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(71) Applicant: **APPLIED MATERIALS, INC.** [US/US]; 3050 Bowers Avenue, Santa Clara, California 95054 (US).

(72) Inventors: **VINCENT, Joseph**; Flat No: A201, Vineyard Residency, 22 Heerachand Road, Cox Town, Bangalore, Karnataka 560005 (IN). **DASARI, Nagarjuna**; #6/2, Mallikarjuna Krupa, 2nd Main,New Extn., K R Puram, Bangalore, Karnataka 560036 (IN). **WHITE, John M.**; 28530 Hayward Blvd., Hayward, California 94542 (US).

(74) Agent: **PATTERSON, B. Todd** et al.; 24 Greenway Plaza, Suite 1600, Houston, Texas 77046 (US).

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(54) Title: SUBSTRATE TRANSFER APPARATUS AND METHOD FOR POSITIONING AND CLAMPING A SUBSTRATE ON NON CONTACT GRIPPER

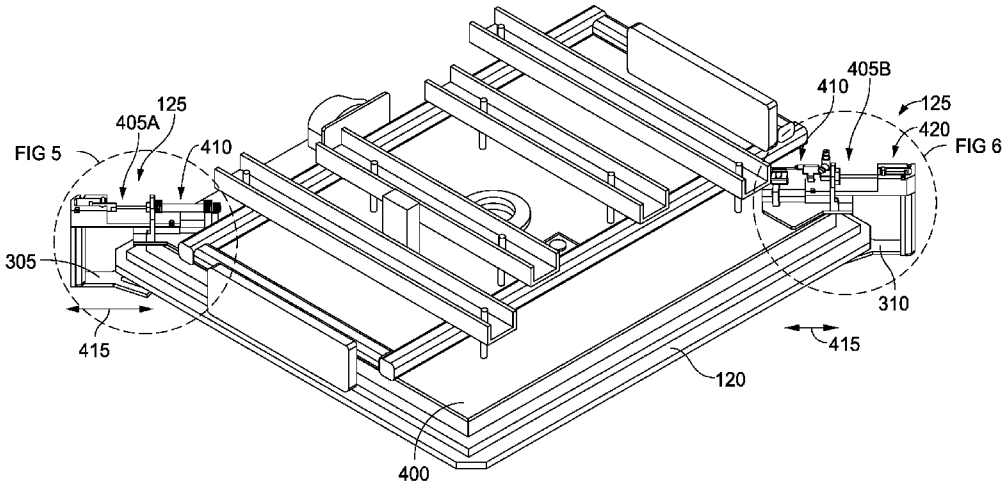


FIG. 4

(57) Abstract: Embodiments of the present disclosure provide a substrate transfer apparatus that includes a pair of clamping/positioning devices for a substrate transfer apparatus. Each of the clamping/positioning devices comprise a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate, and a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

[Continued on next page]

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SUBSTRATE TRANSFER APPARATUS AND METHOD FOR POSITIONING AND CLAMPING A SUBSTRATE ON NON CONTACT GRIPPER

BACKGROUND

Field

[0001] Embodiments of the present disclosure generally relate to a substrate transfer apparatus having a clamping/positioning device that is utilized to position and clamp a substrate on a non-contact gripper/air table.

Description of the Related Art

[0002] Flat media, such as rectangular, flexible sheets of glass, plastic or other material is typically used in the manufacture of flat panel displays, solar devices, among other applications. Materials to form electronic devices, films and other structures on the flat media are deposited onto the flat media by numerous processes. The processes are typically performed in a vacuum chamber which requires handling of the flat media numerous times to move the flat media in and out of the vacuum chamber.

[0003] The size of the flat media is getting larger with each generation in order to have more usable surface area for deposition and electronic device fabrication. Currently, the flat media includes a surface area of greater than 4 square meters that is processed. The trend towards increasingly larger substrates and smaller device features requires increasingly precise positional accuracy of the flat media. Ensuring positional accuracy not only prevents collisions and/or breakage of the flat media, but also facilitates accurate placement of the flat media in a load lock chamber or other vacuum chamber.

[0004] However, positioning and clamping of the flat media is challenging as the substrate may crack or break if excessive pressure or force is used.

[0005] What is needed is a method and apparatus for positioning and clamping of substrates on a substrate transfer apparatus.

SUMMARY

[0006] Embodiments of the present disclosure provide a substrate transfer apparatus that includes a pair of clamping/positioning devices for a substrate transfer apparatus. Each of the clamping/positioning devices comprise a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate, and a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

[0007] In another embodiment, a pair of clamping/positioning devices for a substrate transfer apparatus is disclosed. Each of the clamping/positioning devices include a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate, and a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

[0008] In another embodiment, a substrate transfer apparatus is disclosed and includes a pair of clamping/positioning devices mounted to a pedestal at opposing corners thereof, each of the clamping/positioning devices comprising a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate, and a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] 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, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this disclosure and are therefore not to be considered limiting of its scope, for the disclosure may admit to other equally effective embodiments.

[0010] Figures 1 and 2 are schematic sectional side views of a substrate transfer apparatus according to one embodiment.

[0011] Figures 3A and 3B are bottom plan views of the pedestal and the substrate along line 3-3 of Figure 2.

[0012] Figure 4 is an isometric view of the backside of the pedestal.

[0013] Figures 5 and 6 are enlarged isometric views of the clamping/positioning devices of Figure 4.

[0014] Figure 7 is a schematic sectional side view of a substrate transfer apparatus according to another embodiment.

[0015] Figures 8A and 8B are schematic plan views of other embodiments of the clamping/positioning devices positioned about a substrate.

[0016] Figure 9 is a flowchart describing one embodiment of a method of transferring a substrate with the substrate transfer apparatus as described herein.

[0017] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements disclosed in one embodiment may be beneficially utilized on other embodiments without specific recitation

DETAILED DESCRIPTION

[0018] Embodiments of the present disclosure provide a substrate transfer apparatus having a pair of clamping/positioning devices mounted adjacent to a non-contact gripper/air table at opposing corners thereof. Both of the clamping/positioning devices comprise a yoke member having rollers configured to

contact a substrate edge. A first clamping/positioning device of the pair of clamping/positioning devices comprises a linear motion drive that moves the yoke member attached thereto toward and away from the substrate edge. A second clamping/positioning device of the pair of clamping/positioning devices comprises a linear motion drive that moves the yoke member attached thereto toward and away from the substrate edge, and a spring mechanism is coupled between the drive and the yoke. The linear drive of the first clamping/positioning device is actuated to contact the substrate edge initially while the linear drive of the second clamping/positioning device is actuated after the first clamping/positioning device. The spring mechanism in the second clamping/positioning device buffers the force provided by the linear motion drive but provides enough force to move the substrate into position and clamp the substrate while preventing breakage of the substrate.

[0019] The non-contact gripper/air table is configured as a pedestal to support a large area rectangular flat substrate in a vertical orientation or a horizontal orientation without contact with the substrate. The pedestal is equipped with a plurality of jets that provide an outward gas flow to prevent contact between the substrate and the pedestal. In some embodiments, the pedestal is equipped with a plurality of vacuum ports in addition to the plurality of jets. The vacuum ports are utilized to provide a force that pulls the substrate toward the pedestal. In one example, the pedestal as described herein is utilized to support a substrate in a horizontal orientation without contact therebetween. In another example, the pedestal as described herein is utilized to suspend a substrate in a horizontal orientation. In order to suspend the substrate, an equilibrium between outward gas flow from the plurality of jets (to prevent the substrate from contacting the pedestal) and vacuum flow from the vacuum ports is established to overcome the force of the weight (mass X gravity) of the substrate while simultaneously preventing contact with the pedestal. In other examples, the pedestal as described herein is utilized to suspend a substrate in a vertical or near vertical orientation by a combination of outward gas flow and vacuum flow.

