(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 December 2024 (19.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/256585 A2

(51) International Patent Classification:
A01G 9/08 (2006.01) *B25J 15/00* (2006.01)
A01H 4/00 (2006.01)

(21) International Application Number:
PCT/EP2024/066453

(22) International Filing Date:
13 June 2024 (13.06.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2035082 13 June 2023 (13.06.2023) NL

(71) Applicant: **IG SPECIALS B.V.** [NL/NL]; Middelkampseweg 9, 5311 PC Gameren (NL).

(72) Inventors: **VAN DER MEIJDEN, Wim**; Middelkampseweg 9, 5311 PC Gameren (NL). **STRUIJK, Wim**; Middelkampseweg 9, 5311 PC Gameren (NL). **VAN OOIJEN, Henk-Jan**; Middelkampseweg 9, 5311 PC Gameren (NL).

(74) Agent: **HOYNG ROKH MONEGIER B.V.**; Rembrandt Tower, 30th Floor Amstelplein 1, 1096 HA Amsterdam (NL).

(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, 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))*

(54) **Title:** SYSTEM AND METHODS FOR PROCESSING PLANT MATERIAL

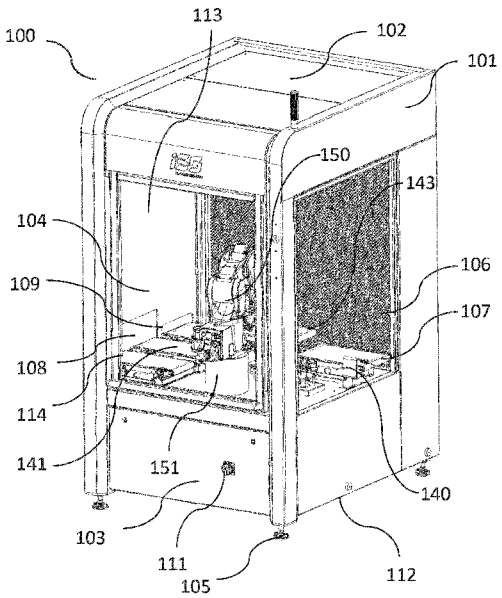

Figure 1

(57) **Abstract:** The present invention discloses a system for processing plant material, such as sprouts and explants, and comprises a plant supply unit which comprises a platform that supports supplied plant material. The system further comprises a container supply unit for supply 5 containers preferably having a bottom with walls and an open top. The system further comprises a pick-and-place robot for picking individual plant material, the pick and place robot comprising a grasping element for grasping the plant material, wherein the grasping element has elongated rods for grasping individual plant material between ends of the rods. In this system, the pick-and-place robot is arranged to pick supplied individual plant material 0 from the platform and to place the individual plant material in the container. In this system, the pick-and-place robot is also arranged to place the individual plant material having a predetermined orientation, preferably root downwards, in the container.

WO 2024/256585 A2

System and methods for processing plant material

TECHNICAL FIELD

[001] The disclosed technology relates generally to the processing of plant material, such as sprouts and explants. The disclosed technology further relates to the processing of plant material inside a cleanroom or in a clean environment.

BACKGROUND

[002] The present invention aims to improve the processing of plant materials, such as explants or sprouts, in clean environment wherein the processing comprises orienting the plant material into a holder, e.g. a container with nutrients. This processing is mostly handled by humans as this can be very delicate. Automated processing can reduce costs.

SUMMARY

[003] There is proposed, according to a first aspect of the disclosure, combinable with any of the features disclosed herein, a system for processing plant material, such as sprouts and explants. The system can comprise a frame or a cabinet that surround units and modules of the system for providing clean environment. The cabinet can be (partially) closed off to keep out contamination.

[004] The system can comprise a plant supply unit. Plant material, e.g. explants, can be provided onto the plant supply unit. Humans or machines can load plant material onto the plant supply unit. The plant supply unit can be embodied by one or more conveyor units. The plant supply unit allows transporting the supplied plant material into the system and allows transporting the plant material from one location to another in the system. In embodiments, the plant supply unit is arranged to support a substrate that carries plant material, such as sprouts or explants. The substrate can be transported from one conveyor unit to another. The plant supply unit can comprise one or more platforms that support the supplied plant material. The plant supply unit can transport the plant material to a predetermined location in the system, e.g. a platform which can be one of the conveyor units. The platform can comprise a support surface, horizontally positioned.

[005] The system may further comprise a container supply unit. Containers can be loaded onto the container supply unit and the container supply unit can transport the supplied

containers into the system and in the system from one location to another. The container supply unit can transport the container to a predetermined location in the system, which is suitable for a pick-and-place robot of the system to reach the container. Containers can have a bottom with walls and an open top. A cultivation medium and/or nutrients may be provided in the containers. In embodiments, each container is arranged to receive multiple sprouts or explants in the cultivation medium.

[006] The system can be arranged to process the supplied plant material and position individual plant materials in the supplied containers, for example by inserting the plant material into the container's cultivation medium while orienting the plant material such that the root end of the plant material is facing the bottom surface of the container. The root end of the plant is preferably inserted into a fluid held on the bottom of the container. In embodiments the system comprises a pick-and-place robot for picking individual plant material. In embodiments, the pick-and-place robot comprises a grasping element for grasping the plant material, preferably grasping supplied plant material from the platform. Subsequently, the grasping element is controlled to grasp the plant material and the pick-and-place robot is controlled to insert the plant material in a cultivation medium of a container while the root end of the plant material is facing downwards. In embodiments, the grasping element has elongated rods for grasping individual plant material between ends of the rods. In embodiments, the grasping element can be in form of a tweezer or a tweezer with angled tips.

[007] In embodiments the pick-and-place robot is arranged to pick supplied individual plant material from the platform and to place the individual plant material in the container. In embodiments, the pick-and-place robot is arranged to grasp the individual plant material by orienting the grasping element with respect to the individual plant material in a predetermined orientation. In embodiments, the platform with supplied plant material and the pick-and-place robot are arranged to cooperate for orienting the grasping element with respect to the individual plant material supplied on that platform. That platform can be oriented with respect to the pick-and-place robot and the grasping element. In embodiments, the system comprises a camera to capture images of the supplied plant material. In embodiments, the system comprises a processor for processing captured images of plant material to obtain orientations of the individual supplied plant material. The pick-and-place robot is controlled to orient the grasping element with respect to the obtained orientation of the individual plant material to be grasped and picked-up.

[008] In embodiments, the pick-and-place robot is arranged to orient the grasping element that grasped the plant material during placing the individual plant material in the container, so that the plant material is positioned in the container in a predetermined orientation, preferably with the root end downwards. By orienting the grasping element before grasping the plant material, the plant material is held in a predetermined orientation in the grasping element. Subsequently the grasping element can be used to orient, position and/or place the plant material in a predetermined position in the container.

[009] In embodiments, the system comprises one or more modules for cleaning, decontaminating and/or conditioned air supply. This allows using the system to process fragile sprouts or explants in clean environment. Sprouts and explants can be contaminated without such cleaning module. By providing a system with a cleaning module, e.g. for cleaning the grasping unit, contamination between batches of supplied plant material is reduced. The frequency of cleaning of the grasping unit, such as cleaning of the grasping surfaces of the grasping unit which make contact with the plant material, can be adjusted as needed. It can be cleaned whenever the system recognises contamination on the grasping unit. It can be clean after each picking-and-placing of the plant material, or after completing the tasks on each container, or before and after each batch of plant material is provided from the outside to the system. Conditioned air supply also lowers the risk of contamination. In embodiments, the modules and supply units are contained in a cabinet, preferably in a overpressure environment. This keeps contaminations away from the processing area.

[0010] According to a further aspect of the invention, combinable with any of the features disclosed herein, a method for processing plant material is proposed. The method comprises steps of:

- supplying plant material;
- transporting the supplied plant material to a predetermined location within a controlled environment;
- picking up the plant material using a pick-and-place robot;
- orienting the picked plant material such that a root end of the plant material is facing downwards;
- supplying a container having a cultivation medium to a second predetermined location;

- inserting the picked plant material into the cultivation medium of the container with the root end facing downwards;

[0011] In embodiments, the method further comprises a step of orienting the supplied plant material to an orientation that require a less movement for the pick-and-place robot to pick up compared to picking up from the original orientation.

[0012] In embodiments, the method further comprises a step of cleaning a grasping element of the pick-and-place robot. The cleaning can be done by induced heat or other appropriate means.

[0013] In embodiments, the method further comprises a step of recognizing the supplied plant material using pattern recognition to identify a suitable pick-up angle for the pick-and-place robot to pick up the plant material.

[0014] In embodiments, the method further comprises a step of providing a laminar air flow to the plant material such that no external contaminant can approach the plant material.

[0015] In embodiments, the method further comprises a step of providing an over-pressure environment at the grasping and placing locations.

[0016] According to a further aspect of the invention, combinable with any of the features disclosed herein, a method for processing plant material, such as sprouts and explants is provided. In embodiments of the method containers and plant material are provided.

[0017] In embodiments of the method the plant material is supplied onto a platform that supports supplied plant material. Container are supplied, e.g. to a predetermined position.

[0018] In embodiments of the method a robot arm picks-and-places individual plant material. The picking comprises grasping the plant material, placed on the platform, between ends of elongated rods which may comprise two flat surfaces facing one another. In embodiments, the orientation of individual plant material supplied on the platform is recognised, e.g. by capturing an image. In embodiments, grasping the individual plant material comprises orienting the grasping elements with respect to the orientation of the plant material. In embodiments, the pick-and-place robot and the platform cooperate to orient the plant material, e.g. by rotating the platform such that the plant material is oriented in a direction that is suitable for pick-up by the pick-and-place robot. Preferably, the orientation is provided such that when the plant material is picked up, the root of the plant material is pointing away from the grasping elements so that the pick-and-place robot can easily rotate the plant material with minimal rotational motion and insert the root into a cultivation medium in a

container. When a first targeted plant material is picked up by the pick-and-place robot, the platform can already rotate such that a second plant material is already in an orientation suitable for easy pick-up.

[0019] The placing in a container can comprise positioning the picked plant material in the container oriented in a predetermined orientation, preferably with the root end downwards. By grasping the plant material in accordance with a predetermined orientation, the plant material can be oriented subsequently in a predetermined orientation during placing in the container.

[0020] Placing in one container of individual grasped plant material is repeated multiple times in embodiments. The positions of the individual plant materials in the cultivation medium in that container are in accordance with a predetermined pattern, e.g. having a minimum distance to each other and/or to the wall of the container.

[0021] According to a further aspect, combinable with any of the features disclosed herein, a system and method for processing plant material, such as sprouts and explants, is provided wherein plant material and containers are supplied. The plant material is supplied to a platform. A pick-and-place robot for picking individual plant material will pick the plant material from the platform using a grasping element. The pick-and-place robot can place the individual plant material into the container, wherein the plant material will have a predetermined position, e.g. with the roots downwards. The system and method comprise a platform that is rotatable around a vertical axis. This allows rotating the supplied plant material supplied on the platform with respect to the pick-and-place robot. This reorients the supplied plant material. As the pick-and-place robot will be arranged to pick the supplied plant in accordance with a predetermined preferred orientation, which allows the pick-and-place robot to position the plant material in the container with high walls and a low bottom, the orientation of the supplied plant on the platform defines how the robot will grasp and approach that supplied plant material. The orientation can be in any direction (360 degrees). Providing a pick-and-place robot that can pick supplied plant material within a limited domain of orientations / directions (e.g. a range of 100 degrees), will significantly lower the costs of the robot. By providing a rotating platform, supplied plant material can be reoriented to bring the plant material within the orientation range of the robot. According to embodiments, a controller is arranged to drive the platform and robot such that they cooperate to grasp the individual plant material having predetermined orientation. In

embodiments, an input unit, such as a camera, is used to obtain orientations of individual supplied plant materials, preferably when supplied onto the platform.

[0022] Further embodiments of the disclosed invention are disclosed herein. Although features are presented in combination, it will be clear to the skilled man that, unless indicated as essential, any of the features can be taken in isolation or in combination with any other feature. Features of the invention are provided in the claims and in the detailed description with reference to the figure. Divisional can be directed at any combination of features disclosed herein.

BRIEF DESCRIPTION OF DRAWINGS

[0023] Hereinafter, certain embodiments will be described in further detail. It should be appreciated, however, that these embodiments may not be construed as limiting the scope of protection for the present disclosure.

FIG. 1 shows an example embodiment of a system for processing plant material;

FIG. 2 shows a top view of an example embodiment of a system for processing plant material;

FIG. 3 shows an example embodiment of a platform for supporting plant material;

FIGS. 4a-4e show example implementations of a method for processing plant material;

FIG. 5 shows an example implementation of a system for processing plant material;

FIGS. 6a-6b show example embodiments of a grasping element of pick-and-place head;

FIGS. 7a-7b shows example embodiments of a pick-and-place head picking and placing plant material;

[0024] Any of the embodiments disclosed above may be combined in any appropriate manner.

DETAILED DESCRIPTION OF DRAWINGS

[0025] Embodiments will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts. Although separate figures are provided, any of the features disclosed therein and discussed here below can be combined in a single embodiment.

[0026] FIG. 1 shows an example embodiment of a system 100 for processing plant material. The system 100 may carry out operations such as picking the plant material and placing (or

planting) the plant material into a container. The system 100 comprises a plant supply unit 140 and container supply unit 141, here embodied by several conveyors or transporters with drives and belts. The supply units 140,141 can have platforms to support supplied plant material and a supplied container filled with cultivation fluid.

[0027] Plant material described herein may include explants, sprouts, seeds, bulbs, tubers, rhizomes, stolons, runners, corms, cuttings, grafted plant material, micro propagated plantlets, suckers, and offsets. The plant material can be provided by machine(s) or by operator(s). Plant material is preferably provided as individual plant material, separated from each other without being entangled. The system 100 can be further configured to separate explants from a plant and to supply the explants.

