



(51) International Patent Classification:
A01D 46/00 (2006.01)

(21) International Application Number:
PCT/US2023/028939

(22) International Filing Date:
28 July 2023 (28.07.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/393,447 29 July 2022 (29.07.2022) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT,

(54) Title: PRODUCE PICKUP SYSTEM

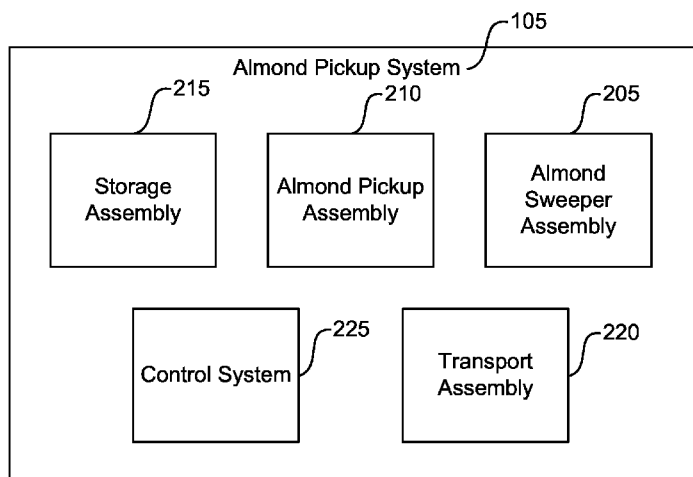


FIG. 2

(57) Abstract: A system is configured to pick up produce. A produce sweeper assembly include a sweeper blade positioned at an adjustable height relative to a ground surface. A produce pickup assembly picks up gathered produce and includes at least one bristle that pushes the gathered produce onto a conveyor belt, which transfers the gathered produce into a produce storage assembly. A control system controls at least one aspect of the produce sweeper assembly and at least one aspect of the produce pickup assembly.

LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,
SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN,
GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *without international search report and to be republished
upon receipt of that report (Rule 48.2(g))*

PRODUCE PICKUP SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The current application claims priority under 35 U.S.C. §119(e) to U.S. Provisional patent application serial number 63/393,447, filed on July 29, 2022, and entitled “ALMOND PICKUP SYSTEM,” which is incorporated by reference herein in its entirety.

BACKGROUND

[0002] Crops, such as nuts, vegetables, and other agricultural produce require extensive manual labor in order to be harvested. For example, almonds are typically harvested from the ground after the almonds are manually shaken and removed from trees. Currently, there are two steps for picking up almond nuts from the ground after being shaken and removed from trees. The harvesters need to use two different machines. A first machine is used to sweep and gather the almonds. Next, a second machine is used to pick up the gathered almonds off the ground. The almonds are then stored in a hauling cart for subsequent processing. This conventional process generates a large amount of dust and involves a large amount of field operation.

[0003] There is a need for improved systems and methods for harvesting crops, such as almonds and other various agricultural produce.

SUMMARY

[0004] Disclosed are systems and methods for efficiently harvesting produce, such as almonds. In one embodiment, an almond pickup system combines the process of sweeping and picking up almonds into an integrated mechanism or machine. The disclosed system enables savings with respect to energy and cost

relative to conventional systems and methods. The disclosed sweeper and pickup system also reduce dust generation, which is a major concern for not only the almond industry, but other industries that produce a lot of dust when harvesting.

[0005] Current almond harvesting systems and methods use multiple items of machinery. The disclosed system combines the sweeping operation for gathering almonds and the pickup operation for picking up almonds into a single integrated machine and method operation, which can reduce the number of field operations relative to the current state. The disclosed system can also be used to pick up wind drop nuts, which are fruit that fall to the ground due to the wind in periods close to normal harvest time.

[0006] In one aspect, there is disclosed a system configured to pick up produce, comprising a produce sweeper assembly configured to gather produce, the produce sweeper assembly including at least one sweeper blade positioned at a height relative to a ground surface, wherein the height of the sweeper blade is adjustable; a produce pickup assembly configured to pick up gathered produce gathered by the produce sweeper assembly, wherein the produce pickup assembly includes at least one bristle that pushes the gathered produce onto a conveyor belt of the produce pickup assembly; a produce storage assembly, wherein the conveyor belt transfers the gathered produce into the produce storage assembly; and a control system communicatively coupled to the produce sweeper assembly and the produce pickup assembly, wherein the control system controls at least one aspect of the produce sweeper assembly and at least one aspect of the produce pickup assembly.

[0007] The details of one or more variations of the subject matter described herein are set forth in the accompanying drawings and the description below. Other features and advantages of the subject matter described herein will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 shows a schematic representation of an almond pickup system and one or more almonds.

[0009] Figure 2 shows a schematic representation of details of the almond pickup system.

[0010] Figure 3 shows an example, side view representation of mechanical components of the almond pickup system.

[0011] Figure 4 shows a perspective, side representation of an almond sweeper assembly.

[0012] Figure 5 shows an enlarged view of an almond gathering component.

[0013] Figure 6 shows a perspective, side representation of an almond pickup assembly.

[0014] Figure 7 shows a side view of the almond pickup assembly.

[0015] Figure 8 shows a schematic representation of an embodiment of the almond pickup system including a cyclone separator assembly.

[0016] Figures 9A and 9B shows a non-limiting example embodiment of a housing and chamber of the cyclone separator assembly.

[0017] Figure 10 depicts a block diagram illustrating an example of a computing control system.

[0018] Figure 11 show an embodiment of the pickup system that includes or is coupled to an autonomous robot.

[0019] Figure 12 shows an example autonomous robot.

DETAILED DESCRIPTION

[0020] Before the present subject matter is further described, it is to be understood that this subject matter described herein is not limited to particular embodiments described, as such may of course vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting. Unless defined otherwise, all technical terms used herein have the same meaning as commonly understood by one skilled in the art to which this subject matter belongs.

[0021] Figure 1 shows a schematic representation of an almond pickup system 105 (or produce pickup system) that is configured to pick up or otherwise harvest one or more almonds 110. The almonds 110 are typically positioned on a ground surface adjacent to or in a general area of the almond pickup system 105, such as in an almond orchard. As discussed in more detail below, the almond pickup system 105 is configured to pick up and gather the almonds 110. The almond pickup system 105 can also deposit the almonds 110 into a storage device such as a bin. The system is described herein in an example context of picking up and gathering almonds. However, it should be appreciated that the system is not limited to use with almonds and can be used to sweep, pick up, and gather other items including various produce, including, but not limited to fruits, vegetables, seeds, agricultural products, other tree nuts (e.g. walnuts, pine nuts, pistachios, and the like), etc.

[0022] Figure 2 shows a schematic representation of the almond (or produce) pickup system 105, which includes an almond sweeper assembly 205 (or produce sweeper assembly), an almond pickup assembly 210 (or produce pickup assembly), and an almond storage assembly 215 (or produce storage assembly). The almond sweeper assembly 205, almond pickup assembly 210, and almond

storage assembly 215 are all part of a mechanically connected and integrated structure.

[0023] The almond sweeper assembly 205 is configured to sweep or otherwise gather almonds positioned on a ground surface. The almond sweeper assembly gathers such almonds and positions them for pickup by the almond pickup assembly 210. The almond pickup assembly 210 is configured to pick up the gathered almonds off the ground and deposit the picked-up almonds into the storage assembly 215, which may be for example a bin or other container. The almond pickup system 105 also includes a transport assembly 220, which may include wheels coupled to an axle, for transporting the almond sweeper assembly 205 along the ground surface relative to the almonds. The transport assembly 220 can also include a motor, such as an internal combustion engine, an electric motor, or a hybrid motor. As described further below with reference to Figs. 11 and 12, the transport assembly can include or be coupled to an autonomous robot that such as an all-electric micro-tractor adapted to be coupled to the pickup system 105.

[0024] The almond pickup system also includes a control system 225, which can automatically control various aspects of the almond pickup system 105, such as movement (e.g. direction) and/or speed of the entire almond pickup system 105 along the ground. The control system 225 can also coordinate relative movement between the almond sweeper assembly 205 and the almond pickup assembly 210, as described more fully below.

[0025] Figure 3 shows an example, side view representation of the mechanical components of the almond pickup system 105 including the almond sweeper assembly 205, the almond pickup assembly 210, and the storage assembly 215. As mentioned, the almond sweeper assembly 205 includes one or more mechanical components configured to mechanically interact with almonds 110 positioned on a ground surface to gather such almonds in a position relative to the almond pickup system 105. The transport assembly can be, for example, one or more wheels 305 that support the almond pickup system 105 and that can rotate to transport the almond pickup system 105 along a ground surface. The mechanical

components can be mechanically attached to one another to form a unified mechanism that includes the almond sweeper assembly 205, the almond pickup assembly 210, and/or the storage assembly 215.

[0026] Figure 4 shows a perspective, side representation of the almond sweeper assembly 205. The almond sweeper assembly 205 includes a transportable housing 410 that is represented in Figure 4 as a tractor-type assembly having a set of wheels. It should be appreciated that the tractor-type assembly is a non-limiting example and that the housing 410 can be inclusive of any of a variety of form factors that can be powered by one or more internal combustion engines and/or one or more electrical or hybrid motors. The housing 410 can be sized and shaped to carry a passenger or it can be remotely controlled without a passenger.

