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(54) Title: APPARATUS AND METHOD FOR HOLDING A SUBSTRATE DURING LAYER DEPOSITION IN A VACUUM CHAMBER

(57) Abstract: The present disclosure provides a holding arrangement (100) for holding a substrate (10) during layer deposition in a vacuum chamber. The holding arrangement (100) includes a carrier (110) having a support surface (112) configured for supporting the substrate (10); and one or more holding devices (120) provided at the carrier (110). Each each holding device (120) includes at least one rotatable device (122) configured to rotate around a rotation axis (124), wherein the rotation axis (124) is substantially perpendicular to the support surface (112), and wherein the rotatable device (122) has a contact element (126, 526) positioned at a distance from the rotation axis (124) for holding the substrate (10) after rotation.

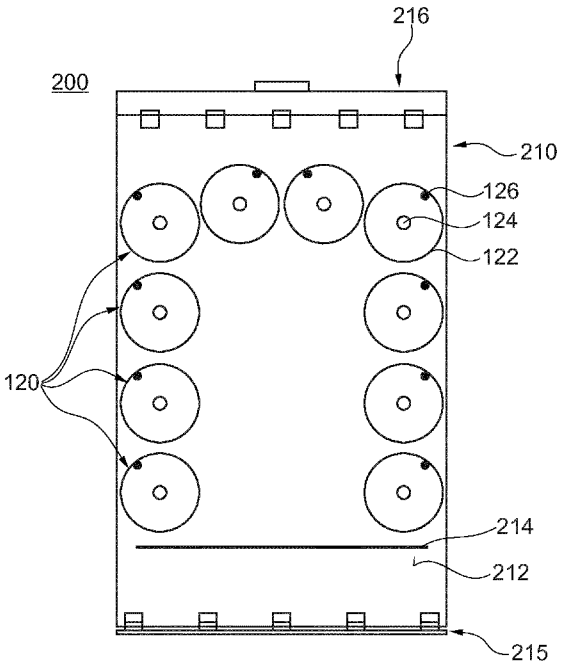


Fig. 2

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APPARATUS AND METHOD FOR HOLDING A SUBSTRATE DURING LAYER DEPOSITION IN A VACUUM CHAMBER

FIELD

[0001] Embodiments of the present disclosure relate to a holding arrangement for holding a substrate during processing, e.g., layer deposition, and to a method for holding a substrate during said processing. Embodiments of the present disclosure particularly relate to a holding arrangement for holding a substrate during layer deposition in a vacuum chamber, an apparatus for depositing a layer on a substrate, and a method for holding a substrate during layer deposition in a vacuum chamber.

BACKGROUND

[0002] Several methods are known for depositing a material on a substrate. For instance, substrates may be coated by a physical vapor deposition (PVD) process, a chemical vapor deposition (CVD) process, a plasma enhanced chemical vapor deposition (PECVD) process etc. The process can be performed in a process apparatus or process chamber, where the substrate to be coated is located. A deposition material is provided in the apparatus. A plurality of materials, but also oxides, nitrides or carbides thereof, may be used for deposition on a substrate. Further, other processes like etching, structuring, annealing, or the like can be conducted in processing chambers.

[0003] Coated materials may be used in several applications and in several technical fields. For instance, an application lies in the field of microelectronics, such as generating semiconductor devices. Also, substrates for displays are often coated by a PVD process. Further applications include insulating panels, organic light emitting diode (OLED) panels, substrates with TFT, color filters or the like.

[0004] Glass substrates can be supported on holding arrangements during processing thereof. The holding arrangement drives the glass or the substrate through the processing machine. The holding arrangement may include a carrier that can support a surface of the substrate. Further, holding devices are provided for fixing the substrate to the carrier and holding it in place during the deposition process.

[0005] In mobile applications such as display PVD touch panels, different substrate sizes are processed, wherein different carriers are provided for different substrate sizes or display sizes. When using different carriers, switching from one substrate size to another substrate size is time consuming and causes workload. Further, the provision of a plurality of carriers for different substrate sizes increases complexity and maintenance costs of the processing machine.

[0006] In view of the above, it is an object of the present disclosure to provide a holding arrangement for holding a substrate during layer deposition in a vacuum chamber, an apparatus for depositing a layer on a substrate having the holding arrangement, and a method for holding a substrate during layer deposition in a vacuum chamber, that allows for holding substrates of different sizes.

SUMMARY

[0007] In light of the above, a holding arrangement for holding a substrate during layer deposition in a vacuum chamber, an apparatus for depositing a layer on a substrate, and a method for holding a substrate during layer deposition in a vacuum chamber are provided. Further aspects, benefits, and features of the present disclosure are apparent from the claims, the description, and the accompanying drawings.

[0008] According to an aspect of the present disclosure, a holding arrangement for holding a substrate during layer deposition in a vacuum chamber is provided. The holding arrangement includes a carrier having a support surface configured for supporting the substrate; and one or more holding devices provided at the carrier. Each holding device includes at least one rotatable device configured to rotate around a rotation axis, wherein

the rotation axis is substantially perpendicular to the support surface, and wherein the rotatable device has a contact element positioned at a distance from the rotation axis for holding the substrate after rotation.

[0009] According to an aspect of the present disclosure, an apparatus for depositing a layer on a substrate is provided. The apparatus includes a vacuum chamber adapted for layer deposition therein, a holding arrangement within the vacuum chamber, and a deposition source for depositing material forming the layer. The holding arrangement includes a carrier having a support surface configured for supporting the substrate; and one or more holding devices provided at the carrier. Each holding device includes at least one rotatable device configured to rotate around a rotation axis, wherein the rotation axis is substantially perpendicular to the support surface, and wherein the rotatable device has a contact element positioned at a distance from the rotation axis for holding the substrate after rotation.

[0010] According to still another aspect of the present disclosure, a method for holding a substrate during layer deposition in a vacuum chamber is provided. The method includes positioning the substrate on a support surface of a carrier; and rotating a rotatable device provided at the carrier around a rotation axis, wherein the rotation axis is substantially perpendicular to the support surface.

[0011] According to yet another aspect of the present disclosure, a holding arrangement for holding a substrate during layer deposition in a vacuum chamber is provided. The holding arrangement includes a carrier plate having a first side and a second side, wherein the first side provides a support surface configured for supporting the substrate; and one or more holding devices provided at the second side of the carrier plate. Each holding device includes at least one rotatable disc configured to rotate around a rotation axis, wherein the rotation axis is substantially perpendicular to the support surface, and wherein the rotatable disc has a contact element positioned at a distance from the rotation axis for holding the substrate after rotation. The carrier plate has at least one cutout, wherein the at least one cutout is configured for a passage of at least a part of the contact element.

[0012] Embodiments are also directed at apparatuses for carrying out the disclosed methods and include apparatus parts for performing each described method aspect. These

method aspects may be performed by way of hardware components, a computer programmed by appropriate software, by any combination of the two or in any other manner. Furthermore, embodiments according to the disclosure are also directed at methods for operating the described apparatus. It includes method aspects for carrying out every function of the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:

FIGs. 1A and 1B	show schematic views of a holding arrangement for holding substrates of different sizes according to embodiments described herein;
FIG. 2	shows a schematic view of a holding arrangement for holding a substrate during layer deposition in a vacuum chamber according to further embodiments described herein;
FIGs. 3A and 3B	show schematic views of the holding arrangement of figure 2 holding substrates of different sizes;
FIG. 4	shows a schematic view of a portion of a holding arrangement for holding a substrate during layer deposition in a vacuum chamber according to yet further embodiments described herein;
FIGs. 5A, 5B and 5C	show schematic views of a holding arrangement with the rotatable device being at different rotation positions according to still further embodiments described herein;

FIG. 6 shows a schematic view of an apparatus for depositing a layer on a substrate according to embodiments described herein; and

FIG. 7 shows a flow chart of a method for holding a substrate during layer deposition in a vacuum chamber according to embodiments described herein.