[0028] Such plant material is fragile. Such plant material is also sensitive. to contamination. Processing of such plant material can be done in a cleanroom. Embodiments of the system and methods provided herein provide for modules arranged to clean, decontaminate and/or supply conditioned air. This reduces contamination between supplied batches of plant material.

[0029] A container may have a bottom and walls having a height of preferably at least 2cm, preferably at least 5cm. The top side of the container can be open, allowing positioning of the plant into the container via providing the plant material into the container through the open top side. Glass or plastic cylindrical containers can be used. Preferably, containers each contains a cultivation medium.

[0030] The system 100 is capable of handling the plant material and the containers as inputs, and providing the containers containing planted plant material as an output. The plant material is preferably positioned with the root side inserted inside the cultivation material held in the container and facing downward in the direction of the gravity.

[0031] The system 100 for processing plant material can have a cabinet having sidewalls 101, a roof 102, and a flooring body 112. The sidewalls, roof and flooring body surround at least a part of the system. The plant material can be processed, picked and placed within the cabinet. Alternatively, the system 100 may also operate without a flooring body 112, thereby being constructed on an existing floor. Similarly, the system 100 may also operate without a roof 102, thereby having an open top. The same applies to sidewalls 101: system 100 may be enclosed by any number of sidewalls 101.

[0032] The sidewalls 101, roof 102, and flooring body 112 may allow the system 100 be at least partially isolated from the exterior. Isolation may comprise an airtight, dust-resistant, heart-resistant, moisture-resistant, and/or any other type of isolation and/or shielding of system 100 from the exterior of system 100, appropriate for handling the plant material in clean, contaminant-free environment. Within the sidewalls of the cabinet a work area chamber is formed, where plant material is processed.

[0033] The sidewalls 101, as well as the roof 102, may each comprise one or more windows. In FIG. 1, several example windows are shown, such as a first window 106. First window 106 may span the entire surface area of its corresponding sidewall 101, or may only span part of its corresponding sidewall 101. The first window 106 may be used to inspect system 100. The first window 106 may also comprise plant-supply inlet 107, through which plant material can be supplied to the system 100 from the exterior of the system 100.

[0034] A plant supply unit 140 is embodied in Figure 1 as a transporter or conveyor belt. The plant supply unit may extend from outside of the cabinet through the plant-supply inlet 107 into the cabinet (also referred to as internal chamber or the work area). Alternatively, the plant supply unit 140 may be fully contained within the system 100. Plant material may be supplied onto a conveyor belt, which transports said plant material from the outside of the cabinet to the inside of the cabinet to the plant supply unit 140. A machine or an operator may provide the plant material to the plant supply unit 140 through a plant-supply inlet 107 of the first window 106 when the first window 106 is equipped with a plant-supply inlet 107.

[0035] In FIG. 1, plant supply unit 140 comprises several conveyors positioned adjacent one and other. Plant material is supplied at the plant-supply inlet 107 and the plant supply unit 140 provides the plant material to a pick-up robot 150 such that the pick-up robot 150 can pick the plant material and insert it into a cultivation material in a container which is then outputted through a container-supply outlet 114. The plant material can also be outputted without being inserted into a container and be transported outside the system 100 via a plant-supply outlet 109. To transport the plant material, the conveyor belts of the plant supply unit 140 are driven in a controlled manner. To supply from one conveyor to a next, the conveyor surfaces are mostly aligned, preferably laterally in a horizontal direction. A second conveyor 143 is shown in FIG. 1, elevated with respect to the first conveyor 140. A vertical guide and drive allow moving the second conveyor 143 in the vertical direction when necessary. To transport the supplied plant material from the first to the second conveyor, the second

conveyor 143 is moved downward to align it with the horizontal plane of the top surface of the first conveyor 140.

[0036] Any side wall 101, 103 may comprise a local or remote control unit comprising at least one of network device, user interface, displays, buttons, sliders, emergency buttons 111, or any other means for controlling the system 100. Alternatively, a user interface may be provided external to or connected to the system 100.

[0037] Further example windows of FIG. 1 include front-window 113 and second window 104. Second window 104 (and front-window 113) may be used to inspect the system 100, but may also comprise a plant-supply outlet 109, through which plant material can be discharged from the system.

[0038] Plant discharge unit is embodied in Figure 1 as a transporter or conveyor belt. The plant discharge unit may extend from inside of the cabinet through the plant-supply outlet 109 to the outside the cabinet. The plant discharge unit may be fully contained within the system 100. Plant material may be discharged from a conveyor belt of the plant material discharge unit, which transports said plant material from the inside of the system 100 to the outside.

[0039] Further to plant-supply inlet 107 and plant-supply outlet 109, first, second, and/or front windows 106, 104, 113 may also comprise a container-supply inlet 108 and a container-supply outlet 114. The container-supply inlet 108 and the container-supply outlet 114 may be used to supply and discharge containers in and out of the cabinet of system 100 respectively.

[0040] Container supply unit 141 is embodied in Figure 1 as a transporter or conveyor belt. The container supply unit 141 may extend from outside of the cabinet through the container-supply inlet 108 to the inside the cabinet. The container supply unit 141 may be fully contained within the system 100. Containers may be supplied onto a conveyor belt of the container supply unit 141, which transports said containers from the outside of the cabinet to the inside of the cabinet.

[0041] Container discharge unit can be embodied in Figure 1 as a transporter or conveyor belt. The container discharge unit may extend from inside of the cabinet through the container-supply outlet 114 to the outside the cabinet. Alternatively, the container discharge unit may be fully contained within the system 100. Containers may be discharged from a conveyor belt, which transports said containers from the inside of the cabinet to the outside of the cabinet.

[0042] Alternatively, (some of) side-walls 101 of system 100 may comprise the plant-supply inlet 107, plant-supply outlet 109, container-supply inlet 108, and/or container-supply outlet 114 and directly be provided on any of sidewalls 101. All windows described herein may be removable and/or (partly) openable, such that maintenance or further inspection of system 100 may be performed.

[0043] The inlets and outlets are provided with a means for (temporarily) closing the openings of the inlets and the outlets, such as a door, slide, or any other attachment capable of (temporarily) covering an opening, preferably in an airtight, dust-resistant, heart-resistant, and/or moisture-resistant manner.

[0044] The system 100 for processing plant material of FIG. 1 can be used for processing plant material with high susceptibility to bacteria, viruses, diseases, dust, and/or environmental conditions, like air, heat, light, and/or moisture. To that end, the system 100 can be placed in a clean room with a conditioned, clean, environment. Any of the windows and/or sidewalls 101 described herein may also be provided with inlets and/or outlets for manipulating these environmental conditions. Sidewalls 101, roof 102, and flooring body 112 of system 100 allow system 100 to be sealed off from these external environmental conditions and protect it against bacteria, viruses, diseases, and dust. In particular, the cabinet with walls is generally airtight so as to allow an overpressure inside the cabinet. To provide (further) protection, each of the holes, inlets, and/or outlets described herein may be provided with filters, such as particle filters and/or electrostatic filters, for filtering out bacteria, viruses, diseases, and dust.

[0045] Also received in the cabinet of Figure 1, is pick-and-place robot 150, mounted on a frame 151 of the cabinet. The pick-and-place robot 150 may comprise one or more driven joints allowing the pick-and-place robot 150 to move to a location to another as desired. The end of the robot away from frame 151 can be positioned by controlling and driving the robots. The said end of the pick-and-place robot 150 has a grasping element for picking and placing plant material.

[0046] FIG. 2 shows a top view of an example embodiment of a system 200 for processing plant material. FIG. 2 is a top view of the example embodiment of a system 100 for processing plant material of FIG. 1.

[0047] The system 200 is surrounded by four upstanding sidewalls 217, 218, 219, and 220 which can have windows. Further to the four upstanding sidewalls, another upstanding

sidewall 221 is provided, which separates air chamber or plenum 223 and work-area chamber 225 both formed within the cabinet. Sidewall 221 also accommodates air supplies. Air supply nozzles or inlets can be formed in the sidewall 221. The sidewall 221 may comprise a mesh arranged to supply a generally laminar air flow to the work-area 225, preferably to a platform 204 of the plant supply unit.

[0048] An overpressure may be provided in the work-area chamber 225. This overpressure restricts air, external to the four upstanding sidewalls 217, 218, 219, and 220, from entering the work-area 225. Instead, the overpressure in the work-area chamber 225 ensures air entering from the exterior is prevented.

[0049] Plenum 223 may house pumps, fans, and/or other modules 224 for creating an air flow, e,g. for supplying air to the plenum that can subsequently exit through the sidewall 221 into the work-area 225. The module 224 may additionally comprise filters, such as particle filters, HEPA filters, and/or electrostatic filters for filtering out dust and/or other unwanted particles from the external air that is to be supplied to the work-area chamber 225 through sidewall 221. The module 224 may additionally comprise heaters and moisturizers. As a result, the work-area chamber 225 has a clean environment that is protected from bacteria, viruses, diseases, dust, and/or controlled environmental conditions, like certain levels and/or conditions of air, heat, light, and/or moisture.

[0050] Work-area chamber 225 houses the pick-and-place robot for processing plant material. The system 200 can comprise one or more pick-and-place robots 201. The pick-and-place robot 201 may be mounted onto a frame that is connected to the cabinet and comprises a robot arm with joints (articulation), arms, and drives. The articulation offers one or more degrees of freedom, preferably two or more, more preferably three or more. Degrees of freedom and reach of pick-and-place robot 201 may be provided by a combination of joints and links provided in pick-and-place robot 201. Rotation of links of pick-and-place robot 201 is achieved by actuating electromotors that are provided in the joints of pick-and-place robot 201. Joints of pick-and-place robot 201 may comprise revolute joints, prismatic joints, spherical joints, planar joints and/or wrist mechanisms. Pick-and-place robot 201 may have a work-envelope that spans entire or a significant part of the work-area surface area.

[0051] Pick-and-place robot 201 may further comprise, preferably at the end of the arm distant from the connection to the frame, a grasping unit for grasping plant material, such as sprouts and explants. Grasping unit of pick-and-place robot 201 may comprise grasping

elements such as elongated rods for grasping plant material with high precision. The pick-and-place robot 201 can orient the grasping element in a predetermined position and orientation with respect to the platforms. Suitable control can control the positioning.

[0052] The pick-and-place robot 201 is configured to grasp plant material supplied by a plant-supply unit. To that end, the plant-supply unit comprises a platform 204 that is within reach of the pick-and-place robot 201. FIG. 2 shows two elongated rods 251 that are part of the grasping unit such as a tweezer. Plant material can be grasped between each surface of the elongated rods that are facing each other.

[0053] The system 200may comprise a detection unit for detecting and/or identifying plant material and containers that were supplied. The detection unit may be housed onboard the pick-and-place robot 201 or positioned such that the detection unit can monitor and recognize the plant material supplied to a platform of the plant-supply unit. The detection unit can comprise a camera, ultrasonic sensor, infrared sensor, accelerometers, gyroscopes, and/or any other means for detecting and/or identifying plant material and containers. One or more cameras may alternatively (also) be provided external to pick-and-place robot 201. Using computer vision software, pick-and-place robot 201 may be able to identify and detect plant material and containers using onboard or external camera(s). These one or more external cameras may be provided on the roof of work-area 225, on upstanding sidewalls 217, 218, 219, and 220, and/or any other location where the one or more external cameras are capable of capturing pick-and-place robot 201, plant material, and/or containers.

[0054] Pick-and-place robot 201 is surrounded by several modules within work area 225. FIG. 2 shows a top view of the work area 225. The pick-and-place robot 201 is centrally positioned. The robot is surrounded by: (i) a first platform 203 of a plant- supply unit, (ii) a second platform 204 of a plant supply unit, (iii) a third platform 205 of a plant supply unit for discharging plant material, (iv) a fourth platform 208 of a container supply unit, (v) a fifth platform 212 of the container supply unit for discharge containers, and (vi) a cleaning station 213 for sterilizing the elongated rods 251 of the pick-and-place robot 201. Several of the modules within work area 225 will be discussed in detail below.

[0055] Sidewall 218, or any other sidewall describes herein, may comprise plant-supply inlet 202 through which plant material may be supplied to the work-area 225. Plant material may be supplied through the plant-supply inlet 202 from a machine or by a human operator. Once plant material has been supplied, the plant material is placed on the first platform 203, which

may comprise a conveyor belt for transporting plant material. The first platform 203 may be arranged to transport plant material deeper inside work-area 225 and/or to a location where pick-and-place robot 201 is within reach to pick the plant material.

[0056] The plant-supply unit is arranged to transport plant material into the cabinet/work area 225, such as closer to the pick-and-place robot 201, using first platform 203. Plant material may subsequently be transferred onto an orientation or pick-up platform 204. The orientation or pick-up platform 204 may be adjacent to the first platform 203. The platform 204 may, similarly to the first platform 203, be arranged to transport plant material, and preferably comprises a conveyor belt.

[0057] The platform 204 is close/adjacent to pick-and-place robot 201 such that the pick-and-place robot 201 can reach the plant material on top of the pick-up platform 204. Plant material may be supported by the platform 204 and is provided such that the plant material can be picked up by the pick-and-place robot 201. By having the first platform 203 and the pick-up platform 204, new plant material can already be loaded onto platform 203, while already supplied plant material is supported and held in position by pick-up platform 204 ready for being picked up by the pick-and-place robot 201.

[0058] To transfer plant material from the first platform 203 to platform 204, plant material may be first placed on the first platform 203 which can have a substrate, preferably a sterile substrate, more preferably a flat substrate, such as a foil, piece of paper, or a plat piece of metal or plastic. When the plant material is transported and reaches the end of first platform 203 next to the pick-up platform 204, the substrate onto which the plant material is deposited naturally bridges any gap that may be present between platforms 203 and 204. Bridging of a gap between platforms 203, 204 is performed by allowing the substrate to extend over the gap when it is transported on first platform 203. When further transporting the substrate over the gap, it will eventually end up engaging platform 204, which, in turn, transports the substrate fully onto the platform 204. Throughout the process of transferring the substrate from first platform 203 to platform 204, plant material is transferred without falling into a gap between platforms 203 and 204.

