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(54) Title: METHOD AND APPARATUS FOR LINEAR PAD CONDITIONING

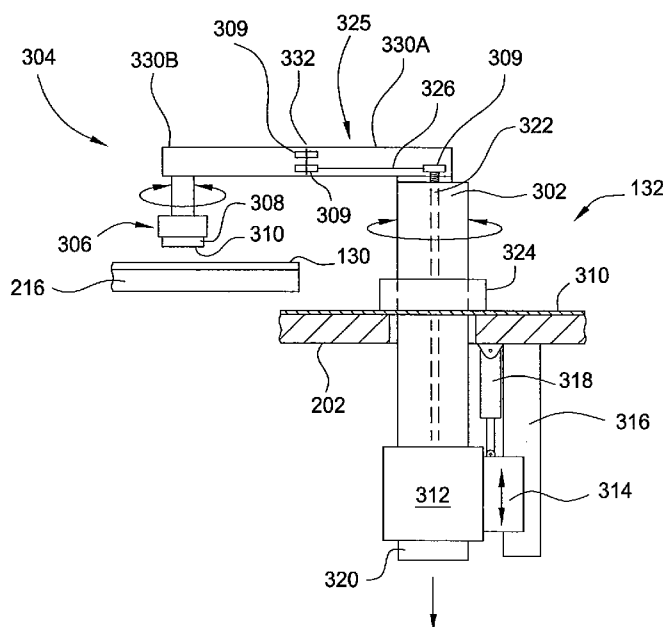


FIG. 3A

(57) Abstract: A method and apparatus for conditioning a polishing pad is described. The apparatus includes a base coupled to a platform, a first arm member having a first end coupled to the base, and a second arm member having a first end pivotably coupled to a second end of the first arm member and a conditioning disk coupled to a second end opposite the first end. The method includes rotating a polishing pad, urging a rotating conditioning disk against a polishing surface of the polishing pad, and moving the conditioning disk in a linear direction relative to the rotating polishing pad to perform a conditioning process.



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METHOD AND APPARATUS FOR LINEAR PAD CONDITIONING

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] Embodiments of the present invention generally relate to polishing a substrate, such as a semiconductor wafer.

Description of the Related Art

[0002] In the fabrication of integrated circuits and other electronic devices on substrates, multiple layers of conductive, semiconductive, and dielectric materials are deposited on or removed from a feature side, *i.e.*, a deposit receiving surface, of a substrate. As layers of materials are sequentially deposited and removed, the feature side of the substrate may become non-planar and require planarization and/or polishing. Planarization and polishing are procedures where previously deposited material is removed from the feature side of the substrate to form a generally even, planar or level surface.

[0003] Chemical mechanical polishing is one process commonly used in the manufacture of high-density integrated circuits to planarize or polish a layer of material deposited on a semiconductor wafer by moving the feature side of the substrate in contact with a polishing pad while in the presence of a polishing fluid. Material is removed from the feature side of the substrate that is in contact with the polishing surface through a combination of chemical and mechanical activity.

[0004] Periodic conditioning of the polishing surface is required to maintain a consistent roughness across the polishing surface to facilitate enhanced material removal. The conditioning is typically performed using a rotating conditioning disk that is urged against the polishing surface. The conditioning disk is coupled to a support member that moves the conditioning disk in a sweeping pattern relative to the polishing surface. Providing a specific and/or consistent sweep pattern across the polishing surfaces creates challenges during conditioning that may result non-uniform roughness of the polishing surface. The non-uniform roughness may decrease material removal, which results in decreased throughput.

[0005] Therefore, there is a need for a method and apparatus that facilitates selective and/or consistent conditioning of the polishing surface.

SUMMARY OF THE INVENTION

[0006] The present invention generally provides an apparatus and method for conditioning a polishing pad using linear motion. In one embodiment, an apparatus for conditioning a polishing pad is described. The apparatus includes a base coupled to a platform, a first arm member having a first end coupled to the base and an opposing second end, a second arm member having a first end pivotably coupled to a second end of the first arm member, and a conditioning disk coupled to a second end of the second arm member opposite the first end of the first arm member.

[0007] In another embodiment, a method of conditioning a polishing pad is described. The method includes rotating a polishing pad, urging a rotating conditioning disk against a polishing surface of the polishing pad, and moving the conditioning disk in a linear direction relative to the rotating polishing pad to perform a conditioning process.

[0008] In another embodiment, an apparatus for conditioning a polishing pad is described. The apparatus includes a base coupled to a platform, a first arm member coupled to the base, a second arm member coupled to the first arm member, a conditioning disk coupled to the second arm member opposite the base, and a joint member coupled between the first arm member and the second arm member, the joint member adapted to provide rotation of the first arm member relative to the second arm member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, 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

invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0010] Figure 1 is a plan view of a polishing module.

[0011] Figure 2 is a partial cross-sectional view of polishing module of Figure 1.

[0012] Figure 3A shows one embodiment of a conditioning module.

[0013] Figure 3B is a cross-sectional view of one embodiment of a conditioning arm assembly.

[0014] Figure 4A is a side view of a platen assembly showing one embodiment of a conditioning arm assembly in a partially extended position.

[0015] Figure 4B is top view of the platen assembly shown in Figure 4A.

[0016] Figure 4C is a side view of the platen assembly of Figure 4A showing the conditioning arm assembly in a partially retracted position.

[0017] Figure 4D is a top view of the platen assembly shown in Figure 4C.

[0018] Figure 5A is a side view of a platen assembly showing another embodiment of a conditioning arm assembly in a partially extended position.

[0019] Figure 5B is top view of the platen assembly shown in Figure 5A.

[0020] Figure 5C is a side view of the platen assembly of Figure 5A showing the conditioning arm assembly in a partially retracted position.

[0021] Figure 5D is a top view of the platen assembly shown in Figure 5C.

[0022] 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

[0023] Embodiments of the present invention generally provide a method and apparatus for conditioning a polishing surface of a polishing pad. A conditioning device having a linearly extendable arm configuration is described for use on a polishing pad having a circular configuration. Although not shown, embodiments of the conditioning device may be used on polishing pads having other shapes, such as rectangular polishing pads or belt-type polishing pads.