[0027] The almond sweeper assembly 205 includes an almond gathering component 415 configured to gather almonds on a ground surface. Figure 5 shows an enlarged view of the almond gathering component 415, which includes one or more sweeper wheels 505 each having one or more sweeper blades 510. Each sweeper blade 510 forms a surface or edge (such as a bottom edge or side edge) that is configured to mechanically interact with the almond(s) positioned on a ground surface to gather the almonds relative to the almond sweeper assembly 205. The sweeper blades 510 can be formed from any known material such as steel, plastic, aluminum, and the like. Sweeper blade 510 can be a solid plate as illustrated in Fig. 5. However, this is not intended to be limiting as the sweeper blade 510 can be shaped as bristles, blades, have a plurality of apertures, or be formed with any desired design.

[0028] With reference still to Figure 5, each sweeper wheel 505 includes a vertically-extending post 520 with one or more extender posts 525 radiating outward therefrom. The blades 510 are attached to the extender posts 525. For each sweeper wheel 505, the sweeper blades 510 are configured to rotate about an axis A (which is co-axial with the post 520) so that the sweeper blades 510 collectively sweep in a rotating manner around a vertical axis and gather almonds. The blades 510 can be configured to rotate and/or move in other manners as the

mechanism shown in Figure 5 is a non-limiting example. In an embodiment, each sweeper blade 510 defines a side surface plane that is oriented at a non-normal angle relative to a vertical axis, such as at an angle of about 110 degrees in a non-limiting example. The sweeper blades 510 push the almonds toward a pathway or window that can be accessed by the almond pickup assembly 210.

[0029] The sweeper wheels 505 are positioned at a height relative to a ground surface wherein the height is adjustable, such as automatically adjustable based on the size of the produce and position of the sweeper wheels relative to the ground surface. In this regard, the sweeper wheels can be mechanically attached to one or more actuators configured to cause the sweeper wheels 505 to move upward or downward. The height is controlled by the control system 225 to keep the level of sweeper blades 510 fixed with the ground surface or floor to minimize dust generation when sweeping the almond nuts on the ground. The sweeper wheels 505 move all the almond nuts on the ground with reduced or minimum dust generation. The control system 225 automatically controls a rotational speed of the sweeper blades 510 so that it is synchronized with a forward speed of the entire system. For example, the rotational speed can proportionally increase or decrease relative to a forward speed of the entire system. The control system 225 also adjusts the forward speed to minimize the amount of dust generation. In one embodiment, the airborne dust can be measured using a dust and particle sensor and forward speed can be controlled based on the feedback from the dust sensor. For example, if a dust and particle sensor measures a high dust or particulate matter concentration (e.g. levels $35 \mu\text{g}/\text{m}^3$ or above) and/or detects a dust or particulate matter concentration above a desired predetermined concentration level (or range of concentration levels), control system 225 can reduce the forward speed of the pickup system 105 until the dust or particulate matter concentration decreases to a predefined limit. In another embodiment, control system 225 can control the rotational speed of sweeper blades 510 based on the readings from the dust and particle sensor. For example, if a dust and particle sensor measures a high dust or particulate matter concentration (e.g. levels $35 \mu\text{g}/\text{m}^3$ or above) and/or detects a dust or particulate matter concentration above a desired predetermined concentration level (or range of concentration

levels), control system 225 can reduce the rotational speed of the sweeper blades 510 until the dust or particulate matter concentration decreases to a predefined limit.

[0030] Almond gathering component 415 can be removably or permanently coupled to the transportable housing 410 through any known means and method. As illustrated, almond gathering component 415 can be attached to transportable housing 410 through use of connector 402. Connector 402 may have a first brace 404 coupled to the transportable housing 410 and a second brace 406 coupled to the almond gathering component 415. First brace 404 may be coupled to the transportable housing 410 using any known means such as screws, latches, welding, adhesives, and the like. Second brace 406 may be coupled to frame 412 of the almond gathering component 415. Second brace 406 may be coupled to frame 412 using any known means such as screws, latches, welding, adhesives, ties, and the like. Brackets 408 may be used to connect first brace 404 and second brace 406. Although illustrated with two brackets, this is not intended to be limiting as any number of brackets may be used as desired. Connector 402 may be made of any known material such as steel, carbon fiber, metal, plastic, aluminum, and the like.

[0031] With reference again to Figure 3, the almond pickup assembly 210 is mechanically attached to and located behind the almond sweeper assembly 205 relative to a direction of motion 325 of the almond sweeper assembly 205. Figure 6 shows a perspective, side representation of the almond pickup assembly 210. Figure 7 shows a side view of the almond pickup assembly 210. The almond pickup assembly 210 includes a brush assembly 605 that is positioned forward of a conveyor belt 610. The brush assembly 605 includes paddles, blades or bristles 615 that rotate about an axis. In this regard, the brush assembly 605 can be rotationally attached to a frame 623 such that the brush assembly rotates about an axis such as a horizontal axis. The bristles 615 are configured to mechanically interact with almonds that have been gathered by the almond sweeper assembly 205. The bristles 615 rotate and push such gathered almonds onto the conveyor belt 610 such as via a platform 625, which is positioned behind the brush assembly 605. The conveyor belt 610 is positioned and oriented to guide the gathered almonds from a location adjacent the brush assembly 605 to an entry location of the storage

assembly 215. The conveyor belt may be made of a material that is configured to maintain a grip with the almonds and minimize the likelihood of almonds sliding downward and back to the brush assembly as they are transported toward the storage assembly. It should be appreciated that mechanism other than a conveyor belt can be used to transport the almonds toward and into the storage assembly 215.

[0032] The almond pickup assembly 210 thus mechanically interacts with almonds on a ground surface and transports almonds from a gathered position and into the storage assembly 215. The brush assembly 605 is positioned so that bristles 615 barely touch the ground and only push objects with the size of an almond or bigger onto the conveyor belt 610. For example, a bottom edge of the bristles 615 may be positioned at a distance from the ground surface wherein the distance is a predetermined distance that corresponds to the size of an almond. In this manner, the brush assembly 605 transfers objects the size of almonds onto the conveyor belt 610. Moreover, since the bristles 615 barely touch the ground, there is much less dust generation when moving or pushing the almond nut from the ground to the storage assembly 215.

[0033] The conveyor belt 610 can also act as a cleaner such that only harvested almonds will be moved by the conveyor belt. Other objects such as dirt and small pebbles fall back into the field through a plurality of holes in the conveyor belt 610. The holes in the conveyor belt may be smaller in size than an almond such that an almond does not fall through the hole.

[0034] The harvested almonds travel along the conveyor belt 610 and into the storage assembly 215, which is adapted to at least temporarily receive and store harvested almonds during the harvesting process. The storage assembly 215 can be removable from the almond pickup system 105.

[0035] As mentioned, the control system 225 is configured to control various aspects of the almond pickup system 105. The control system 225 can control and synchronize the rotational speed of the almond sweeper assembly 205 with a forward speed of the almond pickup system 105. The control system 225

adjusts the forward speed to minimize the amount of dust generation. As mentioned, the airborne dust is measured using a dust and particulate sensor and forward speed is controlled based on the feedback from the dust sensor. In another embodiment, as discussed above, rotational speed of the sweeper blades 510 can also be controlled by the control system 225 based on the measured airborne dust using the dust and particulate sensor to minimize the amount of dust generation.

[0036] Cyclones are designed to trap the existing harvest dust near the sweepers and pickup section and eliminate them from the atmosphere around the harvester. Figure 8 shows a schematic representation of an embodiment of the almond pickup system 105 including a cyclone separator assembly 805. The cyclone separator 805 is configured to reduce dust output of the system, as described more fully below. The cyclone separator assembly 805 is positioned adjacent the brush assembly 605, which is attached to a brush height adjuster 810 that is configured to adjust the height of the brush assembly 605 relative to a ground surface. In one embodiment, the height of the brush assembly 605 can be controlled by control system 225. In still another embodiment, the height of the brush assembly 605 can be controlled by control system 225 based on the measured airborne dust using the dust and particulate sensor to minimize the amount of dust generation. A pickup cover 815 is positioned to cover or at least partially cover the brush assembly 605 so that dust is collected therein. An inlet 818 provides a passageway for dust captured within the pickup cover 815 to pass into the cyclone separator assembly 805.

[0037] With reference still to Figure 8, at least one dust sensor 820 is coupled to the pickup system 105. The embodiment of Figure 8 includes a first dust sensor 820a and a second dust sensor 820b wherein the dust sensor(s) are communicatively coupled to the cyclone separator assembly 805, brush height adjuster 810, and/or any other part of the pickup system 105. The cyclone separator assembly 805 is shown at the leading edge of the pickup system 105 although it should be appreciated that the cyclone separator assembly 805 can be located at various locations of the pickup system 105. The dust sensors 820 are configured to sense and measure an amount of dust. The dust sensors 820 can be located at various positions relative to the pickup system 105. For example, the dust sensor

820a is located at or near the cyclone separator assembly 805 and the dust sensor 820b is located at the conveyor belt 610. The pickup system 105 can include more or less dust sensors located at any of a variety of positions along the pickup system 105.