[0020] Figures 1 and 2 are schematic sectional side views of a substrate transfer apparatus 100 according to one embodiment. The substrate transfer apparatus 100

may be utilized to move a substrate between an atmospheric substrate storage device (not shown) and a load lock chamber (not shown). The substrate transfer apparatus 100 includes a loading frame assembly 105 that supports a substrate 110. The loading frame assembly 105, along with the substrate 110, is coupled to an actuator 115. The actuator 115 moves the loading frame assembly 105 and the substrate 110 in at least the Z direction toward or away from a non-contact gripper/air table, hereinafter referred to as a pedestal 120. The substrate transfer apparatus 100 of Figures 1 and 2 is configured to suspend the substrate 110 from a bottom of the pedestal 120.

[0021] The pedestal 120 is configured to exert a gas, such as air or other gas to space the substrate 110 a distance away from the pedestal 120. The pedestal 120 may also be configured to apply a vacuum that pulls the substrate 110 toward the pedestal 120. The pedestal 120 includes one or both of a plurality of jets 130 and a plurality of vacuum ports 135.

[0022] Each of the plurality of jets 130 is coupled to a pressurized gas source 140. The gas source 140 includes clean dry air (CDA), nitrogen (N_2), or an inert gas. The gas source 140 includes a flow controller 142 that can vary the rate of flow to each of the jets 130. Each of the plurality of vacuum ports 135 is coupled to a pump 145. The pump 145 is a variable rate vacuum pump that can vary the rate of flow through each of the vacuum ports 135. The jets 130 are configured to flow gas outwardly or away from a substrate facing surface 150 of the pedestal 120. Likewise, the vacuum ports 135 are configured to direct flow toward the substrate facing surface 150 of the pedestal 120. Inherently, the jets 130 flow gas toward the substrate 110 and the vacuum ports 135 function to pull the substrate 110 toward the substrate facing surface 150 of the pedestal 120. A balance between the outward flow from the jets 130 and the inward flow of the vacuum ports 135 enables the substrate 110 to be suspended but not in contact with the substrate facing surface 150 of the pedestal 120 as shown in Figure 2.

[0023] The loading frame assembly 105 is in a lowered position in Figure 1. The lowered position may be utilized for substrate transfer using a robot blade or end

effector to place or remove the substrate 110 onto or off of the loading frame assembly 105. The loading frame assembly 105 is moved in the Z direction in Figure 2 to place a deposit-receiving side of the substrate 110 in proximity to the pedestal 120. The pedestal 120 includes a vacuum capability (negative flow) as well as a positive flow to enable the substrate 110 to be held adjacent to the surface of the pedestal 120 while not contacting the pedestal 120. The substrate transfer apparatus 100 also includes one or more clamping/positioning devices 125 (only one is shown in Figures 1 and 2). The clamping/positioning devices 125 are utilized to position the substrate 110 relative to the pedestal 120. The clamping/positioning devices 125 are also utilized to clamp the substrate 110 once positioning thereof is provided. Thus, the substrate 110 is effectively positioned and clamped while floating adjacent to a surface of the pedestal 120.

[0024] The substrate 110 may be moved in the X and/or Y directions on the substrate transfer apparatus 100 while clamped on the pedestal 120. In a loading process of an unprocessed substrate, the substrate 110 may be transferred to a load lock chamber (not shown) after any movement of the substrate transfer apparatus 100 is completed. The substrate 110 may be transferred from the clamped position shown in Figure 2 into the load lock chamber using a robot blade or end effector, or by magnetic levitation.

[0025] Proper positioning of the substrate 110 relative to the pedestal 120 enables more precise positioning of the substrate 110 into the load lock chamber. However, positioning and subsequent clamping of the substrate 110 is challenging as the clamping may causes cracking or breakage if excessive pressure or force is used.

[0026] Figures 3A and 3B are bottom plan views of the pedestal 120 and the substrate 110 along line 3-3 of Figure 2. Figure 3A shows the substrate 110 slightly misaligned relative to a surface 300 of the pedestal 120.

[0027] The substrate 110 may be in the position shown in Figure 3A when the loading frame assembly 105 is raised toward the pedestal 120. The clamping/positioning devices 125 are positioned at opposing corners (or diagonally)

of the substrate 110. The clamping/positioning devices 125 include a first arm or first central base member 305 and a second arm or second central base member 310. The clamping/positioning devices 125 are retracted (biased away from an edge 315 of the substrate 110) in the view shown in Figure 3A. However, the clamping/positioning devices 125 are in a clamped position in Figure 3B (engaging the edge 315 of the substrate 110 at opposing corners thereof).

[0028] Each of the first central base member 305 and the second central base member 310 include angled branch members 320 that form a Y shape when coupled to the respective members 305, 310 according to this embodiment. Each of the angled branch members 320 includes a roller element 325. The roller elements 325 contact the edge 315 of the substrate 110 when the clamping/positioning devices 125 are actuated. The roller elements 325 may be a plastic or a rubber material in order to reduce shock when contacting the edge 315 of the substrate 110.

[0029] Figure 3B shows the clamping/positioning devices 125 in an extended position (biased inward toward the edge 315 of the substrate 110). The first central base member 305 is a portion of a reference clamping/positioning device having an actuator that is coupled to the first central base member 305. The second central base member 310 is a portion of an active clamping/positioning device having an actuator and a cushioning member coupled to the second central base member 310. The actuators and other portions coupled to the first central base member 305 and the second central base member 310 are described in more detail below.

[0030] Extending the clamping/positioning devices 125 toward the edge 315 of the substrate 110 moves the substrate laterally in order to position the substrate 110 relative to the surface 300 of the pedestal 120. Further extension or actuation of the clamping/positioning devices 125 clamps the substrate 110 in the proper position.

[0031] Figure 4 is an isometric view of the backside of the pedestal 120. The clamping/positioning devices 125 are shown coupled to a backing plate 400 of the pedestal 120. The clamping/positioning devices 125 comprise a first clamp/positioner 405A and a second clamp/positioner 405B. Each of the clamping/positioning devices 125 includes a linear motion drive 410 in this

embodiment. The linear motion drive 410 may be electro-mechanical, pneumatic or hydraulic. The linear motion drives 410 move the respective members 305, 310 in the direction indicated by 415 (toward or away from a substrate). The linear motion drives 410 may be operated independently or in unison. The clamping/positioning devices 125 are similar in many respects with the exception of a cushioning member 420.

[0032] Figures 5 and 6 are enlarged isometric views of the clamping/positioning devices 125 of Figure 4. Each of the first clamp/positioner 405A and the second clamp/positioner 405B include the linear motion drive 410 coupled between a base 500 and the respective members 305, 310. Each of the bases 500 may be coupled to the backing plate 400 by fasteners (not shown), such as bolts or screws. Each linear motion drive 410 comprises a piston 505. The piston 505 is coupled to a bracket 510 that is coupled to or part of the respective members 305, 310. One or both of the first clamp/positioner 405A and the second clamp/positioner 405B include an adjustable stop 515 (shown in Figure 6). The adjustable stop 515 provides an adjustment for stroke length of the linear motion drive 410.

[0033] As described above, the first clamp/positioner 405A and the second clamp/positioner 405B are substantially similar with the exception of the cushioning member 420, which is only part of the second clamp/positioner 405B. The cushioning member 420 may be a spring form, such as a compression spring, coupled between the bracket 510 and the piston 505 of the second clamp/positioner 405B.

[0034] In operation, the first clamp/positioner 405A is actuated and moves the first central base member 305, which moves the substrate laterally, as necessary, to provide a reference position. The second clamp/positioner 405B is actuated and moves the second central base member 310, which moves the substrate laterally, as necessary, and pushes the substrate toward the first clamp/positioner 405A. When the second clamp/positioner 405B and the first clamp/positioner 405A are biased toward each other, the substrate is firmly held in an intended position relative to the pedestal 120. The cushioning member 420 provides a dampening effect to the

compressive forces provided by the first clamp/positioner 405A and the second clamp/positioner 405B. The dampening effect provided by the cushioning member 420 prevents bending and breakage of the substrate when clamped by the first clamp/positioner 405A and the second clamp/positioner 405B.