[0024] Figure 1 is a plan view of a polishing module 100 for processing one or more substrates, such as semiconductor wafers. The polishing module 100 includes a polishing platform 106 that at least partially supports and houses a plurality of polishing stations 124. Each of the plurality of polishing stations 124 are adapted to polish substrates that are retained in the one or more polishing heads 126. The polishing stations 124 may be sized to interface with the one or more polishing heads 126 simultaneously so that polishing of one or a plurality of substrates may occur at a single polishing station 124 at the same time. The polishing heads 126 are coupled to a carriage 108 that is mounted to an overhead track 128. The platform 106 also includes one or more load cups 122 adapted to facilitate transfer of a substrate between the polishing heads 126 and a factory interface (not shown) or other device (not shown) by a transfer robot 110. The load cups 122 generally facilitate transfer between the transfer robot 110 and each of the polishing heads 126.

[0025] The overhead track 128 allows each carriage 108 to be selectively positioned around the polishing module 106. The configuration of the overhead track 128 and carriages 108 facilitates positioning of the polishing heads 126 selectively over the polishing stations 124 and the load cups 122. In the embodiment depicted in Figures 1-2, the overhead track 128 has a circular configuration (shown in phantom in Figure 1) which allows the carriages 108 retaining the polishing heads 126 to be selectively rotated over and/or clear of the load cups 122 and the polishing stations 124. It is contemplated that the overhead track 128 may have other configurations including elliptical, oval, linear or other suitable orientation.

[0026] Referring now primarily to Figure 1, two polishing stations 124 are shown, located in opposite corners of the polishing module 100. Optionally, a third polishing station 124 (shown in phantom) may be positioned in the corner of the polishing module 100 opposite the load cups 122. Alternatively or additionally, a second pair of load cups 122 (also shown in phantom) may be located in the corner of the polishing module 100 opposite the load cups 122 that are positioned proximate the robot 108. Additional polishing stations 124 may be integrated in the polishing module 100 in systems having a larger footprint. In one embodiment, each polishing station 124 may be a stand-alone unit adapted to couple to the platform 106, other polishing stations 124, and/or a facility floor. In this embodiment, the polishing module 100 includes a modular capability wherein polishing stations, load cups, transfer devices or other equipment may be added or replaced within the platform 106.

[0027] Each polishing station 124 generally includes a polishing surface 130, a conditioning module 132 and a polishing fluid delivery module 134. The polishing surface 130 is supported on a platen assembly (not shown in Figure 1) which rotates the polishing surface 130 during processing. In one embodiment, the polishing surface 130 is suitable for at least one of a chemical mechanical polishing and/or an electrochemical mechanical polishing process.

[0028] The polishing surface 130 is configured, in one embodiment, to accommodate polishing of at least two substrates simultaneously thereon. In such an embodiment, the polishing station 124 includes two conditioning modules 132 and two polishing fluid delivery modules 134 which condition and provide polishing fluid to the region of the polishing surface 130 just prior to interfacing with a substrate. Additionally, each of the polishing fluid delivery modules 134 are positioned to provide independently a predetermined distribution of polishing fluid on the polishing surface 130 so that a specific distribution of polishing fluid is respectively interfaced with each substrate during processing.

[0029] Figure 2 shows a partial cross-sectional view of polishing module 100 of Figure 1. Specifically, the interface between the overhead track 128 and the

carriage 108 is shown. The overhead track 128 is coupled to a support member 212 that is supported by a frame member 204. The carriage 108 is utilized to position the polishing head 126 over the load cups 122 (Figure 1) or polishing surface 130, to sweep the polishing head 126 across polishing surface 130 during processing, or to position the polishing head 126 clear of the load cups 122 and polishing surface 130 for maintenance of the polishing head 126, the load cups 122 or polishing surface 130. The carriage 108 is controllably positioned along the overhead track 128 by an actuator 205. The actuator 205 may be in the form of a gear motor, servo motor, linear motor, sawyer motor or other motion control device suitable for accurately positioning the carriage 108 on the track 128. In one embodiment, each carriage 108 includes a linear motor that interfaces with a magnetic track coupled to the track 128. The magnetic track comprises magnets arranged in alternating polarity so that each carriage 108 may be moved independently of the other carriages coupled to the overhead track 128.

[0030] In one embodiment, the overhead track 128 is coupled to the frame member 204 while the polishing stations 124 are coupled to a polishing station platform 202. In this embodiment, each polishing station 124 can be provided as a stand-alone unit or a plurality of polishing stations 124 may be coupled together with the platform 202. In one embodiment, the polishing station platform 202 and frame member 204 are coupled to a floor 203 of the facility without being connected to each other. The decoupled polishing station platform 202 and frame member 204 allows vibrations associated with the movement of the carriages 108 to be substantially isolated from the polishing surface 130, thereby minimizing potential impact to polishing results. Moreover, utilization of the polishing station platform 202 without a machine platform provides significant cost savings over conventional designs.

[0031] The polishing head 126 is coupled to the carriage 108 by a shaft 232. A motor 234 is coupled to the carriage 108 and is arranged to controllably rotate the shaft 232, thereby rotating the polishing head 126 and a substrate 201 disposed therein during processing. At least one of the polishing head 126 or carriage 108 includes an actuator (not shown) for controlling the elevation of the polishing head

126 relative to the polishing surface 130. In one embodiment, the actuator allows the polishing head 126 to be pressed against the polishing surface 130 at about 6 psi or less, such as less than about 1.5 psi.

[0032] A platen assembly 200 supports a polishing pad 218 that may be made entirely of a dielectric material or include conductive material disposed in a dielectric material. The upper surface of the pad 218 forms the polishing surface 130. The platen assembly 200 is supported on the polishing station platform 202 by one or more bearings 214. The platen 216 is coupled by a shaft 206 to a motor 208 that is utilized to rotate the platen assembly 200. The motor 208 may be coupled by a bracket 210 to the polishing station platform 202. In one embodiment, the motor 208 is a direct drive motor. It is contemplated that other motors may be utilized to rotate the shaft 206. In the embodiment depicted in Figure 2, the motor 208 is utilized to rotate the platen assembly 200 such that the pad 218 retained thereon is rotated during processing while the substrate 201 is retained against the polishing surface 130 by the polishing head 126. It is contemplated, as shown in Figure 1, that the platen assembly 300 may be large enough to support a polishing pad 218 which will accommodate polishing of at least two substrates retained by different polishing heads 126. In one embodiment, the dielectric polishing pad 218 is greater than 30 inches in diameter, for example, between about 30 and about 52 inches, such as 42 inches. Even though the dielectric polishing pad 218 may be utilized to polish two substrates simultaneously, the pad unit area per number of substrate simultaneously polished thereon is much greater than conventional single substrate pads, thereby allowing the pad service life to be significantly extended, for example, approaching about 2000 substrates per pad.

