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Hoffman

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(54) **SYSTEMS AND METHODS FOR PHARMACEUTICAL CONTAINER PROCESSING**

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(52) **U.S. Cl.**
CPC ***B65B 69/0033*** (2013.01)

(58) **Field of Classification Search**
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USPC 53/381.4, 492
See application file for complete search history.

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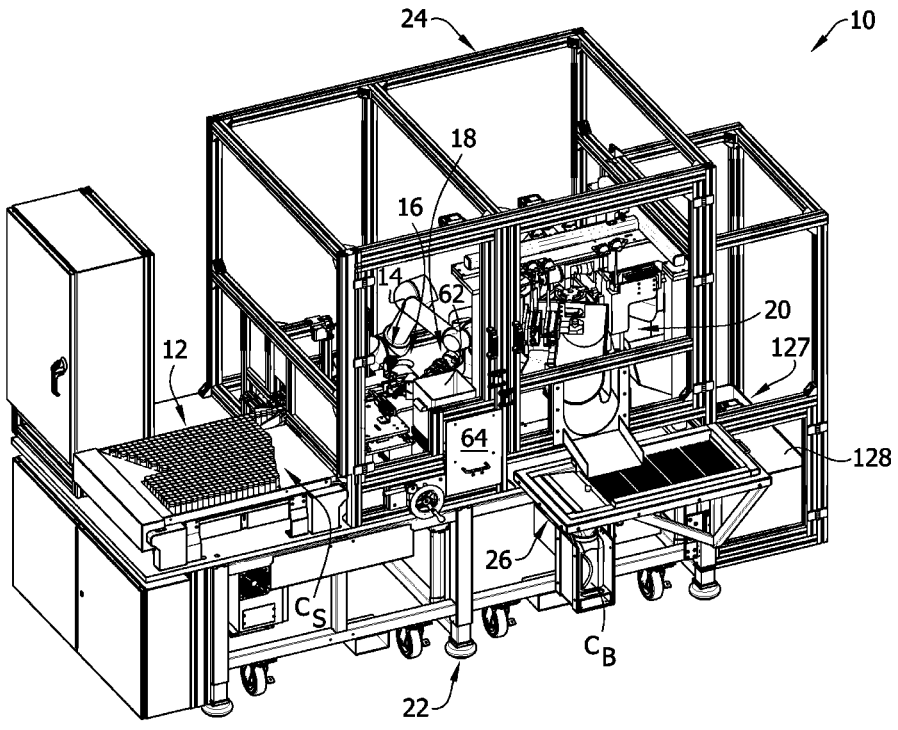
(57) **ABSTRACT**

A pharmaceutical extractor and associated components and methods for removing pharmaceuticals from a plurality of containers. The extractor includes a plurality of holders. Each holder is configured to hold at least one container of the plurality of containers. Each holder is repeatedly cycled through a series of container operation locations of the pharmaceutical extractor. In the series of container operation locations, the holders receive containers, the containers are cut to form pharmaceutical outlets in the containers, pharmaceuticals are moved out of the pharmaceutical outlets, and empty containers are dropped by the holders.

22 Claims, 10 Drawing Sheets



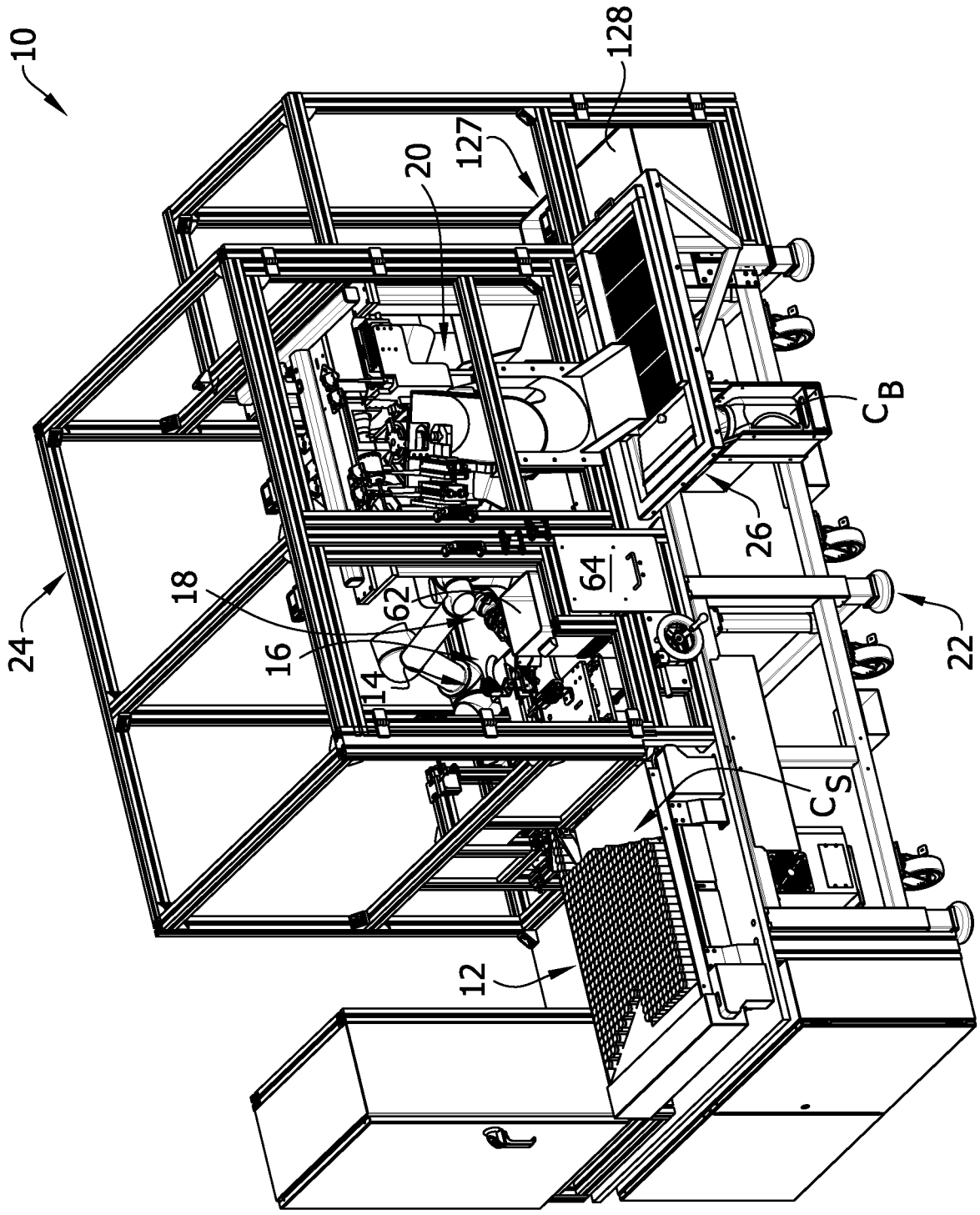
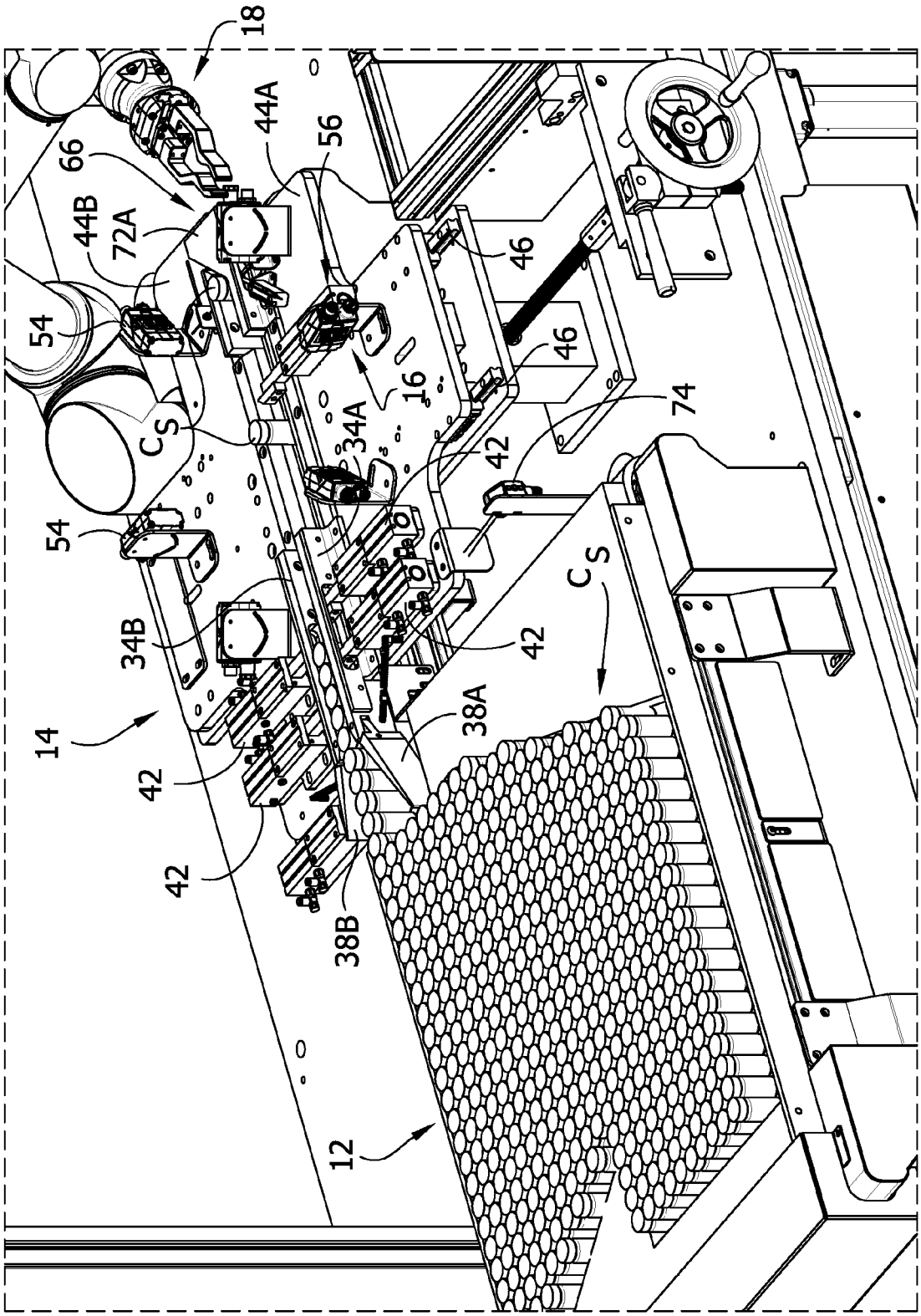


FIG. 1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44A
56
66
44B
72A
46
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46
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74
34A
42
54
34B
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38A
14
42
42
38B
12