[0059] Once the plant material has been transported to the platform 204, the system 200 is configured to detect/identify plant material on platform 204 that is suitable for pick-up. Plant material that is suitable for pick-up may be plant material that is healthy, has the correct dimensions, and has a suitable engagement point for pick-up.

[0060] Further, to reduce the required complexity of pick-and-place robot 201, in terms of degrees of freedom and range work-envelope, plant material suitable for pick-up may need to be positioned and oriented within a predetermined range. Preferably, plant material suitable for pick-up should lie flat on the surface of pick-up platform 204, and have an orientation provided by the length direction angled between -50° and +50° with respect to a default position of the pick-and-place robot 201. Also, an engagement point of the plant material (such as a stem, e.g. at a predetermined distance from the root end) is to be within reach of the pick-and-place robot.

[0061] The pick-up platform 204 can move with respect to the mount/frame of the pick-and-place robot 201 and acts as an orienting platform for the supplied plant material. The movement is such that the top surface of the platform that supports supplied plant material, is moved. In the shown embodiment, the orienting platform 204 is movable in the vertical direction and is rotatable around a vertical axis at the center of the orienting platform 204, wherein the vertical axis is substantially perpendicular to the horizontal surface of the orienting platform 204. Comparing the position of orienting platform 204 in FIG.2 with pick-up platform 143 in FIG.1, it can be seen that pick-up platform 143 is moved upwards and is rotated over 90 degrees.

[0062] Movement of platform 204 can also include movement in any of the horizontal directions either linear or rotational. A suitable joint or a translational means and drive controlled via a control unit can move the orienting platform. By moving, preferably rotating, the surface of the platform 204 supported plant material on that surface can be moved within the reach of the robot 201.

[0063] Specifically rotating the platform 204 results in reorientation of the supplied plant material on the surface of platform 204 with respect to the pick-and-place robot. Supplied plant material having an orientation that can not be reached by the pick-and-place robot is rotated to an orientation in which the pick-and-place robot can grasp the supplied plant material. Generally, the root part of the sprout or explant supplied to the pick-up/orienting platform 204 is positioned away from the pick-and-place robot during pick-up. During grasping, the elongated grasping units generally align (except for in the vertical direction) with the length of the sprout or explant. This helps the pick-and-place robot 201 to easily pick up the plant material such that a root section of the plant material can be straightforwardly

oriented to face downwards such as facing the bottom of a container to which the plant material is to be inserted.

[0064] In operation, once pick-and-place robot 201 has picked (and placed) most or each piece of plant material present on the second platform 204 that was positioned and oriented in a manner that can be reach by the pick-and-place robot, second platform 204 may be rotated any number of degrees, preferably 90°, 180°, or 270°, and 360°.

[0065] By rotating the orienting platform 204, each of the individual plant material remaining on the orienting platform 204 are reoriented. A rotation of 90 degrees or another suitable results in some or all plant material being within reach of, that is in an orientation with respect to, the pick-and-place robot and those plant materials can be picked and placed.

[0066] By moving/orienting the pick-up platform as a whole, the range of the pick-and-place robot 201 can be limited such that an overly complicated and costly robot arm design can be avoided. Moving the orienting platform 204, results in bringing the supplied plant material within the reach of the pick-and-place robot 201. This, in turn, reduces the required complexity of pick-and-place robot 201. The pick-and-place robot 201 arranged to pick plant material from every possible position and orientation thinkable on the second platform 204 would require a higher number of degrees of freedom to be able to reach every hard-to-get-to position (and thus be expensive). This further reduces the complexity, especially in terms of the reach of the pick-and-place robot 201 and the complexity of its control and operation. Additionally, the pick-and-place robot 201 arranged to pick plant material from every possible position and orientation thinkable on the second platform 204 would require additional spacing around the orienting platform 204 for the pick-and-place robot 201 to operate. By having rotatable platform 204, the areas of the rotatable platform that are out of reach of the robot can be brought within reach without adding additional degrees of freedom to the pick-and-place robot 201 and may also reduce the spacing required around the orienting platform 204, thereby making the overall work-area 225 more compact. Having a more compact work-area 225 makes it easier to accommodate, transport, and implement the system in existing cultivation infrastructures.

[0067] Once pieces of plant material suitable for pick-up have been picked up (and placed) by the pick-and-place robot 201 (and rotation of orienting platform 204 no longer yields new plant material suitable for pickup), the remaining pieces of plant material (if there are any)

are transferred to a third platform 205. The third platform 205 is arranged to discharge plant-material from work-area 225 to the exterior of the cabinet.

[0068] The third platform 205 may be adjacent to the pick-up platform 204, and preferably comprises a conveyor belt. Plant material may be transferred from the pick-up platform 204 to the third platform 205, similarly to how plant material is transferred from the first platform 203 to the pick-up platform 204, preferably using a substrate or the substrates used for transporting the plant material from the first platform 203. Once all plant material, which was unsuitable for pick-up, is transferred to the third platform 205, the plant material is then transported outside work area 225, through plant-supply outlet 206. This collection of discharged plant material is then collected and either discarded, adjusted, or reused.

[0069] In embodiments, once plant material is removed from the pick-up platform 204, new plant material can be supplied thereto from the first platform 203.

[0070] Before or at the same time that plant-material is supplied, picked, and/or discharged, container 209 is supplied to the interior of work area 225 on the fourth platform 208 through container-supply inlet 207. Containers may be supplied through container-supply inlet 207 robotically or by a human manually placing the container 209 onto the fourth platform 208. Similarly to previously described platforms, the fourth platform 208 preferably comprises a conveyor belt for transporting supplied container 209 to a preferred location and/or orientation.

[0071] Once a container is supplied to the fourth platform 208 near container-supply inlet 207, the fourth platform 208 transports the container 209 to a location on the fourth platform 208 that is suitable for the pick-and-place robot 201 to insert plant material in the container 209. Before reaching the desired location in the fourth platform 208, a positioning arm 210 can be arranged to guide container 209 into a predetermined location and orientation on the fourth platform 208. The location and orientation of the container 209 can be a predetermined position or the position is determined / identified / measured by system 200. Once the position of the container is determined, the pick-and-place robot 201 can be controlled to move while taking the location and orientation of container 209 into account. By using the positioning arm 210, container 209 will always reach the predetermined location and orientation, even after multiple cycles of containers being supplied and discharged.

[0072] Plant material that was suitable for pick-up and has been picked up by the grasping element of the pick-and-place robot 201, is placed, by pick-and-place robot 201, in container

209. Pick-and-place robot 201 is arranged to place the plant material in container 209 in a predetermined position and/or orientation, preferably root end downwards, such that the plant material is either fully submerged in the cultivation medium of container 209 or (partly) protrudes it.

[0073] Placing of plant material in container 209 preferably happens under an angle smaller than 45°, preferably smaller than 30, more preferably less than 20 degrees, with respect to a line that runs perpendicular to the bottom of container 209 (i.e. the vertical direction). In this way, plant material can positioned in the cultivation medium in a preferred orientation with roots downward. The cultivation medium may be present in container 209. Placing the plant material can be done without engaging the high upstanding side portions of container 209.

[0074] By repeating picking and placing individual plant material, multiple pieces of plant material may be placed in a single container 209 and allows positioning plant material (evenly) distributed across its bottom surface. The number of pieces of plant material that may be planted in container 209 depends on the size of container 209, preferably the diameter, and/or how much spacing is required between pieces of plant material.

[0075] To distribute plant material across container 209, pick-and-place robot 201 may be arranged to place the plant material in a new/different position for each subsequent piece of plant material to be placed. Different positions can be calculated / determined based on plant material properties (size, growth) and the size of the container. Identification of new placement positions may also happen in real-time using computer vision to identify empty spots. However, the locations at which pieces of plant material can be planted may also be pre-programmed.

[0076] In embodiments, fourth platform 208 may also be arranged to rotate container 209 after placements, thereby allowing pick-and-place robot 201 to place subsequent pieces of plant material in the same location and/or orientation.

[0077] In embodiments, fourth platform 208 may also be arranged to shift container 209, e.g. in the horizontal plane across the x- and y-directions of the plane that spans the top surface of fourth platform 208, again allowing pick-and-place robot 201 to place subsequent pieces of plant material in the same location and/or orientation.

[0078] It should also be noted that, each of the options for distributing plant material across container 209 may be combined together.

[0079] After container 209 has been (at least partially) filled with plant material, container 209 may be discharged from work area 225. Containers 210 may be discharged from fourth platform 208 (back through container-supply inlet 207) or from fifth platform 212 through container-supply outlet 211. Fifth platform 212 may be adjacent to fourth platform 208, or be remote from fourth platform 208.

[0080] Positioning arm 210 can be arranged to transfer container 209 from fourth platform 208 to fifth platform 212. Transferring of container 209 using positioning arm 210 may comprise pushing container 210 from fourth platform 208 to fifth platform 212. Any gap that may exist between fourth platform 208 and fifth platform 212 is bridged by bridge 216, which is substantially flush with fourth platform 208 and fifth platform 212. In embodiments, positioning arm 210 may be arranged to clamp container 209 before, during, and/or after transferring container 209 from fourth platform 208 to fifth platform 212, thereby allowing container 209 to be transferred over a gap that exists between fourth platform 208 and fifth platform 212 without requiring bridge 216. Once container 209 has been transferred to fifth platform 212, it may be discharged through container-supply outlet 211 by transporting container 209 using a conveyor belt.

[0081] A cycle of processing plant material generally comprises supplying and discharging plant material, picking and placing of plant material suitable for pick-up, and supplying and discharging of empty and filled containers.

[0082] System 200 may further comprise cleaning module 213 for decontaminating pick-and-place robot 201, preferably its grasping element. Cleaning module 213 may comprise one or more cleaning tools for performing individual cleaning steps. Examples of cleaning tools may comprise heaters, ovens, induction elements, electrodes, UV-lights, autoclave, and/or dispensers, containers, and/or supplies filled with decontaminating liquids, such as alcohol.

[0083] In the example embodiment of FIG. 2, cleaning module 213 comprises a first cleaning tool 214 comprising a coil arranged to heat at least part of pick-and-place robot 201, preferably its grasping elements. Especially the surface of the grasping elements will be heated, resulting in decontamination. Cleaning module 213 further comprises second cleaning tool 215 comprising a container filled with a decontaminating liquid arranged to decontaminate at least part of pick-and-place robot 201, preferably its grasping element. Second cleaning tool 215 may further be arranged to cool down at least part of pick-and-

place robot 201 after it has been heated by first cleaning tool 214. This accelerates the cycle for decontamination, reducing the time needed for decontamination.

[0084] Cleaning module 213 is capable of eliminating contamination across different plant material, batches, species, and/or reduces the overall level of contamination within work area 225. It is noted that some types of plant material will require pick-and-place robot 201 to be cleaned after one or more picking and/or placing actions, instead of full cycles. It is also noted that cleaning module 213 may further comprise a supply of clean grasping elements to be replaced with the contaminated grasping element that is currently attached to pick-and-place robot 201 and a discharge tool for discharging contaminated grasping elements from pick-and-place robot 201. In doing so, cleaning of contaminated grasping elements may happen during processing of plant-material, thereby saving time.

[0085] FIG. 3 shows an example embodiment of a (second) pick-up and/or orienting platform 300 for supporting plant material, the platform 300 being part of the plant supply unit. Platform 300 comprises a table 301 for supporting plant material or trays with plant material. In embodiments, the table 301 may comprise a conveyor belt 302, which is arranged to transport items, preferably plant-material, across any horizontal direction of the plane that spans the surface 301. Platform 300 may comprise drive system 304 for driving conveyor belt 302. Conveyor drive system 304 may comprise a pulley(s), electromotor(s), gearbox(es), and/or a control unit(s).

[0086] In embodiments the platform 300 with table 301 is connected to and vertically rotatable around axis 303. The axis 303 may comprise a shaft that is connected to rotational drive system 306, which may comprise an electromotor, gearbox, and/or a control unit. Rotational drive system 306 is arranged to rotate surface 301 in both directions and every increment step, preferably at least by 90°, 180°, 270°, and 360°.

[0087] Platform 300 may further comprise translating drive system 305, which is arranged to vertically translate table 301 upward and downward, and may comprise an electromotor, gearbox, and/or a control unit.

[0088] In embodiments, platform 300 may be directly adjacent other platforms. In such cases, surface 301 may not be able to rotate directly, due to adjacent platforms constraining its rotation. Translating drive system 305 may then be used to allow surface 301 to first translate upward to a position where it is not constrained, and then rotate, using rotational drive system 306.

[0089] Platform 300 may be used in conjunction and collaboration with a pick-and-place robot. Using conveyor belt 302 and rotational drive system 306, platform 300 may be arranged to re-position and re-orient items, preferably plant material, support on table 301. Using platform 300 in conjunction and collaboration with a pick-and-place robot, allows plant-material to be positioned and oriented in a preferred manner for the pick-and-place robot. In turn, this may reduce the required complexity of the pick-and-place robot and the complexity of motion procedures that the pick-and-place robot has to perform.

[0090] FIG. 3 also shows several schematically represented pieces of plant material, represented by a general arrow shape supported on table 301. The arrow or vector represents a size and orientation of the piece of plant material on the table. Seven pieces are shown. The arrows/vectors can correspond with a visualisation of the image processing techniques used in a system according to the invention to identify and determine the position and orientation of the plant material on second platform 300.