DETAILED DESCRIPTION OF EMBODIMENTS

[0014] Reference will now be made in detail to the various embodiments of the disclosure, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same components. Generally, only the differences with respect to individual embodiments are described. Each example is provided by way of explanation of the disclosure and is not meant as a limitation of the disclosure. Further, features illustrated or described as part of one embodiment can be used on or in conjunction with other embodiments to yield yet a further embodiment. It is intended that the description includes such modifications and variations.

[0015] According to an aspect of the present disclosure, a holding arrangement for holding a substrate during layer deposition in a vacuum chamber is provided. The holding arrangement includes a carrier having a support surface configured for supporting the substrate; and one or more holding devices provided at the carrier. Each holding device includes at least one rotatable device configured to rotate around a rotation axis, wherein the rotation axis is substantially perpendicular to the support surface, and wherein the rotatable device has a contact element positioned at a distance from the rotation axis for holding the substrate after rotation.

[0016] The present disclosure provides a flexible holding arrangement, particularly a holding arrangement for holding a substrate during layer deposition in a vacuum chamber, that allows for holding substrates of different sizes. Switching from one substrate size to

another substrate size can be done quickly and/or with reduced effort. Further, only one holding arrangement is provided for different substrate sizes, wherein complexity and maintenance costs of the processing machine are reduced.

[0017] The term "substantially perpendicular" relates to a substantially perpendicular orientation e.g. of the rotation axis with respect to the support surface or the substrate surface, wherein a deviation of a few degrees, e.g. up to 1° or even up to 5°, from an exact perpendicular orientation is still considered as "substantially perpendicular".

[0018] The term "substrate" as used herein shall embrace substrates which can be used for display manufacturing, such as glass or plastic substrates. For example, substrates as described herein shall embrace substrates which can be used for an LCD (Liquid Crystal Display), a PDP (Plasma Display Panel), an OLED (Organic Light Emitting Diode) and the like. Unless explicitly specified otherwise in the description, the term "substrate" is to be understood as "large area substrate" as specified herein. For instance, a large area substrate or carrier can be GEN 4.5, which corresponds to about 0.67 m² substrates (0.73x0.92m), GEN 5, which corresponds to about 1.4 m² substrates (1.1 m x 1.3 m), GEN 7.5, which corresponds to about 4.29 m² substrates (1.95 m x 2.2 m), GEN 8.5, which corresponds to about 5.7m² substrates (2.2 m x 2.5 m), or even GEN 10, which corresponds to about 8.7 m² substrates (2.85 m × 3.05 m). Even larger generations such as GEN 11 and GEN 12 and corresponding substrate areas can similarly be implemented.

[0019] Figures 1A and 1B show schematic views of a holding arrangement 100 for holding substrates of different sizes according to embodiments described herein. Figure 1A shows the holding arrangement 100 holding a substrate 10 having a first size or a first surface area 12. Figure 1B shows the holding arrangement 100 holding another substrate 20 having a second size or a second surface area 22. The second size or second surface area 22 is smaller than the first size or first surface area 12.

[0020] The holding arrangement 100 includes a carrier 110 having a support surface 112 configured for supporting the substrate 10, and one or more holding devices 120 provided at the carrier 110. Each holding device 120 includes at least one rotatable device 122 configured to rotate around a rotation axis 124 (the rotation is indicated with arrow 125 in figures 1A and 1B), wherein the rotation axis 124 is substantially perpendicular to the

support surface 112, and wherein the rotatable device 122 has a contact element 126 positioned at a distance from the rotation axis 124 for holding the substrate 10 after rotation.

[0021] The contact element 126 is positioned at the distance from the rotation axis 124. In other words, the contact element 126 is positioned eccentrically or off-axis on, or at, the rotatable device 122. In some examples, the distance can be in the range of 50 to 250 mm, specifically in the range of 100 to 200 mm, and more specifically about 145 or 150 mm. According to some embodiments, which can be combined with other embodiments described herein, the distance between the rotation axis 124 and the contact element 126 can be changed. As an example, the contact element 126 can be provided detachably at, or on, the rotatable device 122 for changing the distance.

[0022] According to some embodiments, which can be combined with other embodiments described herein, the contact element 126 includes or is made of a material such as metal, ceramics, rubber, and/or plastics. Using these materials allows for avoiding a damage of the substrate 10 by the contact element 126.

[0023] The substrate 10 in figure 1A and the other substrate 20 in figure 1B are supported by the support surface 112 of the carrier 110. The carrier 110 can form a frame or a plate, wherein the carrier 110 can support a surface of the substrate 10 (or the other substrate 20) along the periphery thereof or, in the latter case, supports the surface of the substrate 10 as such. As an example, the carrier 110 may include or be a carrier plate. At least a part of the mechanics, such as the one or more holding devices 120, can be implemented in the carrier plate. Providing e.g. a closed carrier plate allows for protecting the substrate 10 against backside coating. Further, the carrier plate can avoid coating through the carrier into the processing machine and/or can avoid the occurrence of arcing.

[0024] The holding arrangement 100 may include a support device 114, e.g., a support bar, at a lower portion of the carrier 110. As an example, the support device 114 can be configured to support or carry a weight of the substrate 10, in particular when the substrate 10 is vertically oriented.

[0025] For loading the substrate 10 (or the other substrate 20), the substrate 10 is positioned on the support surface 112 of the carrier 110 with the contact element 126 being, for example, at a first position 127. In some embodiments, the loading can be done with the carrier 110 and the substrate 10 being in a substantially horizontal orientation. For fixing or holding the substrate 10, the rotatable device 122 is rotated around the rotation axis 124, wherein the rotation axis 124 is substantially perpendicular to the support surface 112 or the first surface area 12. The contact element 126 will contact or touch the substrate 10 and hold or fix the substrate 10 in position. According to some embodiments, which can be combined with other embodiments described herein, the contact element 126 is configured to contact an edge portion 14 of the substrate 10 for holding the substrate 10.

[0026] According to some embodiments, which can be combined with other embodiments described herein, the contact element 126 can provide a holding force or clamping force for holding the substrate in position. As an example, the holding force or clamping force can be substantially perpendicular to the support surface 112, or the holding force or clamping force can be substantially parallel to the support surface 112.

[0027] In some implementations, the rotatable device 122 is configured to be rotated around the rotation axis 124 in at least one of a first direction and a second direction, wherein the first direction can be a clockwise direction and the second direction can be a counter-clockwise direction. As an example, for fixing the substrate 10, the rotatable device 122 can be rotated in the first direction, e.g., the clockwise direction, and for releasing the substrate 10, the rotatable device 122 can be rotated in the second direction, e.g., the counter-clockwise direction.

[0028] According to some embodiments, which can be combined with other embodiments described herein, the at least one rotatable device includes at least one of a circular shaped member, a segment of a circle, an arm and a rotatable disc. However, the present disclosure is not limited thereto, and the at least one rotatable device can have any regular or irregular shape.

[0029] As an example, the at least one rotatable device 122 is or constitutes the rotatable disc. The rotatable disc as understood throughout this disclosure may refer to a region in a plane bounded by a circle, and may particularly refer to a circular plate. The rotatable disc

may have a disc radius. The disc radius may be in the range of of 50 to 250 mm, specifically in the range of 100 to 200 mm, and more specifically about 150 or 155 mm. The rotation axis 124 may pass through a center of the rotatable disc.

[0030] As another example, the at least one rotatable device 122 is an arm. The arm may have a first end portion and a second end portion. The first end portion may be connected to the rotation axis 124 and/or may provide the rotation axis 124 for the arm. The contact element 126 can be provided on, or at, the second end portion.