[0035] Figure 7 is a schematic sectional side view of a substrate transfer apparatus 700 according to another embodiment. The substrate transfer apparatus 700 is similar to the substrate transfer apparatus 100 of Figures 1 and 2 except that the pedestal 120 is configured to support the substrate 110 from a top side thereof. The pedestal 120 of the substrate transfer apparatus 700 includes the plurality of jets 130 that provide an outward gas flow towards the substrate 110 to prevent the substrate 110 from contacting the substrate facing surface 150. The substrate transfer apparatus 700 includes the clamping/positioning devices 125 described above in Figures 3A-6 or the clamping/positioning devices 125 described in Figures 8A or 8B below.

[0036] Figures 8A and 8B are schematic plan views of other embodiments of the clamping/positioning devices 125 positioned about a substrate 110. The clamping/positioning devices 125 shown in Figures 8A and 8B may be utilized with the substrate transfer apparatus 100 of Figures 1 and 2 as well as the substrate transfer apparatus 700 of Figure 7.

[0037] In Figure 8A, the clamping/positioning devices 125 include a first clamp 800 and a second clamp 805 positioned diagonally from the first clamp 800. In this embodiment, the first clamp 800 is fixed and the second clamp 805 is coupled to a linear motion drive 410 that moves the second clamp 805 in the direction of the arrow 810. Movement of the second clamp 805 moves the substrate 110 in the X-Y plane in order to position the substrate 110.

[0038] In this embodiment, the first clamp 800 and the second clamp 805 comprise angled branch members 320 having a roller element 325 on each of the branch members 320. The angled branch members 320 according to this embodiment comprise a shape resembling angular “C” shape.

[0039] In Figure 8B, the clamping/positioning devices 125 include a first clamp 815 and a second clamp 820 positioned diagonally from the first clamp 815. In this embodiment, the clamping/positioning apparatus includes a first fixed pin 825A positioned adjacent to the first clamp 815 and a second fixed pin 825B positioned adjacent to the second clamp 820. Each of the first fixed pin 825A and the second fixed pin 825B are coupled to the pedestal 120 and/or the loading frame assembly 105 (shown in Figures 1 and 2), and the substrate 110 is positioned thereon between the first fixed pin 825A and the second fixed pin 825B.

[0040] In this embodiment, the second clamp 820 is coupled to a rotary drive 830 that rotates a circular arm 835 about a pivot point 840 in the direction of the arrow 845. The circular arm 835 includes a roller element 325 that contacts the substrate 110 and causes the substrate 110 to move in the Y direction against a roller element 325 of a circular arm 850 of the first clamp 815 to position the substrate 110. In some embodiments, the first clamp 815 includes a pivot point 855 and a rotary drive similar to the rotary drive 830. Thus, both of the first clamp 815 and the second clamp 820 may rotate to move the circular arms 835 and 850 toward the substrate 110 to move the substrate 110 in the Y direction.

[0041] Figure 9 is a flowchart describing one embodiment of a method 900 of transferring a substrate with the substrate transfer apparatus 100 of Figures 1 and 2. The method 900 is exemplarily described using Figures 3A-6 but may be modified accordingly to include the operations described in Figures 8A and 8B, The method 900 begins at 905 with transfer of a substrate (using a robot blade or end effector) onto the loading frame assembly 105 of the substrate transfer apparatus 100. Transfer of the substrate onto the loading frame assembly 105 often results in positional inaccuracies such that the substrate is not properly aligned with the pedestal 120.

[0042] At box 910, the loading frame assembly 105 is moved toward the pedestal 120 with the substrate thereon. At this time, the clamping/positioning devices 125 are retracted as shown in Figure 3A.

[0043] At box 915, the substrate is transferred to the pedestal 120 as described in Figures 1 and 2. Acquisition of the substrate by the pedestal 120 effectively holds the substrate relative to a surface of the pedestal 120 without contact therebetween. While held in that position, the substrate may be moved laterally relative to the surface of the pedestal 120.

[0044] At box 920, edges of the substrate are contacted with the clamping/positioning devices 125. With respect to Figure 5, the first clamp/positioner 405A shown in Figure 5 contacts the edges at one corner thereof to position the substrate relative to the pedestal 120, and the second clamp/positioner 405B contacts the edges of the substrate at an opposing corner thereof. Contact of the substrate by the first clamp/positioner 405A and the second clamp/positioner 405B positions and/or centers the substrate on the pedestal 120.

[0045] At 925, the substrate is clamped using the first clamp/positioner 405A and the second clamp/positioner 405B. The linear motion drive 410 coupled to one or both the first clamp/positioner and the second clamp/positioner provide compressive force that is applied to the corners of the substrate by the first member 305 and the second member 310. However, the cushioning member 420 of the second clamp/positioner 405B buffers the compressive forces while holding the substrate firmly between the first central base member 305 and the second central base member 310.

[0046] The substrate transfer apparatus 100 may be utilized to transfer substrates as described above but may also be utilized to “flip” substrates from one orientation to another orientation. For example, if a deposit-receiving side of the substrate is facing downward when loaded into the substrate transfer apparatus 100, the pedestal 120 may be rotated 180 degrees to place the deposit-receiving side of the substrate upward. Likewise, if the deposit-receiving side of the substrate is facing upward when loaded into the substrate transfer apparatus 100, the pedestal 120 may be rotated 180 degrees to place the deposit-receiving side of the substrate downward.

[0047] While the foregoing is directed to embodiments of the present 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.

What is Claimed is:

1. A pair of clamping/positioning devices for a substrate transfer apparatus, each of the clamping/positioning devices comprising:

a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate; and

a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

2. The clamping/positioning devices of claim 1, wherein the cushioning member comprises a spring.

3. The clamping/positioning devices of claim 1, wherein each of the first clamp and the second clamp comprise a branch member.

4. The clamping/positioning devices of claim 3, wherein each of the branch members comprise a Y shape.

5. The clamping/positioning devices of claim 3, wherein each of the branch members comprise a C shape.

6. The clamping/positioning devices of claim 1, wherein each of the first clamp and the second clamp comprise a circular arm.

7. The clamping/positioning devices of claim 1, wherein the drive mechanism comprises a linear drive.

8. The clamping/positioning devices of claim 1, wherein the drive mechanism comprises a rotary drive.

9. The clamping/positioning devices of claim 1, wherein the first clamp is fixed relative to the second clamp.

10. A substrate transfer apparatus, comprising:

a pair of clamping/positioning devices mounted to a pedestal at opposing corners thereof, each of the clamping/positioning devices including:

a first clamp and a second clamp each having roller elements positioned thereon configured to contact an edge of a substrate; and

a drive mechanism that moves one or both of the first clamp and the second clamp toward and away from the edge of the substrate, wherein one of the clamping/positioning devices of the pair of clamping/positioning devices comprises a cushioning member that is coupled between the drive mechanism and the respective first or second clamp.

11. The substrate transfer apparatus of claim 10, wherein each of the first clamp and the second clamp comprise a branch member.

12. The substrate transfer apparatus of claim 11, wherein each of the branch members comprise a Y shape.

13. The substrate transfer apparatus of claim 11, wherein each of the branch members comprise a C shape.

14. The substrate transfer apparatus of claim 10, wherein each of the first clamp and the second clamp comprise a circular arm.