[0091] In an embodiment, the grasping element of the pick-and-place robot is arranged to pick plant materials with an orientation that is within a range of –50 to +50 degrees (in the horizontal plane) of the orientation indicated by arrow 310. Of the schematically shown plant material pieces only two or three have an orientation within this range and can be picked up. After rotation of table 301 over 90 degrees, other pieces of plant material are oriented within the reachable domain of the pick-and-place robot indicated by arrow 310. By the cooperation of pick-up platform and pick-up robot, grasping element and the supplied plant material can be positioned in a preferred predetermined pick-up orientation while the reach of the pick-up robot can be reduced, resulting in a significant cost reduction.

[0092] Also, again referring to the schematical representation of the plant material, the image recognition can be such that a grasping location on the plant material is identified, e.g. at a distance from one of the ends of the plant material. In embodiments, the arrowed end of the schematical arrows in FIG. 3 is the root end of the piece of plant material. The grasping area of the plant material can be within 2 – 8 mm from that end.

[0093] FIG. 4a-4e show an example implementation 400 of a system and method for processing plant material. Reference numerals shown in FIG. 4a correspond to the same components in FIG 4b-4e. The system 400 shown in FIG. 4a includes a pick-and-place robot 401 comprising grasping element 402. The grasping element 402 is connected to a remote end of articulated arm of the pick-and-place robot 401. As a result, the grasping element 402

can be positioned within a predetermined reach of positions and orientations. Grasping element 402 has elongated rods 423 at a remote end. The elongated rods can be opened when not grasping and closed when grasping, and have grasping surfaces for grasping plant material.

[0094] The system 400 further comprises a first platform 403 for supplying plant material and a second pick-up and orienting platform 404 for transporting plant material, which is shown raised upward in FIG. 4a. Provided on the second platform 404 is a substrate 405, which is carrying plant material 406. The system 400 further comprises a third platform 407, which is configured to discharge plant material. Lastly, the system 400 comprises a fourth platform 410 for supplying containers 408. One example of such containers is plastic container 408, which has been positioned onto the fourth platform 410. A positioning arm 409 in configured to receive the container 408 and to hold it in a predetermined position.

[0095] A upstanding wall 411 separates a plenum provided behind upstanding wall 411 from the work area. The upstanding wall 411 can has air outlets, which can be formed as a mesh. The air outlets supply a laminar air flow (indicated by the arrows 425 in FIG. 4a) into the work area, preferably directed at the plant supply 403, 404, 407, 410, more preferably directed at the second platform 404, even more preferably directed at first, second, and third platforms 403, 404, and 407.

[0096] FIG. 4b shows a system 400 for processing plant material, when a grasping element 402 of a pick-and-place robot 401 is picking plant material 406 from second platform 404. As can be seen in FIG. 4b, the angle of the elongated rods 423 of the grasping element 402 with the vertical (perpendicular to the surface of second platform 404) is more than 45 degrees, more preferably more than 60 degrees, and most preferably more than 70 degrees. The angle is less than 95 (note that the elongated rods can have a hooked or bended end for grasping; that hooked or bended end is directed towards the second platform) or 90 degrees. The hooked or bended end can be 3-30mm long. The positioning/orienting of the grasping unit allows picking up the plant material at an angle that is close to the longitudinal direction of the elongated rods. This in turn allows positioning the grasped plant material close to a bottom in a container with high upstanding walls. The elongated rods allow to place the grasped plant material near a bottom of a container.

[0097] FIG. 4b shows the grasping element 402 approaching to grasp the plant material 406 at about 3 mm from the root end. This distance can be dependent on the characteristics of the

plant material. It can be set / programmed. Also, FIG. 4b shows that the elongated rods 423 are generally oriented towards with root end of the plant material, with the head of the plant material directed towards and closer to the robot and the root end of the plant material further away.

[0098] FIG. 4c shows pick-and-place robot 401 reorienting towards container 408 while a picked piece of plant material 406 is grasped by grasper 402. Reorienting results in the elongated rods now being oriented close to a vertical line. This allows entering of the elongated rods into the container and to reach towards the bottom of the container.

[0099] In embodiments, a location in the container can be identified that is (still) free for inserting plant material in a cultivation medium and/or suitable for placing and reorienting pick-and-place robot 401 and/or grasper 402 to a location and orientation that is suitable for placing in said identified location. In other embodiments, the pick-and-place robot is programmed to place plant material at predetermined locations in the container. The container can be identified, which allows picking suitable predetermined locations from a memory connected to the processor of the control unit of the pick-and-place robot.

[00100] FIG. 4d shows pick-and-place robot 401 placing a picked piece of plant material 406 in an identified location in container 408 using grasper 402. Placing of the piece of plant material 406 may comprise fully submerging plant material 406 in the cultivation medium of container 209 or (partly) protruding it.

[00101] Whereas the grasping unit is positioned generally horizontal when grasping supplied plant material from the pick-up platform, the pick-up robot is arranged to orient the grasping unit in a generally vertical orientation when depositing the plant material in the container. The grasping unit is swung between 80-100 degrees with respect to the vertical between pick-up and depositing position.

[00102] FIG. 4e shows pick-and-place robot 401 releasing a placed piece of plant material 406. After repositioning pick-and-place robot 401 toward second platform 404, the steps outlined in FIG 4b-4d may be repeated until there is no longer plant material 406 provided on second platform 404 that is suitable for pick-up or until the container is filled.

[00103] Plant material can be positioned in the container at predetermined positions. The positions can be according to a predetermined pattern, e.g. four centered positions and 12 positions radially outward around the four positions with a predetermined minimum distance between each position. With the pick-and-place robot according to the invention, a optimum

filling of the container is possible as the pick-and-place robot and the system as a whole allows positioning the plant material with great accuracy, e.g. within 0.5 mm position. This is an enormous increase over the accuracy of human. Moreover, the pick-and-place machine can do the positioning faster and more reliable. This increases the conformity in delivered filled containers.

[00104] FIG. 5 shows an example implementation of a system 500 for processing plant material. The system 500 comprises a plant supply unit. The plant supply unit may comprise one or more platforms for supplying and/or supporting supplied plant material, such as first platform 501, second platform 502, and third platform 503. The plant supply unit may also comprise a single platform. Any of the platforms described herein may further configured to be rotatable around a vertical axis such that plant material supplied on the platform can be rotated with respect to the pick-and-place robot. Second platform 502 of system 500 shows such a platform, which has been rotated by 90° with respect to pick-and-place robot 504 compared to FIG. 4a. Other embodiments of plant supply systems, different from platforms and conveyor belts are also contemplated within embodiments of the invention.

[00105] The system 500 further comprises a pick-and-place robot 504 for picking individual plant material, which may be supplied on the supply unit. Pick-and-place robot 504 further comprises grasping element 505 for grasping the plant material. Pick-and-place robot is arranged to pick supplied individual plant material from the platform, such as platform 502, and place the individual plant material.

[00106] Mounted on the frame of the pick-and-place robot 504 is an example decontamination module. An induction heating device 520 is provided. The induction heating device 520 comprises a coil, winding or spool that can be fed with power / current. The pick-and-place robot 504 can be controlled to move the grasping elements, in particular the ends of the grasping elements arranged to grasp the plant material, into the coil wherein an open space is provided for the ends of the grasping elements can enter and be heated by induction. By providing a current, heat will be induced in tweezer tips. The advantage of this method is that induction will heat the surface of the tweezers very fast up to 300 degrees Celsius. The high temperature is achieved generally on the surface and kills potential viruses and bacteria. Because only the surface is heated up and the core temperature of the tweezers is minimal affected, it cools down very fast once the current is turned off.

[00107] The decontamination module also comprises a container 521 filled with a fluid, such as alcohol. After the inductive heating the tweezers can be dipped, by controlling the pick-and-place robot, in the alcohol liquid, both for extra disinfection but also to cool the tweezers down. This makes it possible to pick the next explant directly after the cleaning cycle without burning the plant material.

[00108] FIG. 6a and 6b show an example embodiment of a grasping element 600 of a pick-and-place head, as well as a zoomed-in version of the same FIG. 6a.

[00109] Grasping element 600 comprises at least two elongated rods 601, similar to tweezers or chopsticks, and are arranged to grasp plant material 603 with high precision. Elongated rods 601 may be at least 4 cm in length, preferably at least 8 cm, more preferably at least 12 cm, and may be manufactured from metal, preferably stainless steel, and/or plastics. Elongated rods 601 may be entirely straight. Preferably the elongated rods have curved ends or hooks 602. Curved ends 602 are arranged to pick and place plant material 603 and provide more precision, flexibility, control, and safety.

[00110] With curved ends 602, the elongated rods can be positioned generally aligned with the plant material, indicated by dotted line 604. The ends of curved ends 602 can approach the plant material 603 supported by the platform be descending in the vertical direction. Curved ends 602 may also prevent accidental damage to plant material 603 or elongated rods 601. The curvature of curved ends 602 statistically reduces the risk of poking or scratching objects and/or plant material 603 present in the work area.

[00111] The pick-and-place robot, specifically grasping element 600, is arranged to grasp plant material 603 on their stems, more preferably from 4-30 mm, or 1-10mm, to the end of their stem. This allows plant material 603 to be placed successfully in the container and allows at least 4 mm of the stem of plant material 603 to be inserted inside the cultivation medium present in the container in which plant material 603 is to be planted.

[00112] In embodiments the (optimal) grasp location on plant material 603 is identified. This may comprise identifying a (centre of a) leaf of plant material 603 and a stem-end (end of a stem). Once the (centre of a) leaf and the stem-end of plant material 603 has been identified, the (optimal) grasp location lies on a straight line between the (centre of a) leaf and a stem-end at a distance of preferably 4-30 mm, or 1-10 mm, to the stem-end.

[00113] Grasping element 600 of the pick-and-place robot may be arranged to pick plant material 603 in an orientation that is substantially parallel to the stem of plant material

603, indicated by dotted line orientation 604, which is parallel to the stem of plant material 603 . Preferably, grasping element 600 of the pick-and-place robot may be arranged to pick plant material 603 with a leaf of plant material 603 facing grasping element 600. The orientation of the plant material can be determined using image capturing and processing.

[00114] Grasper element 600 of the pick-and-place robot may pick (and place) a piece of plant material 603 that is provided on a platform, one that is closest/best-oriented to pick-and-place robot 401, and/or one that is next up in line of a predetermined picking-sequence.

[00115] Elongated rods 601 of grasping element 600 are arranged to open, that means moved away from each other, prior to picking of plant material 603. Opening of elongated rods 601 may comprise both elongated rods 601 (simultaneously) being moved away from each other, or having one elongated rod 601 staying fixed while moving the other elongated rod 601 away from the other elongated rod 601. Elongated rod(s) 601 may be opened by actuating one or more hinge(s) that are connected to the one or more elongated rod(s) 601. These hinge(s) may be actuated by an electromotor, such as a servomotor, to move one or more elongated rod(s) 601 away from the one or more other elongated rod(s) 601, thereby creating an opening between the two or more elongated rods 601. During grasping, the two or more elongated rods 601 are arranged to close, that means moved towards each other. Again, closing of elongated rods 601 may comprise both elongated rods 601 (simultaneously) being moved towards each other, or having one elongated rod 601 staying fixed while moving the other elongated rod 601 towards from the other elongated rod 601.

[00116] The force that grasping element 600 exerts on plant material 603, after picking and before placing, may be preconfigured and limited to a predetermined value, e.g. less than 20 N, preferably less than 10 N, more preferably less than 5 N. The force may also be controlled in real time using feedback, preferably using a strain gauge sensor, load cell, force sensing resistors, piezoelectric sensors, capacitive sensors, and/or other force measuring units.

[00117] FIG. 7a and FIG. 7b show example embodiments 700 of a pick-and-place head picking and placing plant material. FIG. 7a shows grasping element 701 picking plant material 704 under a first angle 702, which is defined as the angle between grasping element 701 and the plane upon which plant material 704 is deposited. [90 degrees minus angle 702] corresponds with the angle to the perpendicular of the surface area of the second platform.

[00118] FIG. 7b shows grasping element 701 placing plant material 704 under a second angle 703, which is defined as the angle between grasping element 701 and a line that runs perpendicular to the bottom of container 705. First and second angles 702 and 703 may preferably be substantially equal to each other. Preferably the first and second angles are between 10 and 30 degrees.

[00119] The following numbered clauses provide further embodiments:

Clause 1: System for processing plant material, such as sprouts and explants, comprising:

- a plant supply unit, comprising a platform that supports supplied plant material;
- a container supply unit for supplying containers preferably having a bottom with walls and an open top;
- a pick-and-place robot for picking individual plant material, the pick and place robot comprising a grasping element for grasping the plant material, wherein the grasping element has elongated rods for grasping individual plant material between ends of the elongated rods,

wherein the pick-and-place robot is arranged to pick supplied individual plant material from the platform and to place the individual plant material in the container,

wherein the pick-and-place robot is arranged to place the individual plant material having a predetermined orientation, preferably root downwards, in the container.

Clause 2: The system for processing plant material of any of the clauses, any of the claims and/or any of the embodiments disclosed herein, wherein the system comprises a frame forming a cabinet, preferably having windows, one or more inlets and outlets, wherein the pick-and-place robot, the plant supply unit, and the container supply unit are received within and surrounded by the cabinet,

wherein preferably the plant supply unit and/or the container supply unit extend through an opening in the cabinet to an exterior of the cabinet.

Clause 3: The system for processing plant material clause 2, or according to any of the other clauses and/or claims or according to any of the embodiments disclosed herein, wherein the system further comprises an air supply for supplying air into an interior of the cabinet,

wherein the air supply is preferably formed by a fan having an air filter and/or air decontamination unit,

wherein the cabinet preferably has an air chamber or plenum, preferably separated by an upstanding wall of a work area chamber formed within the cabinet, wherein the air supply is connected to the air chamber,

wherein more preferably the upstanding wall separating the plenum from the work area chamber comprises air outlets, more preferably a nozzle, most preferably air outlets forming a mesh, for supplying a laminar air flow into the work area chamber, preferably directed at the plant supply, more preferably directed at the platform,

wherein more preferably the platform is positioned between the pick-and-place robot and the air outlets.