FIG. 2

FIG. 3

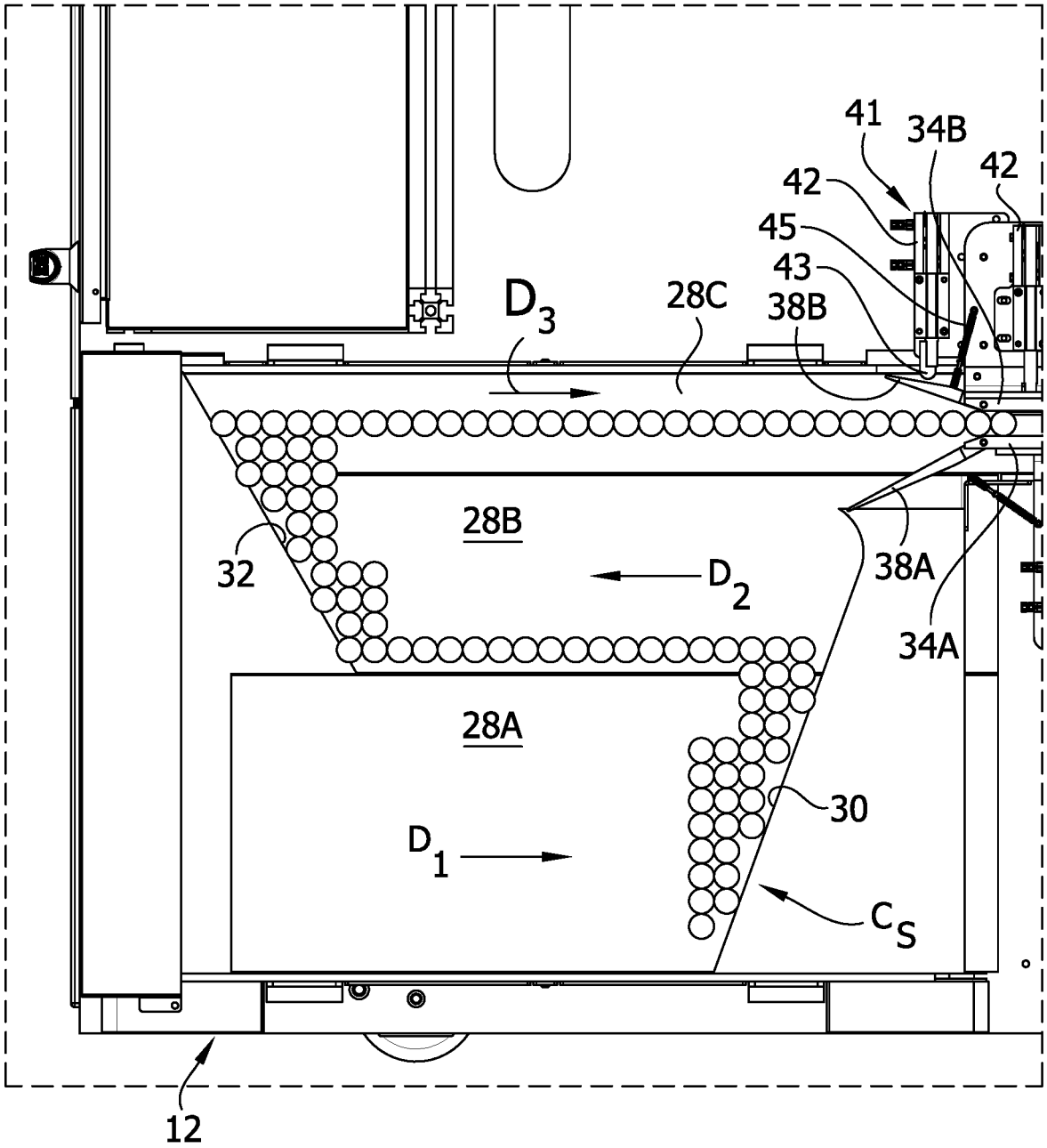
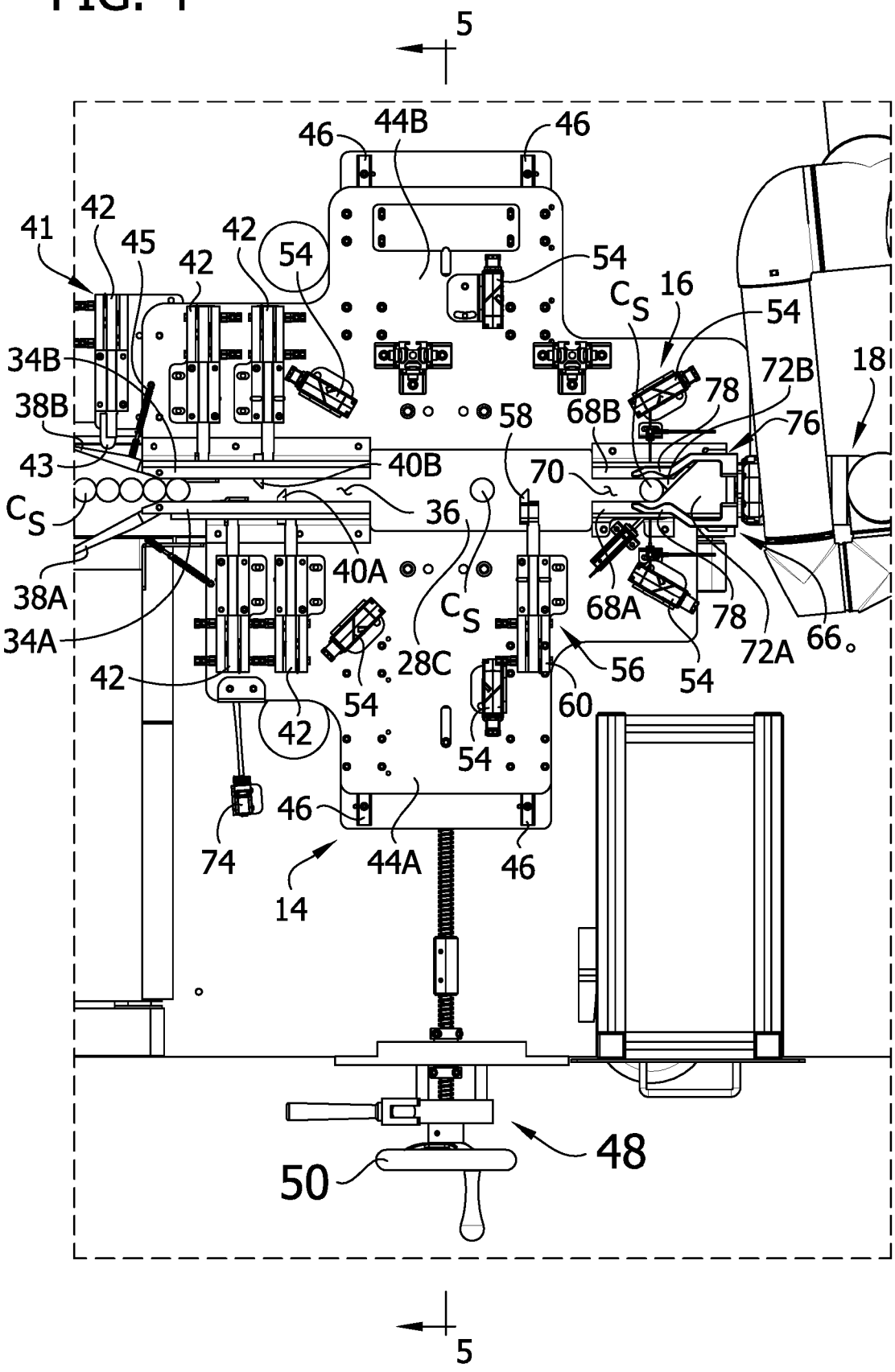