[0033] During processing or when otherwise desired, the conditioning module 132 is activated to contact and condition the polishing surface 130. Additionally, polishing fluid is delivered through the polishing fluid delivery module 134 to the polishing surface 130 during processing and/or conditioning. The distribution of fluid provided by the polishing fluid delivery arm 134 may be selected to control the distribution of polishing fluid across the lateral surface of the polishing surface

130. It should be noted that only one polishing head 126, conditioning module 132 and polishing fluid delivery module 134 are depicted in Figure 2 for the sake of clarity.

[0034] Figure 3A shows one embodiment of a conditioning module 132. In this embodiment, the conditioning module 132 is coupled to the polishing station platform 202. The conditioning module 132 includes a base 302 having a conditioning arm assembly 304 extended therefrom in a cantilevered fashion. The distal end of the arm assembly 304 supports a conditioning head 306. A conditioning disk 308 is removably attached to the conditioning head 306. In one embodiment, a first motor or actuator 312 is provided to rotate the arm assembly 304 over the polishing surface 130 during conditioning, and to position the arm assembly 304 clear of the polishing surface 130 when desired.

[0035] The conditioning arm assembly 304 includes at least two articulatable arms or links, such as a first arm member 330A and a second arm member 330B. The conditioning arm assembly 304 also includes at least one pivot point or joint 332 coupling the first and second arm member 330A, 330B providing relative movement between the arm members 330A, 330B. A second motor 320 is utilized to move the first arm member 330A relative to the second arm member 330B. The second motor 320 is coupled to a transmission system 325 that, in one embodiment, includes a shaft 322 (shown in phantom) which is coupled to a drive member 309, which in turn are coupled to one or more transmission members 326, which may be belts, wires, or cables. In one embodiment, the transmission members 326, such as belts are coupled to drive members 309 and the shaft 322 to facilitate movement of the first arm member 330A relative to the second arm member 330B such that angular changes are provided between the first arm member 330A and the second arm member 330B.

[0036] Each of the drive members 309 may be a pulley or gear adapted to transfer rotational or translation motion from one element to another. The term "gear" as used herein is intended to generally describe a component that is rotationally coupled to a transmission member 326, such as a belt, teeth, wires,

cables, and is adapted to transmit motion from one element to another. In general, a gear, as used herein, may be a conventional gear type device or pulley type device, which may include but is not limited to components such as, a spur gear, bevel gear, rack and/or pinion, worm gear, a sheave, a timing pulley, and a v-belt pulley. The joint 332 may be a revolute joint, a screw joint, or other joint having one or more degrees of freedom.

[0037] In one embodiment, the elevation of the conditioning arm assembly 304 may be controlled by a vertical actuator 318. In one embodiment, the actuator 318 is coupled to a guide 314 that is coupled to the base 302. The guide 314 may be positioned along a rail 316 which is coupled to the polishing station platform 202 so that the actuator 318 may control the elevation of the conditioning arm assembly 304 and the conditioning head 306. A collar 324 is provided to prevent liquid from passing between the base 302 and an upper surface 310 of the polishing station platform 202.

[0038] Figure 3B shows a cross-sectional view of one embodiment of a conditioning arm assembly 304. In this embodiment, the conditioning arm assembly 304 includes two transmission systems that may be used together or separately. A first transmission system 325 includes a first drive system 351A coupled to a second drive system 351B. The first drive system 351A includes a first gear 352A coupled to a shaft 353 extending from a first motor 356A. The first gear 352A is coupled to a second gear 352B by a transmission member 354A, such as a belt. The second gear 352B is coupled to a shaft 322 that is coupled to a second drive system 351B. The second drive system includes the third gear 352C and a fourth gear 352D which are coupled by a second transmission member 354B, such as a belt. The fourth gear 352D is fixedly coupled to a shaft 358 that extends from the first arm member 330A and is fixedly coupled to the second arm member 330B. Rotational movement from the first motor 356A is transmitted to the shaft 358 to provide movement of the second arm member 330B relative to the first arm member 330A.

[0039] In one aspect, the first transmission system 325 includes a transmission ratio (e.g., ratio of diameters, ratio of the number of gear teeth) of the first drive system 351A and second drive system 351B that is designed to achieve a desired shape and resolution of an actuation or extension path (e.g., path 450A and/or 450B in Figure 4A). The transmission ratio will be hereafter defined as the driving element size to the driven element size, or in this case, for example, the ratio of number of teeth of on third gear 352C to the number of teeth on the fourth gear 352D. Therefore, for example, where the first arm member 330A is rotated 270 degrees which causes the second arm member 330B to rotate 180 degrees equates to a 0.667 transmission ratio or alternately a 3:2 gear ratio. The term gear ratio is meant to denote that n_1 number of turns of the first gear causes n_2 number of turns of the second gear, or an $n_1:n_2$ ratio. Therefore, a 3:2 ratio means that three turns of the first gear will cause two turns of the second gear and thus the first gear must be about two thirds the size of the second gear. In one aspect, the gear ratio of the third gear 352C to the fourth gear 352D is between about 3:1 to about 4:3, such as between about 2:1 and about 3:2.

[0040] In one embodiment, a second transmission system 360 is provided on the conditioning arm assembly 304 that may be utilized along with the first transmission system 325. In this embodiment, the second transmission system 360 is configured to rotate the conditioning head 306 about a center axis. The second transmission system 360 includes a first gear 362A coupled to a second motor 356B by a shaft 361. The first gear 362A is coupled to a second gear 362B and third gear 362C by a transmission member 363A. Rotational movement from the second motor 356B is transmitted to the second gear 362B and third gear 362C by the transmission member 363A. A second transmission member 363B is coupled between the third gear 362C and a fourth gear 362D and fifth gear 362E to transmit rotational movement from the second motor 356B to the fifth gear 362E. A sixth gear 362F is rotationally coupled to the fifth gear 362E by a third transmission member 363C. The sixth gear 362F is coupled to a shaft 364 that is coupled to the conditioning head 306. Thus, rotational movement of the second motor 356B is transmitted to the conditioning head 306 through the conditioning

arm assembly 304. While not shown, bearings and/or seals for each of the gears and shafts may be provided. In one aspect, one or both of the first motor 356A and second motor 356B is a stepper motor or DC servomotor. A flexible sleeve or cover 350 may be coupled to the conditioning arm assembly 304 at the joint 332 to contain any particles that may be generated at the joint 332.