Clause 4: The system for processing plant material of clauses 1-3, or according to any of the other clauses and/or claims and/or according to any of the embodiments disclosed herein, wherein the platform generally provides a horizontal surface for supporting plant material,

wherein preferably the elongated rods of the grasping element of the pick-and-place robot are arranged to grasp the individual plant material from the platform at an angle of more than 45 degrees, preferably more than 60 degrees, most preferably more than 75 degrees, with respect to a perpendicular of the horizontal surface.

Clause 5: The system for processing plant material of any of the previous clauses, or according to any of the other clauses, and/or claims and/or according to any of the embodiments disclosed herein, wherein the platform is movable with respect to the robot,

wherein preferably the platform is rotatable around a vertical axis, wherein preferably the platform is mounted to a frame of the system via a pivot or joint,

wherein preferably a drive unit for moving, preferably rotating, the platform, wherein preferably a control unit is arranged for controlling the drive,

wherein preferably the platform is translatable vertically, e.g. connected to the frame via a linear guide, in embodiments having a drive unit and connected to the control unit.

Clause 6: The system for processing plant material of clauses 1-5, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the plant supply unit comprises at least one, at least two, and, in a preferred embodiment, three separately driven supply units,

wherein preferably the plant supply unit is formed by a conveyor, preferably conveyors arranged adjacently, more preferably in a single line,

wherein preferably the conveyor comprises a belt, the belt driven by a drive, wherein a control unit is provided arranged to control the drive for separately driving the conveyors,

wherein a substrate or support is provided on the plant supply unit for transporting multiple pieces of plant material,

wherein the plant supply unit comprises a plant material discharge unit, preferably extending out of the interior of the cabinet, preferably through an outlet in the cabinet.

Clause 7: The system for processing plant material of any of the previous clauses or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein at least one of the elongated rods of the grasping unit is moveable, the grasping unit having a drive for moving an end of the elongated rod towards and away from an end of the other elongated rod,

wherein preferably at least one of the elongated rods is mounted via a joint to the grasping unit

wherein preferably the remote ends of the elongated rods have a bended hook, and the bended hook forms a grasping surface for grasping the plant material therebetween

wherein preferably the elongated rods form tweezers

wherein preferably the grasping unit has a force measuring unit for measuring an applied grasping force, wherein more preferably a control unit of the grasping unit limits the applied grasping force to a predetermined maximum, e.g. less than 5 Newton.

Clause 8: The system for processing plant material of any of the previous clauses, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the system is arranged to place the individual plant material at different positions, preferably arc sections distributed over a ground surface, of the container

wherein the system comprises an input unit, e.g. a measuring unit, identification unit and/or a camera, for determining a property of a supplied container and wherein a control unit, based on the property determined by the input unit, is arranged to drive the robot to different positions of the container

wherein the system comprises a container moving unit that is arranged to move, e.g. rotate, a supplied container such that different positions of the ground surface of the container are positioned at a predetermined place position of the pick-and-place robot.

Clause 9: The system for processing plant material of any of the previous clauses, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, further comprising a cleaning module comprising a cleaning tool for cleaning, preferably decontaminating, the grasping element of the pick-and-place robot,

wherein the cleaning modules is preferably received within the cabinet, preferably within the work area chamber,

wherein preferably the pick-and-place robot is arranged to position the elongated rods into the cleaning modules.

Clause 10: The system for processing plant material of clause 9, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the cleaning module comprises a first, and preferably a second, cleaning station, such as a heater, autoclave, alcohol supply.

Clause 11: The system for processing plant material of any of the previous clauses or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the container supply unit comprises one or more separate driving units, preferably one or more conveyors, preferably having a conveyor belt,

wherein container supply unit comprises a platform or engaging unit for supporting and/or receiving the container, wherein the platform or engaging unit is arranged to have a predetermined position with respect to the mount of the pick-and-place robot,
wherein preferably the container supply unit comprises a predetermined position for receiving the container so that the container is held at a predetermined position with respect to the pick-and-place robot,

wherein preferably a pushing unit is arranged to push a container from a first supply conveyor to a discharge conveyor,

wherein preferably the container supply unit extends through an outlet out of the interior of the cabinet,

wherein preferably the container supply unit comprises a nutrient dispenser for filling the container with nutrients and/or the at least one container is filled with nutrients.

Clause 12: Method for processing plant material, such as sprouts and explants, the method comprising:

- providing containers, preferably having a bottom with walls and an open top, and plant material,
- supplying the plant material onto a platform that supports supplied plant material;
- supplying the container;
- picking-and-placing individual plant material with a robot arm, wherein picking comprises grasping the plant material from the platform between ends of elongated rods, and wherein placing comprises positioning the picked plant material in the container oriented in a predetermined orientation, preferably with the root downwards.

Clause 13: Method of clause 12, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein picking and placing is operated in a cabinet,

wherein preferably plant material is supplied into and/or out of the cabinet and wherein preferably containers are supplied into and/or out of the cabinet.

Clause 14: Method of clause 13, according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the method comprises supplying air into an interior of the cabinet,

wherein supplying air preferably comprises air filtering and/or air decontaminating,

wherein preferably air is supplied into an air chamber or plenum in the cabinet,

wherein more preferably air flows from the air chamber or plenum to a work area chamber in which the picking and placing is operated, wherein air flows through nozzles, preferably air outlets forming a mesh, in a wall separating the air chamber or plenum from the work area chamber in the cabinet, wherein preferably the air flow is directed at the platform

wherein the method comprises air flowing, preferably laminar, from nozzles over the platform towards the pick and placing operation.

Clause 15: Method of any of the clauses 12-14, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the method comprises supporting the plant material in a horizontal manner on the platform,

wherein preferably grasping the individual plant material from the platform comprises grasping the individual plant material with the elongated rods under an angle of more than 45

degrees, preferably more than 60 degrees, with respect to a perpendicular of the horizontal surface of the platform.

Clause 16: Method of any of the clauses 12-15, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein the method further comprises moving the platform with plant material supplied thereto,

wherein moving preferably comprises rotating the platform around a vertical axis,

wherein more preferably moving comprises driving the platform by controlling,

wherein preferably the platform moves vertically.

Clause 17: Method of any of the clauses 12 -16, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein supplying plant material comprises conveying the plant material, preferably serially conveying the plant material over two or more conveyors, wherein the conveyors are preferably driven individually,

wherein supply plant material comprises providing the plant material onto a substrate or support, e.g. a decontaminated sheet, for transporting multiple pieces of plant material, preferably by conveying the substrate or support,

wherein supplying plant material comprises discharging plant material, preferably out of the interior of the cabinet, preferably through an outlet in the cabinet.

Clause 18: Method of any of the clauses 12-17, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein grasping and releasing the plant material comprises moving tips of the elongated rods towards and away from each other,

wherein grasping the plant material comprises grasping the plant material with a hook formed on the tip of the elongated rods, preferably forming tweezers

wherein grasping comprises measuring a grasping force, wherein the method preferably comprises comparing the grasping force with a predetermined maximum and controlling the movement of the grasping unit to prevent the grasping force from going over the predetermined maximum.

Clause 19: Method of any of the clauses 12-18, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein placing the individual plant material comprises positioning the individual plant material at different positions in the container,

wherein the method comprises determining, e.g. by measuring, identifying or capturing, a property of a supplied container and controlling, based on the determined property, driving the robot to different positions in the container,

wherein preferably the supplied container is moved, e.g. rotated, such that different positions of the ground surface of the container are positioned at a predetermined place position of the pick-and-place robot.

Clause 20: Method of any of the clauses 12-19, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, further comprising cleaning, preferably decontaminating, the grasping element of the pick-and-place robot,

wherein cleaning preferably comprises moving the grasping element into a cleaning module positioned inside the cabinet, preferably within the work area chamber,

wherein cleaning preferably comprises positioning the elongated rods into the cleaning module.

Clause 21: Method of clause 20, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein cleaning comprises a first, and preferably a second, cleaning step, such as a combination of heating, autoclaving, supplying alcohol.

Clause 21: Method of any the clauses 12-21, or according to any of the other clauses and/or claims, and/or according to any of the embodiments disclosed herein, wherein supplying containers comprises transporting, preferably conveying, containers over one or more separately driven conveyors,

wherein supplying containers preferably comprises supporting or engaging the container to position the container in a predetermined position with respect to the mount of the pick-and-place operation,

wherein preferably container with plant material placed therein are pushed for discharging the filled container, preferably to the outside of the cabinet,

wherein supplying containers preferably comprises filling the container with a nutrient.

Clause 22: System for processing plant material, such as sprouts and explants, comprising:

- a plant supply unit, comprising a platform that supports supplied plant material;

- a pick-and-place robot for picking individual plant material, the pick and place robot comprising a grasping element for grasping the plant material, wherein the pick-and-place robot is arranged to pick supplied individual plant material from the platform and to place the individual plant material,

wherein the platform is rotatable around a vertical axis such that plant material supplied on the platform can be rotated with respect to the pick-and-place robot.

Clause 23: System according to clause 22, including any of the clauses, claims or any of the features disclosed herein.

CLAIMS

1. System for processing plant material, such as sprouts and explants, comprising:

- one or more modules for cleaning, decontaminating and/or conditioned air supply;
- a plant supply unit comprising a platform configured to support plant material;
- a container supply unit for supplying containers, wherein the supplied containers have an open top;
- a pick-and-place robot for picking individual plant material, wherein the pick-and-place robot comprises a grasping element for grasping the plant material, wherein the grasping element has elongated rods for grasping individual plant material between ends of the elongated rods,

wherein the pick-and-place robot is arranged to pick supplied individual plant material from the platform, to orient the individual plant material, and to place the individual plant material in the supplied container through the open top.,

wherein the pick-and-place robot arranged to place the individual plant material is also arranged to orient the grasping element in a predetermined orientation, preferably with a root end of the individual plant material downwards, in the supplied container.

2. The system for processing plant material of claim 1, wherein the system comprises a cabinet, preferably having windows, one or more inlets and outlets, wherein the one or more modules for cleaning, decontaminating and/or conditioned air supply, the pick-and-place robot, the plant supply unit, and the container supply unit are received within and surrounded by the cabinet,

wherein preferably the plant supply unit and/or the container supply unit extend through an opening in the cabinet to an exterior of the cabinet,

wherein preferably a work area chamber is formed within the cabinet that contains the one or more modules for cleaning, decontaminating and/or conditioned air supply and/or the pick-and-place robot, the platform of the plant supply unit and the container supply unit supporting the supplied container, wherein preferably the pick-and-place robot is arranged to drive the elongated rods with grasped sprout or explant from the platform to the supplied container within the work area chamber, wherein preferably the supplied container supported

by the container supply unit, the platform of the plant supply unit and the one or more modules for cleaning and/or decontaminating are positioned around the pick-and-place robot.

3. The system for processing plant material claim 2, wherein the system further comprises an air supply for supplying air into an interior of the cabinet,

wherein the air supply is preferably formed by a fan having an air filter and/or air decontamination unit,

wherein the cabinet preferably has an air chamber or plenum, preferably separated by an upstanding wall of a work area chamber formed within the cabinet, wherein the air supply is connected to the air chamber,

wherein more preferably the upstanding wall separating the plenum from the work area chamber comprises air outlets, more preferably a nozzle, most preferably air outlets forming a mesh, for supplying a laminar air flow into the work area chamber, preferably directed at the plant supply, more preferably directed at the platform,

wherein more preferably the platform is positioned between the pick-and-place robot and the air outlets.

4. The system for processing plant material of any of the previous claims, wherein the platform of the plant supply unit generally is a horizontal surface for supporting plant material or for supporting a substrate carrying plant material,

wherein preferably the system comprises an input unit, e.g. a measuring unit, identification unit and/or a camera, for determining an orientation of supplied individual plant material and wherein a control unit, based on the orientation determined by the input unit, is arranged to drive the pick-and-place robot for grasping the individual plant material,

wherein preferably the pick-and-place robot is arranged to drive and orient the elongated rods of the grasping element for grasping the individual plant material from the platform in accordance with a predetermined orientation, preferably with the grasping element at an angle of more than 45 degrees, preferably more than 60 degrees, most preferably more than 75 degrees, with respect to a perpendicular of the horizontal surface.

5. The system for processing plant material of any of the previous claims, wherein the platform is movable with respect to the pick-and-place robot,

wherein preferably the platform is rotatable around a vertical axis, wherein preferably the platform is mounted to a frame of the system via a pivot or joint,

wherein preferably a drive unit for moving, preferably rotating, the platform, wherein preferably a control unit is arranged for controlling the drive,

wherein preferably the platform is translatable vertically, e.g. connected to the frame via a linear guide, in embodiments having a drive unit and connected to the control unit

wherein preferably the platform and the pick-and-place robot cooperate to orient the grasping element in a predetermined orientation with respect to individual plant material supplied to the platform.

6. The system for processing plant material of any of the previous claims, wherein the plant supply unit comprises at least one, at least two, and, in a preferred embodiment, three separately driven supply units,

wherein preferably the plant supply unit is formed by a conveyor, preferably conveyors arranged adjacently, more preferably in a single line,

wherein preferably the conveyor comprises a belt, the belt driven by a drive, wherein a control unit is provided arranged to control the drive for separately driving the conveyors,

wherein a substrate or support is provided on the plant supply unit for transporting multiple pieces of plant material,

wherein the plant supply unit comprises a plant material discharge unit, preferably extending out of the interior of the cabinet, preferably through an outlet in the cabinet.