FIG. 4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68B
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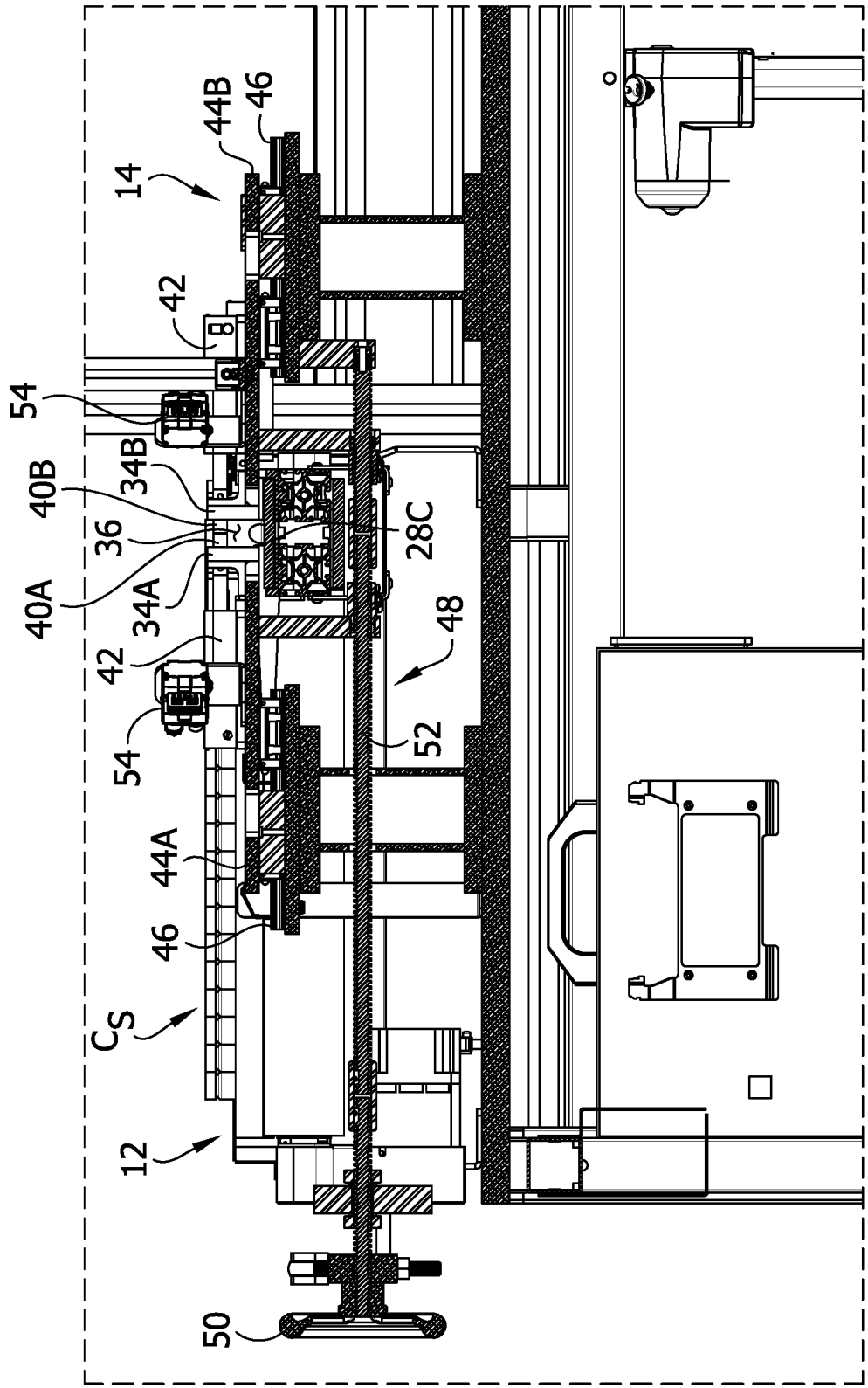
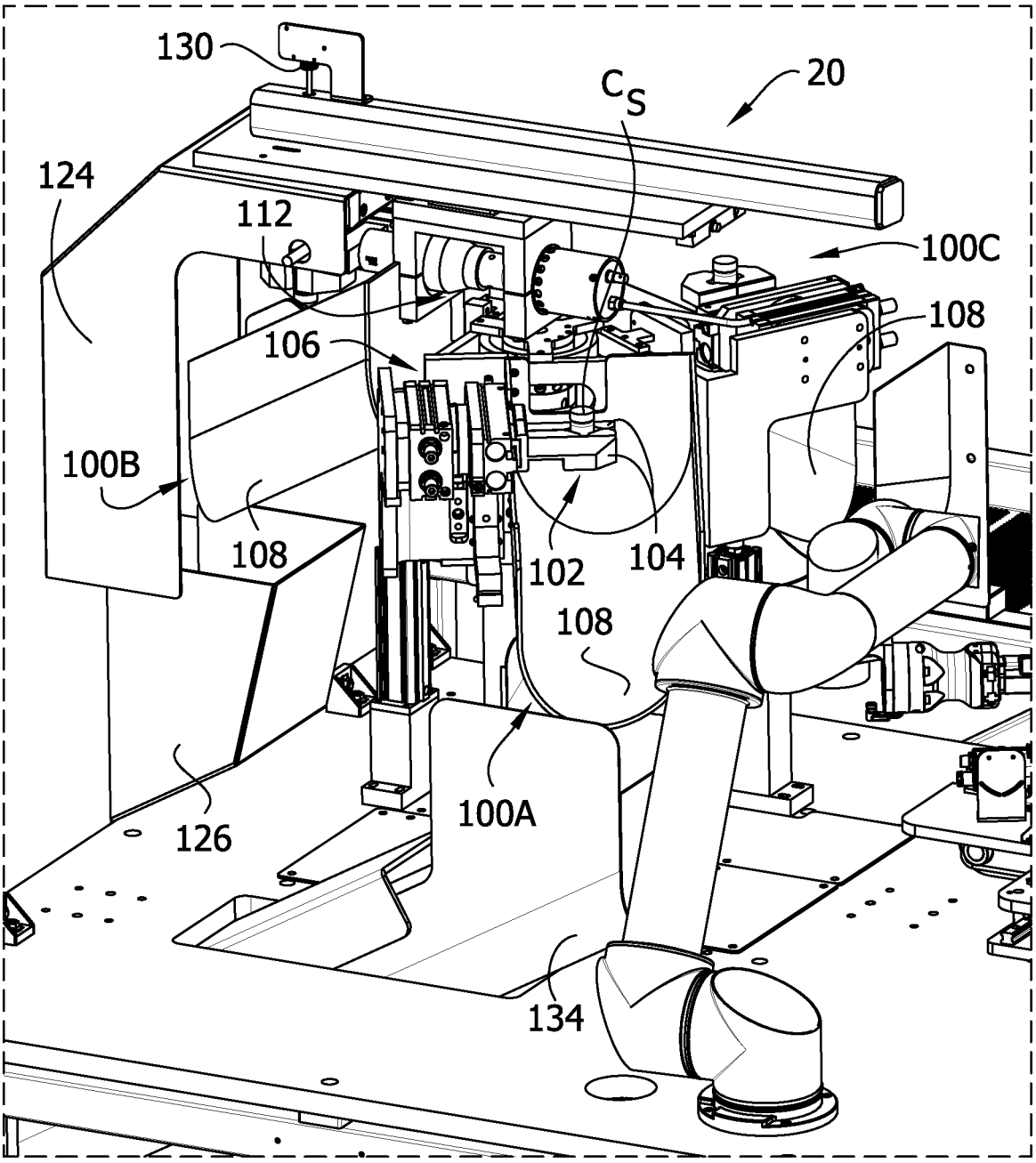
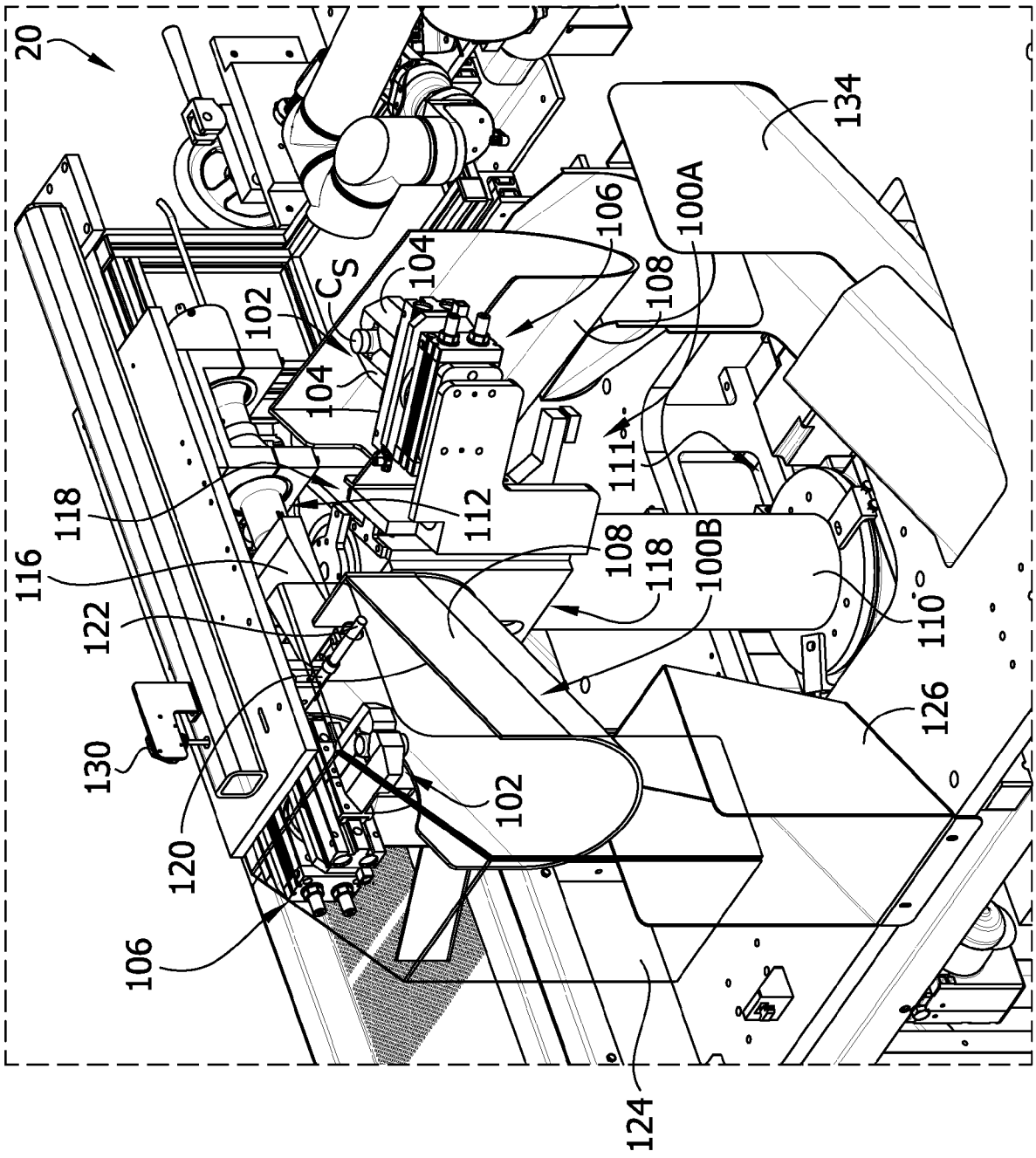


FIG. 5

FIG. 6




20
134
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104
C_S
102
108
104
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108
118
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110
122
126
130
102
120
106
124

FIG. 7

FIG. 8

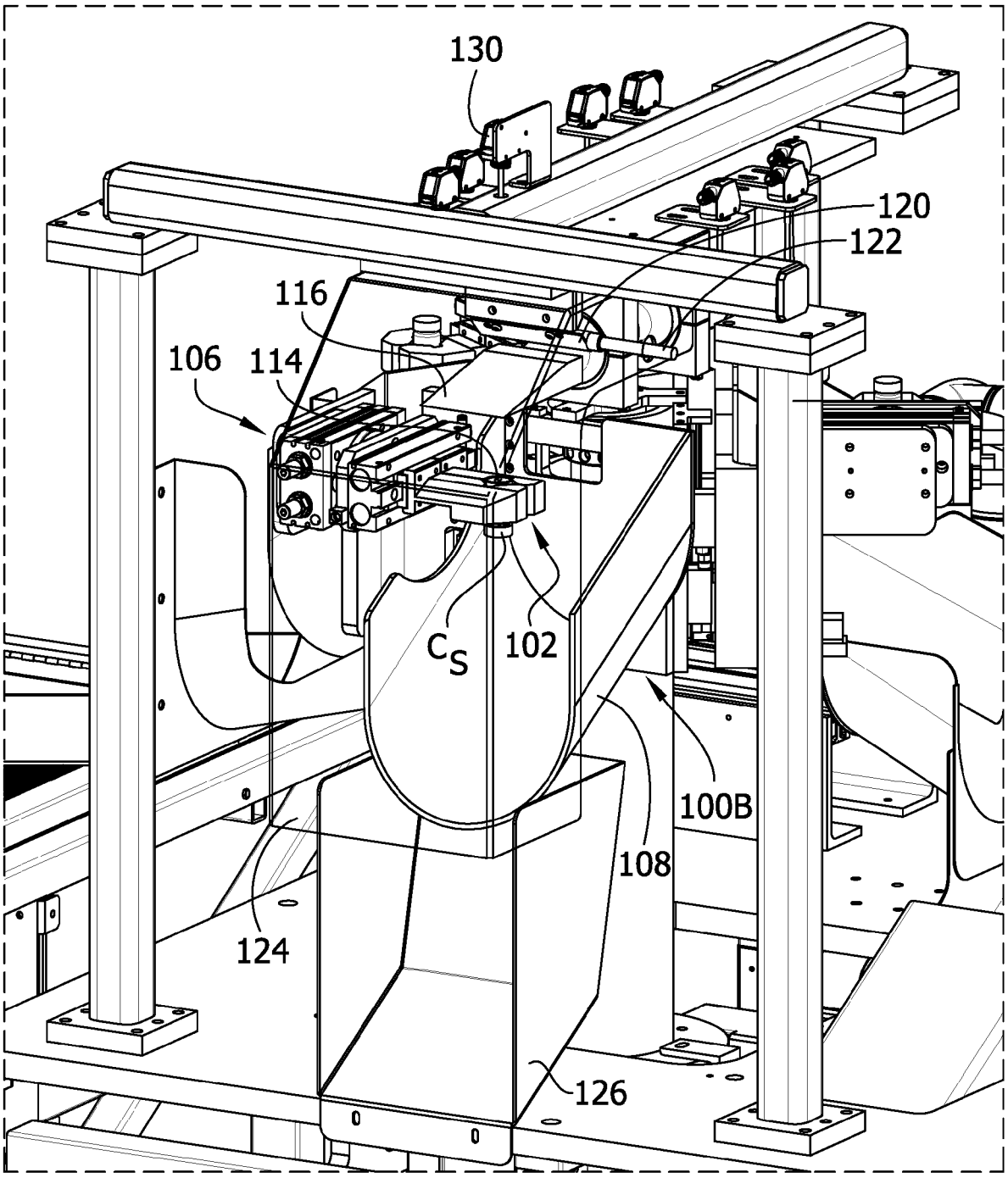
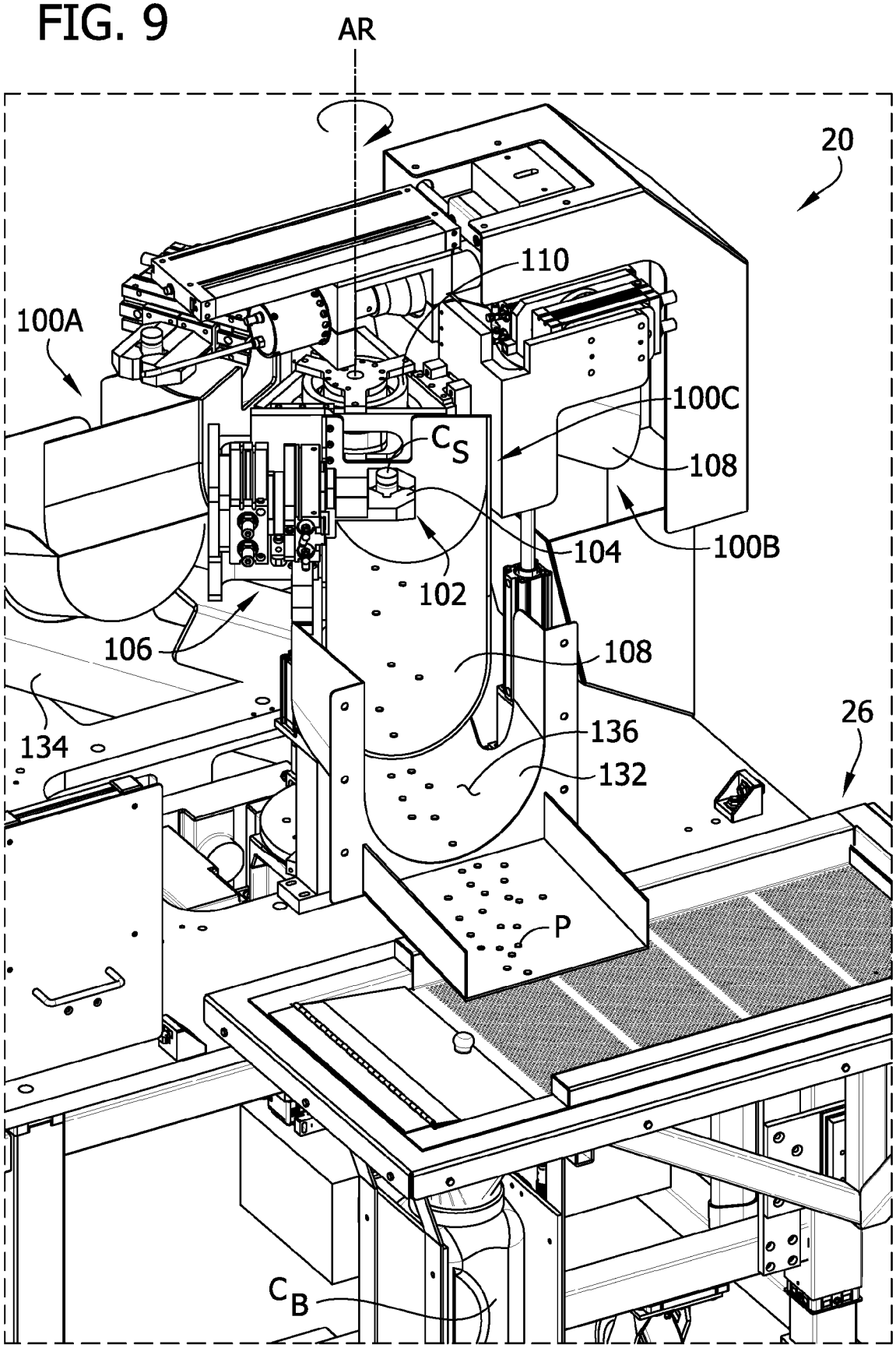