[0031] The holding device 120 can include a drive (not shown) configured for rotating the rotatable device 122. The drive may be connected to the rotatable device at a contact position corresponding to the rotation axis 124. In some implementations, the drive can be configured to adjust a rotational position of the rotatable device 122, and/or the drive can be configured to lock or hold the rotational position of the rotatable device 122. In some embodiments, the drive can be, or include, a fixture and/or a robot.

[0032] According to some embodiments, which can be combined with other embodiments described herein, the carrier 110 includes a first side and a second side, wherein the support surface 112 is provided at the first side of the carrier 110, and wherein the rotatable device 122 is provided at the second side of the carrier 110. As an example, the first side is a deposition side or a front side of the carrier 110, and/or the second side is a non-deposition side or backside of the carrier 110. The first side of the carrier 110 may be configured to face a deposition source, and the second side may be facing away from the deposition source. Providing the rotatable device 122 at the second side of the carrier allows to cover and protect the rotatable device 122 at the uncoated side of the carrier 110.

[0033] According to some embodiments, which can be combined with other embodiments described herein, the carrier 110 includes the first side and the second side, wherein the support surface 112 is provided at the first side of the carrier 110, and wherein the rotatable device 122 is provided at the first side of the carrier 110.

[0034] The holding arrangement 100 of the present disclosure provides an adjustable mechanism. Rotating the rotatable device 122 around the rotation axis 124 allows for fixing or holding substrates of different sizes in position using one single holding

arrangement or carrier. Switching from one substrate size to another substrate size can be done fast with reduced effort.

[0035] In the example of figures 1A and 1B, one holding device 120 is provided at the upper portion of the carrier 110. However, the present disclosure is not limited thereto and any number of holding devices 120 can be provided at different positions of the carrier. As an example, one or more holding devices 120 can be provided in the upper portion of the carrier 110, and/or one or more holding devices 120 can be provided on a first lateral side (e.g., the left side in figures 1A and 1B) of the carrier 110, and/or one or more holding devices 120 can be provided on a second lateral side (e.g., the right side in figures 1A and 1B) of the carrier 110. Examples of such configurations are shown in figures 2 to 4.

[0036] Figure 2 shows a schematic view of a holding arrangement 200 for holding a substrate during layer deposition in a vacuum chamber according to further embodiments described herein. Figure 3A shows the holding arrangement 200 holding the substrate 10 having the first size or the first surface area 12. Figure 3B shows the holding arrangement 200 holding the other substrate 20 having the second size or second surface area 22. The second size or second surface area 22 is smaller than the first size or first surface area 12.

[0037] One or more holding devices 120 can be provided in the upper portion of the carrier 210, and/or one or more holding devices 120 can be provided on a first lateral side (e.g., the left side in figure 2) of the carrier 210, and one or more holding devices 120 can be provided on a second lateral side (e.g., the right side in figure 2) of the carrier 210.

[0038] According to some embodiments, which can be combined with other embodiments described herein, the carrier 210 includes or is a carrier plate, wherein the support surface 212 is provided by a surface of the carrier plate. The carrier plate can be configured to support the surface of the substrate as such. As an example, the carrier plate includes the first side and the second side, wherein the support surface 212 is provided at the first side of the carrier plate, and wherein the rotatable device 122 is provided at the second side of the carrier plate. In some implementations, the first side is the deposition side or the front side of the carrier plate, and/or the second side is the non-deposition side or the backside of the carrier plate. Providing the rotatable device 122 at the second side of

the carrier plate allows to cover and to protect the rotatable device 122 at the uncoated side of the carrier 210.

[0039] According to some embodiments, which can be combined with other embodiments described herein, the carrier plate has at least one cutout 128, wherein the at least one cutout 128 is configured for a passage of at least a part of the contact element 126. In some implementations, the rotatable device 122 is provided at the second side or non-deposition side of the carrier plate, and the contact element 126, which can be mounted on the rotatable device 122, extends through the cutout 128 to a distance above the support surface 212.The distance, to which the contact element 126 extends above the support surface 212, may substantially correspond to a substrate thickness or may be greater than the substrate thickness. The distance, to which the contact element 126 extends above the support surface 212, can be in the range of 2 to 5 mm, specifically in the range of 3 to 4 mm, and can more specifically be about 3.5 mm.

[0040] In some implementations, a shape of the cutout 128 corresponds to at least a part of a moving path of the contact element 126 when the rotatable device 122 is rotated. In other words, when the rotatable device 122 is rotated around the rotation axis 124, the contact element 126 can move within the cutout 128, and can particularly move freely within the cutout 128 without touching an edge of the cutout 128.

[0041] According to some embodiments, which can be combined with other embodiments described herein, the at least one cutout 128 has a circular shape, and particularly a pitch-circular shape. As an example, the at least one cutout 128 has a semi-circular shape, as it is shown in the examples of figures 2, 3A and 3B.

[0042] According to some embodiments, which can be combined with other embodiments described herein, the holding arrangement 200 may include one or more transport devices. The one or more transport devices can include a first or lower transport device 215 and a second or upper transport device 216. The one or more transport devices can be configured to be connected with a substrate transport system e.g. provided within a vacuum chamber for transporting the holding arrangement 200 and the substrate attached thereto through the vacuum chamber.

[0043] The holding arrangement 200 may include a support device 214, e.g., a support bar, at a lower portion of the carrier 210. As an example, the support device 214 can be configured to support or carry a weight of the substrate, in particularly when the substrate is vertically oriented.

[0044] Figure 4 shows a schematic view of a holding arrangement 400 for holding the substrate 10 during layer deposition in a vacuum chamber according to yet further embodiments described herein.

[0045] According to some implementations, the carrier 410 includes or is the carrier plate. According to some embodiments, which can be combined with other embodiments described herein, the carrier plate includes one or more through holes 416.

[0046] The one or more through holes 416 can be configured for providing a through passage for a fixture and/or a robot. In some implementations, the one or more through holes 416 can be used to load and/or unload the substrate 10 e.g., from the backside of the carrier 410. Specifically, the one or more through holes 416 can be used to load and/or unload the substrate 10 using the fixture or using the robot automatically.

[0047] Figures 5A, 5B and 5C show schematic views of a holding arrangement 500 at different rotation positions of the rotatable device 122 of the holding device 520 according to embodiments described herein.

[0048] According to some embodiments, which can be combined with other embodiments described herein, the carrier 510 includes the first side and the second side, wherein the support surface 512 is provided at the first side of the carrier 510. Providing the rotatable device 122 at the second side of the carrier allows to cover and to protect the rotatable device 122 at the uncoated side of the carrier 510.

[0049] According to some embodiments, which can be combined with other embodiments described herein, the contact element 526 includes a clamp device configured for clamping the substrate 10. As an example, the clamp device includes a spring element, and/or the clamp device is substantially T-shaped. The T-shaped clamp device can have a first element 527 having a first extension substantially perpendicular to the support surface 512, i.e., substantially parallel to the rotation axis 124. The T-shaped

clamp device can have a second element 528 having a second extension substantially parallel to the support surface 512, i.e., substantially perpendicular to the rotation axis 124.

[0050] The contact element 526, and in particular the clamp device, can be configured to be moveable substantially parallel to the rotation axis 124 of the rotatable device 122. In other words, the contact element 526, and in particular the clamp device, can be configured to be moved up and down with respect to the support surface 512 or the substrate surface.

[0051] For loading the substrate 10, the substrate 10 is positioned on the support surface 512 of the carrier 510 with the contact element 526 being at a first position. As an example, the first position of the contact element 526 can be an up-position or a raised position. Carrier can include a support device, e.g., a support bar 514, as described above. The holing device 520 can include a drive 530 configured for rotating the rotatable device 122. The drive 530 may include a transmission mechanism such as a shaft 532 connected to the rotatable device 122 for a transmission of the rotational movement. For fixing or holding the substrate 10, the rotatable device 122 is rotated about the rotation axis, e.g., by the drive 530.