7. The system for processing plant material of any of the previous claims, wherein at least one of the elongated rods of the grasping unit is moveable, the grasping unit having a drive for moving an end of the elongated rod towards and away from an end of the other elongated rod,

wherein preferably at least one of the elongated rods is mounted via a joint to the grasping unit

wherein preferably the remote ends of the elongated rods have a bended hook, and the bended hook forms a grasping surface for grasping the plant material therebetween

wherein preferably the elongated rods form tweezers

wherein preferably the grasping unit has a force measuring unit for measuring an applied grasping force, wherein more preferably a control unit of the grasping unit limits the applied grasping force to a predetermined maximum, e.g. less than 5 Newton.

8. The system for processing plant material of any of the previous claims,

wherein the pick-and-place robot is arranged to place the individual grasped plant material in the supplied container with a predetermined orientation,

wherein preferably the pick-and-place robot is arranged to drive and orient the elongated rods of the grasping element in accordance with a predetermined orientation with respect to the supplied container, wherein preferably the grasping element is oriented at an angle of less than 45 degrees, preferably less than 30 degrees, most preferably less than 15 degrees, with respect to a perpendicular of a bottom surface of the supplied container,

wherein preferably the system is arranged to place the individual plant material at different positions, preferably arc sections distributed over a ground surface, of the container

wherein preferably the pick-and-place robot is arranged to place multiple individual plant material in one supplied container positioned according to a predetermined pattern,

wherein preferably the system comprises an input unit, e.g. a measuring unit, identification unit and/or a camera, for determining a property of a supplied container and wherein a control unit, based on the property determined by the input unit, is arranged to drive the robot to different positions of the container

wherein preferably the system comprises a container moving unit that is arranged to move, e.g. rotate, a supplied container such that different positions of the ground surface of the container are positioned at a predetermined place position of the pick-and-place robot.

9. The system for processing plant material of any of the previous claims, further comprising a cleaning module comprising a cleaning tool for cleaning, preferably decontaminating, the grasping element of the pick-and-place robot,

wherein the cleaning modules is preferably received within the cabinet, preferably within the work area chamber,

wherein preferably the pick-and-place robot is arranged to position the elongated rods into the cleaning modules.

10. The system for processing plant material of claim 9, wherein the cleaning module comprises a first, and preferably a second, cleaning station, such as a heater, autoclave, alcohol supply.

11. The system for processing plant material of any of the previous claims, wherein container supply unit is arranged to supply containers, preferably having a bottom and walls, and preferably filled with a liquid, that are arranged to receive multiple individual plant material,

wherein the pick-and-place robot is arranged to place consecutive individual plant material in the container at predetermined positions, e.g. according to a predetermined pattern,

wherein the container supply unit comprises one or more separate driving units, preferably one or more conveyors, preferably having a conveyor belt,

wherein container supply unit comprises a platform or engaging unit for supporting and/or receiving the container, wherein the platform or engaging unit is arranged to have a predetermined position with respect to the mount of the pick-and-place robot,

wherein preferably the container supply unit comprises a predetermined position for receiving the container so that the container is held at a predetermined position with respect to the pick-and-place robot,

wherein preferably a pushing unit is arranged to push a container from a first supply conveyor to a discharge conveyor,

wherein preferably the container supply unit extends through an outlet out of the interior of the cabinet,

wherein preferably the container supply unit comprises a nutrient dispenser for filling the container with nutrients and/or the at least one container is filled with nutrients.

12. Method for processing plant material, such as sprouts and explants, the method comprising:

- providing containers having an open top, and plant material with a root end;
- supplying the plant material onto a platform that supports supplied plant material;
- supplying the container to a predetermined location;
- providing a clean environment at the platform and at the predetermined location by e.g. cleaning, decontaminating and/or supply conditioned air; and

- picking-and-placing, within the clean environment, individual plant material with a pick-and-place robot, wherein picking comprises grasping individual plant material from the platform between ends of elongated rods, and wherein placing comprises orienting the grasped individual plant material in the container in a predetermined orientation, preferably with the root end downwards.

13. Method of claim 12, wherein the method further comprises decontaminating the platform and/or the containers and/or the pick-and-place robot, in particular the elongated rods of the grasper, preferably by supplying conditioned air, preferably a laminar air flow, more preferably by heating for disinfecting,

wherein preferably picking and placing is operated in a cabinet,

wherein preferably plant material is supplied into and/or out of the cabinet and wherein preferably containers are supplied into and/or out of the cabinet.

14. Method of claim 13, wherein the method comprises supplying air into an interior of the cabinet,

wherein supplying air preferably comprises air filtering and/or air decontaminating,

wherein preferably air is supplied into an air chamber or plenum in the cabinet,

wherein more preferably air flows from the air chamber or plenum to a work area chamber in which the picking and placing is operated, wherein air flows through nozzles, preferably air outlets forming a mesh, in a wall separating the air chamber or plenum from the work area chamber in the cabinet, wherein preferably the air flow is directed at the platform

wherein the method comprises air flowing, preferably laminar, from nozzles over the platform towards the pick and placing operation.

15. Method of any of the claims 12-14, wherein the method comprises supporting the plant material in a horizontal manner on the platform,

wherein the method preferably comprises determining, e.g. by measuring, identifying or image capturing, an orientation of individual plant material supplied to the platform,

wherein preferably the determined orientation is used to drive the elongated rods of the grasper in an orientation with respect to the determined orientation of supplied plant material for grasping, wherein more preferably the platform is oriented,

wherein preferably grasping the individual plant material from the platform comprises grasping the individual plant material with the elongated rods under an angle of more than 45 degrees, preferably more than 60 degrees, with respect to a perpendicular of the horizontal surface of the platform.

16. Method of any of the claims 12-15, wherein the method further comprises moving the platform with plant material supplied thereto,

wherein the method further comprises the platform and grasper cooperating to orient the grasping element with respect to the individual plant material supplied on that platform,

wherein moving preferably comprises rotating the platform around a vertical axis,

wherein more preferably moving comprises driving the platform by controlling,

wherein preferably the moving comprises moving the platform vertically along the vertical axis.

17. Method of any of the claims 12 -16, wherein supplying plant material comprises conveying the plant material, preferably serially conveying the plant material over two or more conveyors, wherein the conveyors are preferably driven individually,

wherein supply plant material comprises providing the plant material onto a substrate or support, e.g. a decontaminated sheet, for transporting multiple pieces of plant material, preferably by conveying the substrate or support,

wherein supplying plant material comprises discharging plant material, preferably out of the interior of the cabinet, preferably through an outlet in the cabinet.

18. Method of any of the claims 12-17, wherein grasping and releasing the plant material comprises moving tips of the elongated rods towards and away from each other,

wherein grasping the plant material comprises grasping the plant material with a hook formed on the tip of the elongated rods, preferably forming tweezers,

wherein grasping comprises measuring a grasping force, wherein the method preferably comprises comparing the grasping force with a predetermined maximum and controlling the movement of the grasping unit to prevent the grasping force from going over the predetermined maximum.

19. Method of any of the claims 12-18, wherein placing the individual plant material comprises positioning multiple individual plant material at different positions in a single container,

wherein placing the individual grasped plant material in the supplied container with predetermined orientation comprises driving the elongated rods of the grasping element in accordance with a predetermined orientation with respect to the supplied container, wherein preferably the grasping element is oriented at an angle of less than 45 degrees, preferably less than 30 degrees, most preferably less than 15 degrees, with respect to a perpendicular of a bottom surface of the supplied container,

wherein the method comprises determining, e.g. by measuring, identifying or capturing, a property of a supplied container and controlling, based on the determined property, driving the robot to different positions in the container,

wherein preferably the supplied container is moved, e.g. rotated, such that different positions of the ground surface of the container are positioned at a predetermined place position of the pick-and-place robot.

20. Method of any of the claims 12-19, further comprising cleaning, preferably decontaminating, the grasper of the pick-and-place robot,

wherein cleaning preferably comprises moving the grasper into a cleaning module positioned inside the cabinet, preferably within the work area chamber,

wherein cleaning preferably comprises positioning the elongated rods into the cleaning module,

wherein cleaning preferably comprises heating up the grasper using induction, wherein more preferably cleaning comprises cooling the heated grasper in a cooling module before grasping the individual plant material.

21. Method of claim 20, wherein cleaning comprises a first, and preferably a second, cleaning step, such as a combination of heating, autoclaving, supplying alcohol.

22. Method of any the claims 12-21, wherein supplying containers comprises transporting, preferably conveying, containers over one or more separately driven conveyors,

wherein supplying containers preferably comprises supporting or engaging the container to position the container in a predetermined position with respect to the mount of the pick-and-place operation,

wherein preferably container with plant material placed therein are pushed for discharging the filled container, preferably to the outside of the cabinet,

wherein supplying containers preferably comprises filling the container with a nutrient.

23. System for processing plant material, such as sprouts and explants, comprising:

- a plant supply unit, comprising a platform that supports supplied plant material;
- a pick-and-place robot for picking individual plant material, the pick and place robot comprising a grasping element for grasping the plant material, wherein the pick-and-place robot is arranged to pick supplied individual plant material from the platform and to place the individual plant material,

wherein the platform is rotatable around a vertical axis such that plant material supplied on the platform can be rotated with respect to the pick-and-place robot.

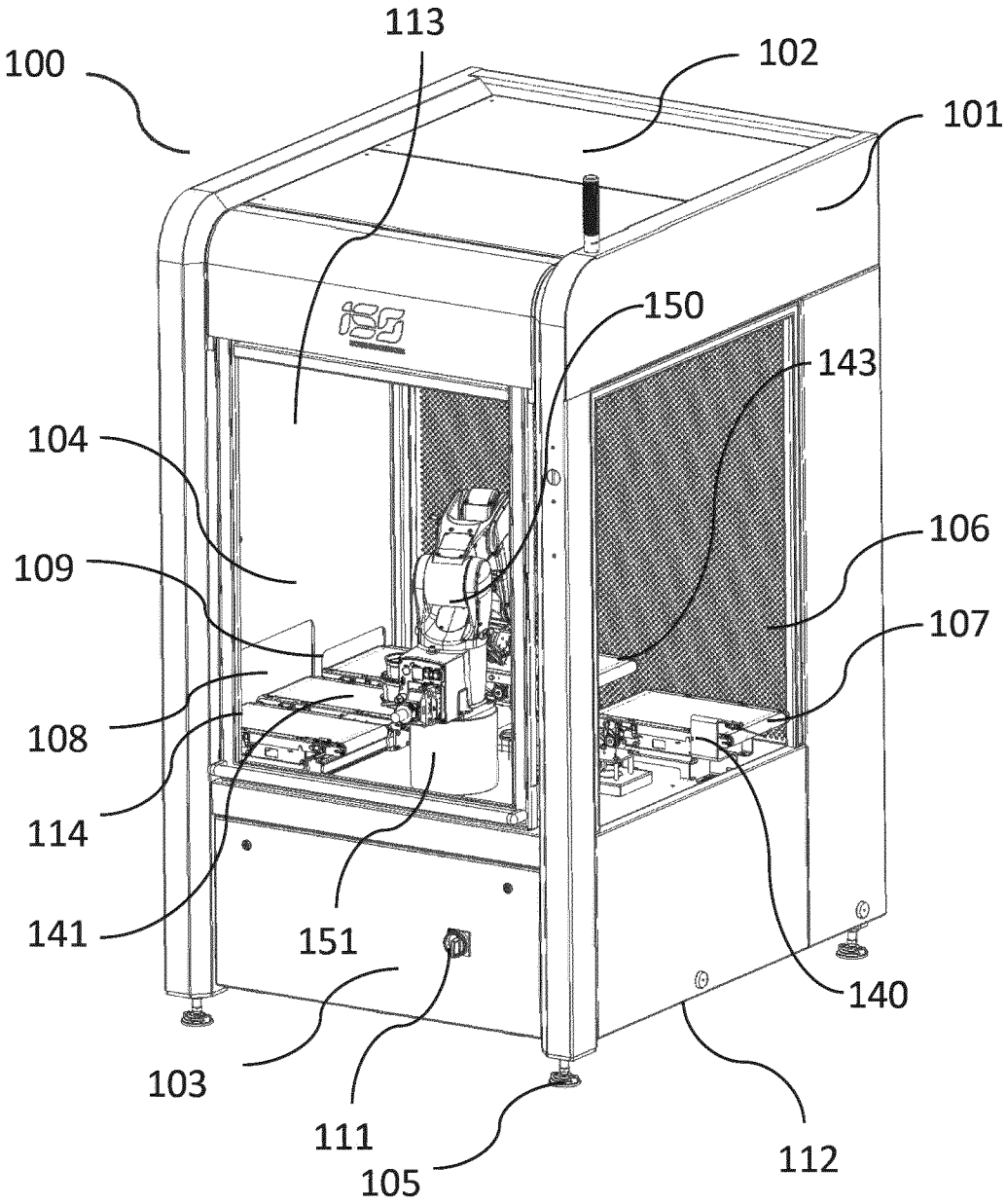
113
100
102
101
150
143
104
106
109
107
108
114
141
151
140
103
111
105
112