FIG. 9


AR
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100B
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134
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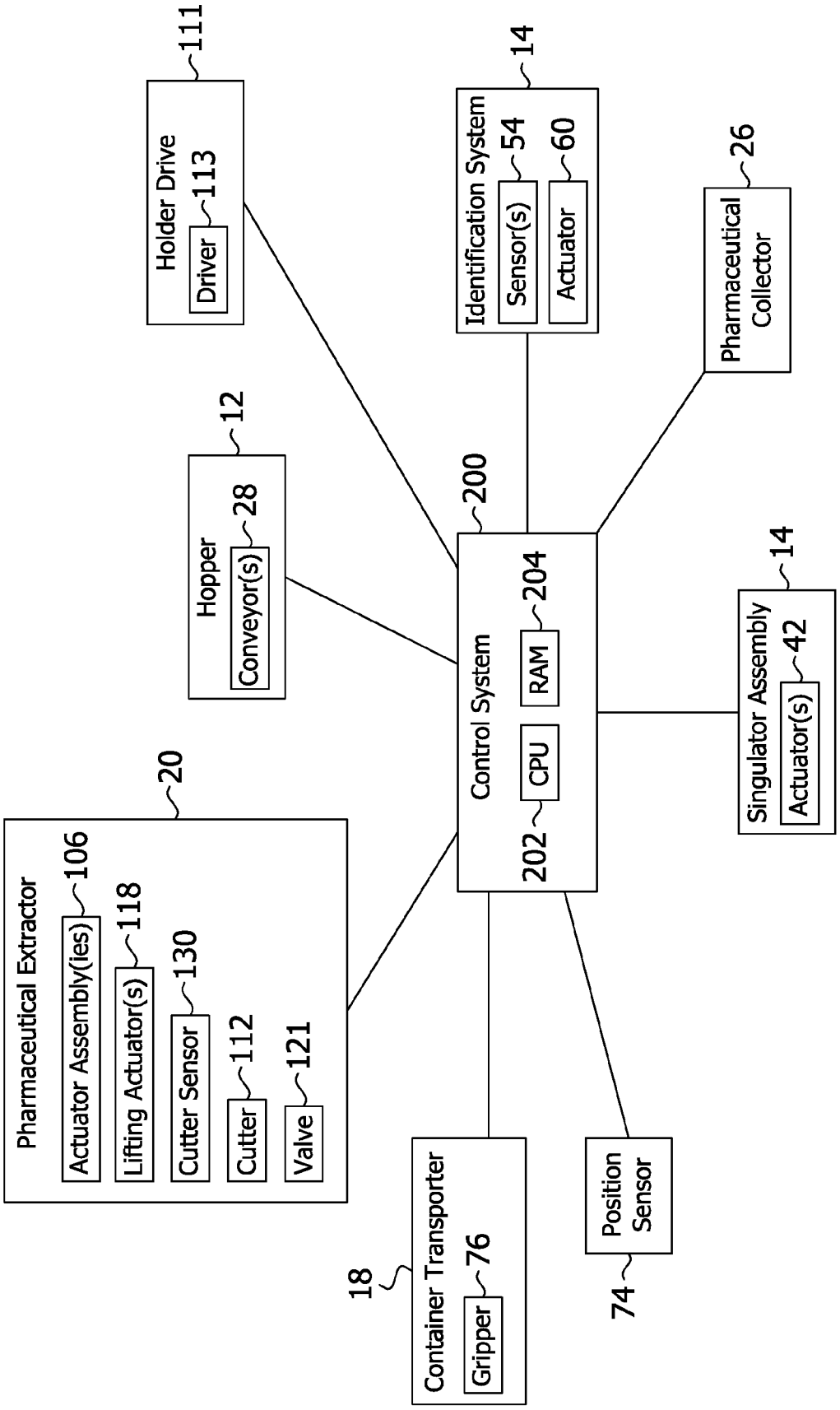
P
C_B

FIG. 10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Driver
113
Identification System
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Sensor(s)
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Actuator
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Pharmaceutical Collector
26
Hopper
12
Conveyor(s)
28
200
Control System
RAM
204
CPU
202
Singulator Assembly
14
Actuator(s)
42
Pharmaceutical Extractor
20
Actuator Assembly(ies)
106
Lifting Actuator(s)
118
Cutter Sensor
130
Cutter
112
Valve
121
Container Transporter
18
Gripper
76
Position Sensor
74

SYSTEMS AND METHODS FOR PHARMACEUTICAL CONTAINER PROCESSING

FIELD

The present disclosure generally relates to pharmacy order processing systems, and more particularly to pharmaceutical container processing systems for removing pharmaceuticals from containers and related methods.

BACKGROUND

Pharmaceutical order processing systems typically involve labor intensive processes to remove pharmaceuticals from manufacturer packaging and transfer the pharmaceuticals to a bulk storage container. Once in the bulk storage container, the pharmaceuticals can be used to fill pharmacy orders.

BRIEF SUMMARY

In one aspect, a pharmaceutical extractor for removing pharmaceuticals from a plurality of containers comprises a plurality of holders and a plurality of container operation locations. Each holder includes a gripper configured to hold at least one container of the plurality of containers. The plurality of container operation locations are arranged in a series of container operation locations along which the pharmaceutical extractor is configured to perform a series of container operations. A cutter is located along the series of container operation locations. The cutter is configured to cut containers held by the grippers to create pharmaceutical outlets in the containers. A pharmaceutical collection inlet is located along the series of container operation locations. The pharmaceutical collection inlet is configured to receive pharmaceuticals from the pharmaceutical outlets in the containers. The pharmaceutical extractor is configured to move the plurality of holders, one holder after another holder, along the series of container operation locations to extract the pharmaceuticals from the containers.

In another aspect, a pharmaceutical container processing system for removing pharmaceuticals from a plurality of containers comprises a hopper configured to hold the plurality of containers and to dispense the plurality of containers. A singulator assembly is configured to singulate the plurality of containers as the containers are dispensed from the hopper. A pharmaceutical extractor is configured to remove the pharmaceuticals from the plurality of containers. The pharmaceutical extractor includes a holder configured to hold at least one container of the plurality of containers and a cutter configured to cut said at least one container held by the holder to create a pharmaceutical outlet in said container. The holder is configured to move between a first location where the holder receives said container, a second location where the cutter cuts the pharmaceutical outlet in said container and third location where the pharmaceuticals in said container move through the pharmaceutical outlet and out of said container. A pharmaceutical collector is configured to receive the pharmaceuticals from the containers disposed at the third location.

In another aspect, a method of removing pharmaceuticals from a plurality of containers comprises receiving a first container of the plurality of containers in a first holder of a pharmaceutical extractor at a first location, moving said first container and first holder to a second location, forming a pharmaceutical outlet in said first container while said first container is held by the first holder at the second location, moving said first container and first holder to a third location and moving pharmaceuticals out of said first container through the pharmaceutical outlet while said first container is held by the first holder at the third location.

Other objects and features of the present disclosure will be in part apparent and in part pointed out herein.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective of a pharmaceutical container processing system embodying aspects of the present disclosure;

FIG. **2** is an enlarged, fragmentary perspective of a hopper and singulator assembly of the pharmaceutical container processing system of FIG. **1**;

FIG. **3** is an enlarged, fragmentary top view of the hopper of FIG. **2**;

FIG. **4**, is an enlarged, fragmentary top view of the singulator assembly of FIG. **2**;

FIG. **5** is a section of the pharmaceutical container processing system taken in a plane including line 5--5 of FIG. **4**;

FIG. **6** is an enlarged, fragmentary perspective of a first container operation location of a pharmaceutical extractor of the pharmaceutical container processing system of FIG. **1**;

FIG. **7** is an enlarged, fragmentary perspective of a second container operation location of the pharmaceutical extractor of FIG. **5**, with a shroud of the pharmaceutical container processing system shown as being transparent to show components behind the shroud;

FIG. **8** is a view similar to FIG. **6** but shows a container after the a pharmaceutical opening has been cut therein;

FIG. **9** is an enlarged, fragmentary perspective of a third container operation location of the pharmaceutical extractor of FIG. **5**; and

FIG. **10** is a diagram of an exemplary control system of the pharmaceutical container processing system.

Corresponding reference characters indicate corresponding parts throughout the drawings.

DETAILED DESCRIPTION

Referring to the drawings, FIG. **1** illustrates a pharmaceutical container processing system embodying aspects of the present disclosure, indicated generally by reference numeral **10**. The pharmaceutical container processing system (e.g., a container disassembly workstation) **10** is used in a pharmaceutical order processing system, such as a high volume pharmaceutical order processing system, to facilitate the fulfillment of a prescription order received by the pharmaceutical order processing system. The prescription order may include one or more pharmaceuticals (e.g., prescription drugs). Pharmaceutical order processing systems typically involve processes to remove pharmaceuticals P (FIG. **9**) from the manufacturer's packaging, transfer the pharmaceuticals to bulk storage containers, retrieve the pharmaceuticals from the bulk storage containers and fill and package the various pharmacy orders. The pharmaceutical container processing system **10** disclosed herein is used in a pharmaceutical order processing system to remove the pharmaceuticals P from the manufacturer's packaging and transfer the pharmaceuticals to bulk storage containers. After the pharmaceuticals P are transferred to the bulk storage containers, the bulk storage containers are transported to other components of the pharmaceutical order processing system where the pharmaceuticals can be used to fill pharmacy orders. Further details on pharmaceutical order processing systems and components thereof may be found in U.S. Pat. Application No. 15/996,909 and U.S. Pat. Application No. 16/226,944, the entireties of which are hereby incorporated by

reference. However, it will be appreciated that the systems and components disclosed herein can be used in other contexts without departing from the scope of the present disclosure.