15. The substrate transfer apparatus of claim 10, wherein the cushioning member comprises a spring.

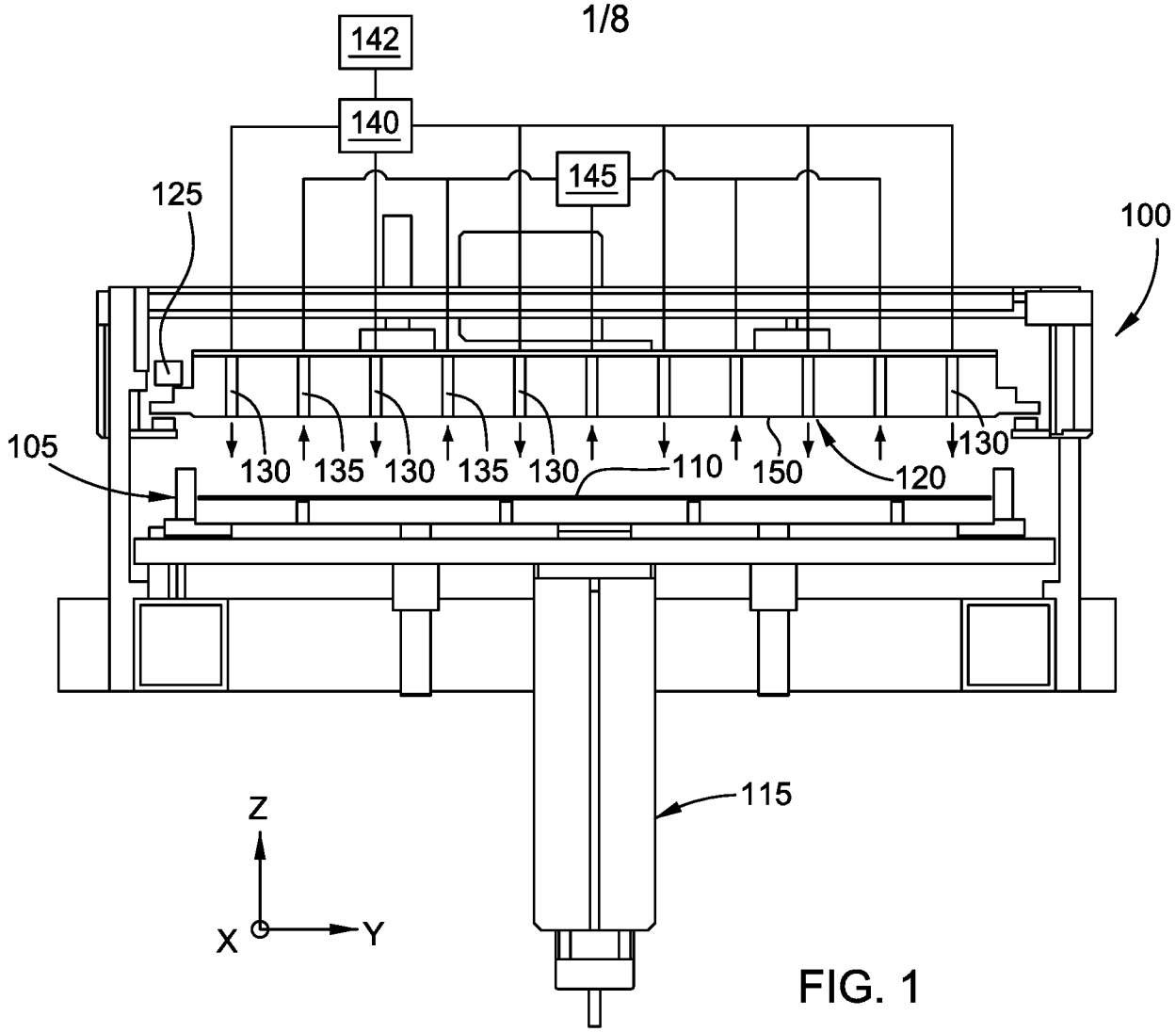

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FIG. 1

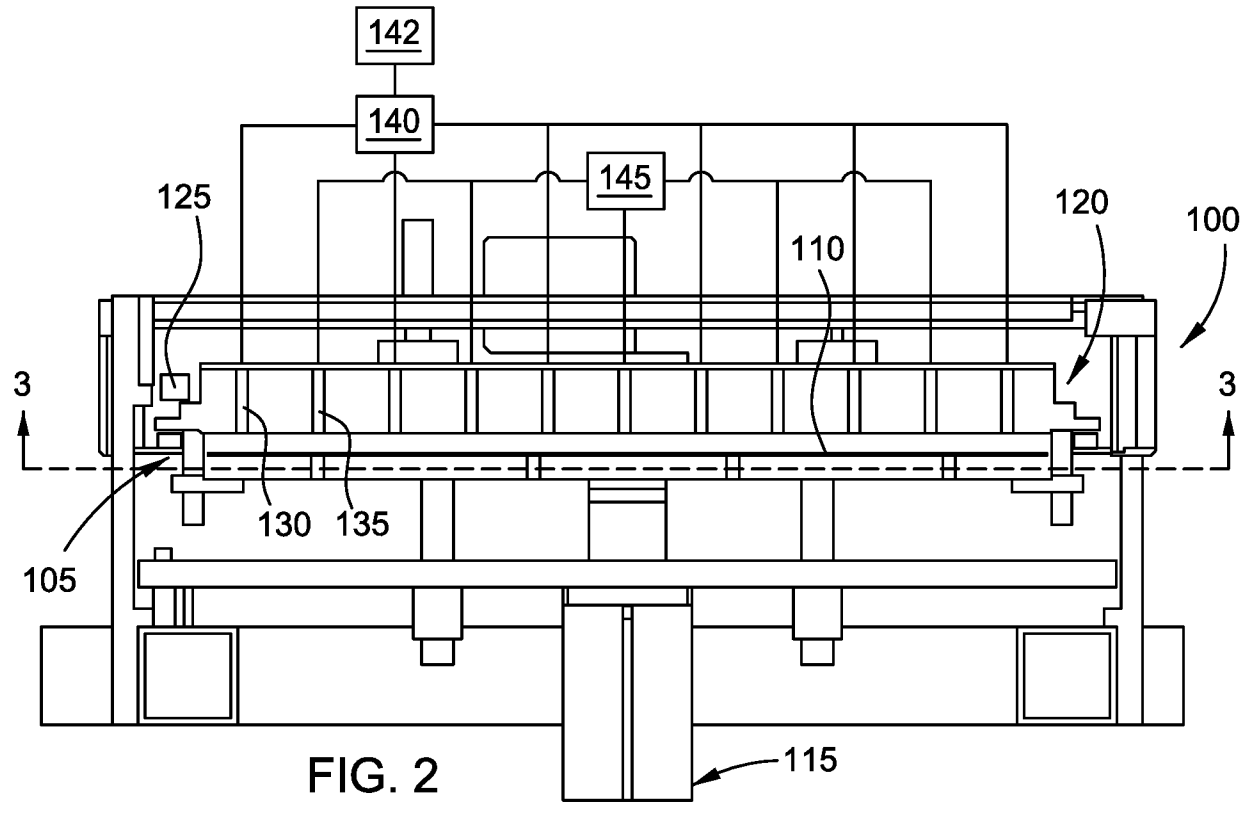