Figure 1

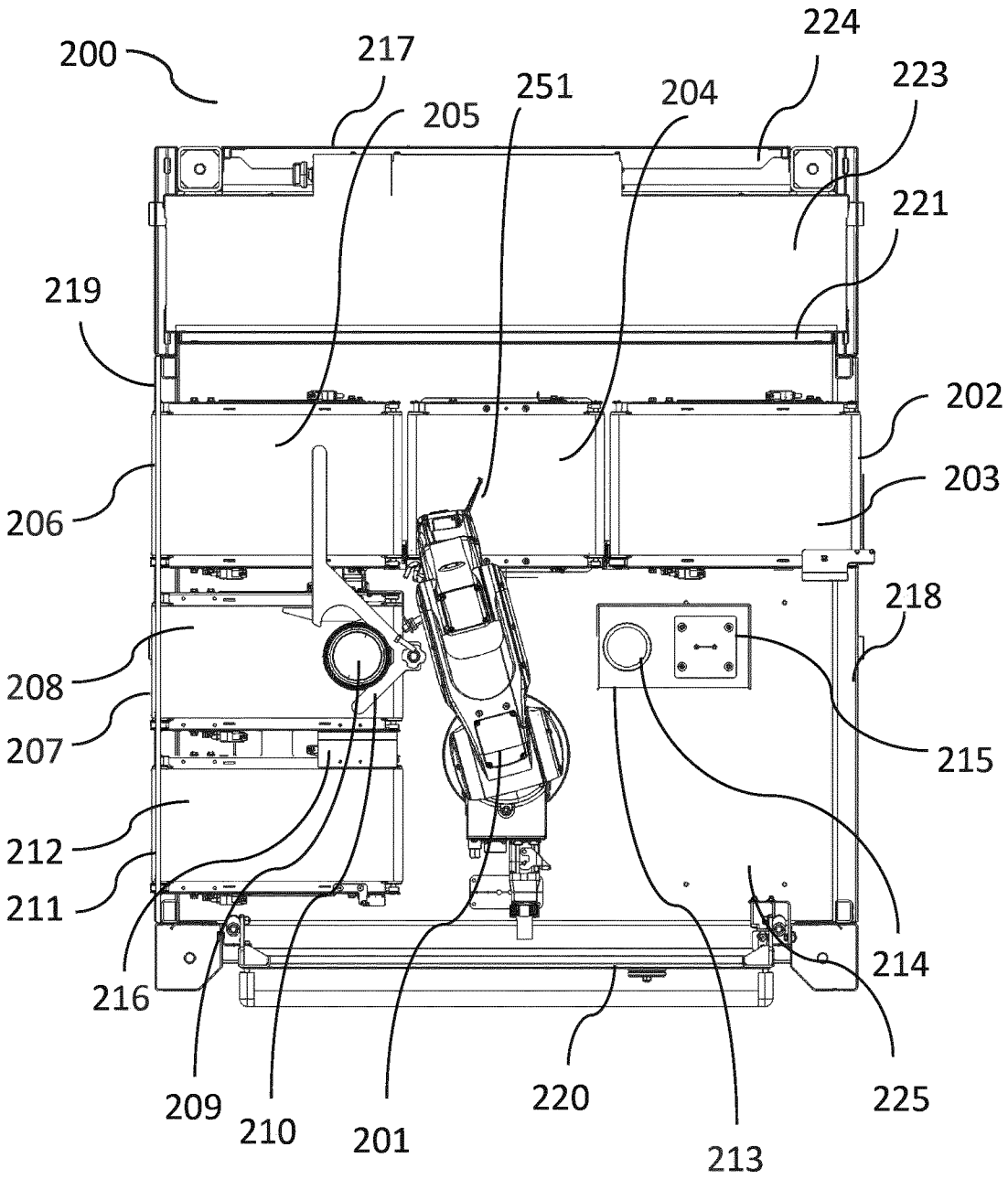
200
217
205
251
204
224
223
221
219
202
203
206
218
208
215
207
212
214
211
216
209
210
201
220
225
213