[0041] Figures 4A-4D are side and plan views of one embodiment of conditioning arm assembly 404. Figures 4A and 4B show the conditioning arm assembly 404 in a partially extended position and Figures 4C and 4D show the conditioning arm assembly 404 in a partially retracted position. In the embodiment shown in Figures 4A-4D, the conditioning arm assembly 404 may be configured similarly to the embodiment of the conditioning arm assembly 304 of Figures 3A and 3B, or include additional or alternative transmission systems. In one embodiment, the conditioning arm assembly 404 may include a first transmission system 325 as described in Figures 3A and 3B and a second transmission system comprising a motor 415 coupled to the conditioning head 306 to rotate the conditioning head 306.

[0042] In Figures 4A-4D, the conditioning arm assembly 404 includes arm members 330A, 330B, a first joint 432A and a second joint 432B. Each arm member 330A, 330B moves relative to the other in a horizontal plane (X direction). The first joint 432A is proximate the base 302 and may be either fixed to the base 302 to move the first member with the base 302 or movably coupled to the base 302 such that the first arm member 330A moves at least rotationally relative to the base 302. The second joint 432B is configured to pivotally couple the first arm member 330A to the second arm member 330B. In one embodiment, the first joint 432A may be coupled to the first transmission system 325 of Figure 3B to move the first arm member 330A and second arm member 330B. In another embodiment, the first joint 432A may be coupled to an actuator 410, such as a stepper motor or DC servomotor adapted to rotate the first arm member 330A relative to the base 302 about axis A. Alternatively or additionally, a joint actuator 420 may be coupled at the second joint 432B to move the first arm member 330A relative to the second arm member 330B about axis B. As another alternative, the

conditioning head 306 may be coupled to the motor 415 coupled to the second arm member 330B. The motor 415 may be a direct drive motor is adapted to provide rotational motion to the conditioning head 306 along axis C.

[0043] Figure 4B is a top view of the conditioning arm assembly 404 of Figure 4A. In one embodiment, the conditioning arm assembly 404 provides a first sweep path 450A to condition the polishing surface 130. In this embodiment, the conditioning arm assembly 404 moves in a radial direction across the polishing surface 130. The first sweep path 450A may also include a linear directional component such as substantial back and forth movement in the Y direction. The conditioning head 306 moves across the polishing surface 130 from a position near the center of the polishing surface 130 to a position near an edge of the polishing surface 130 as shown in Figures 4C and 4D. Alternatively or additionally, the conditioning head 306 may be actuated to move in a second sweep path 450B, such as an arcuate path. For example, the conditioning head 306 may be moved in an arcuate orientation by actuating the conditioning arm assembly 404 to move about at least one or both of axes A and B. During conditioning, a downward pressure in a range between about 0.1 pound-force (lb-f) to about 10 lb-f, for example about 0.5 lb-f to about 8 lb-f, such as between about 1.0 lb-f to about 3 lb-f may be applied to conditioning head 306 having the conditioning disk coupled thereto.

[0044] Figures 5A-5D are side and plan views of one embodiment of conditioning arm assembly 504. Figures 5A and 5B show the conditioning arm assembly 504 in a partially extended position and Figures 5C and 5D show the conditioning arm assembly 504 in a partially retracted position. In the embodiment shown in Figures 5A-5D, the conditioning arm assembly 504 may be configured similarly to the embodiment of the conditioning arm assembly 304 of Figures 3A and 3B, or include additional or alternative transmission systems.

[0045] In Figures 5A-5D, the conditioning arm assembly 504 includes arm members 330A, 330B, a first joint 532A and a second joint 532B. Each arm member 330A, 330B moves relative to the other in a vertical plane (Z direction).

The first arm member 330A is movably coupled by first joint 532A to the base 302 to rotate the first arm member 330A relative to the base 302. The second joint 532B is configured to pivotally couple the first arm member 330A to the second arm member 330B. In one embodiment, the first joint 532A may be coupled to the first transmission system 325 of Figure 3B to move the first arm member 330A and second arm member 330B. In another embodiment, the first joint 532A may be coupled to an actuator 410, such as a stepper motor or DC servomotor adapted to rotate the first arm member 330A relative to the base 302 about axis A'. Alternatively or additionally, a joint actuator 520 may be coupled to the second joint 532B to move the first arm member 330A relative to the second arm member 330B about axis B'. A third joint 532C may be utilized to couple the conditioning head 306 to the second arm member 330B. The third joint 532C may be adapted to float or be configured as a gimbal to allow rotational movement along axis C'. In one embodiment, the conditioning head 306 may be coupled to a motor 415 to rotate the conditioning head 306. The motor 415 may be a direct drive motor is adapted to provide rotational motion to the conditioning head 306. The motor 415 may be coupled to a gear box or transmission device (not shown) adapted to translate rotational actuation from the motor 415 to the conditioning head 306, such as a right angle gear box.

[0046] The embodiments of the conditioning arm assemblies 304, 404 and 504 as described above provide a more accurate and controllable sweep pattern as compared to other conditioning apparatus. The configuration of the conditioning arm assemblies 304, 404 and 504 use less space on a polishing module 100 which allows additional space for polishing heads, fluid delivery modules and other hardware used in or on the polishing module 100. For example, the movement configurations of the first arm member 330A and the second arm member 330B may be varied based on allocated space on the polishing module 100. Factors such as height allowances, width allowances, and other dimensional constraints between other hardware disposed on the polishing module 100 may be considered and the conditioning arm assemblies 304, 404 and 504 may be configured accordingly. Additionally, the configuration of the conditioning arm

assemblies 304, 404 and 504 provides alternative sweep patterns, such as movement indicated by path 550A and path 550B to perform a conditioning process.

[0047] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

Claims:

1. An apparatus for conditioning a polishing pad, comprising:
 - a base coupled to a platform;
 - a first arm member having a first end coupled to the base and an opposing second end;
 - a second arm member having a first end pivotably coupled to a second end of the first arm member; and
 - a conditioning disk coupled to a second end of the second arm member opposite the first end of the first arm member.
2. The apparatus of claim 1, wherein the conditioning disk is coupled to a first actuator and a first transmission system disposed on one or both of the first arm member and the second arm member.
3. The apparatus of claim 1, wherein the conditioning disk is coupled to a first actuator disposed on the second end of the second arm member.
4. The apparatus of claim 1, wherein the base is coupled to a rotary actuator adapted to move the base relative to the platform.
5. The apparatus of claim 4, wherein the first arm member is fixedly coupled to the base.
6. The apparatus of claim 4, wherein the actuator is a vertical actuator providing vertical movement of the base relative to the platform.
7. The apparatus of claim 1, wherein the first arm member and second arm member are coupled to a first drive assembly comprising:
 - a motor having a first gear;
 - a second gear coupled to the first end of the second arm member; and
 - a belt coupling the first gear and the second gear.