The pharmaceutical container processing system **10** is configured to "bulk-up" pharmaceuticals P for filling orders in the pharmaceutical order processing system. Generally speaking, "bulking-up" includes transferring the pharmaceuticals P contained by a plurality of containers (which may be the same or different sizes) into a single bulk container to be used with subsequent components of the pharmaceutical order processing system. Specifically, the pharmaceutical container processing system **10** transfers the pharmaceuticals P contained within relatively small volume containers C_S into relatively large volume bulk containers C_B. The bulk container C_B can be ten or more times larger than the small volume container, e.g., about a liter in size. In other words, the pharmaceutical container processing system **10** removes the pharmaceuticals P from the small containers C_S in order to move the pharmaceuticals into the bulk container C_B.

The pharmaceutical container processing system **10** includes a hopper, generally indicated by reference numeral **12**, a singulator assembly, generally indicated by reference numeral **14**, an identification system, generally indicated by reference numeral **16**, a container transporter, generally indicated by reference numeral **18**, and a pharmaceutical extractor, generally indicated by reference numeral **20**. The pharmaceutical container processing system **10** includes a frame **22** supporting the various components of the system. An enclosure or cover assembly **24** is attached to the frame **22** and covers at least the singulator assembly **14**, the identification system **16**, the container transporter **18** and the pharmaceutical extractor **18** to protect operators from being exposed to the pharmaceuticals P as the pharmaceuticals are transferred from the small containers C_S to the bulk container C_B. In various drawings herein, the cover assembly **24** is removed to more clearly show other components. Desirably, the cover assembly **24** is transparent to permit the operator to view the operation of the pharmaceutical container processing system **10**. Other configurations of the pharmaceutical container processing system **10** are within the scope of the present disclosure. Moreover, the pharmaceutical container processing system **10** may not include all of the above listed components or additional components. For example, in the illustrated embodiment, the pharmaceutical container processing system **10** also includes a pharmaceutical collector, generally indicated by reference numeral **26**, for loading the pharmaceuticals P into the bulk container C_B, as will be explained in more detail below.

Referring to FIGS. **1-4**, the hopper **12** is configured to hold many (e.g., a plurality of) containers, such as the small containers C_S, and to dispense the containers from the hopper. For example, the hopper **12** may be configured to hold hundreds of small containers C_S. Operators place the containers C_S in or on the hopper **12**, where the containers are held and stored until the containers are moved (e.g., dispensed) to other components of the pharmaceutical container processing system **10**. In the illustrated embodiment, the hopper **12** holds small containers C_S, although it is understood the hopper may hold containers of generally any size. In the illustrated embodiment, the hopper **12** includes three (broadly, at least two) conveyors, **28**A, **28**B and **28**C, respectively, that move the containers C_S. The conveyors **28**A-C are disposed side-by-side and receive the containers C_S thereon. The conveyors **28**A, **28**C move in a generally opposite direction relative to conveyor **28**B. As shown in FIG. **3**, conveyors **28**A and **28**C move in first and third directions D_1, D_3, respectively, and conveyor **28**B moves in a second direction D_2 generally opposite the first and third direction. The first and third directions D_1, D_3 are generally parallel to one another. Accordingly, in the illustrated embodiment, the hopper **12** is a bi-directional conveyor. The conveyors **28**A-C are each driven by a prime mover, such as an electric motor (not shown), controlled by a control system **200** (FIG. **10**) of the pharmaceutical container processing system **10**. When needed, each prime mover can reverse the direction of each conveyor **28**A-C to re-organize the containers to remove or reduce the possibility of a blockage that prevents the containers C_S from moving on the first conveyor to the singulator assembly **14**.

The hopper **12** is configured to move the containers C_S placed thereon to the third conveyor **28**C. The third conveyor **28**C then moves the containers C_S to the other components of the pharmaceutical container processing system **10**, as described below. The hopper **12** includes a first angled ramp **30** overlying the first conveyor **28**A. The first ramp **30** is angled in the sense that the first ramp extends at a non-orthogonal and non-parallel angle relative to the first direction D_1. As the first conveyor **28**A moves in the first direction D_1, the containers C_S are moved into contact with the first ramp **30** and move along the first ramp, as the first conveyor continues to move, onto the second conveyor **28**B. The hopper **12** also includes a second angled ramp **32** overlying the second conveyor **28**B. The second ramp **32** is angled in the sense that the second ramp extends at a non-orthogonal and non-parallel angle relative to the second direction D_2. As the second conveyor **28**B moves in the second direction D_2, the containers C_S are moved into contact with the second ramp **32** and move along the second ramp, as the second conveyor continues to move, onto the third conveyor **28**C. In this manner, the hopper **12** generally moves the containers C_S in a direction generally perpendicular to the third direction D_3 and onto the third conveyor **28**C. Preferably, the conveyors **28**A-C and ramps **30**, **32** are configured such that the containers C_S move onto the third conveyor at generally one end thereof.

Referring to FIGS. **1-5**, the third conveyor **28**C of the hopper **12** moves the containers C_S to the singulator assembly **14**. In particular, the third conveyor **28**C extends generally along the singulator assembly **14** and moves the containers C_S along and through the singulator assembly. The singulator assembly **14** is configured to singulate the containers C_S (e.g., separate or individualize each container from the other containers) as the containers are dispensed from the hopper **12**. The singulator assembly **14** includes first and second rails **34**A, **34**B, respectively, defining a channel **36** through which the containers C_S move as the containers are moved by the third conveyor **28**C. First and second ramps or guides **38**A, **38**B extend from the proximal end of each respective rail **34**A, **34**B to guide the containers C_S into the channel **36**. The containers C_S extend in a single file line between the rails **34**A, **34**B.

The singulator assembly **14** includes at least one crowder or stop **40**A, **40**B to singulate the containers C_S. Each stop **40**A, **40**B is configured to contact or engage one container C_S as the containers are moved by the third conveyor **28**C to inhibit the containers from moving with the third conveyor. Each stop **40**A, **40**B extends into the channel **36** to contact a lead container C_S to inhibit the lead container, and any containers behind it, from moving with the third conveyor belt **28**C. Each stop **40**A, **40**B is selectively retractable to singulate the lead container C_S from the other containers by per-

mitting the lead container to move with the third conveyor **28**C. Each stop **40**A, **40**B is operatively coupled to an actuator **42** (e.g., linear actuator) which can move the stop between an extended position and a retracted position. In the extended position, each stop **40**A, **40**B extends into (e.g., blocks) the channel **36** and inhibits containers C_S from moving through the channel. In the illustrated embodiment, the stops **40**A, **40**B extend through openings in the rails **34**A, **34**B. In the retracted position, each stop **40**A, **40**B does not obstruct the channel **36** and the containers C_S are free to move through the channel. Preferably, there are at least two stops, spaced longitudinally along the channel **36** such that the first stop **40**A engages the lead container C_S and the second stop **40**B engages the container immediately behind the lead container so that when the first stop is retracted and permits the lead container to move with the third conveyor **28**C, the second stop inhibits the other containers from moving with the third conveyor. In this configuration, once the lead container C_S moves on, the first stop **40**A returns to the extended position and the second stop **40**B retracts to permit the line of containers to move up to the first stop. Once the new lead container C_S engages the first stop **40**A and inhibits the containers from moving any further, the second stop **40**B is moved back into the extended position and the cycle repeats. In the illustrated embodiment, the singulator assembly **14** includes four stops with two stops **40**A, **40**B shown in the extended position and two stops shown in the retracted position and hidden from view. The additional stops enable the singulator assembly **14** to use any two stops to singulate containers of other sizes. In one embodiment, the singulator assembly **14** also includes a dislodging assembly **41** operatively coupled to at least one of the ramps **38**A, **38**B to move the ramps (e.g., the ramps are movable or pivotable) to break-up the containers C_S in the event they become lodged while moving into the channel **36** and transitioning into a single file line. In the illustrated embodiment, the dislodging assembly **41** includes an actuator **42** operatively coupled to a bumper **43**. The actuator **42** is configured to selectively move the bumper in and out to push and move (e.g., rotate) the ramp **38**B to dislodge the containers C_S. A spring **45** biases the ramp **38**B in the position shown in FIGS. **3** and **4** such that the ramp returns to this original position when the bumper **43** does not engage and push the ramp. Other configurations of the singulator assembly **14** are within the scope of the present disclosure.

The singulator assembly **14** is selectively adjustable to enable the singulator assembly to singulate different sizes of containers. The singulator assembly **14** includes first and second movable platforms **44**A and **44**B, respectively. The first rail **34**A, first stop **40**A and corresponding actuator **42** are mounted on the first movable platform **44**A and the second rail **34**B, second stop **40**A and corresponding actuator are mounted on the second movable platform **44**B. The first and second movable platforms **44**A, **44**B (broadly, the first and second rails **34**A, **34**B) move toward or away from one another (e.g., in a direction generally perpendicular the third direction D_3) to change the distance between the rails **34**A, **34**B, and thereby the width of the channel **36**, to configure the singulator assembly **14** for different sizes of containers. Each movable platform **44**A, **44**B is movably mounted on rails or tracks **46**. The singulator assembly **14** includes a drive or adjustment assembly **48** operatively coupled to the first and second movable platforms **44**A, **44**B (broadly, the first and second rails **34**A, **34**B) to move the platforms toward or away from one another. The adjustment assembly **48** includes a handle **50** coupled to and configured to rotate a threaded shaft **52**. The first and second movable platforms **44**A, **44**B are threadably connected to the threaded shaft **52**. As the handle **50** turns the threaded shaft **52**, the threaded shaft rotates and moves the first and second movable platforms **44**A, **44**B along the tacks **46**. The threaded shaft **52** includes oppositely oriented first and second threads along its length. The first threads engage the first movable platform **44**A and the second threads engage the second platform **44**B so that the platforms move either toward or away from one another as the threaded shaft **52** rotates (either clockwise or counter-clockwise). In an example embodiment, the singulator assembly **14** (specifically, the movable platforms **44**A, **44**B) can be automatically adjusted based on the size, e.g., diameter or maximum horizontal dimension, of the containers C_S. The size of the containers C_S can be entered into the control system **200** or sensed by pressure sensors (not shown) connected the control system and mounted on the first and second movable platforms **44**A, **44**B. The size of the containers C_S can be sensed using non-contact sensor, e.g., light, LED, or the like sensors. The control system **200** can activate a prime mover, such as an electric motor (not shown), operatively coupled to the threaded shaft **52** to move the first and second movable platforms **44**A, **44**B to adjust the width the channel **36**.

Still referring to FIGS. **2-5**, the identification system **16** of the pharmaceutical container processing system **10** is configured to identify the containers C_S. In particular, the identification system **16** is configured to identify the containers C_S after the containers have been singulated by the singulator assembly **14**. The identification system **16** includes at least one sensor **54** that reads or scans a machine readable marking (e.g., a barcode, QR code, etc.) on each container C_S. Each sensor **54** may be a camera, a light scanner or a laser scanner, such as a bar code reader. In one embodiment, each sensor **54** is a Cognex® Camera, although other suitable sensors or scanners (broadly, vision systems) are within the scope of the present disclosure. Each sensor **54** is in communication with (e.g., wired or wireless communication) with a processor (not shown). The processor may be part of the identification system **16** or some other component, such as the control system **200** (FIG. **10**). The processor compares the identity of the container C_S, as read by the sensor **54**, with a current work order to verify the container and the pharmaceuticals P contained therein are supposed to be included in the current work order. For example, in one embodiment, each container C_S may be pre-scanned before being placed in the hopper **12** and then identified and validated by the identification system **16** by comparing the identity read by the sensor **54** with the pre-scan. If the container C_S is verified by the identification system **16**, the container transporter **18** will move the verified container to the pharmaceutical extractor **20**, as described in more detail below. If the container C_S is not verified or unable to be read by the sensor **54**, the container transporter **18** will move the unverified container to a reject bin **62** (FIG. **1**) which is accessible to the operator through a door **64** in the cover assembly **24**.