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FIG. 2

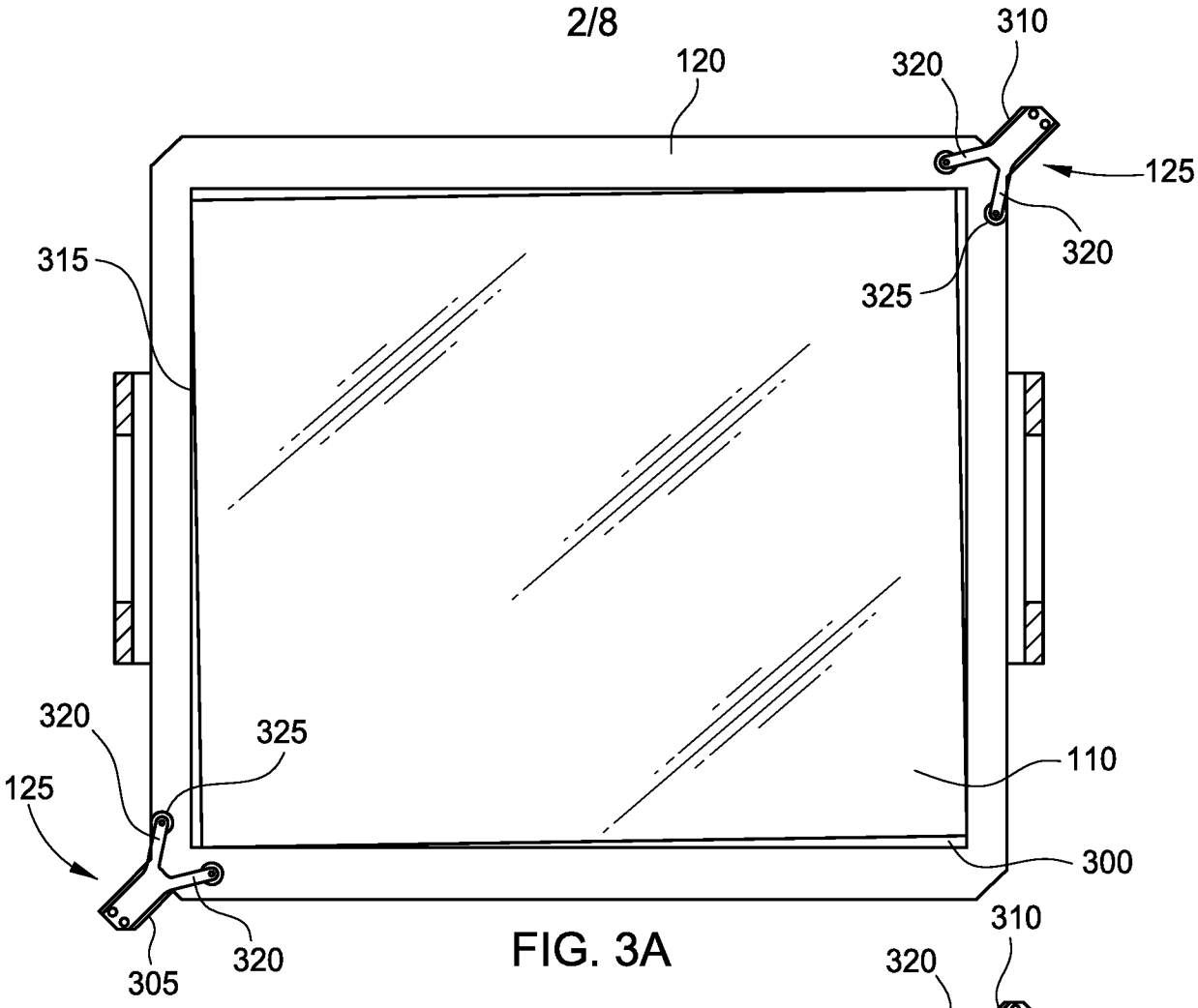

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FIG. 3A

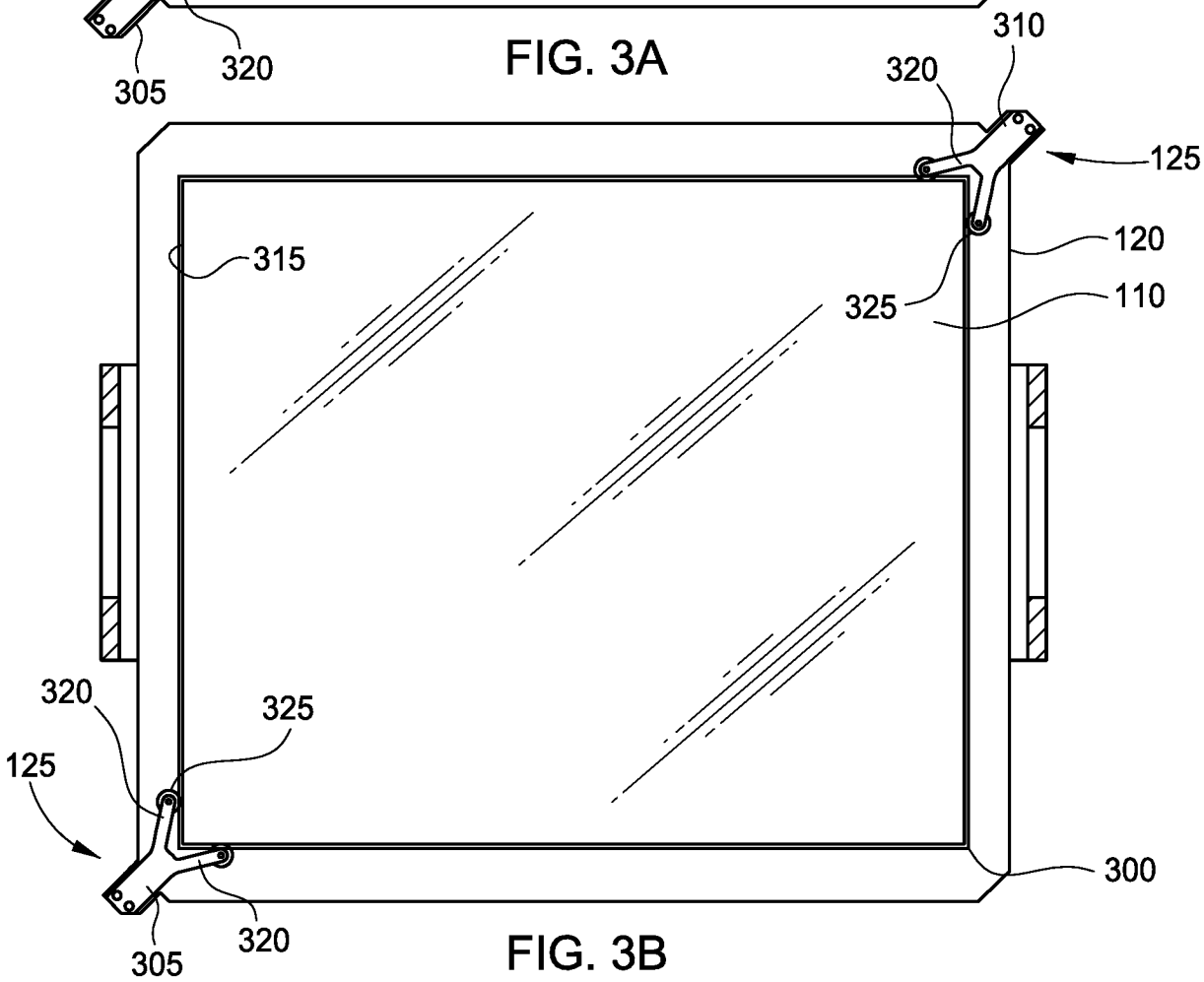

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FIG. 3B

