaction between pushing surface **222** and projection **440** occur at about the same time. For example, these interactions may be simultaneous, or these interactions may at least partially overlap in timing. Thus, in some embodiments, as outer door **410** opens (allowing the consumer to view within delivery area **400**), receptacle **210** rotates. These combined motions may add to the effects or user experience of presenting vending product **12** to the consumer. For example, after outer door **410** is at least partially opened, the consumer may view receptacle **210** finish rotating to present vending product **12** to the consumer. In some embodiments, vending product **12** rotates with the rotation of receptacle **210**.

In some embodiments, inner door **420** isolates delivery area **400** from the storage space **20** of vending machine **10**. In some embodiments, inner door **420** comprises a hinged door. In some embodiments, inner door **420** opens into delivery area **400** in direction **454**, as shown in FIG. **18**A. In some embodiments, inner door **420** is pushed open by delivery cup **200**. In some embodiments, inner door **420** is locked. For example, inner door **420** may include a locking mechanism **422**, as shown, for example, in FIG. **19**. In some embodiments, locking mechanism **422** blocks inner door **420** from opening inward in direction **454**. In some embodiments, locking mechanism **422** may be pressed down to unlock inner door **420**. In some embodiments, projection **224** of delivery cup **200** is configured to interact with locking mechanism **422** as delivery cup **200** enters delivery area **400**. In some embodiments, projection **224** extends farther out than the rest of delivery cup **200** (i.e., closer to

delivery area **400**). Thus, projection **224** may unlock inner door **420** by pressing down locking mechanism **422** prior to delivery cup **200** pushing on inner door **420** to open inner door **420**. In some embodiments, inner door **420** may be unlocked via other mechanisms. For example, in some embodiments, inner door **420** may be configured to unlock itself when delivery cup **200** approaches. In some embodiments, delivery cup **200** may send a signal to inner door **420** when delivery cup approaches delivery area **400**, for example, using wireless communication technology such as RFID, Bluetooth, NFC, etc. Other interactions or mechanisms may also be used.

In some embodiments, inner door **420** cannot be opened from within delivery area **400**. In some embodiments, inner door **420** acts as an anti-vandal door to prevent theft. In some embodiments, inner door **420** includes a horizontal shelf **424** (see FIGS. **20**A and **20**B) to prevent a person from pressing down on locking mechanism **422** to unlock inner door **420**.

The interaction between delivery cup **200** and delivery area **400** to unlock and open inner door **420** and to rotate receptacle **210** so that vending product **12** is presented to a consumer is shown in FIGS. **20**A-**20**G. In some embodiments, delivery cup **200** moves in delivery cup enter direction **470** to enter delivery area **400** and moves in delivery cup exit direction **472** to exit delivery area **400**. In some embodiments, inner door **420** is locked in the closed position, as shown in FIG. **20**A. In some embodiments, horizontal shelf **424** may prevent a person from unlocking inner door **420**. In some embodiments, as delivery cup **200** approaches inner door **420**, delivery cup **200** unlocks inner door **420** (e.g., via projection **224**, wireless communication, or other mechanisms). In some embodiments, delivery cup **200** begins to push inner door **420** open, as shown in FIG. **20**B. In some embodiments, as delivery cup **200** enters delivery area **400**, as shown in FIG. **20**C, pinion gear **426** (not visible in FIG. **20**C) interacts with rack **430**. In some embodiments, as shown in FIGS. **20**D-**20**G, the interaction between pinion gear **426** and rack **430** as delivery cup **200** continues to enter delivery area **400** causes receptacle **210** to rotate in a delivery cup open rotation direction **480**. In some embodiments, the total possible rotation comprises 180 degrees. In some embodiments, delivery cup open rotation direction **480** allows open side **212** to rotate from facing towards shelves **300** (i.e., away from the consumer) to facing towards the consumer (see FIG. **20**G). In some embodiments, as delivery cup **200** withdraws from delivery area **400**, the interaction between pinion gear **426** and rack **430** causes delivery cup **200** to rotate in a delivery cup close rotation direction **482**.

Thus, vending machine **10** may be used to present vending products **12** to consumers in a sophisticated, yet simple, manner. In some embodiments, a consumer may pay for and select vending product **12** via user interface **18** (e.g., keypad, touch screen, and/or payment mechanism). In some embodiments, user interface **18** may include a keypad or touch screen, payment systems (bill, coin, card, etc.), a coin and/or bill return, a display screen, and other similar components. In some embodiments, the selection of vending product **12** at user interface **18** may be communicated to the controller that controls motors **114** and **124**. In some embodiments, based on the communication to the controller, motors **114** and **124** operate to rotate top horizontal lead screw **110**, bottom horizontal lead screw **105**, and vertical lead screw **120** so that delivery cup **200** moves in the X-direction and the Y-direction to arrive at the appropriate shelf **300** for the selected vending product **12**.