In the illustrated embodiment, the identification system **16** includes six sensors **54**. The sensors **54** are arranged (e.g., in a circular configuration) to surround a sensing location on the third conveyor belt **28**C. As a container C_S leaves the singulator assembly **14**, the container moves through the sensing location past the sensors **54**. The machine readable marking on each container C_S may be in a horizontal or vertical orientation on the container and can be at generally any location on the surface of the container. Having six sensors **54** that each scan different sides of the container C_S ensures

that at least one sensor will be able to see and read the machine readable marking on the container. Other arraignments and/or configurations of the sensors **54** are within the scope of the present disclosure. For example, one or more additional sensors **54** may be added at any position along the conveyor **28**C (e.g., either upstream or downstream). The identification system **16**, optionally, may also include an orientation adjuster **56** to adjust the orientation of the container C_S on the third conveyor **28**C if the sensors **54** are unable to clearly see the machine readable marking. The orientation adjuster **56** includes a stop **58** and an actuator **60**, similar to stops **40** and actuators **42**. If the imagers **54** are unable to get a clear image of the machine readable marking, the orientation adjuster **56** activates and the actuator **60** pushes the stop **58** into the path of the container C_S. The container C_S hits the stop **60** and, due to the continued movement of the third conveyor **28**C, jostles or rotates on the conveyor to change the orientation of the container until one of the sensors **54** gets a clear image of the machine readable marking. After a clear image is obtained, or a set period of time passes (e.g., the imagers are unable to read the machine readable marking), the stop **60** retracts to permit the container C_S to continue moving with the third conveyor **28**C. Other configurations of the orientation adjuster **56** are within the scope of the present disclosure. For example, the orientation adjuster may rotate the container C_S while container is being scanned.

Still referring to FIGS. **2-4**, a stop assembly **66**, which may broadly be considered part of the singulator assembly **14**, is disposed at the end of the third conveyor **28**C. The stop assembly **66** receives the containers C_S, after they have been singulated and verified, and holds the containers in position (e.g., at a pickup location) to be picked up by the container transporter **18**. The stop assembly **66** includes first and second rails **68**A and **68**B, respectively, defining a channel **70** there between that receives the container C_S. The end of the channel **70** is closed to prevent the container C_S from continuing to move with the third conveyor **28**C. The end of the channel **70** tapers and is generally V-shaped and is defined by first and second angled plates **72**A, **72**B that overlap one another. Each plate **72**A, **72**B defines one side of the V-shaped end of the channel **70**. The first rail **68**A and first plate **72**A are mounted on the first platform **44**A and the second rail **68**B and second plate **72**B are mounted on the second platform **44**B. Accordingly, the rails **68**A, **68**B and plates **72**A, **72**B move away or toward one another as the platforms **44**A, **44**B are moved toward or way from one another to adjust the singulator assembly **14** to fit containers of various sizes. This also allows the stop assembly **60** to be adjusted to fit containers of various sizes. The end of the channel **70** is V-shaped in order to orient square shapes containers (not shown) so that the container is cut on a leading edge or corner, as will become apparent after the cutting of the container is explained below.

When moved to adjust the stop assembly **66** to containers of other sizes, the angled plates **72**A, **72**B move relative to one another and change the size of the V-shaped end of the channel **70**. Accordingly, the exact pickup location where the container C_S is stopped by the angled plates **72**A, **72**B and is picked up by the container transporter **18** changes as the width of the channels **36**, **70** are adjusted to for different sizes of containers. A position sensor **74** determines the position of the first and second movable platforms **44**A, **44**B. The exact pickup location where the container C_S is stopped by the angled plates **72**A, **72**B is a function of the location of the first and second movable platforms **44**A, **44**B. By determining the position of the first and second movable platforms **44**A, **44**B the pickup location can be determined. This information is used by the container transporter **18** to position the transporter in the correct position to pick up the container C_S from the pickup location. The position sensor **74** is in communication with the container transporter **18** via a processor, which may be part of the control system **200**. The processor receives the information provided by the position sensor **74** and determines the pickup location, based on the received information, and relays the pickup location to the container transporter **18**. In the illustrated embodiment, the position sensor **74** is a distance sensor configured to measure the distance between itself and a portion of the first movable platform **44**A. Other configurations of the stop assembly **66** are within the scope of the present disclosure.

Referring to FIGS. **2-4** and **6**, the container transporter **18** is configured to move the containers C_S to the pharmaceutical extractor **20**. In particular, the container transporter **18** is configured to pick up the container C_S from the pickup location defined by the stop assembly **66** and move the container to the pharmaceutical extractor **20**. In the illustrated embodiment, the container transporter **18** is a robot such as a six-axis robotic arm, a selective-compliance-articulated robotic arm, a cylindrical robot, a delta robot, a polar coordinate robot, a vertically articulated robot, a Cartesian coordinate robot or any other suitable device. The container transporter **18** includes a gripper **76** configured to selectively grab the container C_S. In the illustrated embodiment, the gripper **76** includes two selectively movable jaws **78**, although other configurations are within the scope of the present disclosure. As mentioned above, if the container C_S grabbed by the container transporter **18** is verified by the identification system **16**, the container transporter moves the container to the pharmaceutical extractor **20**. However, if the container C_S is not verified or is unable to be read by the identification system **16**, the container transporter moves the unverified container to the reject bin **62**.

Referring to FIGS. **6-9**, the pharmaceutical extractor **20** is configured to remove the pharmaceuticals P from the containers C_S. The pharmaceutical extractor **20** includes a plurality of holders **100**A-C, each holder configured to hold a container C_S (broadly, at least one container). Specifically, each holder **100**A-C includes a gripper **102** configured to hold one container C_S. Each gripper **102** is configured to selectively grab, retain and release the container C_S. In the illustrated embodiment the gripper **102** includes two selectively movable jaws **104**, although other configurations are within the scope of the present disclosure. Each holder **100**A-C includes an actuator assembly **106**, including one or more actuators (such as but not limited to one or more linear actuators and/or rotary actuators) to open and close the gripper **102** (e.g., move the jaws **104**) to selectively grab and release the container C_S. The actuator assembly **106** can also rotate the gripper **102** and shake the gripper, as discussed in more detail below. In addition, each holder **100**A-C includes a discharge chute **108** disposed below the gripper **102** and configured to catch and guide the pharmaceuticals P contained in each container C_S and the container or portions thereof to other components of the pharmaceutical container processing system **10**, as described in more detail below. In the illustrated embodiment, the pharmaceutical extractor **20** includes three holders **100**A-C (e.g., a first holder, a second holder and a third holder), although more or fewer holders are within the scope of the present disclosure.

Each holder **100**A-C is configured to move between a plurality of different stations or locations (e.g., container operation locations) of the pharmaceutical extractor **20**. At

each location, a different operation or operations (e.g., container operations) occurs in the process of removing the pharmaceuticals P from the container C_S. The plurality of locations are arranged in a series (e.g., a series of locations) along which the pharmaceutical extractor **20** is configured to perform a series of operations. Thus, the pharmaceutical extractor **20** is a progressive, multi-stage disassembly device that moves each holder **100**A-C and container C_S held thereby through the different steps for removing the pharmaceuticals P from the container, as described in more detail below. In the illustrated embodiment, the pharmaceutical extractor **20** includes three locations (e.g., a first location, a second location and a third location) for each holder **100**A-C to move to, although more or fewer locations are within the scope of the presented disclosure.

The holders **100**A-C are configured to cycle through the three locations in series. As explained in more detail below, the pharmaceutical extractor **20** moves the holders **100**A-C, one holder after another holder, along the series of locations to extract the pharmaceuticals P from the containers C_S. In this embodiment, the holders **100**A-C cycle through the series of locations by rotating through the three locations. Moreover, as will become apparent, the pharmaceutical extractor **20** repeatedly cycles the holders **100**A-C through the series of locations to perform the series of operations on additional containers C_S, to extract the pharmaceuticals P from the additional containers. Each holder **100**A-C is mounted to a shaft **110** that defines an axis of rotation AR the shaft and holders rotate about. The shaft **110** is part of a holder drive **111** that rotates the holders **100**A-C between the plurality of locations. The holder drive **111** includes a driver **113**, such as an electric motor, operatively coupled to the shaft **110**. The driver **113** is controlled by the control system **200** to selectively rotate the shaft **110**, and therefore the holders **100**A-C, between the locations in series. In this embodiment, the holder drives **111** moves the holders between the locations at generally the same time. Each location and holder **100**A-C are evenly spaced apart (radially) about the axis of rotation AR (e.g., the holders are radially spaced apart by about 120 degrees). Accordingly, the shaft **110** rotates about 120 degree at a time in order to move the holders **100**A-C to the different locations. As shown in FIGS. **6-9**, the first holder **100**A is disposed in the first location, the second holder **100**B is disposed in the second location and the third holder **100**C is in the third location. Each holder **100**A-C moves, in order, from the first location, to the second location, to the third location and then back to the first location to repeat the cycle. For example, when the holders **100**A-C are moved (e.g., rotated approximately 120 degrees) to the next location from their locations shown in FIGS. **6-9**, the first holder **100**A will be disposed in the second location, the second holder **100**B is disposed in the third location and the third holder **100**C is disposed in the first location. As will become apparent, the first location may be considered a pickup/drop-off location, the second location may be considered a cutting location, and the third location may be considered a pharmaceutical unloading location. It will be appreciated that holder drives having other configurations or arrangements could be used without departing from the scope of the presented disclosure. For example, the holder drive could include a plurality of discrete robotic arms associated with individual or multiple holders for driving the movement of the holders.

Referring to FIG. **6**, each holder **100**A-C is configured to receive one of the containers C_S. In particular, the gripper **102** of each holder **100**A-C receives the container C_S when each holder is at the first location. The container transporter **18** moves the container C_S from the pickup location defined by the stop assembly **66** and delivers the container to the holder **100**A-C at the first location. The container transporter **18** positions the container C_S in a position such that when the gripper **102** of the holder **100**A-C at the first location closes, the gripper holds and retains the container. After the gripper **102** of the holder **100**A-C secures the container C_S, the container transporter **18** releases its hold on the container and moves back to the pickup location to grab another container to be delivered to another holder of the pharmaceutical extractor **20**. Preferably, the gripper **102** inverts (e.g., flips over, rotates about 180 degrees) the container C_S so that the bottom of the container is facing upwards, as shown in FIG. **6**. As mentioned above, the actuator assembly **106** includes a rotary actuator to rotate the gripper **102** and invert the container C_S. In other embodiments, the container transporter **18** may invert the container C_S as the container transporter delivers the container to the holder **100**A-C at the first location. Once the container C_S is secured in the holder **100**A-C, the holder is moved to the second location.

Referring to FIGS. **7** and **8**, the pharmaceutical extractor **20** includes a cutter **112** located along the series of locations. Specifically, the cutter **112** is disposed at the second location. The cutter **112** is configured to cut the container C_S held by the gripper **102** of the holder **100**A-C to create a pharmaceutical opening or outlet **114** in the container. Specifically, the cutter **112** creates the pharmaceutical outlet **114** in the container C_S when the container and corresponding holder **100**A-C holding the container are at the second location. In the illustrated embodiment, the cutter **112** cuts off a bottom portion of the container C_S (which is facing upwards) to form the pharmaceutical outlet **114**. In the illustrated embodiment, the cutter **112** is an ultrasonic cutter that vibrates a horn or blade **116** to cut the container C_S. The cutter **112** is configured to move the blade **116** toward and through the container C_S (e.g., move generally radially outward from the axis of rotation AR). Each holder **100**A-C is configured to lift the container C_S upward. By moving the container C_S upward, the holder **100**A-C places the container to the path of the blade **116** so that as the blade is advanced, the blade cuts off the bottom portion of the container to form the pharmaceutical outlet **114**. FIG. **7** shows the container C_S in the lifted or raised position and FIG. **8** shows the container C_S in the unlifted or lower position, after the pharmaceutical opening **114** has been formed. Each holder **100**A-C includes a lifting actuator **118** (e.g., a linear actuator) operatively connected to and between the gripper **102** and the shaft **110** to move the container C_S upward. In the illustrated embodiment, the lifting actuator **118** connects the holder **100**A-C to the shaft **110**, although other configurations are within the scope of the present disclosure. For example, the lifting actuator may be part of the actuator assembly **106**. In addition, in the illustrated embodiment, the lifting actuator **118** also raises and lowers the discharge chute **108** as well. Preferably, the lifting actuator **118** raises and lowers the container C_S when the holder and container are at the second location, although raising and lower the container at other times is within the scope of the present disclosure.