[0052] By rotating the contact element 526 around the rotation axis 124 (indicated with reference numeral "534" in figure 5B), the contact element 526 will contact or touch the substrate 10. After contact has been established, the contact element 526 is moved to a second position (indicated with reference numeral "536" in figure 5C). The second position can be a down-position or a lowered position. Lowering the contact element 526 to the second position provides holding or fixing the substrate 10 in position.

[0053] According to some embodiments, which can be combined with other embodiments described herein, the contact element 526 can provide a holding force or clamping force for holding the substrate 10 in position. As an example, the holding force or clamping force can be substantially perpendicular to the support surface 512, or the holding force or clamping force can be substantially parallel to the support surface 512. In some implementations, the spring element can be configured for providing the holding force or clamping force.

[0054] According to some embodiments, which can be combined with other embodiments described herein, the clamp device is configured to be actuated or activated from the second side of the carrier, e.g., from the backside or rear side of the carrier. As an example, the clamp device for the substrate is spring supported and can be opened from the rear side, is eccentrically mounted on the rotatable disc and can be opened and closed by robot or fixture.

[0055] According to another aspect of the present disclosure, a holding arrangement for holding a substrate during layer deposition in a vacuum chamber is provided. The holding arrangement includes a carrier plate having a first side and a second side, wherein the first side provides a support surface configured for supporting the substrate; and one or more holding devices provided at the second side of the carrier plate. Each holding device includes at least one rotatable disc configured to rotate around a rotation axis, wherein the rotation axis is substantially perpendicular to the support surface, and wherein the rotatable disc has a contact element positioned at a distance from the rotation axis for holding the substrate after rotation. The carrier plate has at least one cutout, wherein the at least one cutout is configured for a passage of at least a part of the contact element

[0056] Figure 6 shows a schematic view of an apparatus 600 for depositing a layer on a substrate 10 according to embodiments described herein.

[0057] The apparatus 600 for depositing a layer on the substrate 10 includes a vacuum chamber 602 adapted for layer deposition therein, a holding arrangement within the vacuum chamber 602, and a deposition source 630 for depositing material forming the layer. The holding arrangement includes a carrier 610 having a support surface 612 configured for supporting the substrate 10, and one or more holding devices 620 provided at the carrier 610. Each holding device 620 includes at least one rotatable device 622 configured to rotate around a rotation axis 624, wherein the rotation axis 624 is substantially perpendicular to the support surface 612, and wherein the rotatable device 622 has a contact element 626 positioned at a distance from the rotation axis 624 for holding the substrate 10 after rotation. The holding arrangement can be configured according to the embodiments described herein.

[0058] As an example, the holding arrangement may have one or more holding devices 620 at a top portion of the carrier 610, and may optionally include a support device 615, e.g., a support bar, at a lower portion of the carrier 610. As an example, the support device 615 can be configured to carry the weight of the substrate 10, in particularly when the substrate 10 is vertically oriented. The support device 615 can be fixed or moveable, e.g. in the plane of the substrate 10 or swinging downward, away from the substrate edge, to enable the substrate 10 to be taken out of the carrier 610. As an example, this could be the case when the support device 615 has a notch or a groove to prevent the substrate 10 from slipping off the support device 615.

[0059] The apparatus 600 is adapted for a deposition process, such as a PVD or CVD process. The substrate 10 is shown being located within or at a holding arrangement according to embodiments described herein on a substrate transport device 640. A deposition source 630 is provided in the vacuum chamber 602 facing the side of the substrate 10 to be coated. The deposition source 630 provides deposition material to be deposited on the substrate 10.

[0060] In figure 6, the deposition source 630 may be a target with deposition material thereon or any other arrangement allowing material to be released for deposition on substrate 10. As an example, the deposition source 630 may be a rotatable target. According to some embodiments, the deposition source 630 may be movable in order to position and/or replace the deposition source. According to other embodiments, the deposition source may be a planar target. Dashed lines 665 show exemplarily the path of the deposition material during operation of the vacuum chamber.

[0061] According to some embodiments, the deposition material may be chosen according to the deposition process and the later application of the coated substrate. For instance, the deposition material of the deposition source may be a material selected from the group consisting of: a metal, such as aluminum, molybdenum, titanium, copper, or the like, silicon, indium tin oxide, and other transparent conductive oxides. As an example, oxide-, nitride- or carbide-layers, which can include such materials, can be deposited by providing the material from the source or by reactive deposition, i.e. the material from the source reacts with elements like oxygen, nitride, or carbon from a processing gas. According to some embodiments, thin film transistor materials like siliconoxides,

siliconoxynitrides, siliconnitrides, aluminumoxide, aluminumoxynitrides may be used as deposition material.

[0062] According to different embodiments, a holding arrangement can be utilized for PVD deposition processes, CVD deposition process, substrate structuring edging, heating (e.g. annealing) or any kind of substrate processing. Embodiments of holding arrangements as described herein and methods of utilizing such holding arrangements are particularly useful for non-stationary, i.e. continuous substrate processing of the vertically oriented large area glass substrates. In non-Stationary processing, the holding arrangement can provide masking elements for the process.

[0063] The term "vertical direction" or "vertical orientation" is understood to distinguish over "horizontal direction" or "horizontal orientation". That is, the "vertical direction" or "vertical orientation" relates to a substantially vertical orientation e.g. of the carrier and the substrate, wherein a deviation of a few degrees, e.g. up to 10° or even up to 15°, from an exact vertical direction or vertical orientation is still considered as a " substantially vertical direction" or a "substantially vertical orientation". The vertical direction can be substantially parallel to the force of gravity.

[0064] Figure 7 shows a flow chart of a method 700 for holding a substrate during layer deposition in a vacuum chamber. The method 700 may utilize the holding arrangement according to the embodiments described herein.

[0065] According to an aspect of the present disclosure the method 700 for holding a substrate during layer deposition in a vacuum chamber includes positioning the substrate on a support surface of a carrier (block 710); and rotating a rotatable device provided at the carrier around a rotation axis (block 720), wherein the rotation axis is substantially perpendicular to the support surface.

[0066] In some implementations, the method further includes contacting the substrate using a contact element positioned on the rotatable device at a distance from the rotation axis for holding the substrate after rotation.

[0067] According to embodiments described herein, the method for holding a substrate during layer deposition in a vacuum chamber can be conducted by means of computer

programs, software, computer software products and the interrelated controllers, which can have a CPU, a memory, a user interface, and input and output means being in communication with the corresponding components of the apparatus for processing a large area substrate.

[0068] The present disclosure provides a flexible holding arrangement, particularly a holding arrangement for holding a substrate during layer deposition in a vacuum chamber, that allows for holding substrates of different sizes. Switching from one substrate size to another substrate size can be done quickly and/or with reduced effort. Further, only one holding arrangement is provided for different substrate sizes, wherein complexity and maintenance costs of the processing machine are reduced.

[0069] While the foregoing is directed to embodiments of the disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

CLAIMS

1. A holding arrangement (100) for holding a substrate (10) during layer deposition in a vacuum chamber, the holding arrangement (100) comprising:

a carrier (110) having a support surface (112) configured for supporting the substrate (10); and

one or more holding devices (120) provided at the carrier (110), each holding device (120) comprising:

at least one rotatable device (122) configured to rotate around a rotation axis (124), wherein the rotation axis (124) is substantially perpendicular to the support surface (112), and wherein the rotatable device (122) has a contact element (126, 526) positioned at a distance from the rotation axis (124) for holding the substrate (10) after rotation.

2. The holding arrangement (100) according to claim 1, wherein the at least one rotatable device (122) includes at least one of a circular shaped member, a segment of a circle, an arm and a rotatable disc.