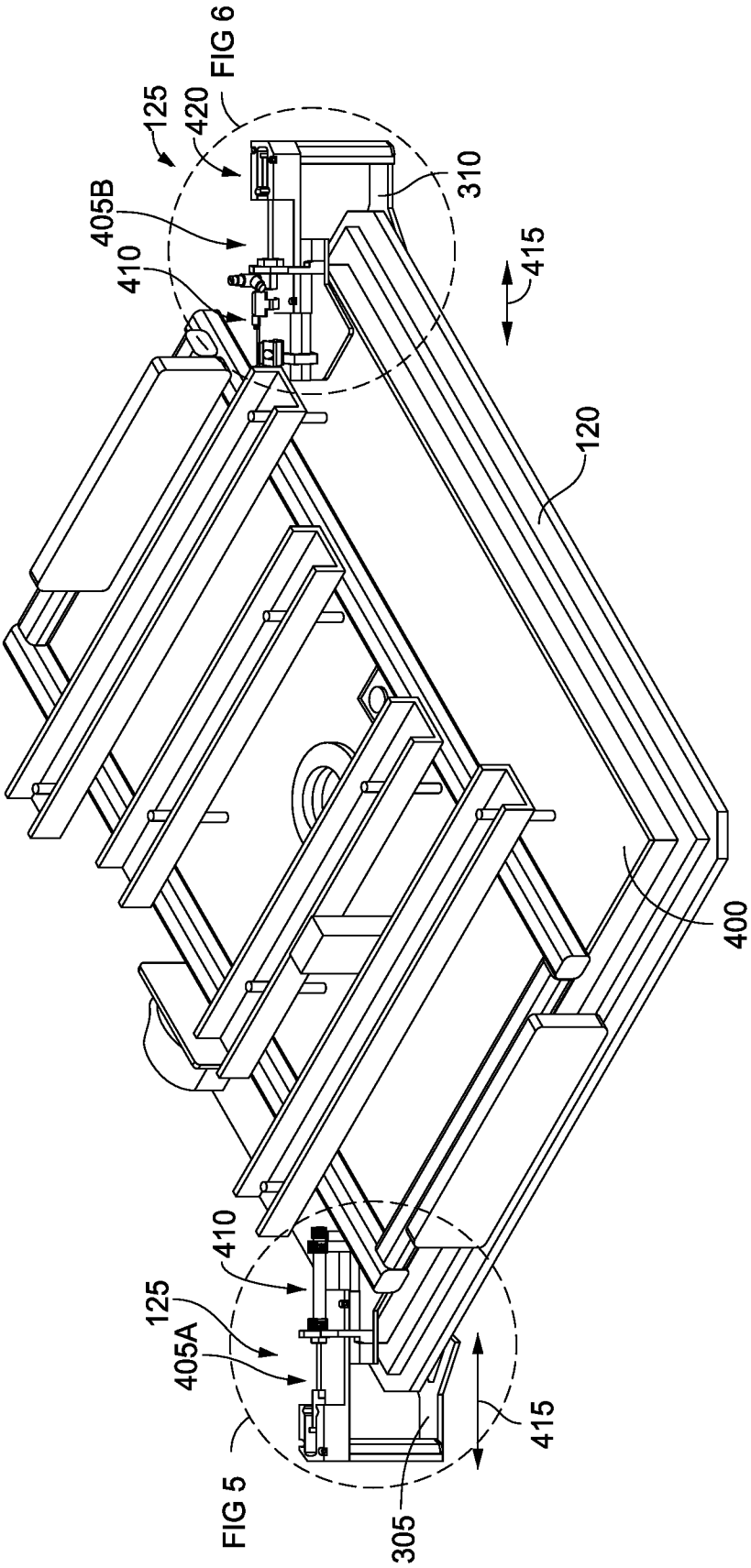


FIG. 4

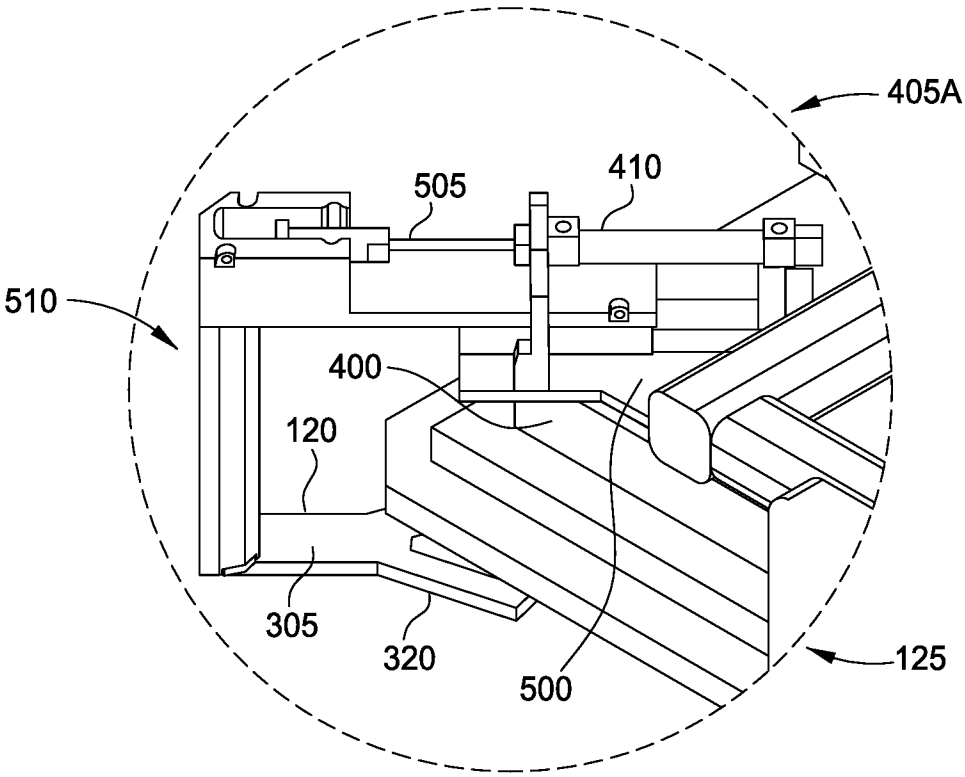

405A
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305
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500
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FIG. 5

