(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 291 132 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.03.2003 Bulletin 2003/11

(51) Int Cl.[7]: **B24B 9/06**, B24B 41/00

(21) Application number: **02019759.6**

(22) Date of filing: **04.09.2002**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **06.09.2001 JP 2001269640**

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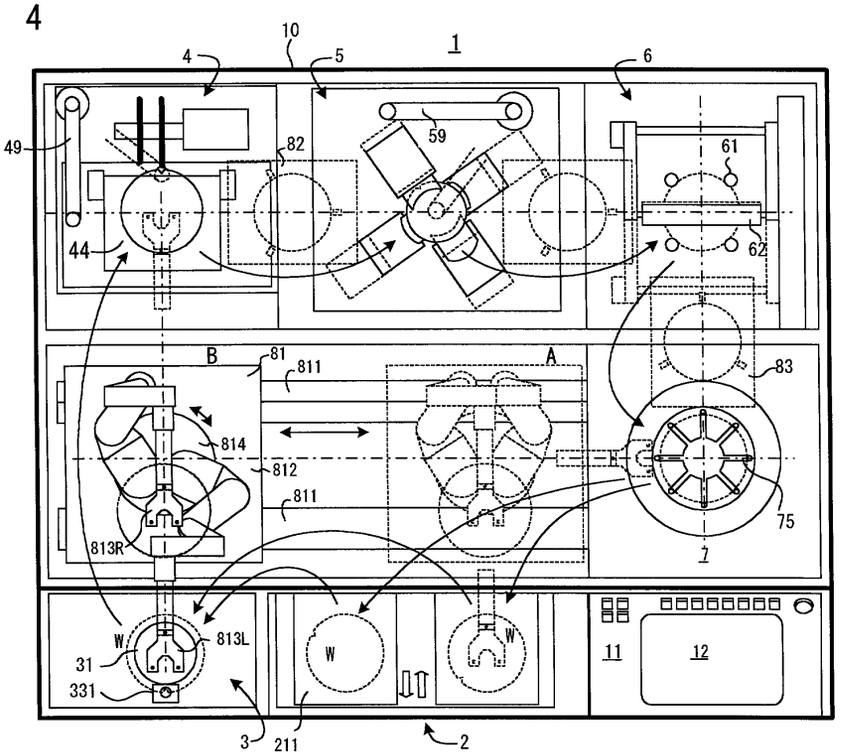
(54) Semiconductor wafer polishing apparatus and polishing method

(57) An object of the present invention is to unchange the order of wafers when passed through a wafer outer peripheral part polishing apparatus, thereby simplifying control for each wafer. In predetermined positions of a frame of a wafer outer peripheral part polishing unit, there are arranged and attached a wafer cassette reception and discharge opening unit, a wafer position aligning unit, a wafer notch polishing unit, a wafer circumferential part polishing unit, an inside carrier unit, a first slurry supply device, and a second slurry supply device. The inside carrier unit has a first carrier sub-unit, a second carrier sub-unit, and a third carrier sub-unit. After a wafer taken out from the wafer cassette reception and discharge opening unit is polished, the wafer is returned to the same slot of the same cassette from which it is taken out. Thus, the order is not changed.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a apparatus for mirror-polishing the outer peripheral part of a semiconductor wafer and more particularly to a wafer polishing apparatus for singly mirror-polishing, cleaning, and drying the circumferential bevel surfaces and the circumferential end surface of the circumference of a semiconductor wafer, and the notch bevel surfaces and the notch end surface provided in a notch part thereof.

2. Description of the Related Art

[0002] A semiconductor wafer is formed with a cutaway for positioning, that is, a notch, and then, with bevel surfaces by cutting off the square part of the edge over the outer peripheral part, that is, the overall contour, of the semiconductor wafer including a notch part. Fig. 1A is a plan view of a semiconductor wafer. Fig. 1B is a partial cross-sectional view of a semiconductor wafer W. Fig. 2 is a perspective view showing the periphery of an enlarged notch N. A pattern forming surface Sp, circumferential bevel surfaces Sb, and a circumferential end surface (a cylindrical surface forming the outer periphery) Sc of the semiconductor wafer in this state will cause particles in the later process. They are mirror-polished including the notch bevel surfaces and the notch end surface of the notch N.