3. The holding arrangement (100) according to claims 1 or 2, wherein the carrier (110) includes a first side and a second side, wherein the support surface (112) is provided at the first side of the carrier (110), and wherein the rotatable device (120) is provided at the second side of the carrier (110).

4. The holding arrangement (100) according to claim 3, wherein the first side is a deposition side or a front side of the carrier (110), and wherein the second side is a non-deposition side or backside of the carrier (110).

5. The holding arrangement (100) according to one of claims 1 to 4, wherein the carrier (110) includes a carrier plate, and wherein the support surface (112) is provided by a surface of the carrier plate.

6. The holding arrangement (100) according to claim 5, wherein the carrier plate has at least one cutout (128), wherein the at least one cutout (128) is configured for a passage of at least a part of the contact element (126, 526).

7. The holding arrangement (100) according to claim 6, wherein the at least one cutout (128) has a circular shape, and particularly a pitch-circular shape.

8. The holding arrangement according to one of claims 5 to 7, wherein the carrier plate includes one or more through holes (416).

9. The holding arrangement (100) according to one of claims 1 to 8, wherein the contact element (126, 526) is configured to contact an edge portion (14) of the substrate (10) for holding the substrate (10).

10. The holding arrangement according to one of claims 1 to 9, wherein the contact element (526) includes a clamp device (527, 528) configured for clamping the substrate (10).

11. The holding arrangement according to claim 10, wherein the clamp device (527, 528) includes a spring element, and/or wherein the clamp device (527, 528) is substantially T-shaped.

12. An apparatus (600) for depositing a layer on a substrate (10), comprising:

a vacuum chamber (612) adapted for layer deposition therein,

a holding arrangement (100, 620) according to any of claims 1 to 11 within the vacuum chamber (612); and

a deposition source (630) for depositing material forming the layer.

13. A method (700) for holding a substrate (10) during layer deposition in a vacuum chamber with a holding arrangement, particularly the holding arrangement of one of claims 1 to 11, the method comprising:

positioning (710) the substrate (10) on a support surface (112) of a carrier (110); and

rotating (720) a rotatable device (122) provided at the carrier (110) around a rotation axis (124), wherein the rotation axis (124) is substantially perpendicular to the support surface (112).

14. The method (700) of claim 13, further including:

contacting the substrate (10) using a contact element (126) positioned on the rotatable device (122) at a distance from the rotation axis (124) for holding the substrate (10) after rotation.

15. A holding arrangement (100) for holding a substrate (10) during layer deposition in a vacuum chamber, the holding arrangement (100) comprising:

a carrier plate having a first side and a second side, wherein the first side provides a support surface (112) configured for supporting the substrate (10); and

one or more holding devices (120) provided at the second side of the carrier plate, each holding device (120) comprising:

at least one rotatable disc configured to rotate around a rotation axis (124), wherein the rotation axis (124) is substantially perpendicular to the support surface (112), and wherein the rotatable disc has a contact element (126) positioned at a distance from the rotation axis (124) for holding the substrate (10) after rotation,

wherein the carrier plate has at least one cutout (128), wherein the at least one cutout (128) is configured for a passage of at least a part of the contact element (126).