[0038] In user, the cyclone separator assembly 805 receives an airflow (including generated dust) via the inlet 818 such that the dust from inside the pickup cover 815 passed into the cyclone separator 805. The cyclone separator assembly 805 separate particulates (such as dust) from the airflow via a vortex separation process. The cyclone separator assembly 805 can output the dust to a separate location (such as back to the ground or to a collector bin) via an outlet 830. The cyclone separator assembly 805 can also include a fan 835 (or other device) to generate airflow. The fan 835 can be powered by a motor, such as a hydraulic or electric motor.

[0039] The cyclone separator assembly 805 can operate continuously with operation of the pickup system 105 or it can operate based on manual input of a user. In an embodiment, the cyclone separator assembly 805 operates automatically based on input from the dust sensor(s) 820a,b. For example, the cyclone separator assembly 805 can automatically activate based upon a level of dust reaching a predetermined threshold as measured by the dust sensor(s) 820. At least one dust sensor 820b can be mounted immediately adjacent the brush assembly 605 where maximum dust is generated.

[0040] The cyclone separator assembly 805 can operate similar to a centrifuge with a continuous feed of dust-filled air. The dust filled air is fed into a chamber defined by a housing 840. The inside of the chamber creates a spiral vortex which forms a combination of spiral fluid formation and dust separation. The lighter components of the airflow have less inertia such that the vortex causes the air to flow upward. Contrarily, larger components of particulate matter, such as dust, have more inertia and are not as easily influenced by the vortex. Since these larger particles have difficulty following the high-speed spiral motion of the air and the vortex, the particles hit the inside walls of the container and drop down into the outlet 830. The

chamber can vary in shape and is not limited to the shape illustrated in Fig. 8. The housing 840 and can be shaped, for example, as an upside-down cone to promote the collection of these particles at the bottom of the container. The cleaned air escapes out the top of the chamber to the atmosphere.

[0041] Figures 9A and 9B shows a non-limiting example embodiment of a housing and chamber of the cyclone separator assembly 805. Figure 9A shows a top down view of the cyclone separator assembly 805 and Figure 9B shows a side view. The cyclone separator assembly 805 has an upper region 907 that forms an inlet 905 configured to receive a continue feed of dust and contaminated or dirty air. The upper region 907 may have a diameter D (where D is an integer.) Inlet 905 may have a diameter b of between about $0.25D - 0.75D$ or $0.5D-1D$. The upper region 907 may have a height d of between about $1D-3D$ or $0.5D-2.5D$. The upper region 907 can communicate with a vortex region 910, which can be cylindrical in shape. The vortex region 910 forms a spiral vortex whereby lighter components, which has less inertia, travels up the vortex region 910. The vortex region 910 communicates with an outlet 915 that expels dust outward from the upper region 907. The outlet 915 may have a diameter a of between about $0.25D$ to $0.75D$ or $0.15D$ to $2D$. Heavier or larger components or particles that move through the vortex region do not have much inertia and do not follow the high-speed spiral motion of the gas vortex. Thus, these larger particles hit the inside walls of the upper region 907 and drop down into the funnel region 920. The upper region 907 downwardly transitions to a funnel region 920 that reduces in diameter moving downward. Thus, funnel region 902 can be shaped similar to an upside-down cone to promote the collection of the larger particles at the base of funnel region 920. The funnel region 920 can have a height e of between about $1D - 3D$ or between $0.5D - 3.5D$. The base of the funnel region 920 can have a diameter h of between about $0.01D$ to $0.75D$ or $0.25D$ to $0.99D$. The funnel region 920 then transitions to a downwardly extending tube 925 that connects to a collection chamber 930. Tube 925 can be of any desired length f . For example, length f can be between about $0.25D - 2D$ or $0.5D-4D$. Collection chamber may have any desired length g and width i . For example, length g can be between about $0.25D$ to $4D$ or $1D$ to $5D$. In another example, width i can be between about $0.25D$ to $4D$, between about $1D$ to $5D$ or the same diameter as D .

[0042] In a method of use, the almond pickup system 105 moves in a forward direction along a ground surface upon which one or more almonds are positioned. The sweeper blades 510 of the almond sweeper assembly 205 rotate and gather the almonds and position the almonds for receipt of the almond pickup assembly 210. The brush assembly 605 rotates to push the almonds onto the conveyor belt, which transports the almonds to the storage assembly 215. As mentioned, the brush assembly 605 barely touches the ground (or does not touch the ground) and only push objects with the size of an almond or bigger onto the conveyor belt 610. In addition, the conveyor belt 610 only moves objects the size of harvested almonds and other objects such as dirt and small pebbles fall back onto the ground through holes in the conveyor belt 610.

[0043] The disclosed system is self-propelled system can optionally run autonomously so it does not need a human operator to manually run and control. The system can also run under the supervision of or in collaboration with a human operator. For example, one or more of the systems disclosed herein can work in a common grove area with one or more humans to increase efficiency and scale a rate of almond pickup. The system can also be used as a tractor-driven implementation and can be attached to conventional tractors or new tractors with autonomous capability. Removal of a human operator from this process can prevent the operator's exposure to excessive dust and/or heat and reduces the health issues that could arise from exposure to excessive dust and/or heat. In addition, control system 225 includes feedback to control the forward speed of system and to control an amount of generated dust. Any moving parts are part of a feedback control loop system and synchronized to have optimized rotational speeds to maximize pickup rate and minimize harvest dust.

[0044] Figure 11 shows an embodiment of the pickup system 105 that includes or is coupled to an autonomous robot such an autonomous micro-tractor 1105, which is described in more detail below in Figure 12. The pickup system 105 includes the almond sweeper assembly 205 with the almond gathering component 415. The autonomous micro-tractor 1105 is removably or fixedly coupled to the almond pickup assembly 210 such as, in one embodiment, by being mechanically

attached to a frame of the conveyor belt 610. The autonomous micro-tractor 1105 may be removably or fixedly coupled to any part of the the pickup system 105 as desired, such as, for example, to the frame of the almond gathering component 415. The autonomous micro-tractor 1105 may be removably or fixedly coupled to the almond sweeper assembly 205 by any known means such as, for example, the use of screws and bolts, welding, glue, fasteners, ties, and the like. In a non-limiting example embodiment, the autonomous micro-tractor 1105 is an AMIGA micro-tractor manufactured by farm-ng, Inc. of Watsonville, CA. although other autonomous micro-tractor systems are within the scope of this disclosure.

[0045] Figure 12 shows an example embodiment of an autonomous micro-tractor 1105, which includes a frame 1205 on which are mounted one or more wheels 1210. The frame 1205 is sized and shaped to be coupled to the pickup system 105 such as by fitting onto or over the conveyer belt 610 (as shown in Figure 11) or onto or over any other portion of the pickup system 105. The frame 1205 may be adjustable to any size or shape desired by a user. The micro-tractor 1105 can include a control element such as a display having one or more user interfaces. The micro-tractor 1105 can include a motor, such as an electric motor and is configured to communicate (wirelessly or wired) with software for controlling movement of the micro-tractor 1105.

[0046] Figure 10 depicts a block diagram illustrating an example of a computing control system consistent with implementations of the current subject matter. The computing control system 1000 may implement processes and methods described herein such as pursuant to control of the pickup system 105 in connection with the control system 225. As shown in Figure 10, the computing system 1000 can include a processor 1010, a memory 1020, a storage device 1030, and input/output device 1040. The processor 1010, the memory 1020, the storage device 1030, and the input/output device 1040 can be interconnected via a system bus 950. The processor 1010 is capable of processing instructions for execution within the computing system 1000. Such executed instructions can implement one or more components of, for example, VESA, 3D-ID AI, and/or MP Tool. In some implementations of the current subject matter, the processor 1010 can be a single-

threaded processor. Alternately, the processor 1010 can be a multi-threaded processor. The processor 1010 is capable of processing instructions stored in the memory 1020 and/or on the storage device 1030 to display graphical information for a user interface provided via the input/output device 1040.

[0047] The memory 1020 is a computer readable medium, such as volatile or non-volatile that stores information within the computing system 1000. The memory 1020 can store data structures representing configuration object databases, for example. The storage device 1030 is capable of providing persistent storage for the computing system 1000. The storage device 1030 can be a floppy disk device, a digital cloud, a hard disk device, an optical disk device, or a tape device, or other suitable persistent storage means. The input/output device 1040 provides input/output operations for the computing system 1000. In some implementations of the current subject matter, the input/output device 1040 includes a keyboard and/or pointing device. In various implementations, the input/output device 1040 includes a display unit for displaying graphical user interfaces. According to some implementations of the current subject matter, the input/output device 1040 can provide input/output operations for a network device. For example, the input/output device 1040 can include Ethernet ports or other networking ports to communicate with one or more wired and/or wireless networks, Bluetooth or digital cloud system (e.g., a local area network (LAN), a wide area network (WAN), the Internet).

[0048] In some implementations of the current subject matter, the computing system 1000 can be used to execute various interactive computer software applications that can be used for organization, analysis and/or storage of data in various (e.g., tabular) format (e.g., Microsoft Excel®, and/or any other type of software). Alternatively, the computing system 1000 can be used to execute any type of software application. These applications can be used to perform various functionalities, e.g., planning functionalities (e.g., generating, managing, editing of spreadsheet documents, word processing documents, and/or any other objects, etc.), computing functionalities, communications functionalities, etc. The applications can include various add-in functionalities, plug ins, or can be standalone computing

products and/or functionalities. Upon activation within the applications, the functionalities can be used to generate the user interface provided via the input/output device 1040. The user interface can be generated and presented to a user by the computing system 1000 (e.g., on a computer screen monitor, etc.). The user interface can be integrated with other devices or virtual ecosystems.