8. The apparatus of claim 7, wherein the conditioning disk is coupled to a second drive assembly.
9. The apparatus of claim 8, wherein the second drive assembly includes a direct drive motor coupled to the conditioning disk.
10. The apparatus of claim 7, wherein the drive assembly articulates the first arm member and second arm member in a linear direction.
11. The apparatus of claim 10, wherein first arm member and second arm member articulate in a vertical plane.
12. The apparatus of claim 10, wherein first arm member and second arm member articulate in a horizontal plane.
13. An apparatus for conditioning a polishing pad, comprising:
 - a base coupled to a platform;
 - a first arm member coupled to the base;
 - a second arm member coupled to the first arm member;
 - a conditioning disk coupled to the second arm member opposite the base;and
 - a joint member coupled between the first arm member and the second arm member, the joint member adapted to provide rotation of the first arm member relative to the second arm member.
14. The apparatus of claim 13, wherein the first drive assembly articulates the first arm member and second arm member in a linear direction.
15. The apparatus of claim 14, wherein first arm member and second arm member articulate in a vertical plane.

16. The apparatus of claim 14, wherein first arm member and second arm member articulate in a horizontal plane.

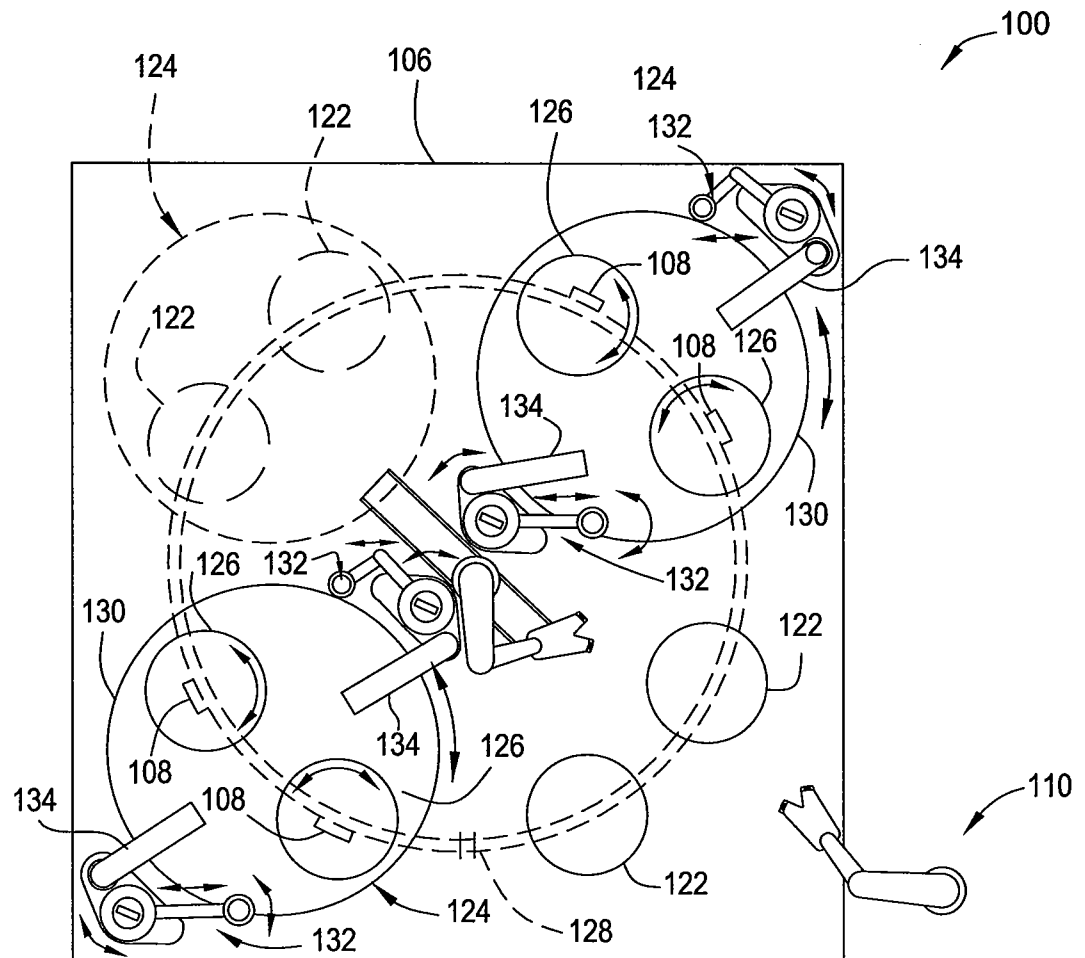


FIG. 1

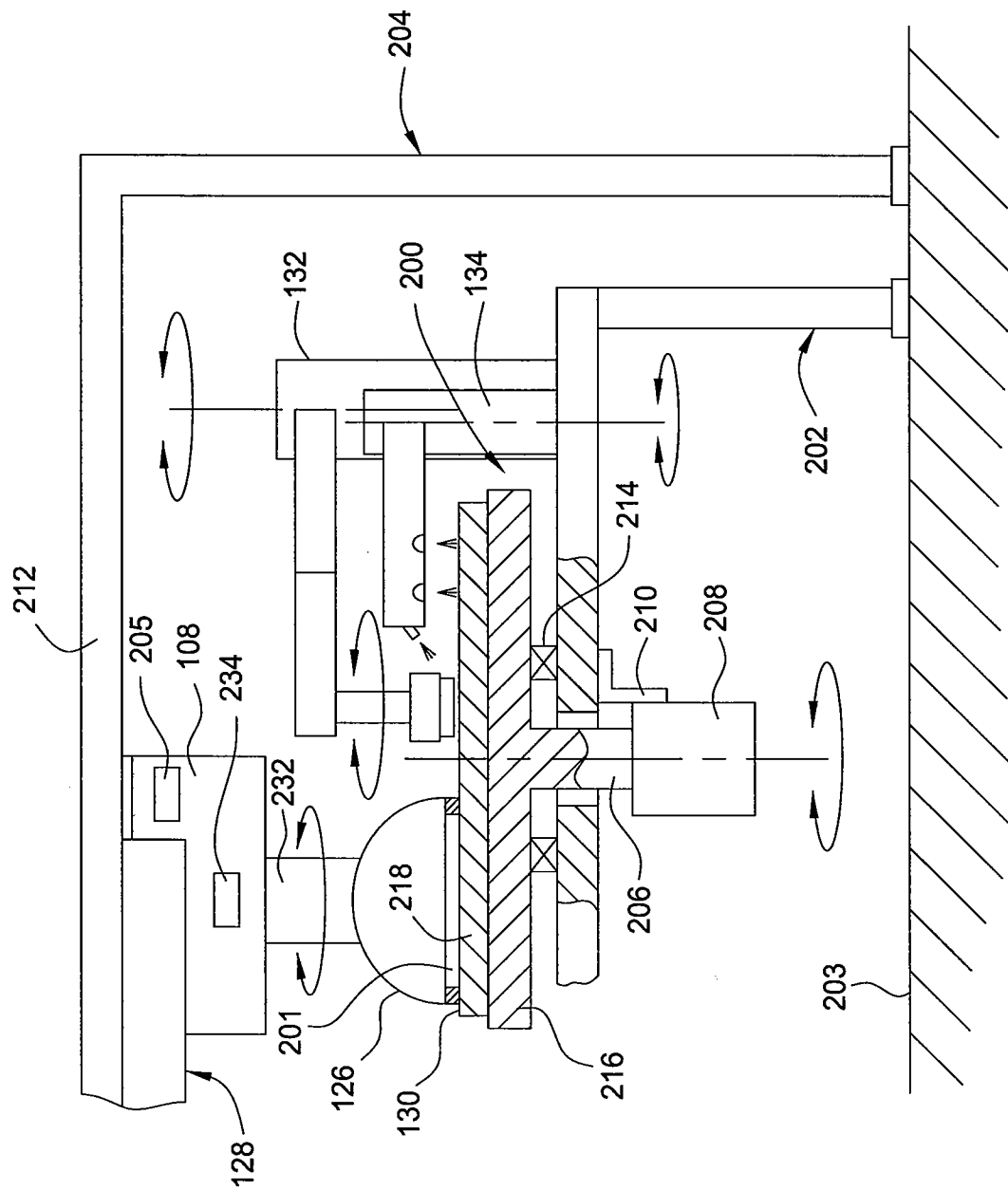


FIG. 2

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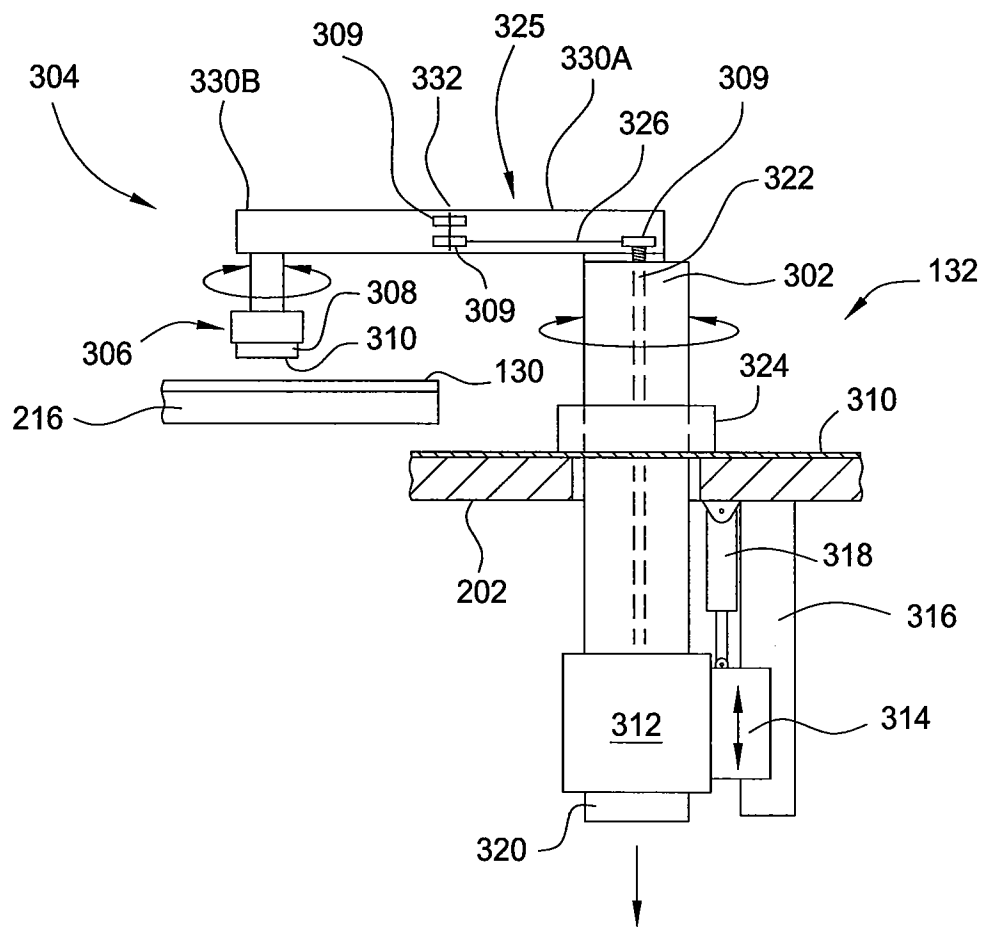