Figure 2

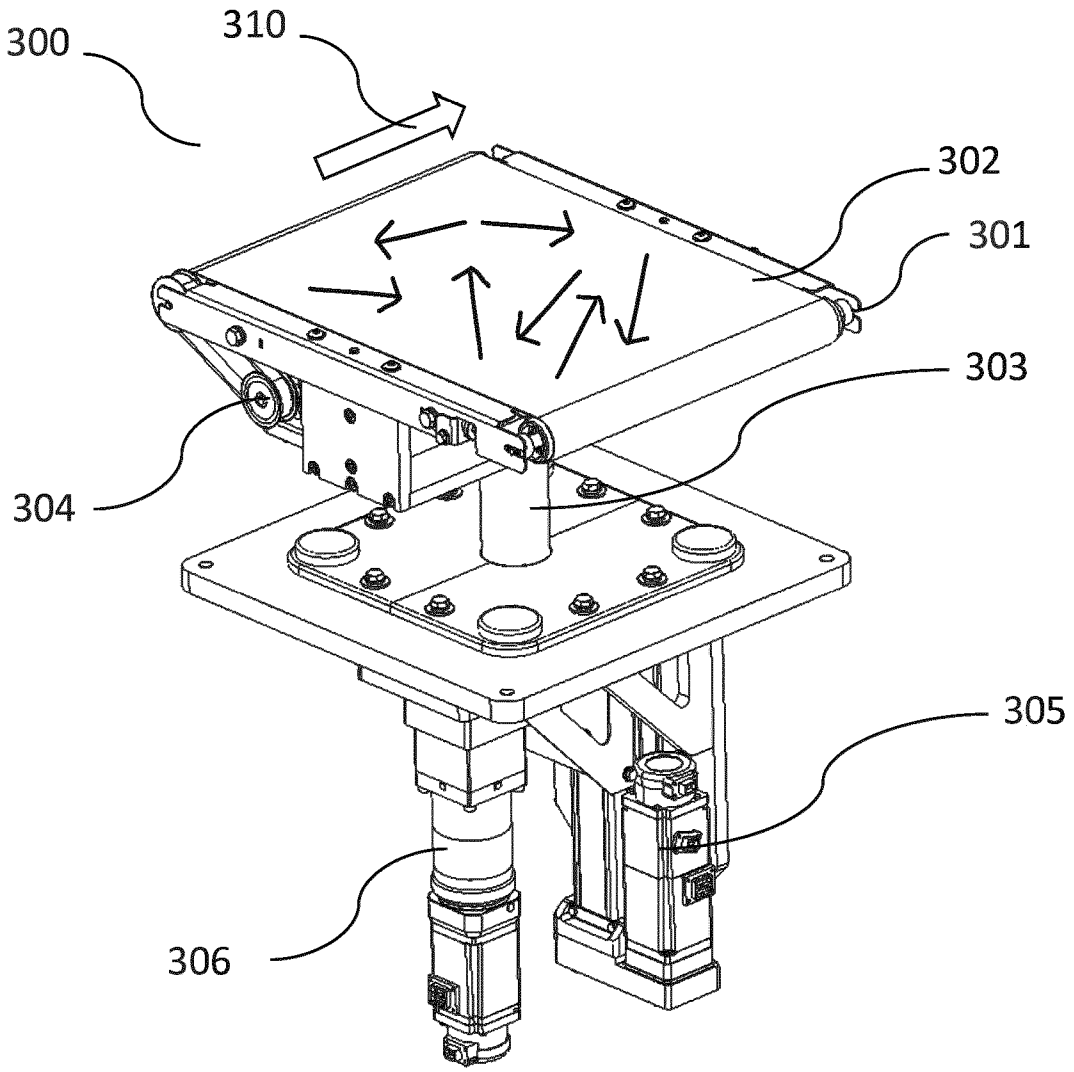

Figure 3

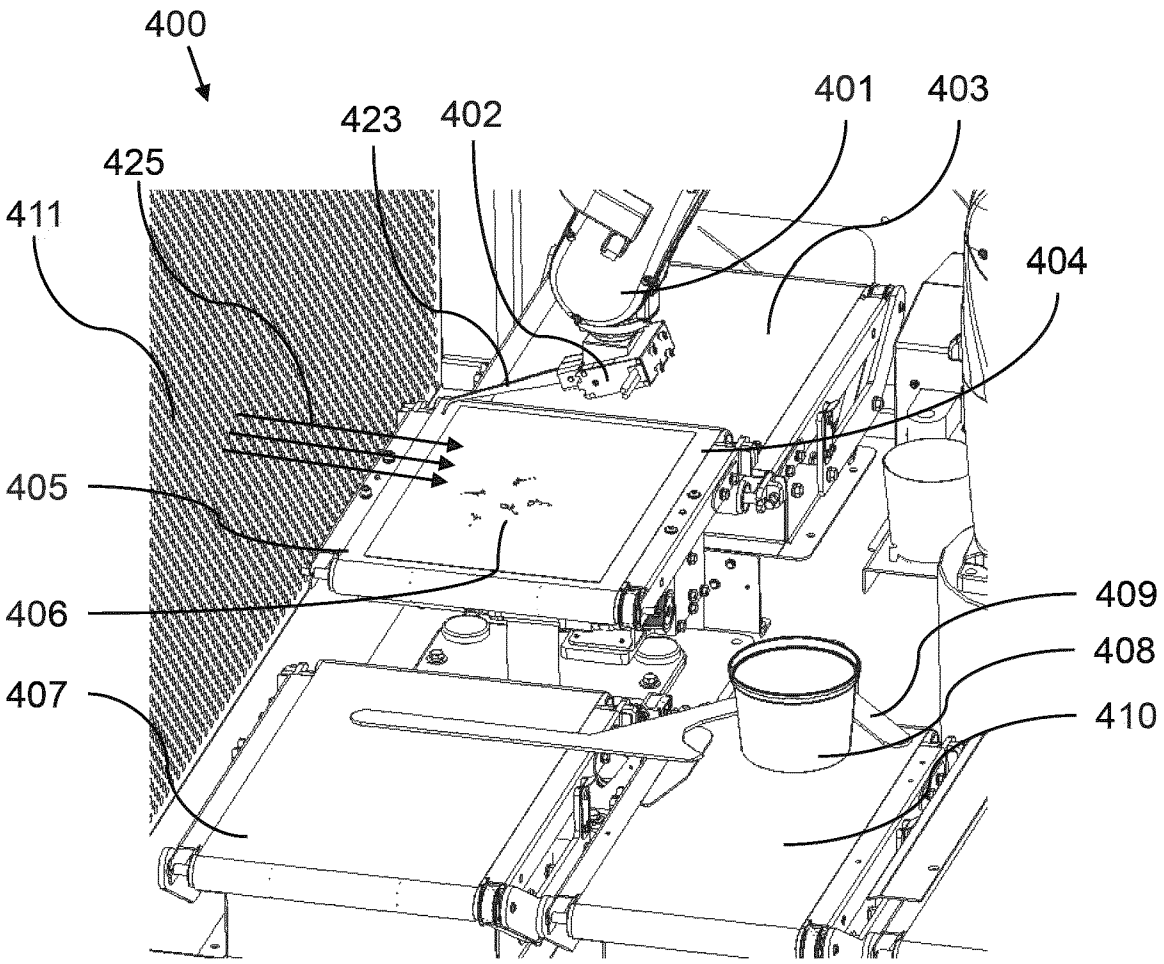

Figure 4a

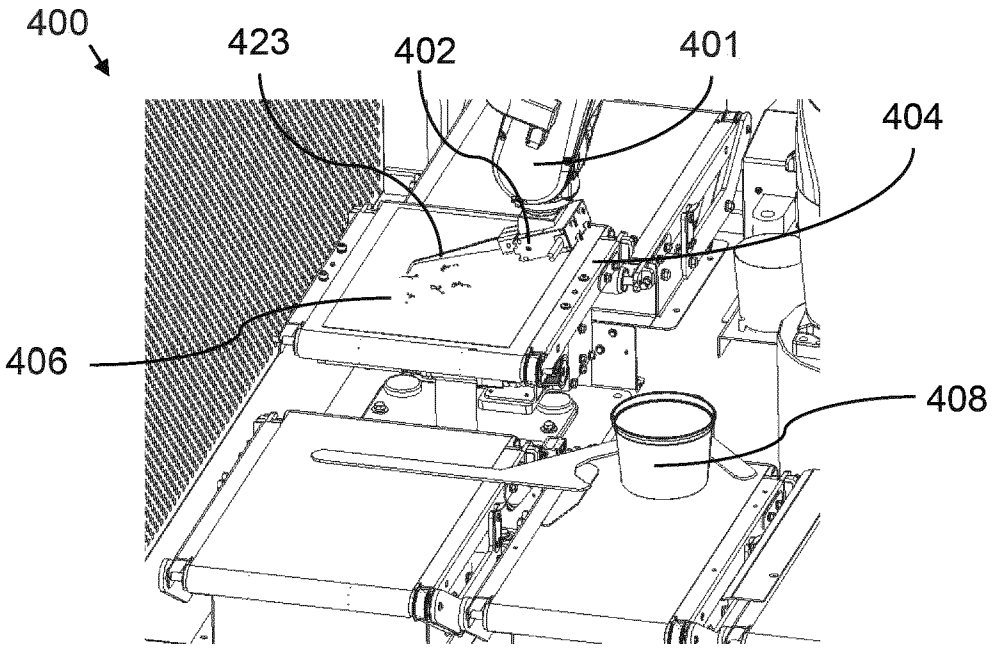

Figure 4b

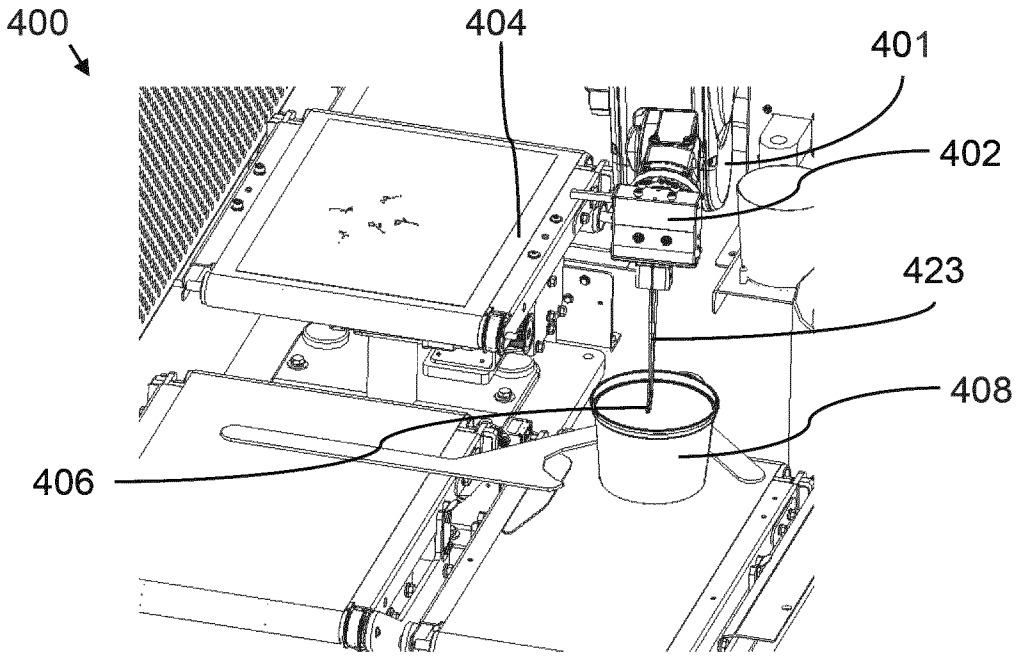

Figure 4c

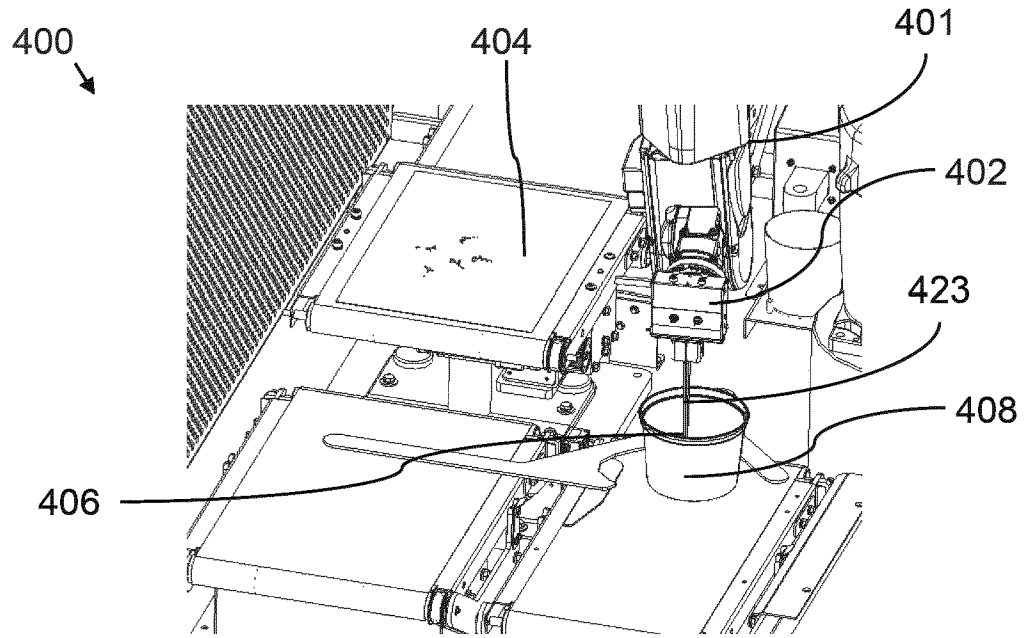

Figure 4d

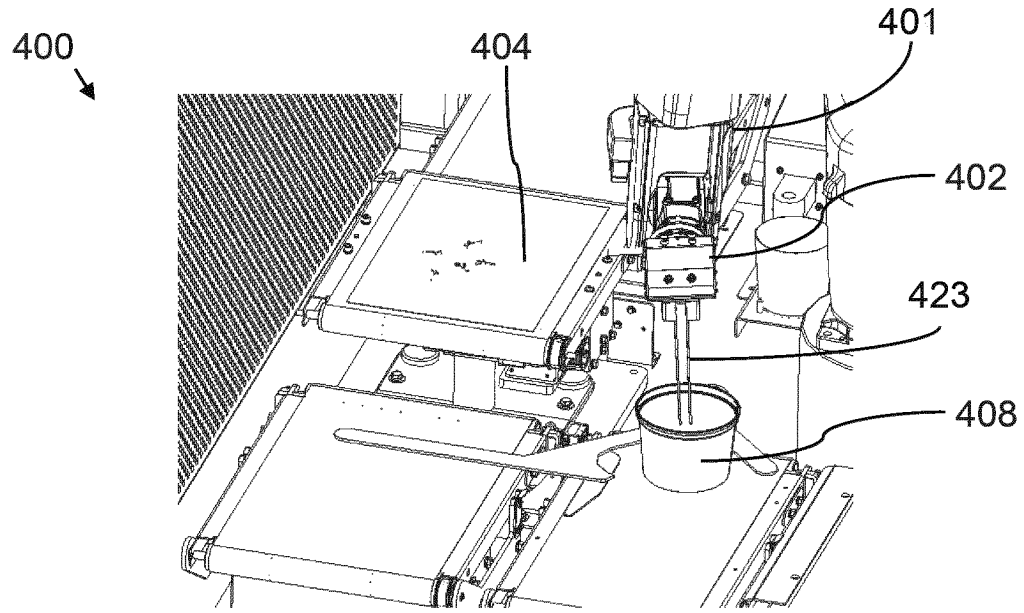

Figure 4e

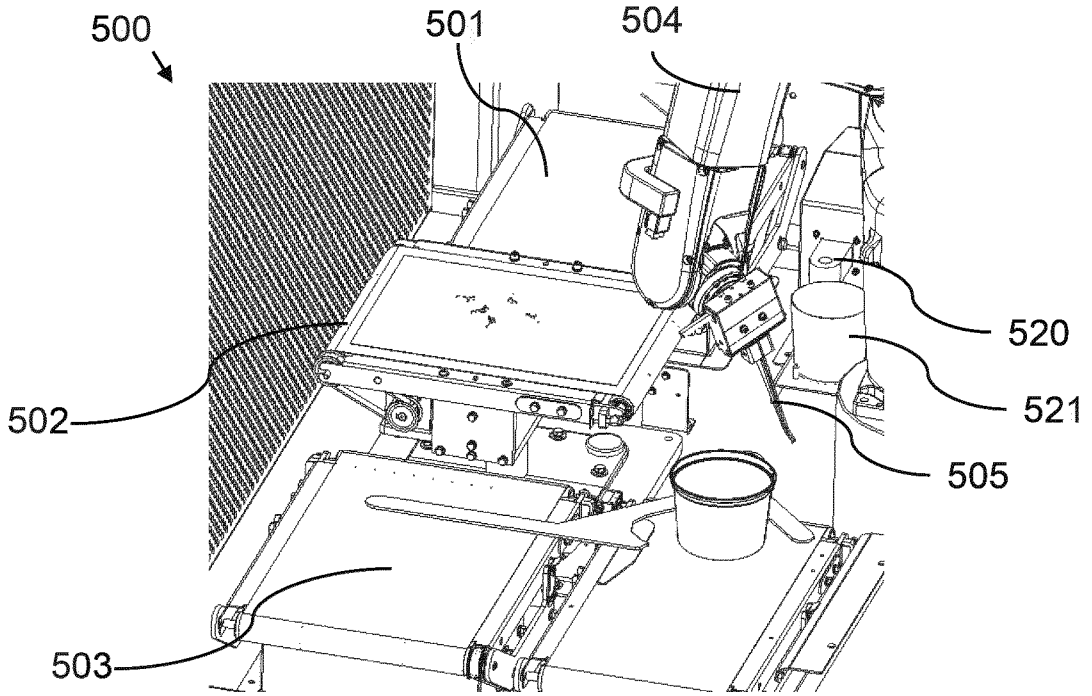

Figure 5

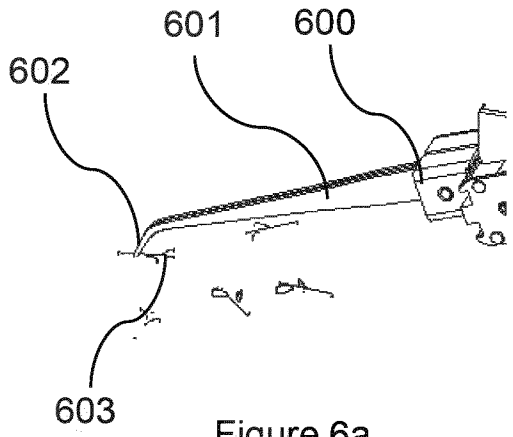

Figure 6a

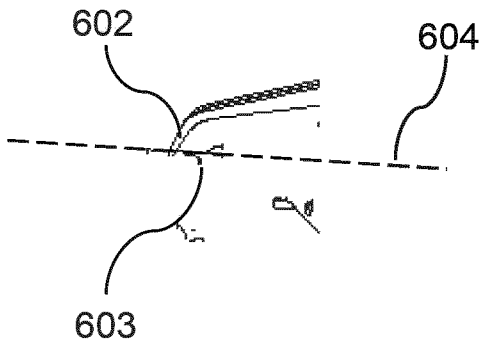

Figure 6b

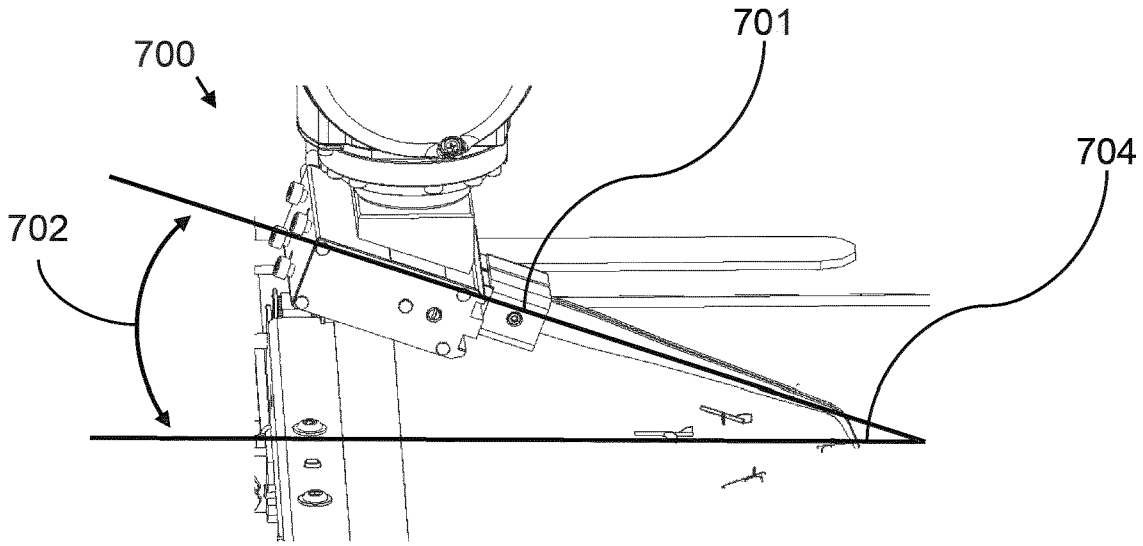

Figure 7a

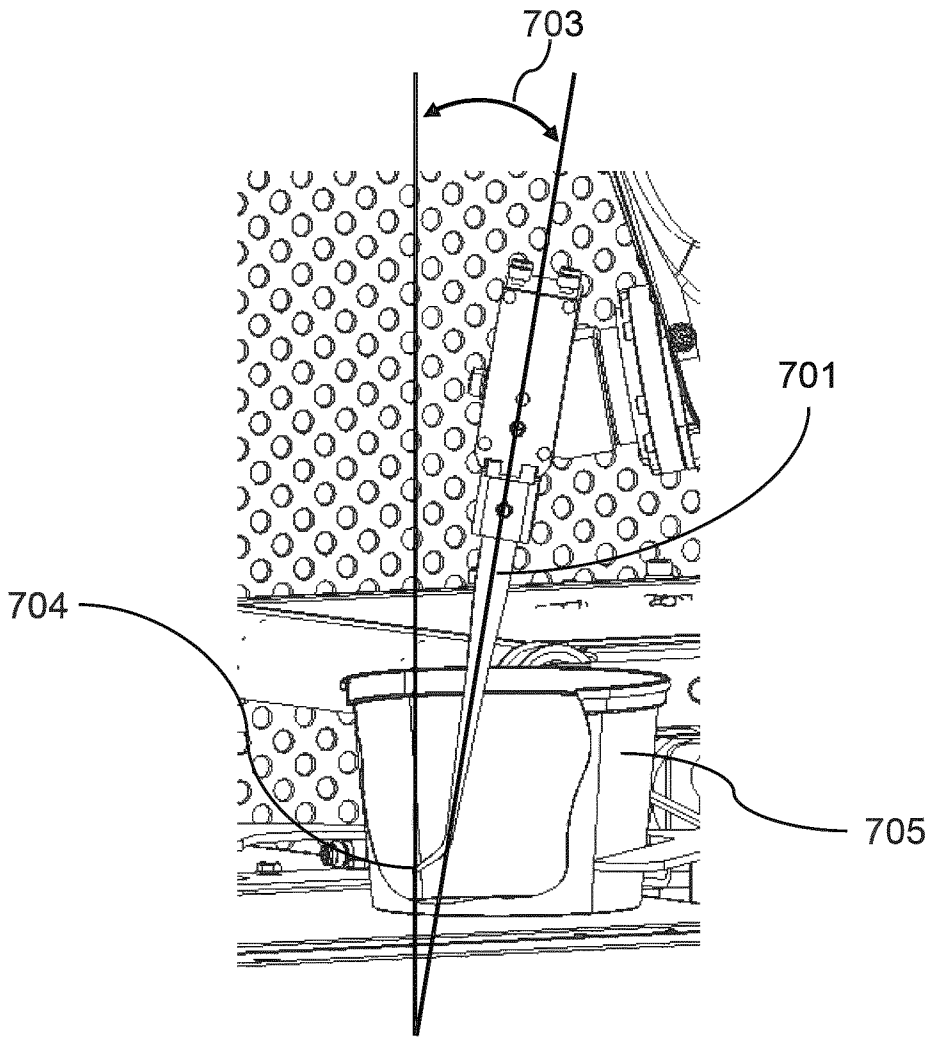

Figure 7b