In some embodiments, delivery cup **200** moves to preset locations to receive vending products **12**. In some embodiments, vending machine **10** knows when delivery cup **200** is at the right location based on controls from the controller of motors **114** and **124**. In some embodiments, vending machine **10** knows when delivery cup **200** is in the right location based on communication between delivery cup **200** and shelf **300** (e.g., wireless communication technology such as RFID, Bluetooth, NFC, etc.).

In some embodiments, delivery cup **200** actuates gate **320** of shelf **300** to dispense one vending product **12** (e.g., via wireless communication technologies or via a mechanical actuator, such as solenoid **240** and plunger **242**). In some embodiments, gate **320** remains open based on a timed pulse that is long enough to allow one vending product **12** to dispense from shelf **300**.

In some embodiments, delivery cup **200** senses when vending product **12** is within delivery cup **200** (e.g., via sensor **230**, such as an ultrasound sensor, or via pressure sensor). In some embodiments, delivery cup **200** sends a communication to the controller of motors **114** and **124** that vending product **12** has been loaded onto delivery cup **200**. In some embodiments, after the selected vending product **12** is loaded into delivery cup **200**, the controller drives motors **114** and **124** to rotate top horizontal lead screw **110**, bottom horizontal lead screw **105**, and vertical lead screw **120** so that delivery cup **200** moves in the X-direction and the Y-direction to arrive at delivery area **400**. In some embodiments, delivery cup **200** interacts with delivery area **400** to unlock and open inner door **420**, open outer door **410**, and rotate receptacle **210** (e.g., with the mechanisms described above). In some embodiments, the combination of these interactions presents vending product **12** to the consumer and provides the consumer with access to retrieve the selected vending product **12**.

In some embodiments, vending product **12** is presented to the consumer in an upright manner. In some embodiments, vending product **12** is presented to the consumer without being dropped. In some embodiments, vending product **12** is presented to the consumer without the consumer needing to open outer door **410** or manually open or push any aspect of vending machine **10** other than user interface **18** (e.g., to select and pay for vending product **12**). In some embodiments, vending product **12** is presented to the consumer by rotating vending product **12**.

In some embodiments, delivery cup **200** senses when vending product **12** has been removed from delivery cup **200** (e.g., via sensor **230**, such as an ultrasound sensor, or via pressure sensor). In some embodiments, delivery cup **200** sends a signal to the controller of motors **114** and **124** that vending product **12** has been retrieved. In some embodiments, after vending product **12** has been retrieved, the controller drives motors **114** and **124** to rotate top horizontal lead screw **110**, bottom horizontal lead screw **105**, and vertical lead screw **120** so that delivery cup **200** moves in the X-direction and the Y-direction to return to a starting position. In some embodiments, as delivery cup **200** leaves delivery area **400**, outer door **410** is closed, receptacle **210** rotates back to its starting position, and inner door **420** is closed and locked.

In some embodiments, if a consumer does not retrieve vending product **12** after a pre-determined amount of time, the controller may drive motors **114** and **124** to rotate top horizontal lead screw **110**, bottom horizontal lead screw **105**, and vertical lead screw **120** so that delivery cup **200** moves in the X-direction and the Y-direction to return to its starting position. When this happens, vending machine **10** may

display (e.g. via user interface **18**) that vending product **12** has not been retrieved. The next consumer that approaches vending machine **10** (seeing this message) may use user interface **18** to cause vending machine **10** to dispense the loaded vending product **12** in the manner described above before another vending product **12** is selected.

In some embodiments, as shown, for example, in FIG. **21**, delivery area **400** comprises a retrieval sensor **490**, such as, for example, a hand presence sensor **490**. Hand presence sensor **490** may ensure that delivery cup **200** will not start moving while a consumer retrieval is in progress, for example, while a consumer's hand is in delivery area **400**. For example, if sensor **230** does not sense vending product **12** (i.e., senses that vending product **12** has been removed), delivery cup **200** may begin to return to a starting position, as described above. Similarly, after a pre-determined amount of time, even if vending product **12** is not retrieved, delivery cup **200** may begin to return to a starting position, as described above. However, if hand presence sensor **490** senses a consumer's hand in delivery area **400** in either of these situations, the return of delivery cup **200** to a starting position will be delayed until the consumer's hand is no longer sensed in delivery area **400**.