FIG. 3A

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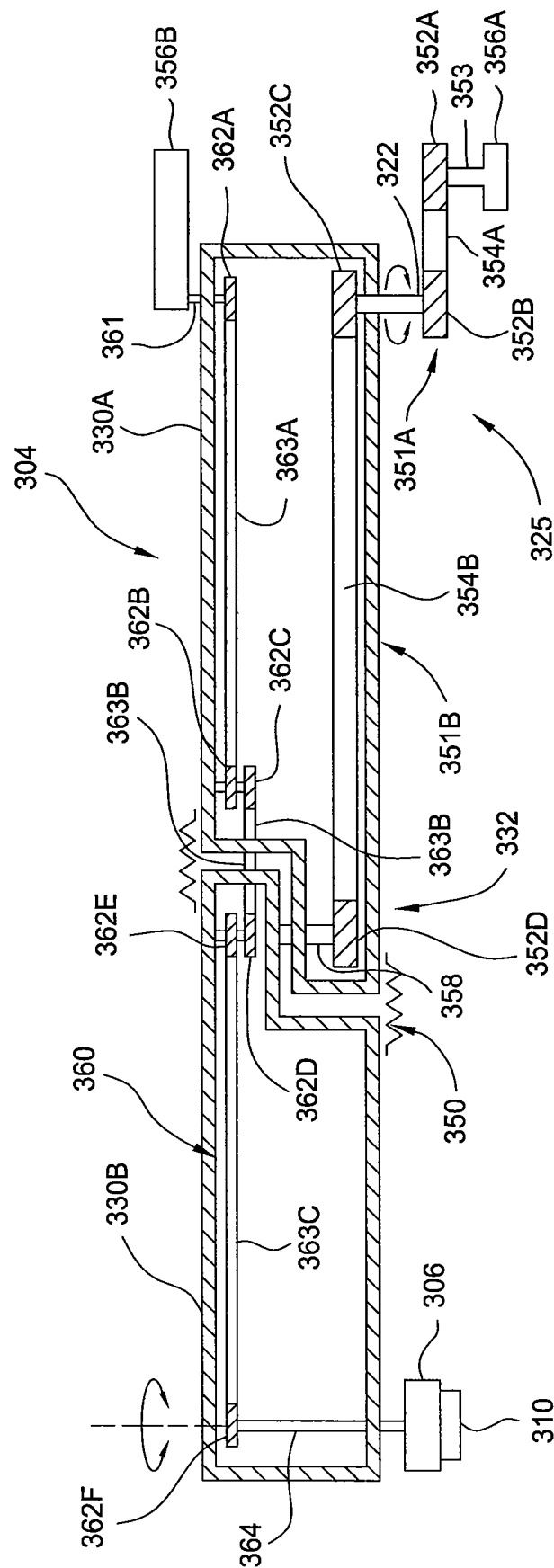


FIG. 3B

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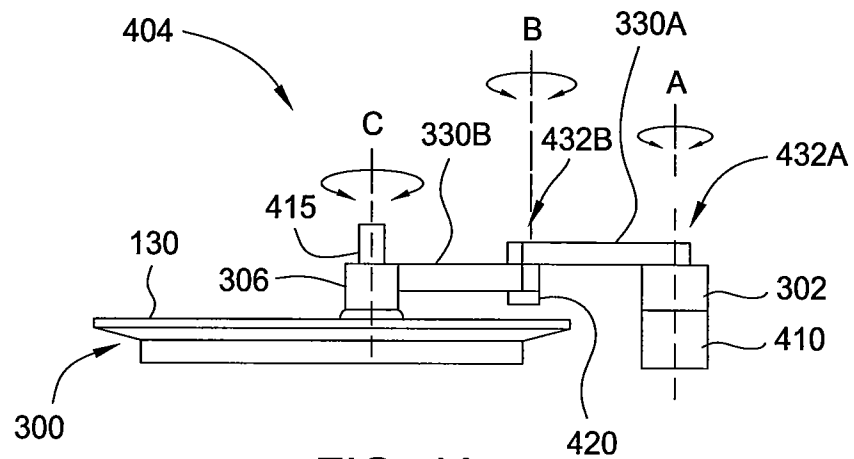


FIG. 4A

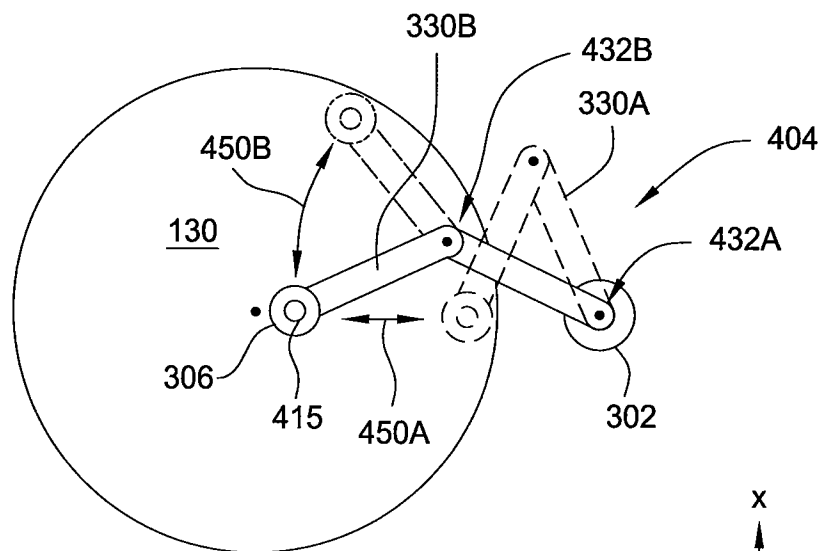
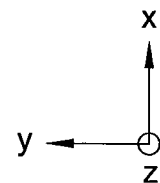


FIG. 4B



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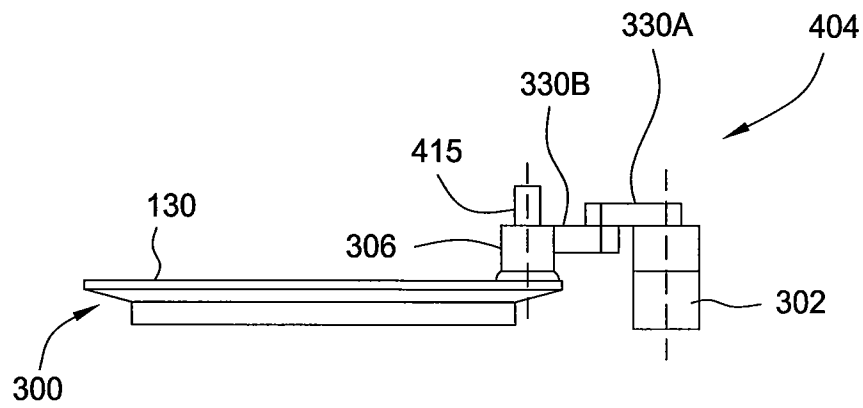