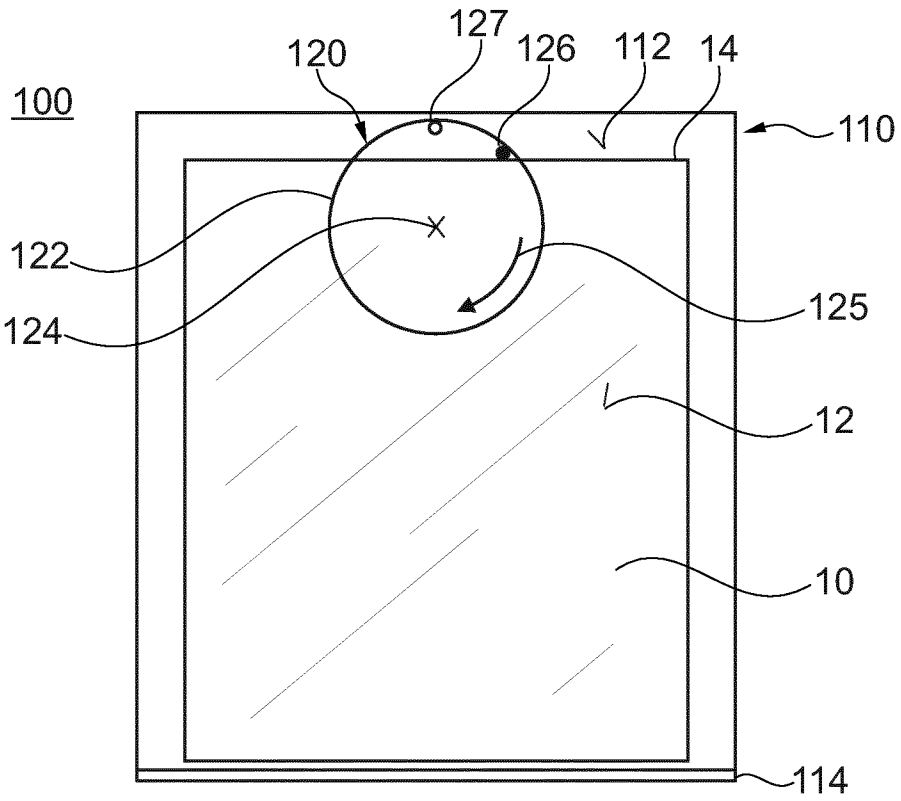

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Fig. 1A

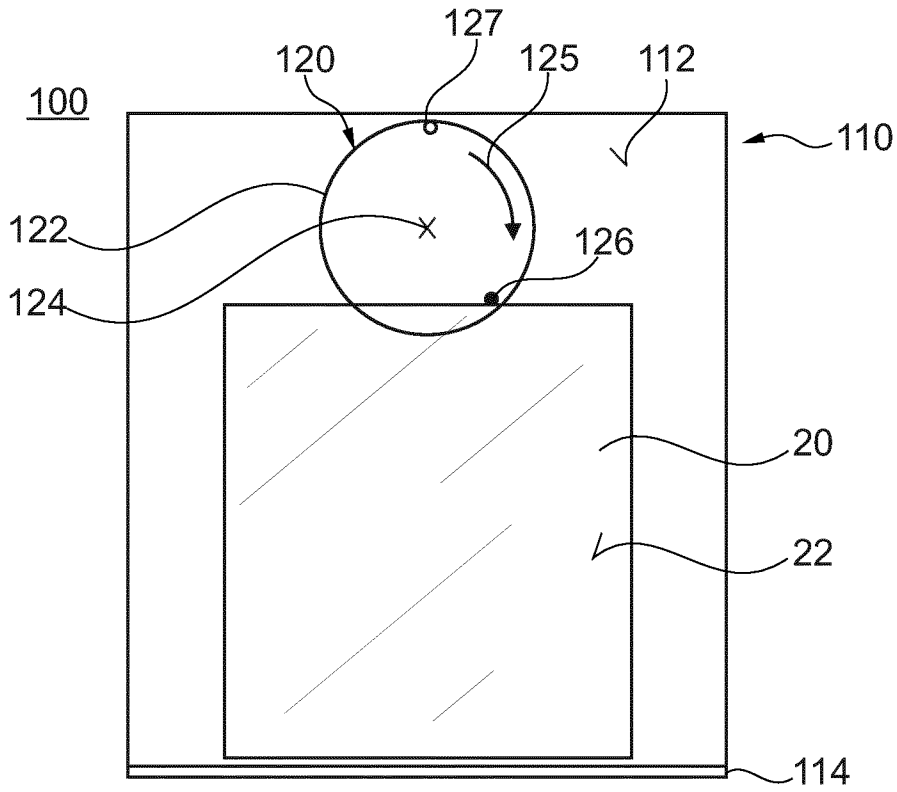

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Fig. 1B

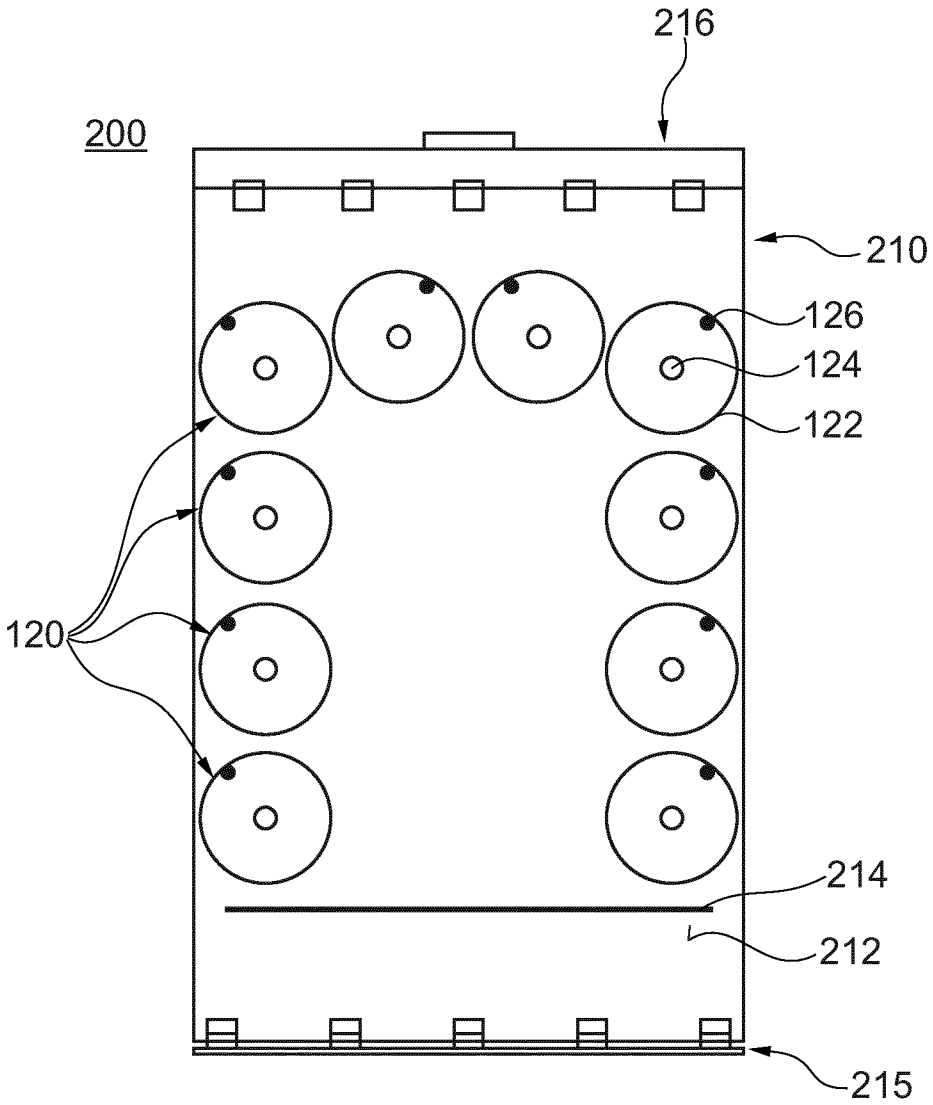


Fig. 2

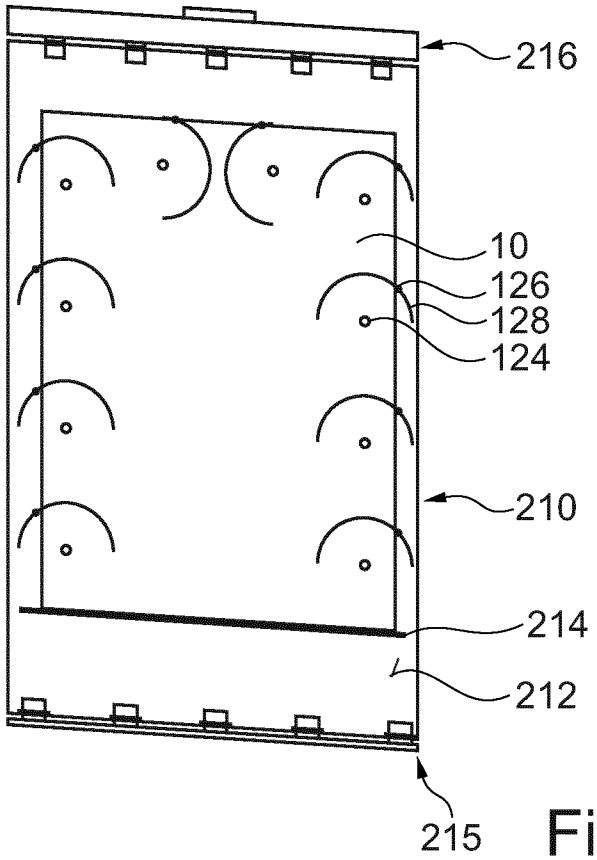


Fig. 3A

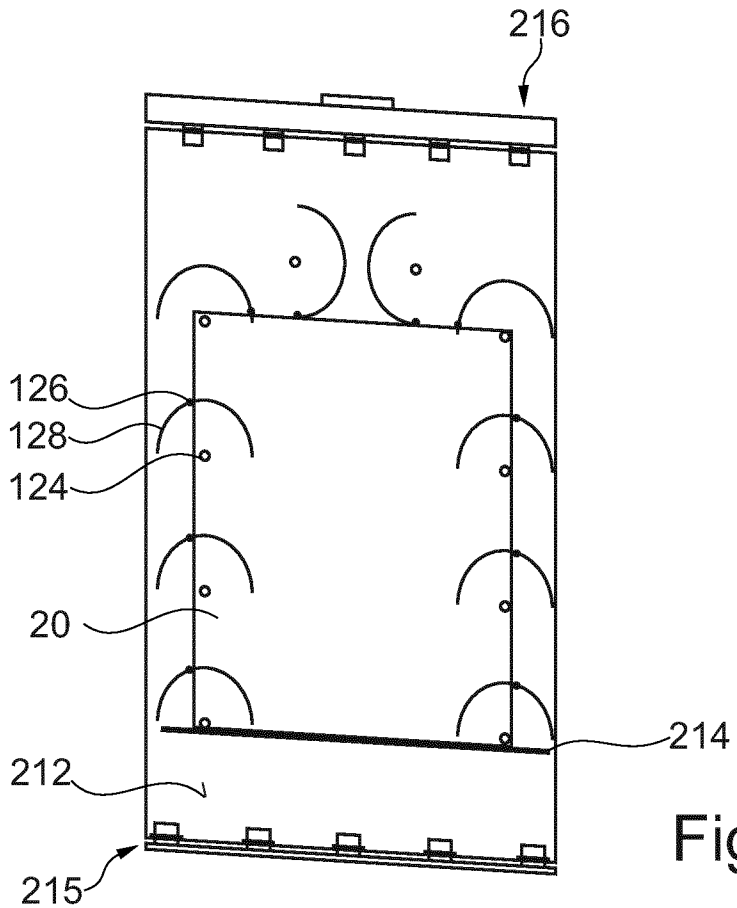


Fig. 3B

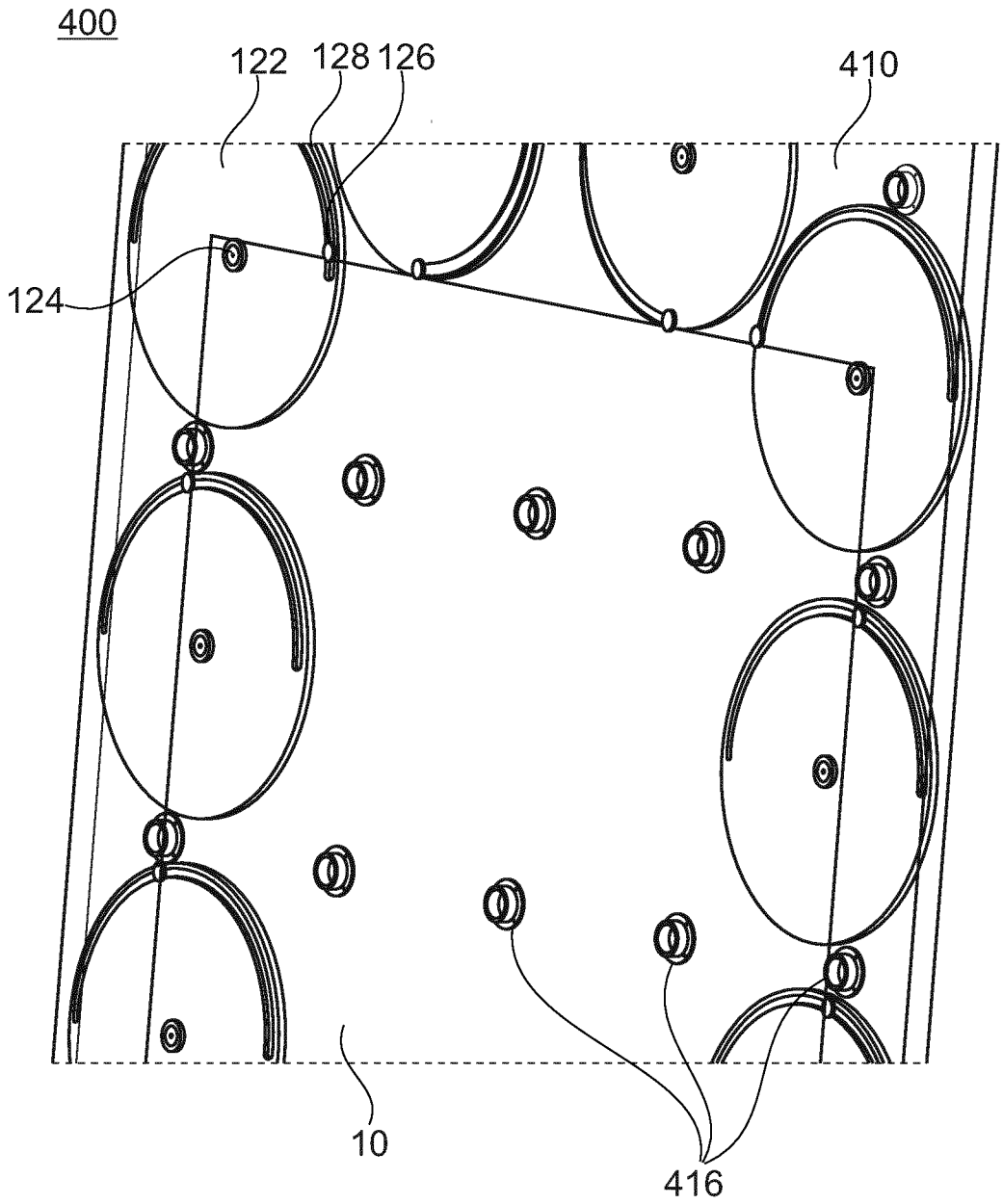


Fig. 4

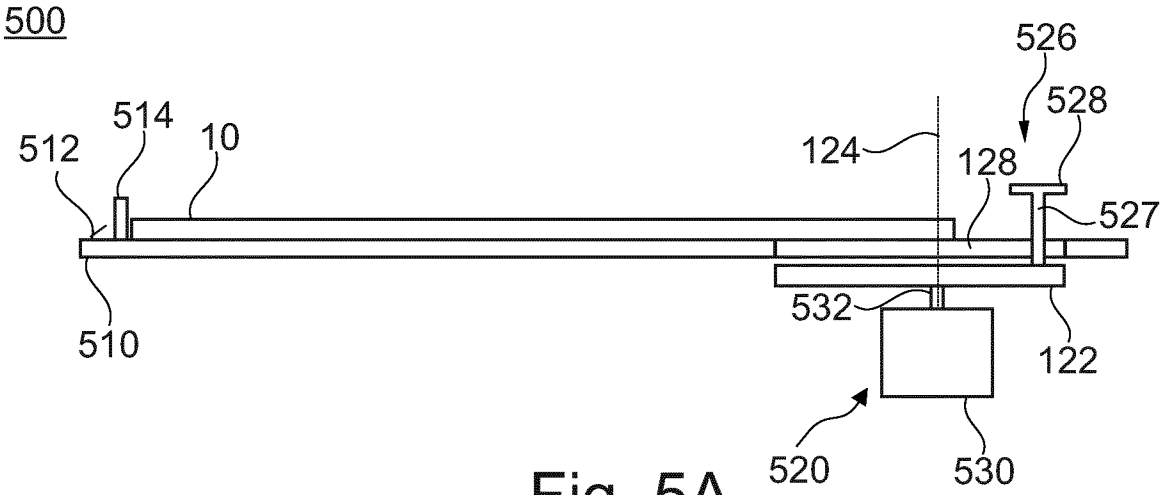


Fig. 5A

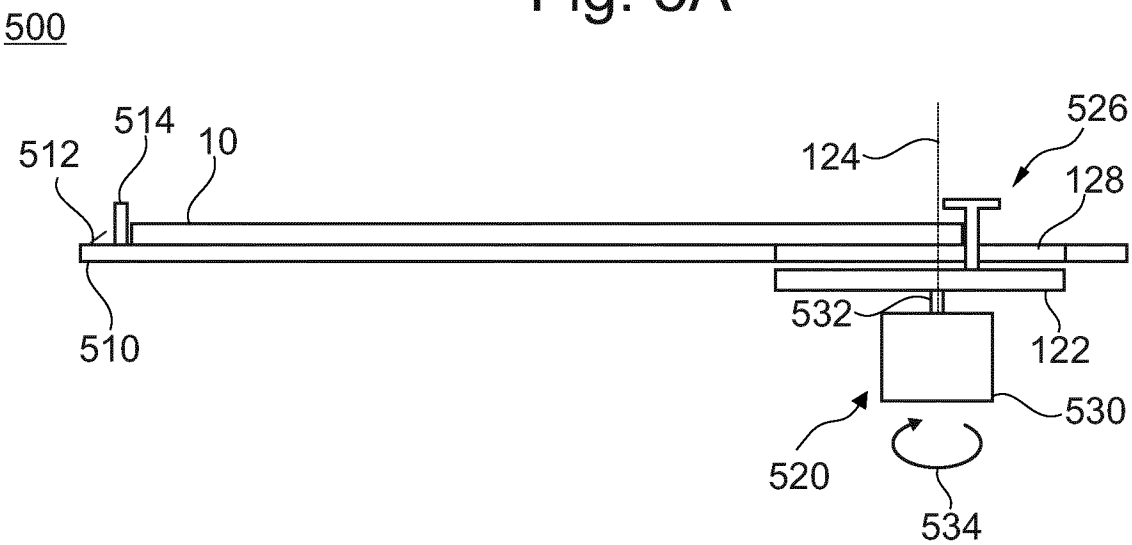


Fig. 5B

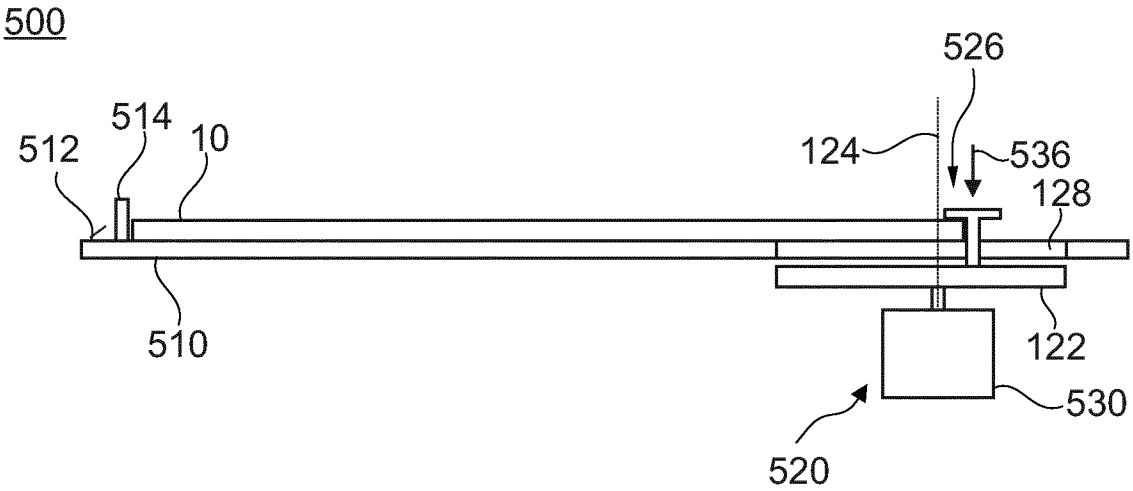


Fig. 5C