[0049] One or more aspects or features of the subject matter described herein can be realized in digital electronic circuitry, integrated circuitry, specially designed ASICs, field programmable gate arrays (FPGAs) computer hardware, firmware, software, and/or combinations thereof. These various aspects or features can include implementation in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor, which can be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device, and at least one output device. The programmable system or computing system may include clients and servers. A client and server are generally remote from each other and typically interact through a communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other.

[0050] These computer programs, which can also be referred to as programs, software, software applications, applications, components, or code, include machine instructions for a programmable processor, and can be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. As used herein, the term “machine-readable medium” refers to any computer program product, apparatus and/or device, such as for example magnetic discs, optical disks, memory, and Programmable Logic Devices (PLDs), used to provide machine instructions and/or data to a programmable processor, including a machine-readable medium that receives machine instructions as a machine-readable signal. The term “machine-readable signal” refers to any signal used to provide machine instructions and/or data to a programmable processor. The machine-readable medium can store such machine instructions non-transitorily, such as for example as would a non-transient

solid-state memory or a magnetic hard drive or any equivalent storage medium. The machine-readable medium can alternatively or additionally store such machine instructions in a transient manner, such as for example, as would a processor cache or other random access memory associated with one or more physical processor cores.

[0051] The subject matter described herein can be implemented in analog electronic circuitry, digital electronic circuitry, and/or in computer software, firmware, or hardware, including the structural means disclosed in this specification and structural equivalents thereof, or in combinations of them. The subject matter described herein can be implemented as one or more computer program products, such as one or more computer programs tangibly embodied in an information carrier (e.g., in a machine readable storage device), or embodied in a propagated signal, for execution by, or to control the operation of, data processing apparatus (e.g., a programmable processor, a computer, or multiple computers). A computer program (also known as a program, software, software application, or code) can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file. A program can be stored in a portion of a file that holds other programs or data, in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by a communication network.

[0052] Any processes and/or logic flows described in this specification, including the method steps of the subject matter described herein, can be performed by one or more programmable processors executing one or more computer programs to perform functions of the subject matter described herein by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus of the subject matter described herein can be

implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application specific integrated circuit).

[0053] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random access memory or both. The essential elements of a computer are a processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, (e.g., EPROM, EEPROM, and flash memory devices); magnetic disks, (e.g., internal hard disks or removable disks); magneto optical disks; and optical disks (e.g., CD and DVD disks). The processor and the memory can be supplemented by, or incorporated in, special purpose logic circuitry.

[0054] To provide for interaction with a user, the subject matter described herein can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor, for displaying information to the user and a keyboard and a pointing device, (e.g., a mouse or a trackball), by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well. For example, feedback provided to the user can be any form of sensory feedback, (e.g., visual feedback, auditory feedback, or tactile feedback), and input from the user can be received in any form, including acoustic, speech, or tactile input.

[0055] The techniques described herein can be implemented using one or more modules. As used herein, the term “module” refers to computing software, firmware, hardware, and/or various combinations thereof. At a minimum, however, modules are not to be interpreted as software that is not implemented on hardware,

firmware, or recorded on a non-transitory processor readable recordable storage medium (i.e., modules are not software per se). Indeed “module” is to be interpreted to always include at least some physical, non-transitory hardware such as a part of a processor or computer. Two different modules can share the same physical hardware (e.g., two different modules can use the same processor and network interface). The modules described herein can be combined, integrated, separated, and/or duplicated to support various applications. Also, a function described herein as being performed at a particular module can be performed at one or more other modules and/or by one or more other devices instead of or in addition to the function performed at the particular module. Further, the modules can be implemented across multiple devices and/or other components local or remote to one another. Additionally, the modules can be moved from one device and added to another device, and/or can be included in both devices.

[0056] The subject matter described herein can be implemented in a computing system that includes a back end component (e.g., a data server), a middleware component (e.g., an application server), or a front end component (e.g., a client computer having a graphical user interface or a web browser through which a user can interact with an implementation of the subject matter described herein), or any combination of such back end, middleware, and front end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a local area network (“LAN”) and a wide area network (“WAN”), e.g., the Internet.

[0057] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as “about,” “approximately,” and “substantially,” are not to be limited to the precise value specified. In at least some instances, the approximating language may correspond to the precision of an instrument for measuring the value. Here and throughout the specification and claims, range limitations may be combined and/or interchanged,

such ranges are identified and include all the sub-ranges contained therein unless context or language indicates otherwise.

[0058] Certain exemplary embodiments have been described to provide an overall understanding of the principles of the structure, function, manufacture, and use of the systems, devices, and methods disclosed herein. One or more examples of these embodiments have been illustrated in the accompanying drawings. Those skilled in the art will understand that the systems, devices, and methods specifically described herein and illustrated in the accompanying drawings are non-limiting exemplary embodiments and that the scope of the present invention is defined solely by the claims. The features illustrated or described in connection with one exemplary embodiment may be combined with the features of other embodiments. Such modifications and variations are intended to be included within the scope of the present invention. Further, in the present disclosure, like-named components of the embodiments generally have similar features, and thus within a particular embodiment each feature of each like-named component is not necessarily fully elaborated upon.

[0059] While this specification contains many specifics, these should not be construed as limitations on the scope of an invention that is claimed or of what may be claimed, but rather as descriptions of features specific to particular embodiments. Certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable sub-combination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a sub-combination or a variation of a sub-combination. Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. Only a few

examples and implementations are disclosed. Variations, modifications and enhancements to the described examples and implementations and other implementations may be made based on what is disclosed.

CLAIMS

1. A system configured to pick up produce, comprising:
 - a produce sweeper assembly configured to gather produce, the produce sweeper assembly including at least one sweeper blade positioned at a height relative to a ground surface, wherein the height of the sweeper blade is adjustable;
 - a produce pickup assembly configured to pick up gathered produce gathered by the produce sweeper assembly, wherein the produce pickup assembly includes at least one bristle that pushes the gathered produce onto a conveyor belt of the produce pickup assembly;
 - a produce storage assembly, wherein the conveyor belt transfers the gathered produce into the produce storage assembly; and
 - a control system communicatively coupled to the produce sweeper assembly and the produce pickup assembly, wherein the control system controls at least one aspect of the produce sweeper assembly and at least one aspect of the produce pickup assembly.
2. The system of claim 1, wherein the control system controls the height of the sweeper blade relative to the ground surface.
3. The system of claim 2, wherein the control system keeps the height constant relative to the ground surface.
4. The system of claim 1, wherein the control system controls a forward speed of the almond sweeper assembly and the produce pickup assembly.
5. The system of claim 4, wherein the control system synchronizes the forward speed of the produce pickup assembly with a rotational speed of the at least one sweeper blade of the almond sweeper assembly.
6. The system of claim 1, wherein the control system controls a speed of the at least one bristle of the produce pickup assembly to minimize dust.
7. The system of claim 1, wherein the at least one sweeper blade is oriented at an angle relative to the ground surface.

8. The system of claim 1, wherein the at least one sweeper blade comprises at least two sweeper blades that rotate.

9. The system of claim 1, wherein the conveyor belt includes at least one hole that is smaller than a size of an almond.

10. The system of claim 1, wherein the almond sweeper assembly, the produce pickup assembly, and the produce storage assembly are mechanically linked to one another.

11. The system of claim 1, further comprising a cyclone separator assembly coupled to the produce sweeper assembly.

12. The system of claim 1, wherein the produce comprises almonds.

13. The system of claim 11, wherein the cyclone separator assembly receives dust from the produce sweeper assembly.

14. The system of claim 11, wherein the cyclone separator assembly includes a first dust sensor is configured to sense an amount of dust.

15. A method of gathering produce, comprising:

moving a produce pickup assembly in a forward direction along a ground surface, wherein at least one produce item is position on the ground surface, the produce pickup assembly including a produce sweeper assembly configured to gather produce, the produce sweeper assembly including at least one sweeper blade positioned at a height relative to a ground surface, wherein the height of the sweeper blade is adjustable;

causing the at least one sweeper blade to move the produce item onto a conveyor belt that transfers the produce item into a storage assembly;

causing the conveyor belt to transfer the produce item into the storage assembly;

automatically adjusting a height of the sweeper blades relative to the ground surface.

16. The method of claim 15, wherein at least a portion of the produce sweeper assembly rotates, and further comprising automatically controlling a

rotational speed of the produce sweeper assembly based in a forward speed of the produce pick up assembly.

17. The method of claim 15, further comprising causing dust into a cyclone separator assembly.

18. The method of claim 15, wherein the produce pickup assembly only pushes objects with the size of an almond or bigger onto the conveyor belt.

19. The method of claim 18, wherein the conveyer belt has at least one hole sized to receive therethrough an object smaller than an almond.

20. The method of claim 15, wherein the almond sweeper assembly, the produce pickup assembly, and the produce storage assembly are mechanically linked to one another.