[0003] Wafers have been controlled by a lot (e.g., for each cassette). It has recently been required to control a single wafer (each wafer) so that a host computer gives, to a fabricating apparatus, a command to process, for example, the first to third wafers and the eighth to fifteenth wafers of a cassette under different conditions. For this reason, it is essential that the wafer be returned to the same slot.

SUMMARY OF THE INVENTION

[0004] An object of the present invention is to unchange the order of wafers when passed through a wafer polishing apparatus to simplify control for each wafer W, thereby reducing a wafer control load, in order to meet the above requests.

[0005] The above problems can be solved by the following means. According to one aspect of the present invention, a wafer polishing apparatus has: a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers; a wafer position aligning unit making alignment for positioning the wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction; a wafer notch polishing unit mirror-polishing notch bevel surfaces and a notch end surface of a notch of the wafer; a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer; a wafer cleaning unit cleaning contamination attached to the wafer by the polishing operation with a cleaning liquid; a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in the wafer cleaning unit; and a wafer carrier unit taking out the wafer from the slot of the wafer cassette placed on the receiving and discharging rack of the wafer cassette reception and discharge opening unit to load the wafer into the wafer position aligning unit, taking out the positioned and oriented wafer from the wafer position aligning unit to load the wafer into the wafer notch polishing unit, taking out the wafer having the mirror-polished notch bevel surfaces and notch end surface from the wafer notch polishing unit to load the wafer into the wafer circumferential part polishing unit, taking out the wafer having the mirror-polished circumferential bevel surfaces and circumferential end surface from the wafer circumferential part polishing unit to load the wafer into the wafer cleaning unit, taking out the cleaned wafer from the wafer cleaning unit to load the wafer into the wafer drying unit, and taking out the wafer from which the cleaning liquid is removed from the wafer drying unit to load the wafer into the same slot from which the wafer in the wafer cassette on the wafer cassette reception and discharge opening unit is taken out.

[0006] According to another aspect of the present invention, a wafer polishing apparatus has: a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers; a wafer position aligning unit making alignment for positioning the wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction; a wafer notch polishing unit mirror-polishing notch bevel surfaces and a notch end surface of a notch of the wafer; a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer; a wafer cleaning unit cleaning contamination attached to the wafer by the polishing operation with a cleaning liquid; a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in the wafer cleaning unit; andawafer carrierunit includinga first carrier sub-unit, a second carrier sub-unit and a third carrier sub-unit, wherein the first carrier sub-unit takes out the wafer from the slot of the wafer cassette placed on the receiving and discharging rack of the wafer cassette reception and discharge opening unit to load the wafer into the wafer position aligning unit, takes out the positioned and oriented wafer from the wafer position aligning unit to

load the wafer into the wafer notch polishing unit, and takes out the wafer from which the cleaning liquid is removed from the wafer drying unit to load the wafer into the same slot from which the wafer in the wafer cassette on the wafer cassette reception and discharge opening unit is taken out; the second carrier sub-unit takes out the wafer having the mirror-polished notch bevel surfaces and notch end surface from the wafer notch polishing unit to load the wafer into the wafer circumferential part polishing unit, and takes out the wafer having the mirror-polished circumferential bevel surfaces and circumferential end surface from the wafer circumferential part polishing unit to load the wafer into the wafer cleaning unit; and the third carrier sub-unit takes out the cleaned wafer from the wafer cleaning unit to load the wafer into the wafer drying unit.