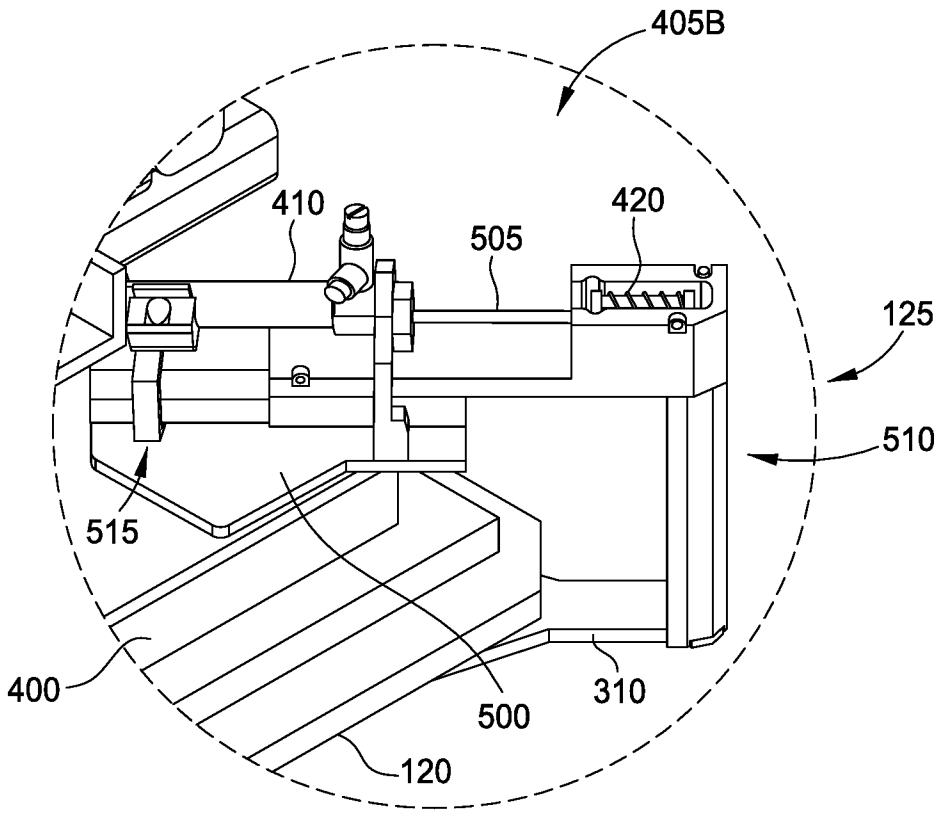

405B
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FIG. 6

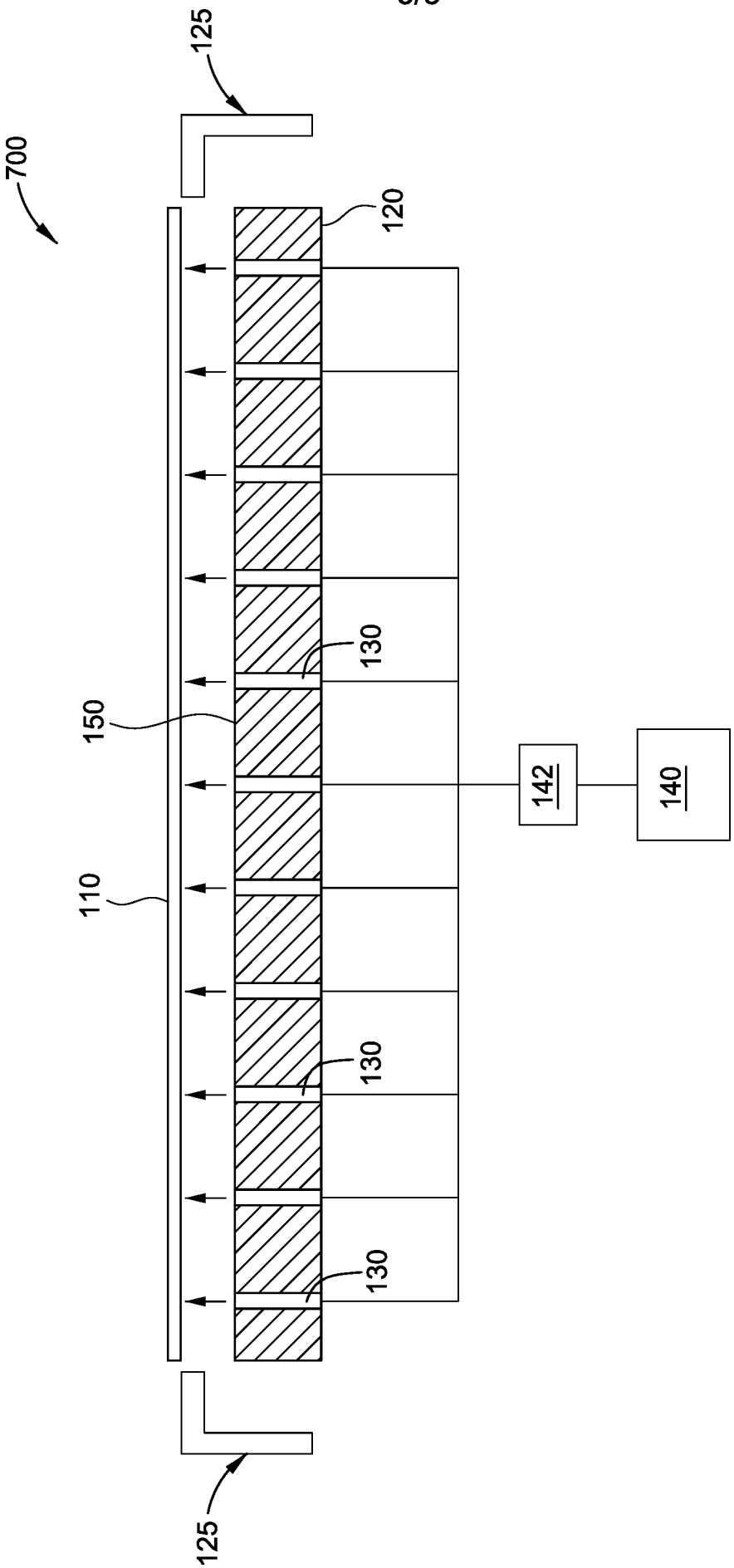


FIG. 7

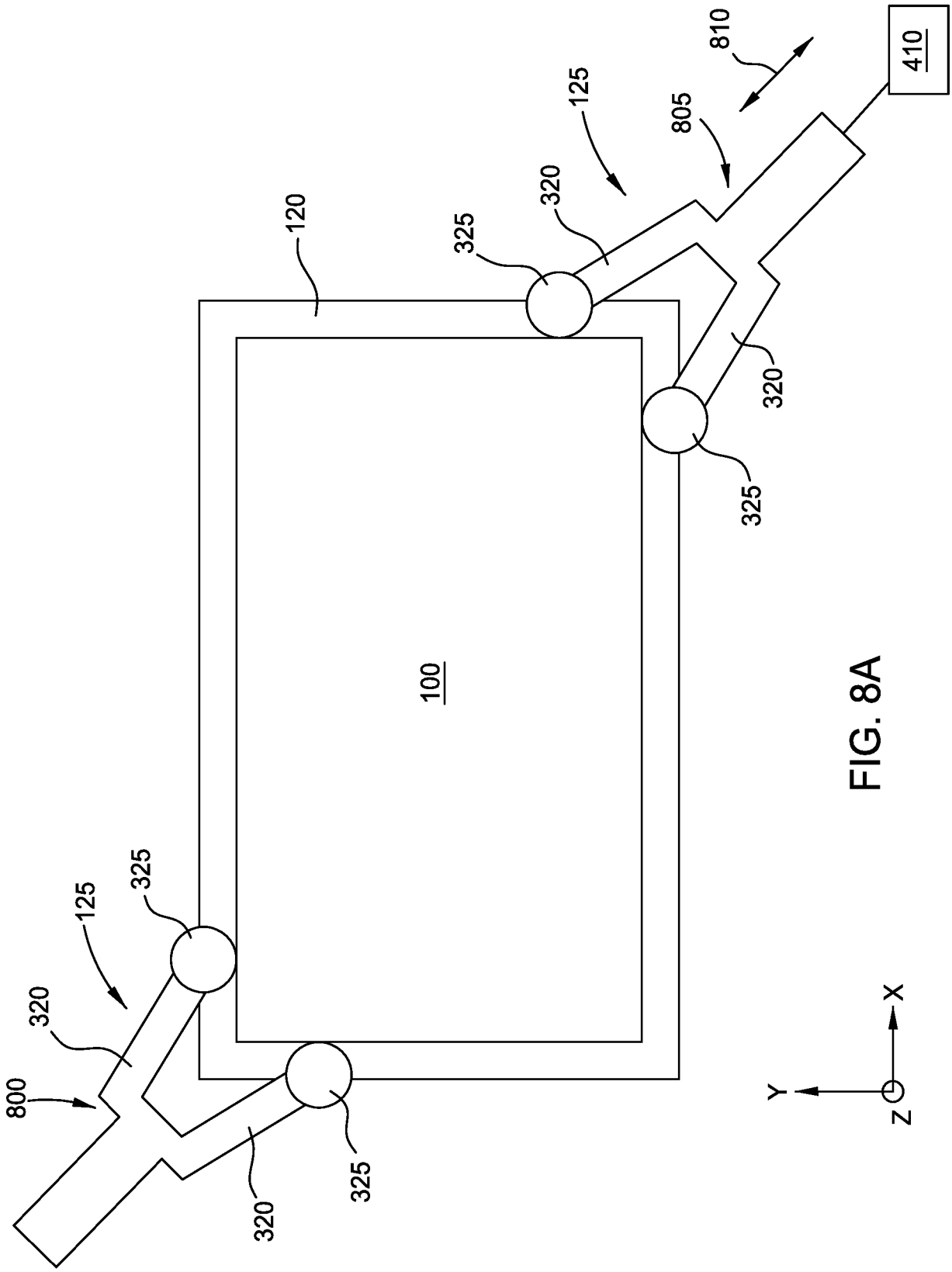

410
810
805
125
320
325
120
320
325
100
325
125
320
800
320
325
X
Y
Z

FIG. 8A

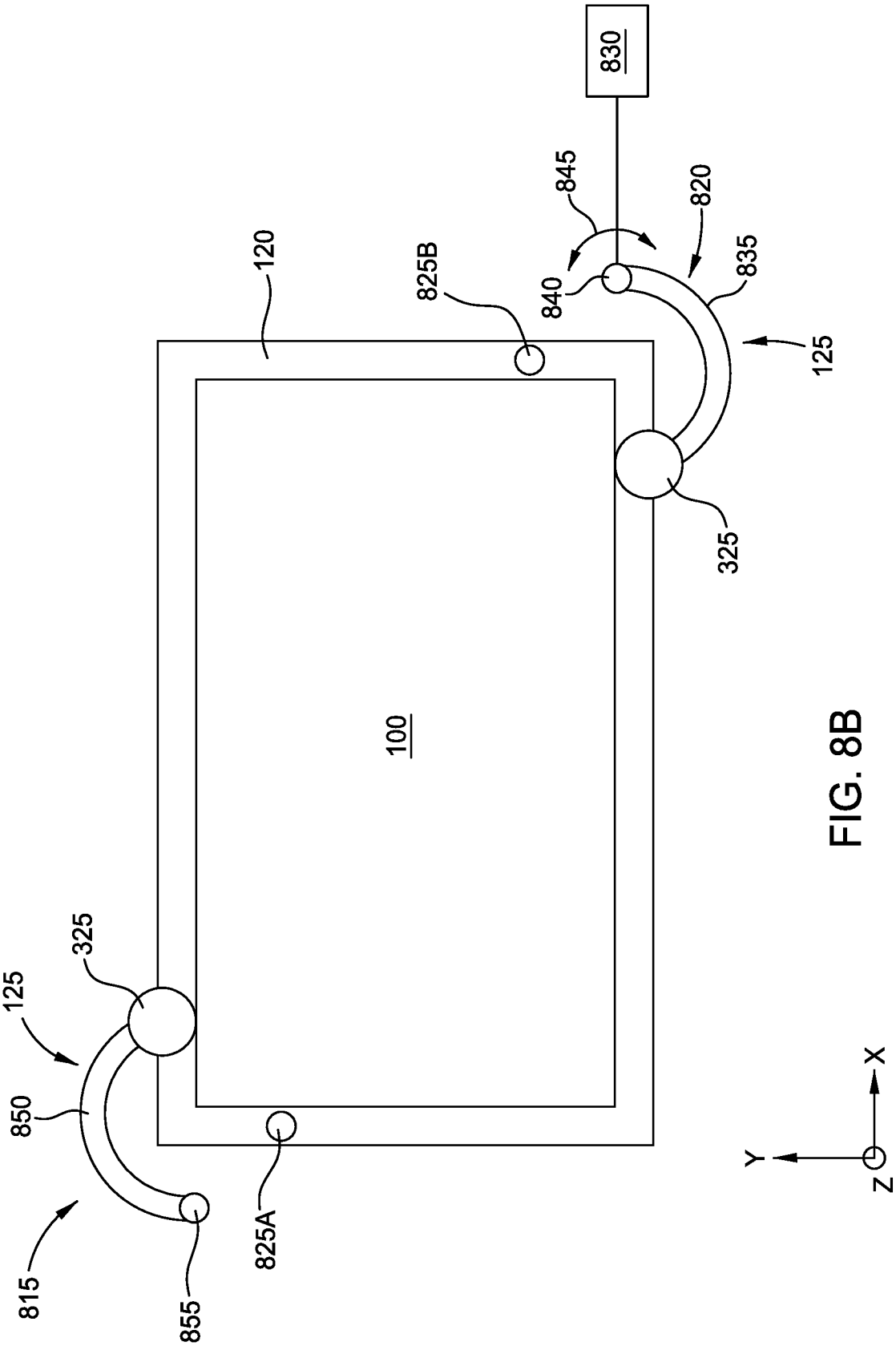

830
845
820
835
840
825B
120
125
325
100
325
125
850
825A
815
855
X
Y
Z

FIG. 8B

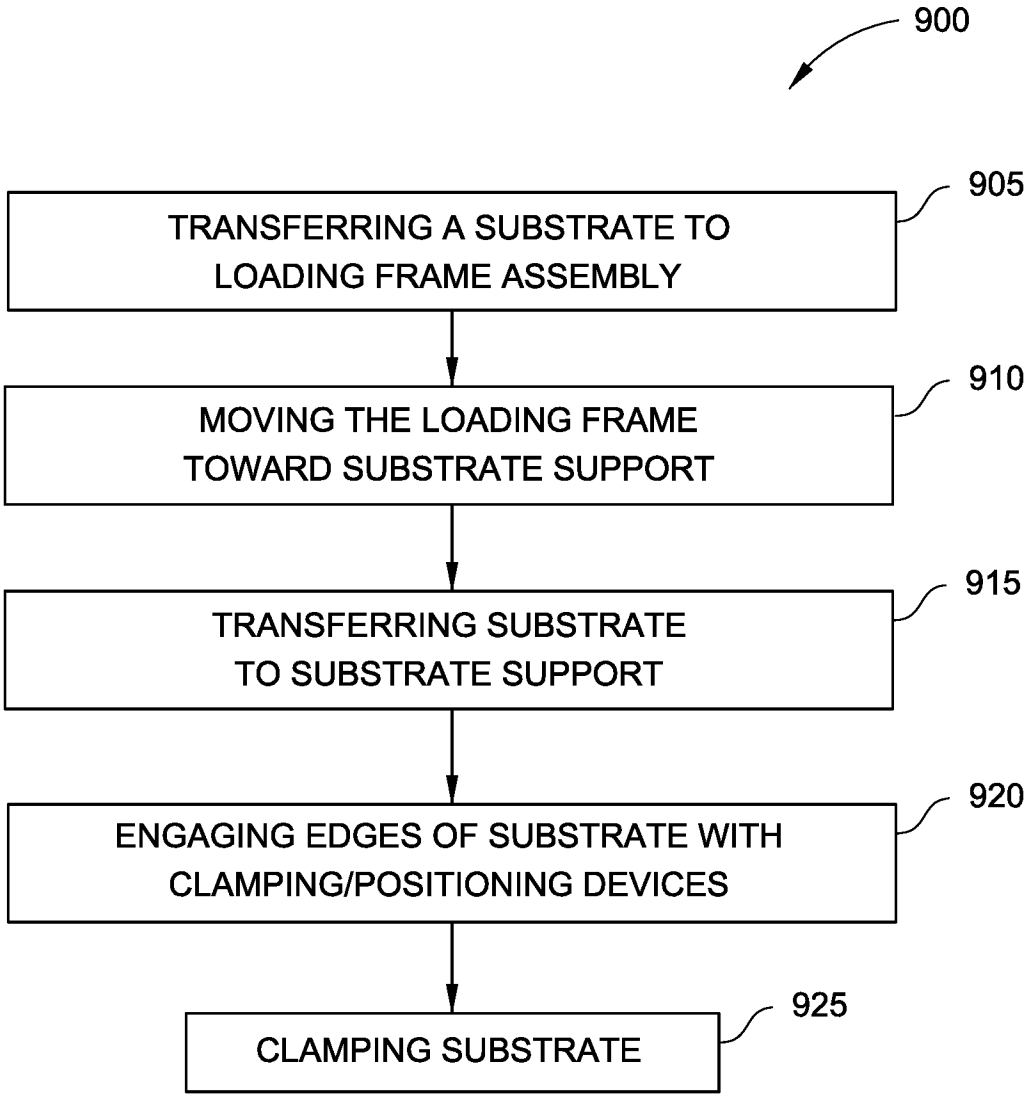

900
TRANSFERRING A SUBSTRATE TO LOADING FRAME ASSEMBLY
905
MOVING THE LOADING FRAME TOWARD SUBSTRATE SUPPORT
910
TRANSFERRING SUBSTRATE TO SUBSTRATE SUPPORT
915
ENGAGING EDGES OF SUBSTRATE WITH CLAMPING/POSITIONING DEVICES
920
CLAMPING SUBSTRATE
925

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/064843

A. CLASSIFICATION OF SUBJECT MATTER

B65G 49/06(2006.01)i

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)
B65G 49/06; B25J 19/00; B65G 1/00; G02F 1/13; G03F 7/16; H01L 21/027; H01L 21/30; H01L 21/68

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: substrate, transfer, position, clamp, roller, corner, drive

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-315146 A (WAKOMU DENSO: K.K.) 11 November 2004 See paragraphs [0020]-[0021], [0026]-[0027], [0030], [0036] and figures 1-7.	1-5,7-13,15