FIG. 4C

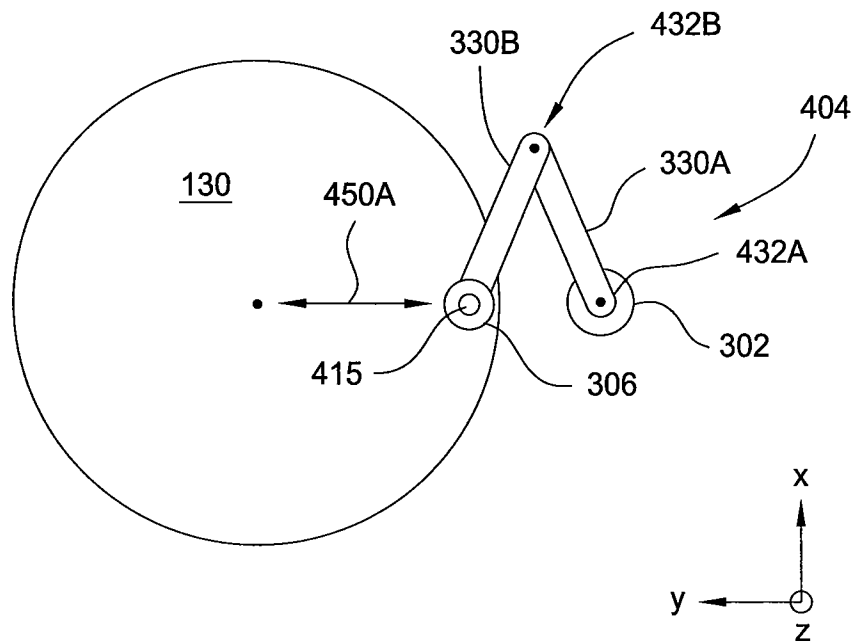


FIG. 4D

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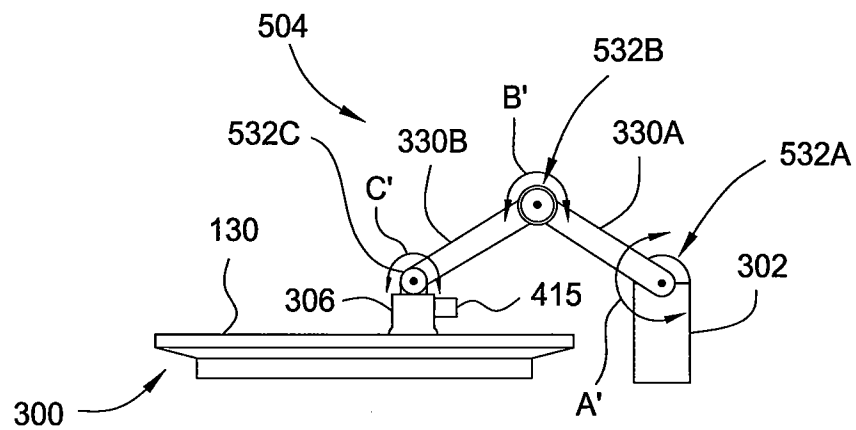


FIG. 5A

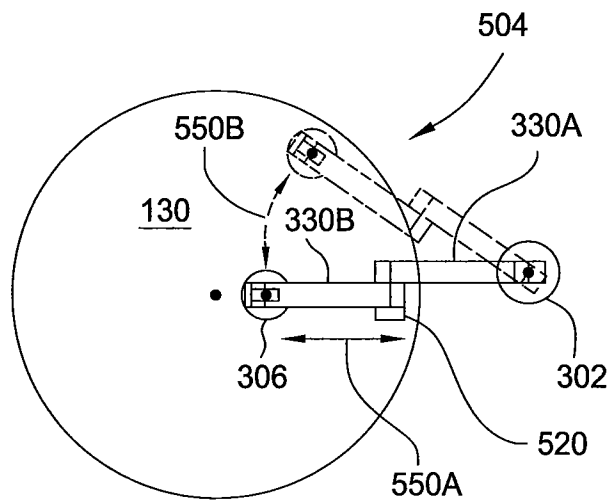
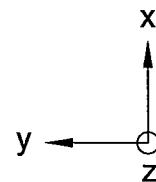


FIG. 5B



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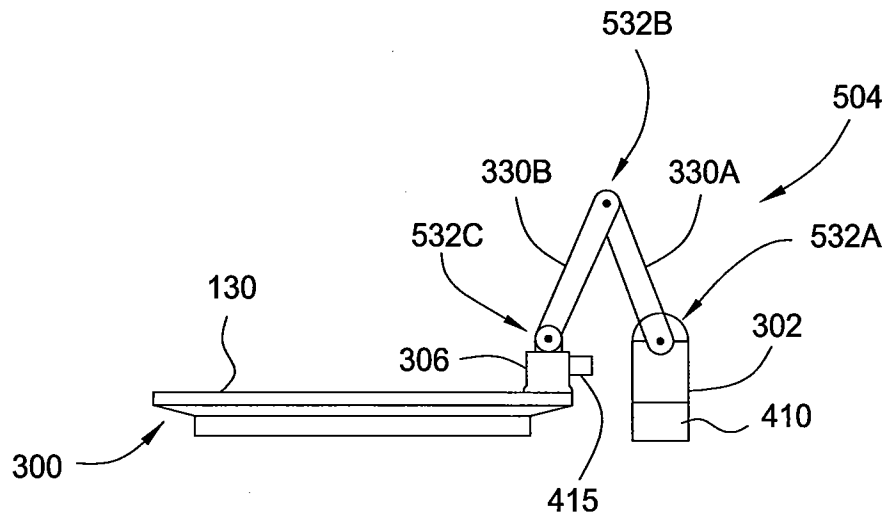


FIG. 5C

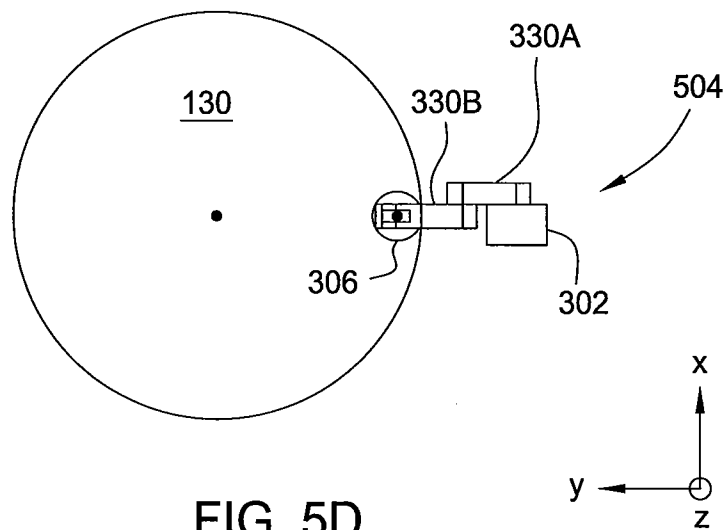


FIG. 5D