[0007] According to another aspect of the present invention, there is provided a wafer outer peripheral part polishing apparatus in the wafer polishing apparatus, wherein the first carrier sub-unit can be moved so as to face the wafer cassette of the wafer cassette reception and discharge opening unit, the wafer position aligning unit, and the wafer drying unit, and has a body part rotatable so as to be directed to the units and two independent arms provided in the body part.

[0008] According to another aspect of the present invention, a wafer polishing apparatus has: a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers; a wafer position aligning unit making alignment for positioning the wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction; a wafer notch polishing unit mirror-polishing notch bevel surfaces and a notch end surface of a notch of the wafer; a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer; a wafer cleaning unit cleaning contamination attached to the wafer by the polishing operation with a cleaning liquid; a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in the wafer cleaning unit; and a wafer carrier unit taking out the wafer from the slot of the wafer cassette placed on the receiving and discharging rack of the wafer cassette reception and discharge opening unit to load the wafer into the wafer position aligning unit, taking out the positioned and oriented wafer from the wafer position aligning unit to load the wafer into one of the wafer notch polishing unit and the wafer circumferential part polishing unit, taking out the wafer from one of the wafer notch polishing unit and the wafer circumferential part polishing unit into the other unit to load the wafer, taking out the mirror-polished wafer from the wafer notch polishing unit or the wafer circumferential part polishing unit to load the wafer into the wafer cleaning unit, taking out the cleaned wafer from the wafer cleaning unit to load the wafer into the wafer drying unit, and taking out the wafer from which the cleaning liquid is removed from the wafer drying unit to load the wafer into the same slot from which the wafer in the wafer cassette is taken out.

[0009] According to another aspect of the present invention, there is provided a wafer polishing method, wherein in a wafer polishing apparatus having: a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers; a wafer position aligning unit positioning the wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction; one or more wafer notch polishing units mirror-polishing both or either of notch bevel surfaces and a notch end surface of a notch of the wafer; one ore more wafer circumferential part polishing units mirror-polishing both or either of circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer; a wafer cleaning unit cleaning contamination attached to the wafer by the polishing operation with a cleaning liquid; a wafer drying unit for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in the wafer cleaning unit; and a wafer carrier unit carrying the wafer between the units, the wafer carrier unit contains the wafer which has been processed in the units into the same slot of the same wafer cassette from which the wafer is taken out.

[0010] According to another aspect of the present invention, there is provided a wafer polishing method, wherein the wafer notch polishing unit is replaced by an orientation flat polishing unit for mirror-polishing orientation flat bevel surfaces and an orientation flat end surface of orientation flat.

[0011] As described above, in the wafer polishing apparatus of the present invention, when wafers are passed through the wafer polishing apparatus, the order of the wafers is not changed. Control for each wafer is simplified to reduce a wafer control load.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1A is a plan view of a semiconductor wafer;
Fig. 1B is a partial cross-sectional view of a semiconductor wafer W;
Fig. 2 is a perspective view showing the periphery of an enlarged notch N;
Fig. 3 is an appearance view showing an example of a wafer outer peripheral part polishing apparatus of an embodiment of the present invention;
Fig. 4 is a plan view of assistance in explaining an overview of the wafer outer peripheral part polishing apparatus of the embodiment of the present invention;

Fig. 5 is an explanatory view showing the essential portions of a wafer cassette reception and discharge opening unit 2 and a first carrier sub-unit 81;
Fig. 6 is an explanatory view showing a state that an unaligned wafer W is placed on a table 31 of a wafer position aligning unit 3;
Fig. 7 is a top view of the essential portion of the wafer position aligning unit 3;
Fig. 8 is a perspective view showing three tilting states of a table 44 in a wafer notch polishing unit 4;
Fig. 9 is a partial enlarged view of a spindle head 43 and two polishing disks in the wafer notch polishing unit 4;
Fig. 10 is an explanatory view showing an overview of a second carrier sub-unit 82, the wafer notch polishing unit 4, and a wafer circumferential part polishing unit 5;
Fig. 11 is a top view showing an overview of a wafer cleaning unit 6; and
Fig. 12 is a partial side view of assistance in explaining the wafer cleaning unit 6, a wafer drying unit 7, and a third carrier sub-unit 83.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Fig. 3 is an appearance view showing an example of a wafer polishing apparatus of an embodiment of the present invention. As shown in the figure, a wafer outer peripheral part polishing apparatus 1 of this embodiment is substantially entirely covered by a frame 10 and its one part, a wafer cassette reception and discharge opening unit 2 is partially seen. Only a limited, small part of the wafer cassette reception and discharge opening unit 2 is opened.