Y		6,14
Y	JP 07-081709 A (KOKUSAI ELECTRIC CO., LTD.) 28 March 1995 See paragraphs [0011]-[0012] and figure 5.	6,14
X	KR 10-2009-0130500 A (JEONG, JIN HWANG) 24 December 2009 See abstract, claims 1-6 and figures 1-4.	1-5,7-13,15
A	JP 2003-142561 A (SHARP CORP.) 16 May 2003 See paragraphs [0018]-[0043] and figures 1-6.	1-15
A	JP 63-124545 A (HITACHI ELECTRONICS ENG. CO., LTD.) 28 May 1988 See claims 1-2 and figures 1-2.	1-15
A	JP 2000-306980 A (TOKYO ELECTRON LTD.) 02 November 2000 See paragraphs [0019]-[0027] and figures 1, 3-5.	1-15

☐ 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
26 March 2019 (26.03.2019)	**27 March 2019 (27.03.2019)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer
LEE, Chang Ho
Telephone No. +82-42-481-8288

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2018/064843

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2004-315146 A	11/11/2004	JP 4312493 B2	12/08/2009
JP 07-081709 A	28/03/1995	None	
KR 10-2009-0130500 A	24/12/2009	None	
JP 2003-142561 A	16/05/2003	None	
JP 63-124545 A	28/05/1988	None	
JP 2000-306980 A	02/11/2000	JP 3335983 B2	21/10/2002