In some embodiments, hand presence sensor **490** comprises a laser emitter **492** and a receiver **494**. In some embodiments, laser emitter **492** and receiver **494** are disposed at a front portion of delivery area **400** so that a consumer's hand is sensed if the hand is within delivery area **400** at all. While FIG. **21** shows laser emitter **492** disposed above receiver **494**, in some embodiments, laser emitter **492** and receiver **494** may be in opposite positions (i.e., laser emitter **492** below receiver **494**). In some embodiments, hand presence sensor **490** comprises two opposing mirrors **496**, **498** on each side of delivery area **400**. In some embodiments, laser emitter **492** transmits a beam of light **495**, which is reflected back and forth between mirrors **496**, **498** until receiver **494** receives beam of light **495**. When a consumer's hand enters delivery area **400**, the hand will block beam of light **495** so that beam of light **495** does not reach receiver **494**, thus allowing hand presence sensor **490** to determine when a consumer's hand is within delivery area **400**. In some embodiments, laser emitter **492**, receiver **494**, and mirrors **496**, **498** are positioned and angled to ensure that a hand will be sensed at any point along the entrance to delivery area **400**.

In some embodiments, vending machine **10** comprises a front door **30**, as shown, for example, in FIG. **22**. In some embodiments, door **30**, when opened, provides access to storage space **20** and to the electrical system of vending machine. In some embodiments, door **30** may be opened to reload shelves **300** with vending products **12**, adjust shelves **300**, or for other maintenance or service of vending machine **10**. In some embodiments, door **30** comprises a hinged door. In some embodiments, door **30** comprises front panel **16**. In some embodiments, door **30** comprises plastic cover **19**. In some embodiments, plastic cover **19** accommodates user interface **18**. In some embodiments, door **30** is modular, thus allowing the same door **30** to be used for vending machines with different user interfaces **18** (e.g., keypad vs. touch screen).

In some embodiments, door **30** comprises a roller **32**, as shown, for example in FIGS. **23** and **24**. In some embodiments, roller **32** is disposed on an inside frame of door **30**. In some embodiments, roller **32** is disposed at a bottom portion of door **30**. In some embodiments, roller **32** may be fixedly attached to door **30**. In some embodiments, roller **32** rests on a bracket **34** disposed on a bottom portion of exterior body **14**, as shown in FIG. **24**, when door **30** is closed. In some embodiments, this configuration may help align door **30** to achieve an accurate closing position and proper seal each time door **30** is closed.

In some embodiments, vending machine **10** comprises a self-contained refrigeration unit **500**, as shown in FIG. **25**. In some embodiments, refrigeration unit **500** comprises a hot side **510** and a cold side **520**. In some embodiments, hot side **510** and cold side **520** are sealed to prevent mixing of hot and cold air. In some embodiments, refrigeration unit **500** comprises an insulated wall **515** to separate hot side **510** and cold side **520**.

In some embodiments, hot side **510** comprises a condenser **512**, a compressor **514**, and a fan **516**. In some embodiments, air comes into hot side **510** via air intake **502** and exits hot side **510** via air exhaust **504**. In some embodiments, cold side **520** comprises an evaporator **522** and a fan **524**. In some embodiments, cold air **506** flows out of cold side **520** into storage space **20** to cool vending products **12**. In some embodiments, warm air **508** returns from storage space **20** back into cold side **520**.

In some embodiments, vending machine **10** comprises cover panels **530** disposed above refrigeration unit **500**, as shown in FIG. **26**. In some embodiments, cover panels **530** attach to vending machine **10** to form ducts that carry cold air **506** into storage space **20** and that carry warm air **508** back from storage space **20** into refrigeration unit **500**.

In some embodiments, because refrigeration unit **500** is self-contained, refrigeration unit **500** can be easily removed and inserted for maintenance, service, or replacement. In some embodiments, refrigeration unit **500** operates to keep vending products **12** at an appropriate temperature.

It is to be appreciated that the Detailed Description section, and not the Summary and Abstract sections, is intended to be used to interpret the claims. The Summary and Abstract sections may set forth one or more but not all exemplary embodiments of the present invention(s) as contemplated by the inventor(s), and thus, are not intended to limit the present invention(s) and the appended claims in any way.