1/12

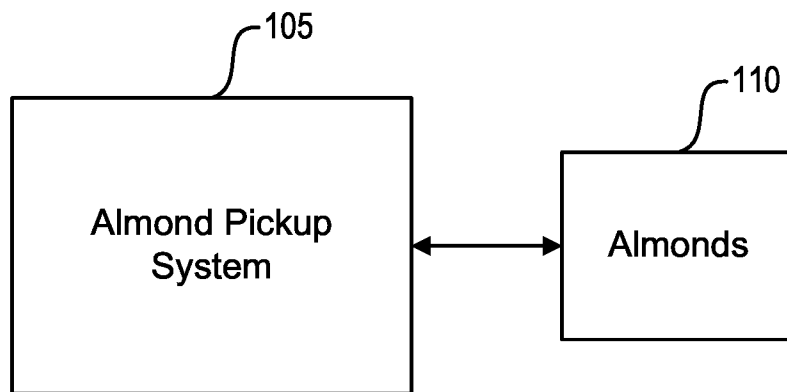


FIG. 1

2/12

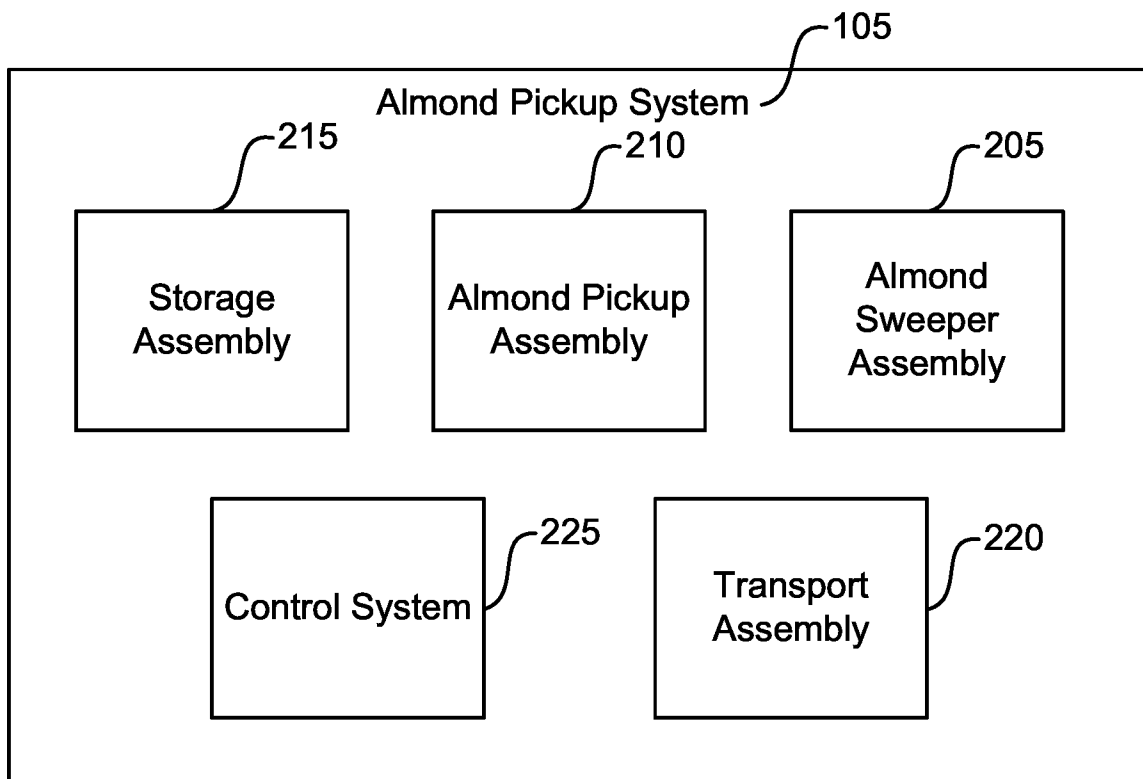


FIG. 2

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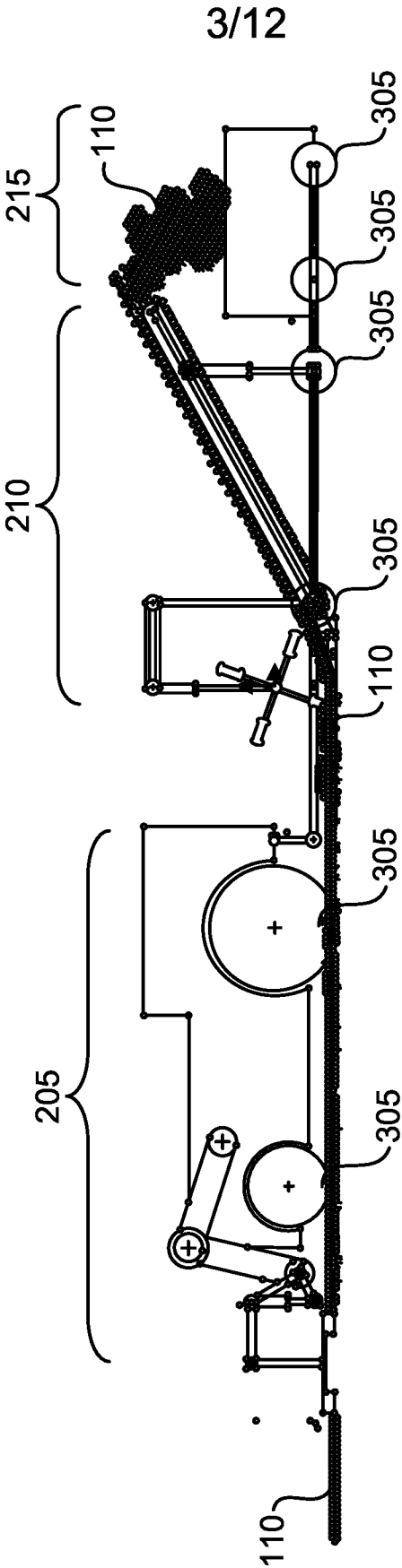