Still referring to FIGS. **6** and **7**, the pharmaceutical extractor **20** includes a nozzle **120** configured to direct a stream of gas (e.g., air) onto the bottom portion of the container C_S to push the bottom portion of the container off the remainder of the container. The nozzle **120** is fluidly connected to a pressure source (not shown), such as an air compressor, via a hose **122**. A selectively actuatable valve **121**

(FIG. **10**) may be connected to the hose **122**. The selectively actuatable valve **121** can be selectively opened and closed to only supply the stream of air after the blade **116** has cut the container C_S. The selectively actuatable valve **121** can be controlled by the control system **200**. In one embodiment, an air ionizer (not shown) ionizes the stream of air before leaving the nozzle **120** to reduce static and dust. The pharmaceutical extractor **20** includes a shroud **124** configured to guide the bottom portion of the container C_S to a waste chute **126** of a waste collector **127** after the bottom portion is blown off the container by the stream of gas from the nozzle **120**. The shroud **124** generally surrounding at least a portion of the second location and acts as a backstop for the bottom portion of the container C_S. The nozzle **120** directs the stream of gas in a direction generally toward the shroud **124**, blowing the bottom portion of the container C_S into the shroud. The bottom portion is then directed downward, by gravity, into the waste chute **126**. The waste chute **126** directs the bottom portion of the container C_S into a waste bin **128** (FIG. **1**) of the waste collector **127**.

The pharmaceutical extractor **20** also includes a cutter sensor **130** at the second location to confirm the pharmaceutical outlet **114** is formed. Specifically, the cutter sensor **130** is used to confirm the bottom portion of the container C_S has been removed. The cutter sensor **130** is in communication with a processor, such as the processor **202** of the control system **200**, which receives the information provided by the sensor to determine if the bottom portion of the container C_S has been removed. In one embodiment, the cutter sensor **130** is a distance sensor configured to measure the distance between itself and the bottom of the container C_S. When the measured distance changes due to the bottom portion being removed, the processor knows the bottom portion has been cut off the container and the pharmaceutical outlet **114** has been formed. If the processor determines the pharmaceutical outlet has not been formed (e.g., the bottom portion has not been removed) in the container C_S, the container is moved back to the first location, as described herein, where the processor instructs the container transporter **18** to grab and move the container to the reject bin **62**. Once the pharmaceutical outlet **114** has been created in the container C_S, the container and holder **100**A-C are moved to the third location.

Referring to FIG. **9**, the pharmaceutical extractor **20** includes a pharmaceutical collection inlet **136** located along the series of locations. Desirably, the pharmaceutical collection inlet **136** is located in the series of locations downstream from the cutter **112**. In the illustrated embodiment, the pharmaceutical collection inlet **136** is disposed at the third location. The pharmaceutical collection inlet **136** is configured to receive the pharmaceuticals P from the pharmaceutical outlets **114** in the containers C_S. The pharmaceuticals P in the container C_S move through the pharmaceutical outlet **114** and out of the container when the container is at the third location. Each holder **100**A-C is configured to move the container C_S so that the pharmaceuticals P in the container flow through the pharmaceutical outlet **114**. In particular, the gripper **102** of each holder **100**A-C moves the container C_S from the inverted orientation (broadly, a first orientation) to an upright or non-inverted orientation (broadly, a second orientation). The gripper **102** is rotated by the actuator assembly **106** of the holder **100**A-C. In the upright orientation, as shown in FIG. **9**, the pharmaceuticals P, under the influence of gravity, move through pharmaceutical outlet **114**, out of the container C_S and into the pharmaceutical collection inlet **136**. It is understood the gripper **102** may move the container C_S into other orientations, besides the upright orientation, to enable the pharmaceuticals P to flow through the pharmaceutical outlet **114**.

In the illustrated embodiment, the pharmaceutical extractor **20** includes a pharmaceutical chute **132** which defines the pharmaceutical collection inlet **136**. When the pharmaceuticals P fall out of the container C_S, the pharmaceuticals fall into the pharmaceutical chute **132** (e.g., pharmaceutical collection inlet **136**). The pharmaceutical chute **132** then directs the pharmaceuticals P to the pharmaceutical collector **26**. Accordingly, the pharmaceutical collector **26** receives the pharmaceuticals P from the container C_S disposed at the third location. The operator can then use to the pharmaceutical collector **26** to move the pharmaceuticals P into the bulk container C_B. The operator can shift through the pharmaceuticals P received by the pharmaceutical collector **26** to remove damaged or broken pharmaceuticals and other contaminants while additional pharmaceuticals are removed from the containers C_S. In some instances, the pharmaceuticals P may fall from the container C_S onto the discharge chute **108**, which then directs the pharmaceuticals to the pharmaceutical collection inlet **136** (e.g., onto the pharmaceutical chute **132**). The pharmaceutical chute **132** may, broadly, be considered part of the pharmaceutical collector **26**. The operator working at the pharmaceutical collector **26** may also be able to start/stop and/or slow down the system **10**, via the control system **200**, in order to shift through the pharmaceuticals at the operator's own pace. Further details on the pharmaceutical collector **26** are described in U.S. Pat. Application No. 16/226,944, incorporated by reference above.

To further facilitate the movement (e.g., extraction) of the pharmaceuticals P through the pharmaceutical outlet **114**, each holder **100**A-C is configured to shake the gripper **102** and container C_S when the container is in the second orientation. In particular, the actuator assembly **106** may shake the container C_S by vigorously moving the container up and down and/or side to side. The containers C_S typically contain a packing material, such as a piece of cotton, with the pharmaceuticals P and shaking the container helps ensure that all the pharmaceuticals flow out of the container and are not blocked by the packing material. Other suitable methods for shaking the container C_S are within the scope of the present disclosure. After the pharmaceuticals P flow out of the container C_S, the gripper **102** may rotate the container back to the first orientation. Once the pharmaceuticals P move out of the container C_S, the container and holder **100**A-C are moved back to the first location.

Referring back to FIG. **6**, upon returning to the first location with the now empty container C_S, the gripper **102** of the holder **100**A-C releases the container. In other words, the gripper **102** of the holder **100**A-C is configured to receive the container C_S when the holder is at the first location during a first period of time (e.g., the first time the container is at the first location) and is configured to release the container when the holder is at the first location during a second period of time, different than the first period of time (e.g., upon the container returning to the first location). When the container C_S is released by the gripper **102**, the container falls into another waste chute **134** of the waste collector **127** which directs the empty container C_S to the waste bin **128** (FIG. **1**). The container C_S may fall directly into the waste chute **134** or fall into the discharge chute **108** which directs the container to the waste chute. After the gripper **102** releases the empty container C_S, the gripper is ready to receive another container from the container transporter **18**, and the cycle repeats.

In one embodiment, the holders **100**A-C are moved to another station every 6-8 seconds. This allows enough time for the actions at each location to be completed. Typically, cutting the pharmaceutical outlet **114** takes the longest amount of time and can vary depending on the wall thickness of the container C_S and the size of the container. Thus, the pharmaceutical extractor **20** can receive a new container C_S every 6-8 seconds with the processing of the container being completed in 18-24 seconds. Moreover, the singulator assembly **14** is timed, via the control system **200**, to release a new container C_S every 6-8 seconds to match the movement of the holders **100**A-C between the different locations. This timing ensures that the container transported **18** will always have a container C_S at the pickup location to deliver to the holders **100**A-C, each time the holders are at the first location.

The operations or processes for removing the pharmaceuticals P from the container C_S at each location occur generally at the same time (e.g., the processes occur generally simultaneously). For example, the first holder **100**A receives a container C_S at generally the same time as the cutter **112** cuts the pharmaceutical outlet **114** in a container held by the second holder **100**B and at generally the same time as a third container held by the third holder **100**C is moved to the second orientation to enable the pharmaceuticals P to move through the pharmaceutical outlet of the third container when the first, second and third holders are at the first, second and third locations, respectively. Simultaneously performing processes for removing the pharmaceuticals P from three containers C_S significantly increases the speed at which the pharmaceutical container processing system **10** can remove pharmaceuticals from the containers (e.g., process containers). In one test, a pharmaceutical container processing system built according to the teachings of the present disclosure was able to process containers C_S twice as fast over conventional systems at a rate of about 450-550 containers/hour, depending on the type of container.

It will be appreciated that container operations other than described herein could be performed at container operation locations, and various combinations of container operations could be performed at container operation locations without departing from the scope of the present application. For example, in one contemplated embodiment, full containers are received and cut at the same container operation location. In another embodiment, the containers are cut and emptied at the same container operation location. In yet another contemplated embodiment, the locations where the empty containers are dropped and the new containers are received can be different locations. Moreover, it will be appreciated that operations can be carried out in other fashions without departing from the scope of the present disclosure. For example, the containers could be received cap-end-down, could be cut while the cap end is up, could have the cap end cut off, or could be cut in other fashions.

Referring to FIG. **10**, an exemplary control system of the pharmaceutical container processing system **10** is generally indicated by reference numeral **200**. The control system **200** (broadly, a computer) includes a CPU or processor **202** (e.g., a control system processor) and RAM or memory **204** (broadly, non-transitory computer-readable storage medium). The control system **200** controls and operates the various components (e.g., conveyors **28**A-C, actuators **42**, actuator assemblies **106**, etc.) of the pharmaceutical container processing system **10**. Broadly, the memory **204** includes (e.g., stores) processor-executable instructions for controlling the operation of the pharmaceutical container processing system **10** and the components thereof. The instructions embody one or more of the functional aspects of the pharmaceutical container processing system **10** and the components thereof, with the processor **202** executing the instructions to perform said one or more functional aspects. The components of the pharmaceutical container processing system **10** may be in wired or wireless communication with the control system **200**. Other configurations of the control system **200** are within the scope of the present disclosure.

In one exemplary method of operation of the pharmaceutical container processing system **10**, a plurality of containers C_S are received in the hopper **12**. The containers C_S can be placed in the hopper **12** by the operator. The hopper **12** then dispenses the containers C_S from the hopper and into the singulator assembly **14**. Specifically, the conveyors **28**A-C move to transport the containers to the singulator assembly. The singulator assembly **14** then singulates the containers C_S. The singulated container C_S is then moved through the identification system **16**, which identifies the container to confirm the container contains the correct pharmaceuticals P. The container C_S is then moved to the stop assembly **66** where the container is stopped in the pickup location. The container C_S is held in the pickup location until the container transporter **18** grabs the container and deliver's it to the pharmaceutical extractor **20**.

One of the holders **100**A-C (e.g., a first holder) of the pharmaceutical extractor **20** is at the first location of the pharmaceutical extractor and receives the container C_S (e.g., a first container). Specifically, the container transporter **18** moves the first container C_S to the gripper **102** of the first holder **100**A and the gripper closes to grab and hold the first container therein. The container transporter **18** then releases the first container C_S and moves back to the pickup location to grab another container C_S therefrom. Once the first container C_S is secured in the gripper **102** of the first holder **100**A, the gripper then inverts the first container. The first holder **100**A is then moved to the second location. Specially, the shaft **110** is rotated about the axis of rotation AR approximately 120 degrees to move the first holder **100**A from the first location to the second location. As the first holder **100**A holds the first container C_S in the inverted (e.g., first) orientation at the second location, a pharmaceutical outlet **114** is formed in the first container. The blade **116** of the cutter **112** is moved through the first container C_S to cut off the bottom portion of the container and form the pharmaceutical outlet **114**. A stream of gas then pushes the bottom portion away from the remainder of the container C_S. The bottom portion is guided to the waste bin **128** by the shroud **124** and waste chute **126**. The first holder **100**A raises the first container C_S into the path of the blade **116** and then lowers the first container after the pharmaceutical outlet **114** is formed. At generally the same time as the pharmaceutical outlet **114** is formed in the first container C_S (e.g., at the same time the first holder **100**A is in the second location), a second container is received in the third holder **100**C. The third holder **100**C was moved to first location from the third location at the same time the first holder **100**A was moved to the second location. The third holder **100**C receives the second container C_S in the same manner as the first holder **100**A, described above.