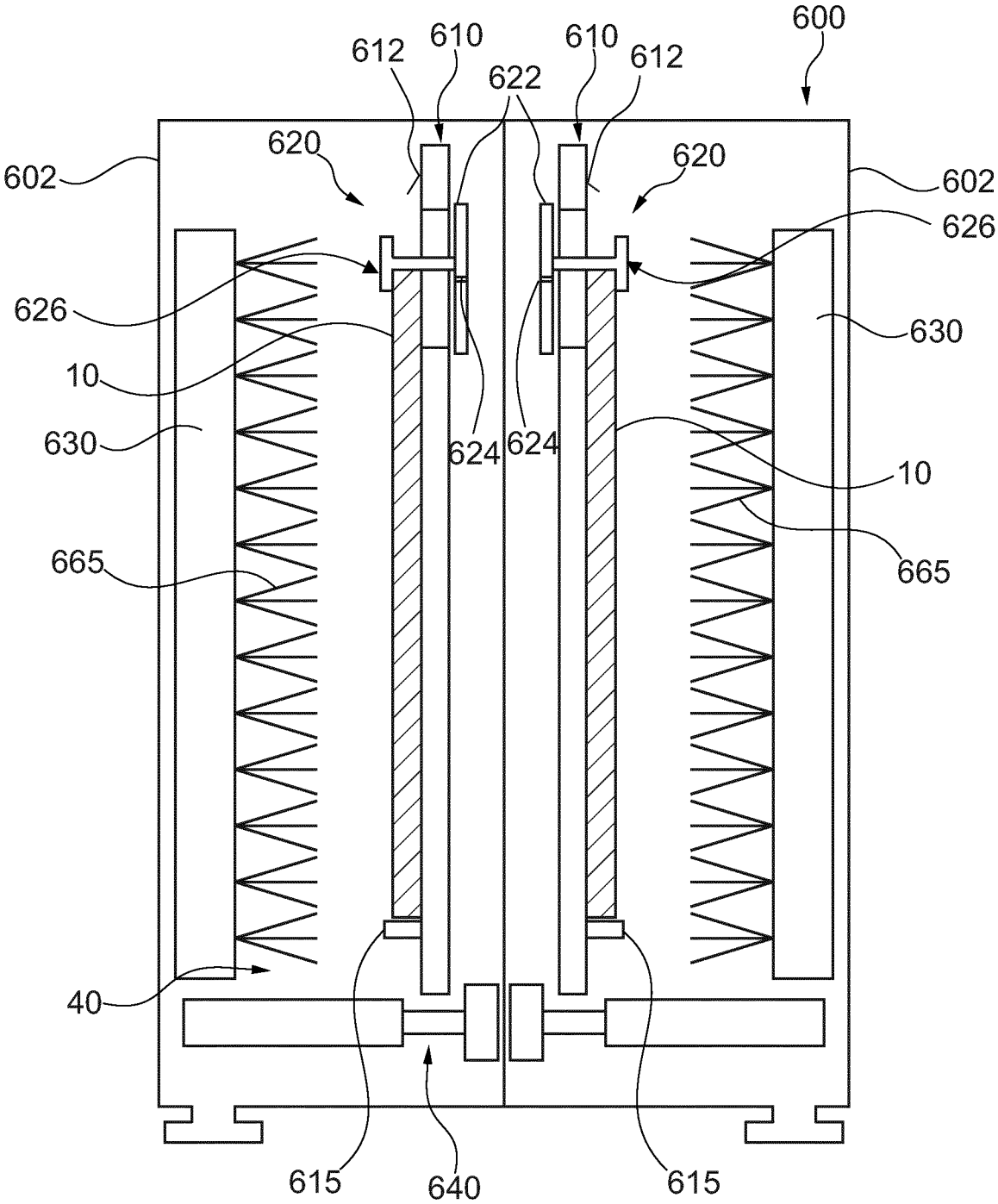

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Fig. 6

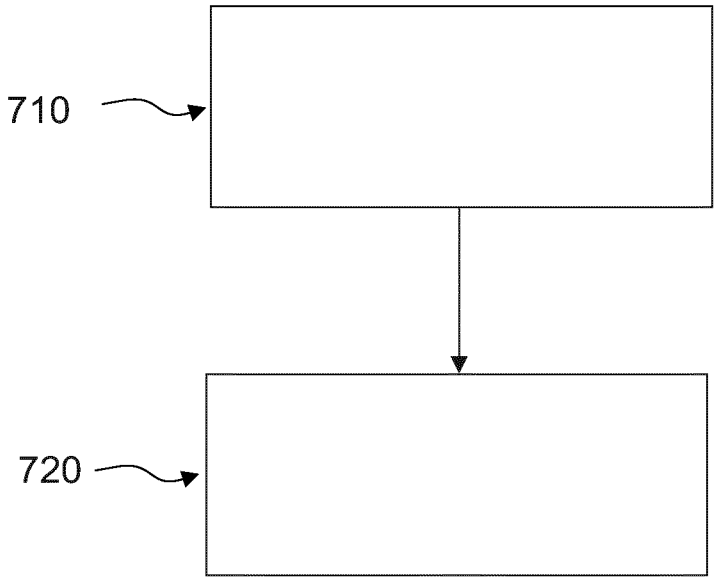


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/066181

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C16/458 C23C14/50 B65G49/06
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B25B C23C B65G

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 409 937 A2 (PRIMESTAR SOLAR INC [US] FIRST SOLAR MALAYSIA SDN BHD [MY]) 25 January 2012 (2012-01-25) paragraphs [0012] - [0017]; figures 1-8 -----	1-15
X	US 2012/263569 A1 (PRIDDY SCOTT WAYNE [US] ET AL) 18 October 2012 (2012-10-18) paragraphs [0028] - [0035]; figures -----	1,2,9-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 April 2015	04/05/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Patterson, Anthony

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/066181

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2409937 A2	25-01-2012	AU 2011204822 A1	09-02-2012
		CN 102345109 A	08-02-2012
		EP 2409937 A2	25-01-2012
		US 2012017410 A1	26-01-2012
US 2012263569 A1	18-10-2012	US 2012263569 A1	18-10-2012
		WO 2012142408 A2	18-10-2012