FIG. 3

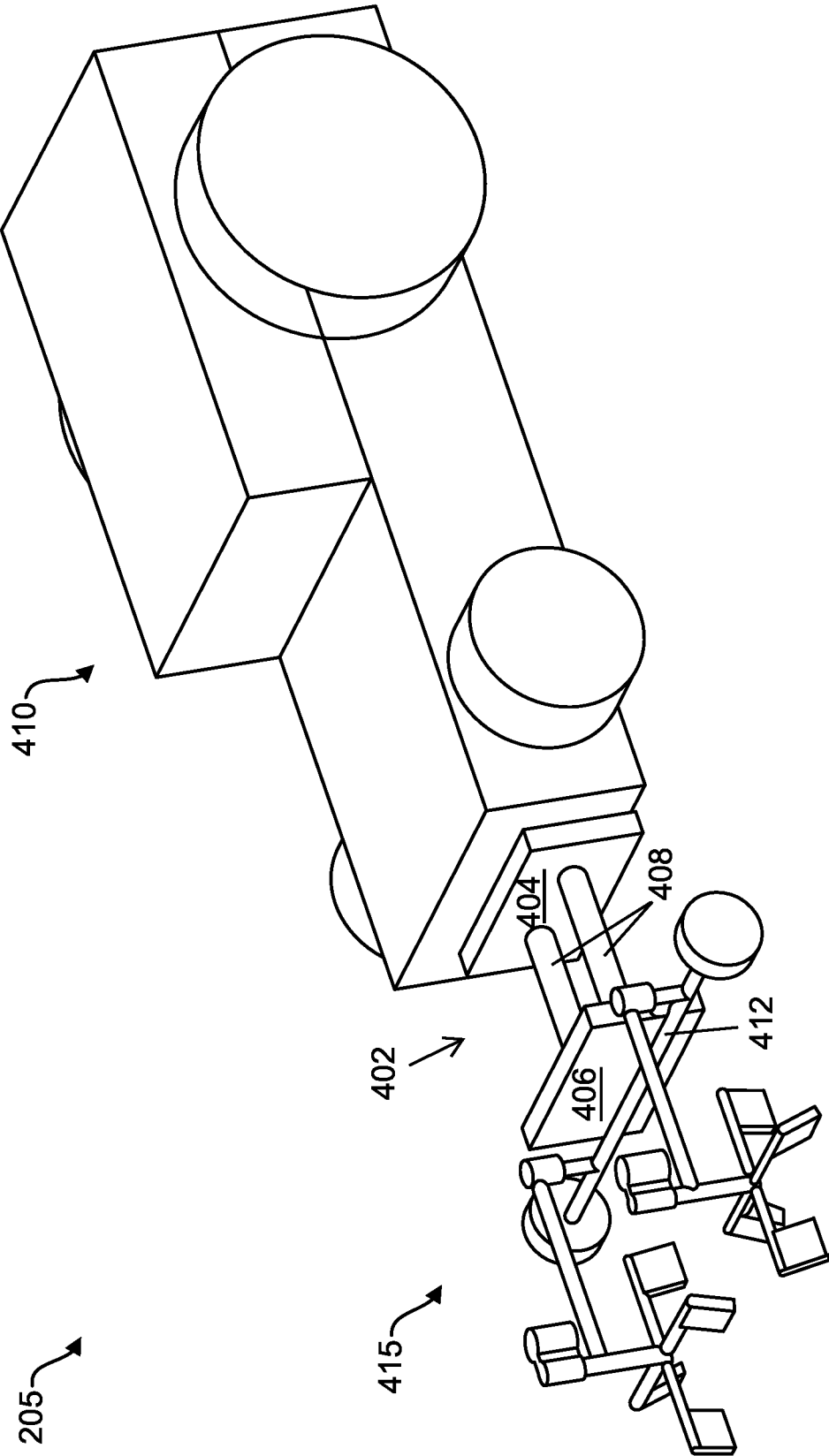


FIG. 4

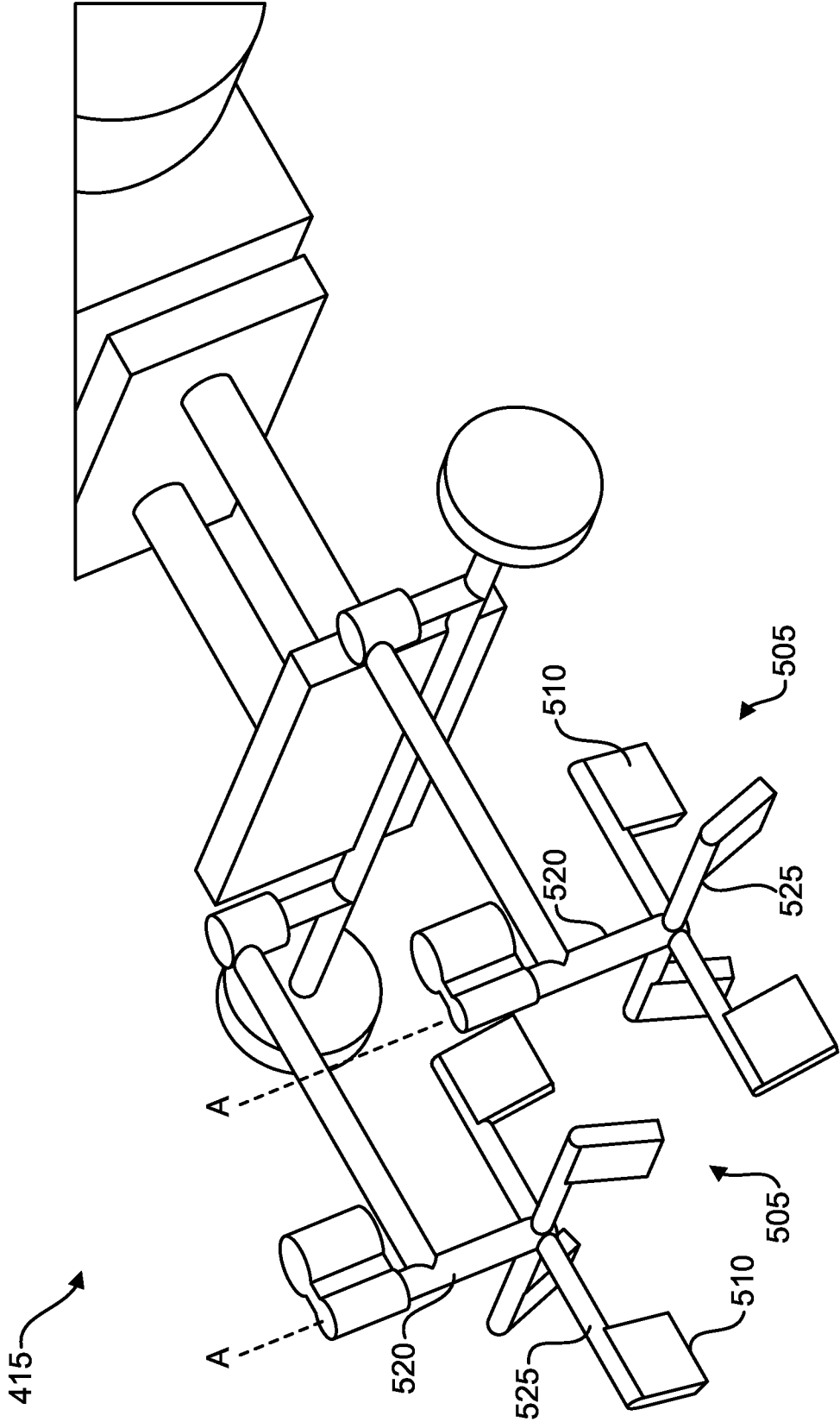


FIG. 5

6/12

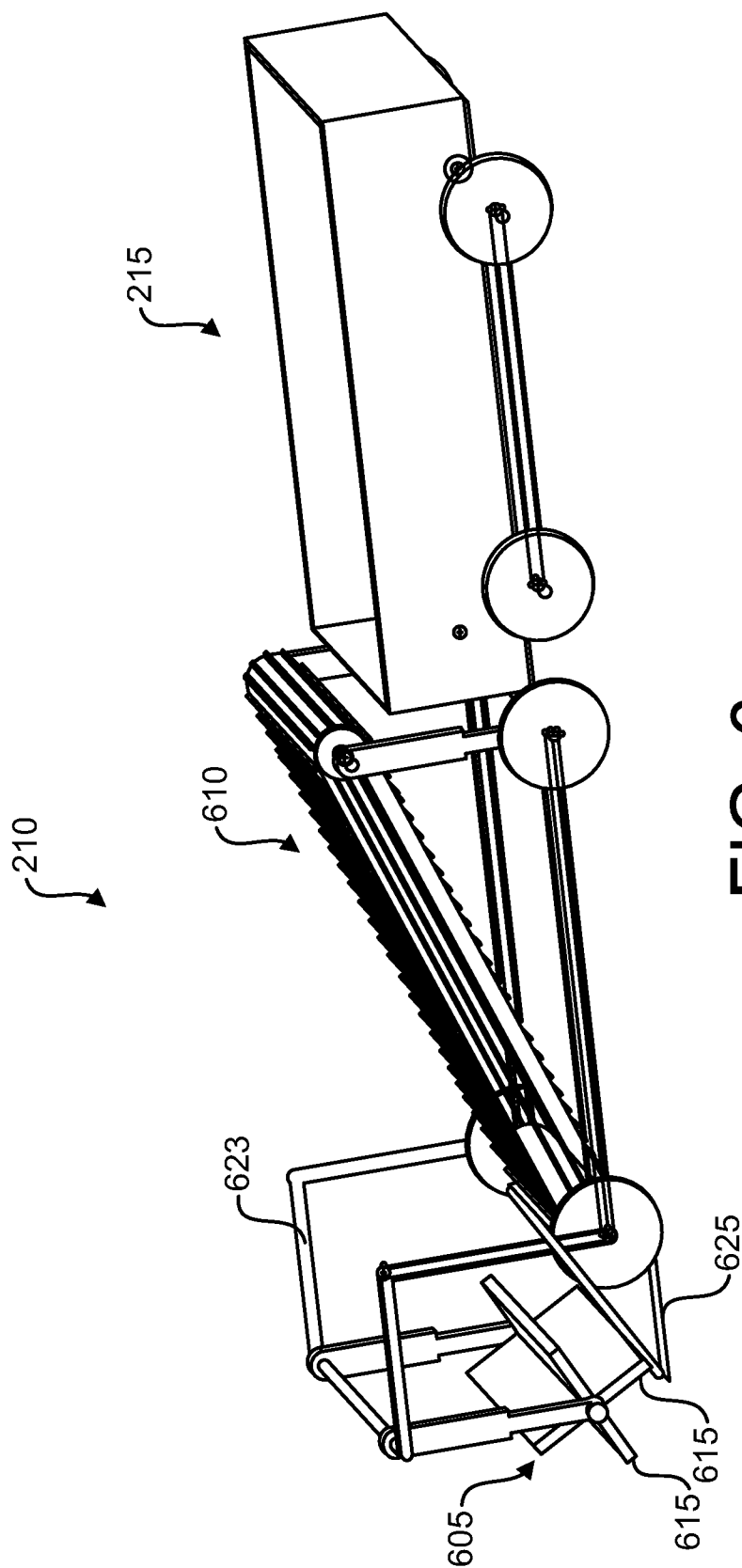


FIG. 6