Once the pharmaceutical outlet **114** is formed in the first container C_S and the third holder **100**C receives the second container, the first holder **100**A is moved to the third location. At generally the same time, the third holder **100**C is moved to the second location and the second holder **100**B is moved to the first location. The pharmaceutical outlet **114** in the second container C_S is formed in the same manner as

the pharmaceutical outlet formed in the first container, described above. Likewise, the second holder **100**B receives a third container C_S is the same manner as the first holder **100**A, described above. In the third location, the first container C_S is moved to a non-inverted (e.g., second) orientation so that the pharmaceuticals P in the first container move through the pharmaceutical outlet **114** and out of the first container. This occurs at generally the same time as the pharmaceutical outlet **114** is formed in the second container C_S and the second holder **100**B receives the third container (e.g., at the same time the second holder **100**B is in the first location and the third holder **100**C is in the second location). In particular, the gripper **102** of the first holder **100**A rotates or generally flips the first container C_S so that the pharmaceuticals P in the first container fall out of the first container and into the pharmaceutical collection inlet **136**. The pharmaceutical chute **132** then guides the pharmaceuticals P to the pharmaceutical collector **26**. The pharmaceutical collector **26** receives the pharmaceuticals P and then the operator can move the pharmaceuticals into the bulk container C_B. The first holder **100**A may shake the first container C_S to ensure that there are no pharmaceuticals P remaining in the first container. Once the first container **100**A is empty, the first container may be moved back into the inverted orientation.

The first holder **100**A is then moved back to the first location. At generally the same time, the third holder **100**C is moved to the third location and the second holder **100**B is moved to the second location. The pharmaceutical outlet **114** in the third container C_S, which is now in the second location, is formed, as described above. Likewise, the pharmaceuticals P are removed from the second container C_S, which is now in the third location, as described above. Upon returning to the first location, the first holder **100**A drops the now empty first container into the waste chute **134** which guides the first container into the waste bin **128**. Specifically, the gripper **102** releases the first container C_S. The first holder **100**A is now ready to receive another (e.g., fourth) container from the container transporter **18** and the cycle repeats.

The Title, Field, and Background are provided to help the reader quickly ascertain the nature of the technical disclosure. They are submitted with the understanding that they will not be used to interpret or limit the scope or meaning of the claims. They are provided to introduce a selection of concepts in simplified form that are further described in the Detailed Description. The Title, Field, and Background are not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the claimed subject matter.

Although described in connection with an exemplary computing system environment, embodiments of the aspects of the disclosure are operational with numerous other general purpose or special purpose computing system environments or configurations. The computing system environment is not intended to suggest any limitation as to the scope of use or functionality of any aspect of the disclosure. Moreover, the computing system environment should not be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary operating environment. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with aspects of the disclosure include, but are not limited to, personal computers, server computers, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, mobile telephones, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, and the like.

Embodiments of the aspects of the disclosure may be described in the general context of data and/or processor-executable instructions, such as program modules, stored one or more tangible, non-transitory storage media and executed by one or more processors or other devices. Generally, program modules include, but are not limited to, routines, programs, objects, components, and data structures that perform particular tasks or implement particular abstract data types. Aspects of the disclosure may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote storage media including memory storage devices.

In operation, processors, computers and/or servers may execute the processor-executable instructions (e.g., software, firmware, and/or hardware) such as those illustrated herein to implement aspects of the disclosure.

Embodiments of the aspects of the disclosure may be implemented with processor-executable instructions. The processor-executable instructions may be organized into one or more processor-executable components or modules on a tangible processor readable storage medium. Aspects of the disclosure may be implemented with any number and organization of such components or modules. For example, aspects of the disclosure are not limited to the specific processor-executable instructions or the specific components or modules illustrated in the figures and described herein. Other embodiments of the aspects of the disclosure may include different processor-executable instructions or components having more or less functionality than illustrated and described herein.

The order of execution or performance of the operations in embodiments of the aspects of the disclosure illustrated and described herein is not essential, unless otherwise specified. That is, the operations may be performed in any order, unless otherwise specified, and embodiments of the aspects of the disclosure may include additional or fewer operations than those disclosed herein. For example, it is contemplated that executing or performing a particular operation before, contemporaneously with, or after another operation is within the scope of aspects of the disclosure.

When introducing elements of aspects of the disclosure or the embodiments thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," "including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

In view of the above, it will be seen that several advantages of the aspects of the disclosure are achieved and other advantageous results attained.

Not all of the depicted components illustrated or described may be required. In addition, some implementations and embodiments may include additional components. Variations in the arrangement and type of the components may be made without departing from the spirit or scope of the claims as set forth herein. Additional, different or fewer components may be provided and components may be combined. Alternatively or in addition, a component may be implemented by several components.

The above description illustrates the aspects of the disclosure by way of example and not by way of limitation. This description enables one skilled in the art to make and use the

aspects of the disclosure, and describes several embodiments, adaptations, variations, alternatives and uses of the aspects of the disclosure, including what is presently believed to be the best mode of carrying out the aspects of the disclosure. Additionally, it is to be understood that the aspects of the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the description or illustrated in the drawings. The aspects of the disclosure are capable of other embodiments and of being practiced or carried out in various ways. Also, it will be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

Having described aspects of the disclosure in detail, it will be apparent that modifications and variations are possible without departing from the scope of aspects of the disclosure as defined in the appended claims. It is contemplated that various changes could be made in the above constructions, products, and methods without departing from the scope of aspects of the disclosure. In the preceding specification, various embodiments have been described with reference to the accompanying drawings. It will, however, be evident that various modifications and changes may be made thereto, and additional embodiments may be implemented, without departing from the broader scope of the aspects of the disclosure as set forth in the claims that follow. The specification and drawings are accordingly to be regarded in an illustrative rather than restrictive sense.

What is claimed is:

1. A pharmaceutical extractor for removing pharmaceuticals from a plurality of containers, the pharmaceutical extractor comprising:

a plurality of holders, each holder including a gripper configured to hold at least one container of the plurality of containers,

a plurality of container operation locations arranged in a series of spaced apart container operation locations along which a series of container operations are performed,

a cutter located along the series of spaced apart container operation locations, the cutter configured to cut containers held by the grippers to create pharmaceutical outlets in the containers,

a pharmaceutical collection inlet located along the series of spaced apart container operation locations, the pharmaceutical collection inlet configured to receive pharmaceuticals from the pharmaceutical outlets in the containers,

wherein the plurality of holders are configured to move, one holder after another holder, along the series of spaced apart container operation locations to extract the pharmaceuticals from the containers.

2. The pharmaceutical extractor of claim **1**, wherein the holders are configured to repeatedly cycle through the series of spaced apart container operation locations to perform the series of container operations on additional containers of the plurality of containers.

3. The pharmaceutical extractor of claim **1**, wherein the series of spaced apart container operation locations includes a first container operation location, a second container operation location, and a third container operation location, the holders configured to receive containers when at the first container operation location, the cutter arranged to cut the pharmaceutical openings in containers held by holders at the second container operation location, and the pharmaceutical collection inlet arranged to receive pharmaceuticals from the pharmaceutical outlets of containers held by holders at the third container operation location.

4. The pharmaceutical extractor of claim **3**, wherein the plurality of holders includes a first holder, a second holder, and a third holder, the first holder being located at the first container operation location while the second holder is located at the second container operation location and the third holder is located at the third container operation location.

5. The pharmaceutical extractor of claim **4**, further comprising a holder drive configured to rotate the holders between the plurality of container operation locations.

6. The pharmaceutical extractor of claim **3**, wherein the holders are configured to drop empty containers at the first container operation location before receiving another container at the first container operation location.

7. The pharmaceutical extractor of claim **3**, wherein the holders are configured to shake the containers at the third container operation location to facilitate the extraction of the pharmaceuticals from the pharmaceutical outlets in the containers.

8. The pharmaceutical extractor of claim **1**, further comprising a holder drive configured to move the holders between container operation locations at generally the same time.

9. The pharmaceutical extractor of claim **1**, wherein the pharmaceutical collection inlet is located in the series of spaced apart container operation locations downstream from the cutter.

10. A pharmaceutical container processing system for removing pharmaceuticals from a plurality of containers, the pharmaceutical container processing system comprising:

a hopper configured to hold the plurality of containers and to dispense the plurality of containers;

a singulator assembly configured to singulate the plurality of containers as the containers are dispensed from the hopper;

a pharmaceutical extractor configured to remove the pharmaceuticals from the plurality of containers, the pharmaceutical extractor including:

a holder configured to hold at least one container of the plurality of containers; and

a cutter configured to cut said at least one container held by the holder to create a pharmaceutical outlet in said container,

wherein the holder is configured to move between a first location where the holder receives said container, a second location where the cutter cuts the pharmaceutical outlet in said container and a third location where the pharmaceuticals in said container move through the pharmaceutical outlet and out of said container, the first, second, and third locations all being spaced apart from one another; and

a pharmaceutical collector configured to receive the pharmaceuticals from the containers disposed at the third location.

11. The pharmaceutical container processing system of claim **10**, further comprising an identification system configured to identify the plurality of containers.

12. The pharmaceutical container processing system of claim **10**, further comprising a container transporter configured to move the containers to the holder of the pharmaceutical extractor.

13. The pharmaceutical container processing system of claim **10**, wherein the hopper includes first and second conveyors configured to move the plurality of containers, the first and second conveyors configured to move in generally opposite directions.

14. The pharmaceutical container processing system of claim 13, wherein the singulator assembly includes at least one stop configured to contact a container of the plurality of containers as the plurality of containers are moved by the first conveyor to inhibit the containers from moving with the first conveyor, wherein the stop is selectively retractable to singulate said one container from the plurality of containers by permitting said one container to move with the first conveyor.

15. The pharmaceutical container processing system of claim 10, wherein the singulator assembly is selectively adjustable to enable the singulator assembly to singulate different sizes of containers.

16. The pharmaceutical container processing system of claim 10, wherein the pharmaceutical extractor includes a plurality of holders, the holder being a first holder of the plurality of holders, the plurality of holders configured to move between the first location, the second location and the third location.

17. The pharmaceutical container processing system of claim 16, wherein the first holder of the plurality of holders is located to receive a container of the plurality of containers at generally the same time as a second holder of the plurality of holders is located for the cutter to cut a container held by the second holder and at generally the same time as a third holder of the plurality of holders is located to move pharmaceuticals from a container held by the third holder to the pharmaceutical collector.

18. A method of removing pharmaceuticals from a plurality of containers, the method comprising:

receiving a first container of the plurality of containers in a first holder of a pharmaceutical extractor at a first location;

moving said first container and first holder to a second location, the second location spaced apart from the first location;

forming a pharmaceutical outlet in said first container with a cutter while said first container is held by the first holder at the second location;

moving said first container and first holder to a third location, the third location spaced apart from the first and second locations; and

while said first container is held by the first holder at the third location, moving pharmaceuticals out of said first container through the pharmaceutical outlet.

19. The method of claim 18, further comprising, before said receiving the first container, singulating the first container from other containers of the plurality of containers.

20. The method of claim 19, further comprising, before said receiving the first container and after said singulating the first container, identifying the first container.

21. The method of claim 18, further comprising, at generally the same time as said forming the pharmaceutical outlet in said first container, receiving a second container of the plurality of containers in a second holder of the pharmaceutical extractor.

22. The method of claim 21, further comprising:

at generally the same time as said moving pharmaceuticals out of said first container, receiving a third container of the plurality of containers in a third holder of the pharmaceutical extractor and forming a pharmaceutical outlet in the second container while said second container is held by the second holder.

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