The present invention(s) have been described above with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed.

The foregoing description of the specific embodiments will so fully reveal the general nature of the invention(s) that others can, by applying knowledge within the skill of the art, readily modify and/or adapt for various applications such specific embodiments, without undue experimentation, without departing from the general concept of the present invention(s). Therefore, such adaptations and modifications are intended to be within the meaning and range of equivalents of the disclosed embodiments, based on the teaching and guidance presented herein. It is to be understood that the phraseology or terminology herein is for the purpose of description and not of limitation, such that the terminology or phraseology of the present specification is to be interpreted by the skilled artisan in light of the teachings and guidance.

The breadth and scope of the present invention(s) should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A vending machine comprising:
a shelf containing a vending product;
a delivery area comprising a rack, an outer door, and a projection mechanically linked to the outer door and protruding through a slot; and
a delivery cup configured to transport the vending product to the delivery area, the delivery cup comprising:
an actuator configured to send a signal to the shelf to dispense the vending product onto the delivery cup,
a sensor configured to sense a presence of the vending product within the delivery cup,
a pinion gear configured to interact with the rack as the delivery cup moves the vending product into the delivery area, and
a pushing surface configured to push the projection to mechanically open the outer door and provide access to the vending product within the delivery area from the exterior of the vending machine.

2. The vending machine of claim 1, wherein the delivery cup is configured to stay in the delivery area until it senses that the vending product is not present within the delivery cup.

3. The vending machine of claim 1, wherein the delivery cup further comprises:
a receptacle,
wherein the sensor senses the presence of the vending product within the delivery cup by the weight of the receptacle.

4. The vending machine of claim 1, wherein the delivery cup further comprises:
a receptacle,
wherein the pinion gear is coupled to the receptacle such that rotation of the pinion gear by interaction with the rack causes rotation of the receptacle.

5. The vending machine of claim 1, wherein the actuator comprises a mechanical actuator configured to open the shelf to dispense the vending product onto the delivery cup.

6. The vending machine of claim 5, wherein the mechanical actuator comprises a solenoid and a plunger, and wherein the solenoid is configured to activate the plunger and the plunger is configured to open the gate to dispense the vending product onto the delivery cup.

7. The vending machine of claim 1, wherein the delivery cup further comprises:
a platform,
wherein the platform comprises the pinion gear and the pushing surface.

8. The vending machine of claim 7, wherein the delivery cup further comprises:
a receptacle configured to move relative to the platform.

9. A vending machine comprising:
a shelf containing a vending product;
a delivery area; and
a delivery cup configured to transport the vending product to the delivery area, the delivery cup comprising:
a sensor configured to sense a presence or absence of the vending product is within the delivery cup, and
a receptacle comprising holes configured to facilitate sensing by the sensor of the vending product,
wherein the delivery cup is configured to stay in the delivery area until it senses the absence of the vending product.

10. The vending machine of claim 9, wherein the delivery cup is configured to stay by the shelf until it senses the vending product on the delivery cup.

11. The vending machine of claim 9, wherein the holes comprise a first hole on a first side of the receptacle and a second hole on a second side of the receptacle, the second side opposite the first side.

12. The vending machine of claim 9, wherein the sensor comprises an ultrasound sensor.

13. The vending machine of claim 9, wherein the sensor comprises a pressure sensor.

14. The vending machine of claim 9, wherein a receptacle comprising an open side configured to face the shelf.

15. A vending machine comprising:
a shelf containing a vending product, the shelf configured to hold the vending product on the shelf; and
a delivery cup configured to receive the vending product from the shelf and transport the vending product to a delivery area,
wherein the shelf is configured to send a signal to the delivery cup indicating that the delivery cup has arrived at a proper location, and
wherein the delivery cup comprises an actuator configured to actuate the shelf to dispense the vending product onto the delivery cup.

16. The vending machine of claim 15, wherein the signals between the shelf and the delivery cup utilize RFID, NFC, or Bluetooth technology.

17. The vending machine of claim 15, wherein
the actuator is a mechanical actuator.

18. The vending machine of claim 17, wherein the actuator is actuated for a timed pulse to send the signal to the shelf to dispense the vending product onto the delivery cup.

19. The vending machine of claim 15, wherein the shelf is configured to send a signal to the delivery cup when the shelf is open.

20. The vending machine of claim 19, wherein the delivery cup is configured to send the signal to the shelf to dispense the vending product onto the delivery cup after receiving the signal that the shelf is open.

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