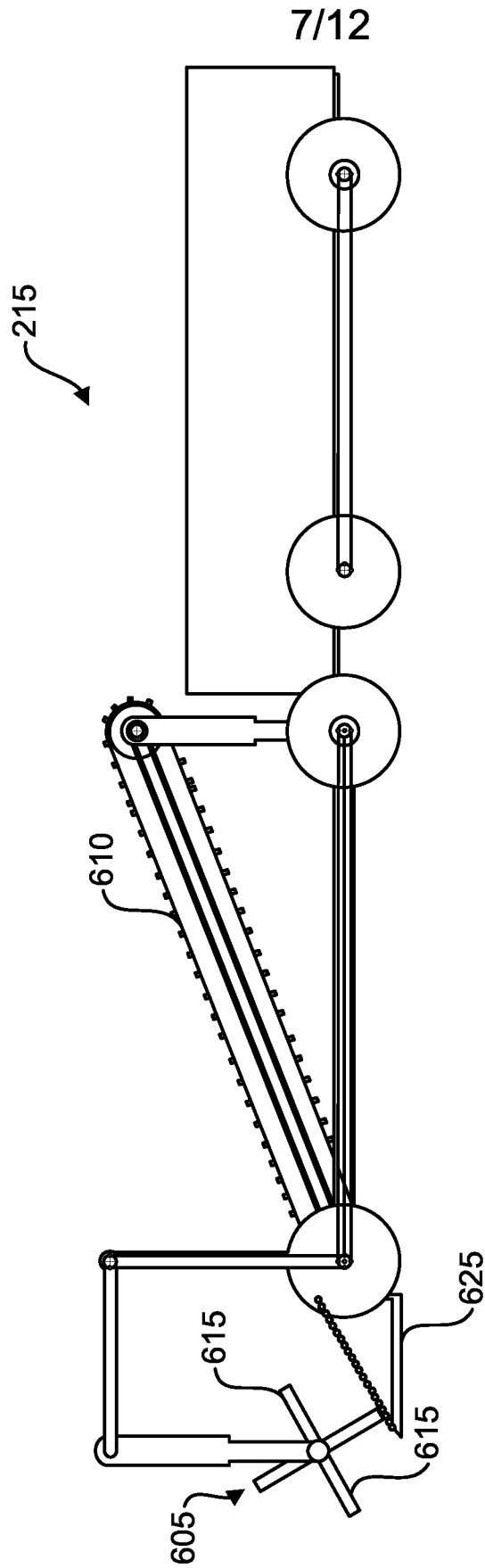


FIG. 7

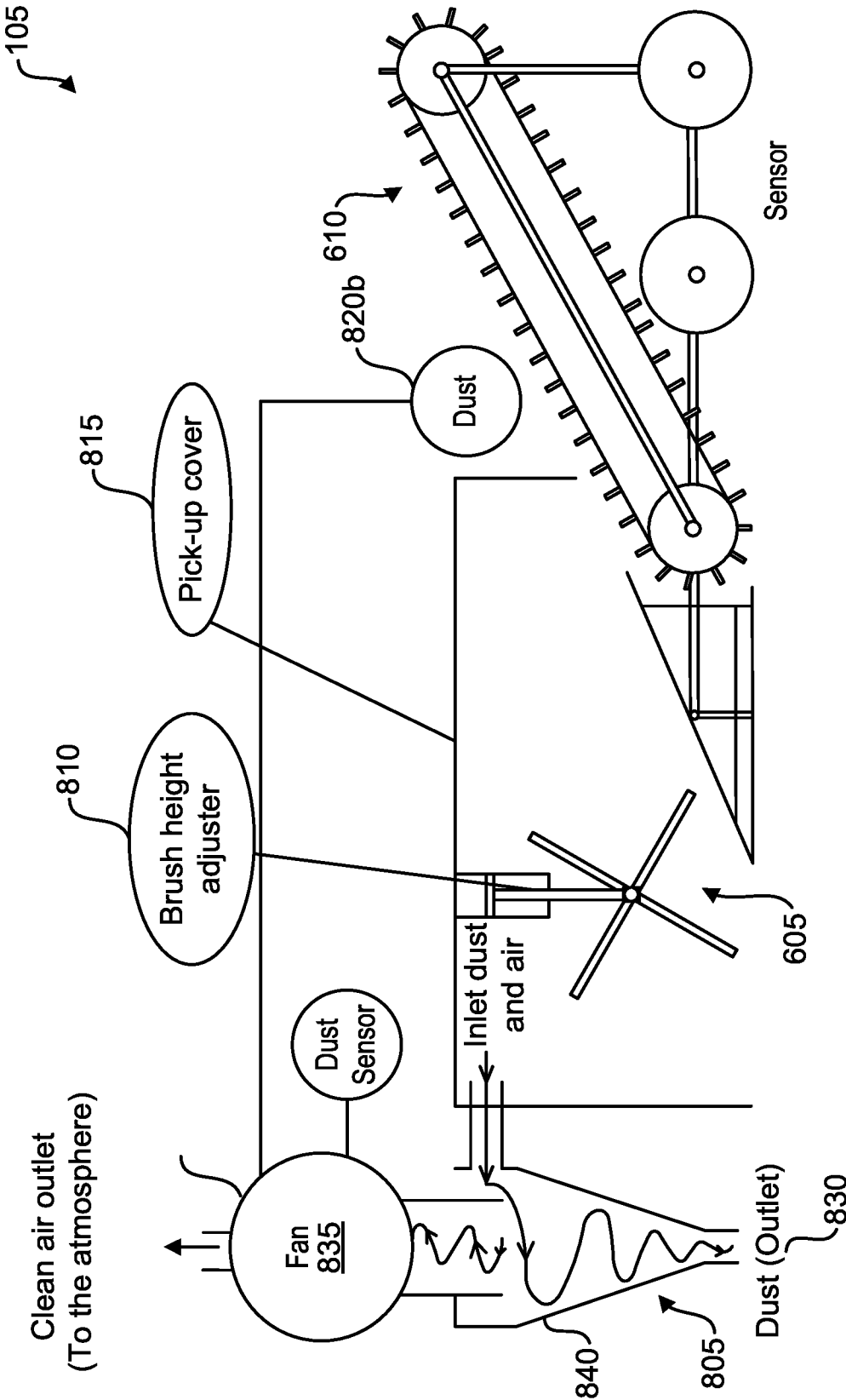


FIG. 8

9/12

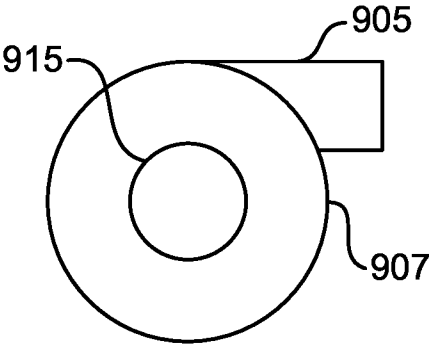


FIG. 9A

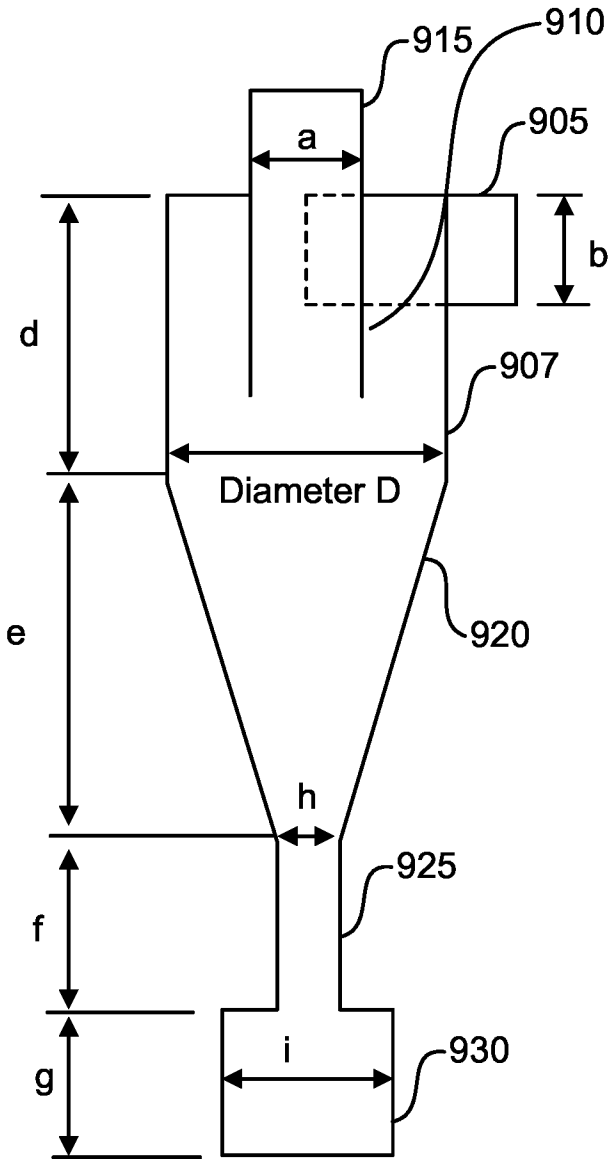


FIG. 9B

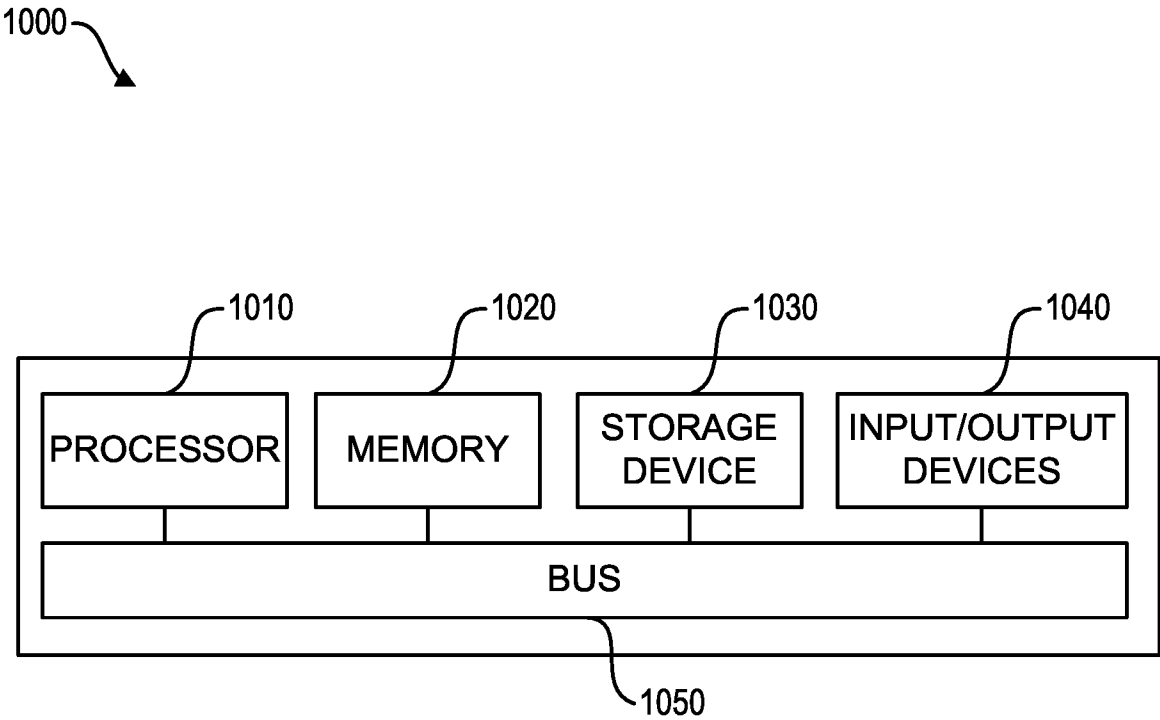


FIG. 10

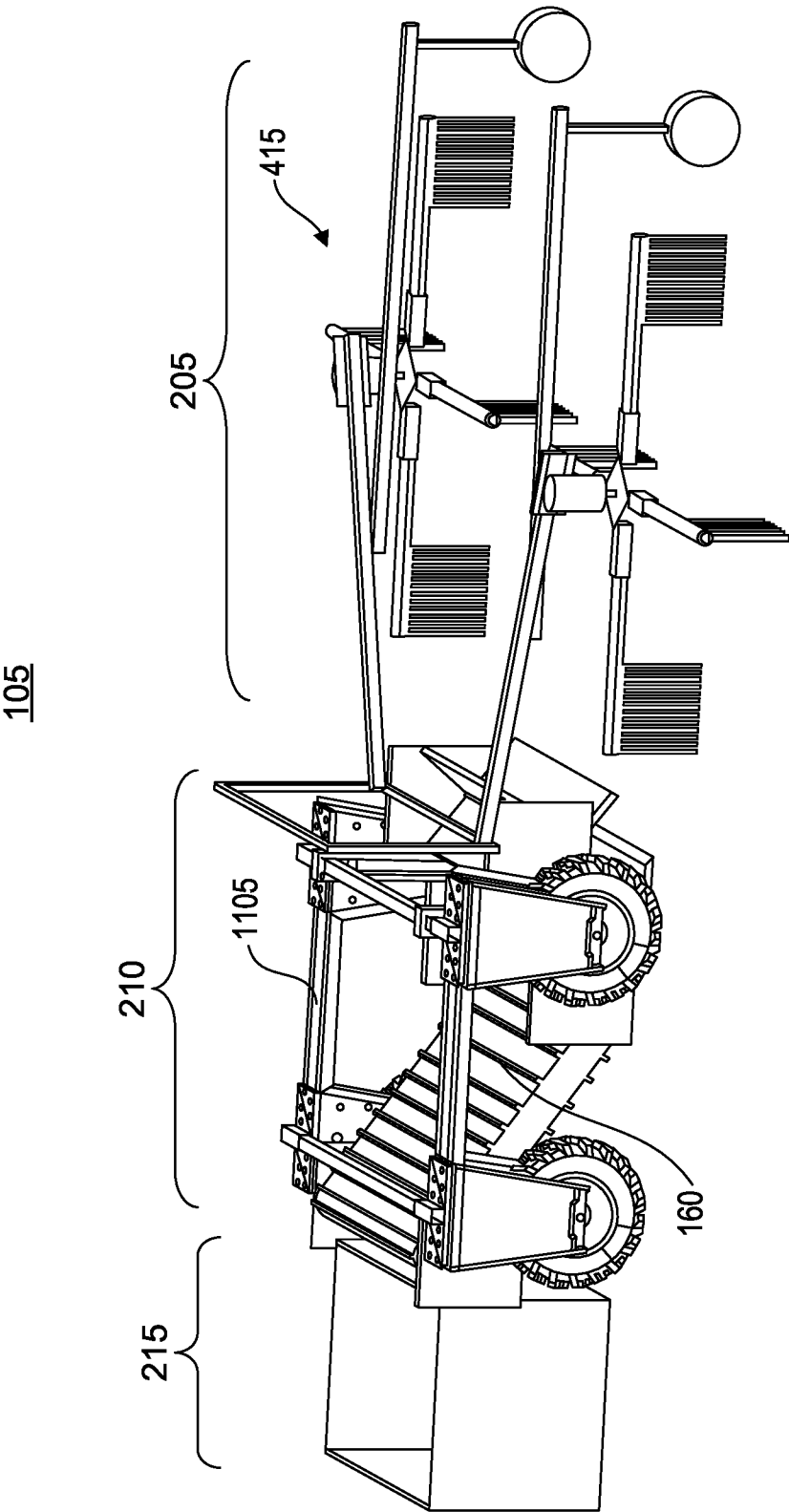


FIG. 11

12/12

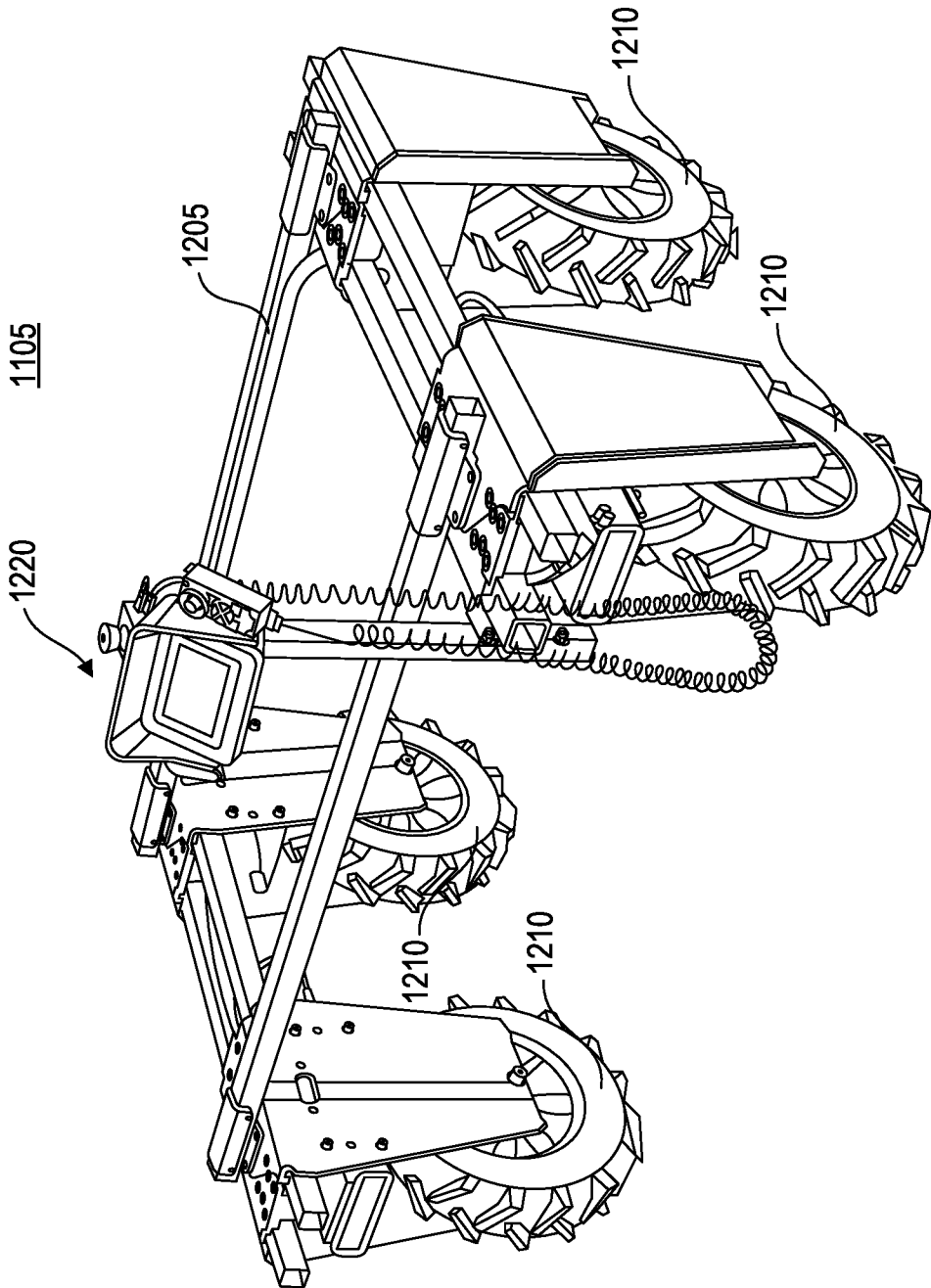


FIG. 12