[0014] The wafer outer peripheral part polishing apparatus 1 is controlled by a controller for controlling the whole including other units. The outer surface of the frame 10 is provided in suitable height positions with a console 11 and a display unit 12 so that the operator can manually operate the device. A plurality of transparent windows 13 are windows for covering the whole and observing the operation state of the wafer outer peripheral part polishing apparatus 1 from outside when needed and detachable for repair and adjustment.

[0015] The wafer cassette reception and discharge opening unit 2 has a rack-like construction. A wafer cassette 211 into which an unprocessed wafer W is loaded is placed on a receiving and discharging rack 21 while the wafer W is in a substantially horizontal state. The wafer W is fed into the wafer outer peripheral part polishing apparatus 1 therefrom to be mirror-polished. The mirror-polished wafer W is contained in the same slot of the same wafer cassette 211 again. The wafer W together with the wafer cassette 211 is carried to the next process. The wafer cassette 211 is placed on the receiving and discharging rack 21 so that the wafer W can enter and exit from the device.

[0016] Fig. 4 is a plan view of assistance in explaining an overview of the wafer outer peripheral part polishing apparatus 1. In the frame 10, there are arranged the wafer cassette reception and discharge opening unit 2, a wafer position aligning unit 3, a wafer notch polishing unit 4, a wafer circumferential part polishing unit 5, an inside carrier unit, and two slurry supply devices (a first slurry supply device 49 and a second slurry supply device 59). The respective units are attached to predetermined positions of the frame 10. In this example, as described later, the inside carrier unit has three carrier units, that is, a first carrier sub-unit 81, a second carrier sub-unit 82, and a third carrier sub-unit 83.

[0017] The following outlines movement of the wafer W (indicated by arrows in Fig. 4). The wafer W is first contained in the wafer cassette 211 to be placed on the wafer cassette reception and discharge opening unit 2. The wafer W is taken out from the wafer cassette 211 to be moved to the wafer position aligning unit 3. The wafer position aligning unit 3 positions the wafer W so that the center of the wafer W comes to a predetermined position, and orients the wafer W so that its notch is directed in a predetermined direction.

[0018] The position and direction are adjusted in this manner. The wafer W is then moved to the wafer notch polishing unit 4 to polish the notch here. The wafer portions to be polished are upper and lower notch bevel surfaces Sbn and a notch end surface Scn shown in Fig. 2. The wafer W is moved to the wafer circumferential part polishing unit 5. Here, polishing is performed to the circumferential part, that is, as shown in Fig. 2, upper and lower circumferential bevel surfaces Sb and a circumferential end surface Sc.

[0019] The wafer W is moved to the wafer cleaning unit 6. Contamination attached to the wafer W by the polishing operation in the wafer notch polishing unit 4 and the wafer circumferential part polishing unit 5 is cleaned with a cleaning liquid and cleaning rollers. The wafer W is further moved to a wafer drying unit 7. The wafer to which the cleaning liquid is attached in the wafer cleaning unit 6 is rotated at high speed to remove the cleaning liquid from the wafer W. It is possible to employ any cleaning liquid which can be used for cleaning the wafer, such as pure water, and an alkaline or acidic solution.

[0020] The inside carrier unit has the first carrier sub-unit 81, the second carrier sub-unit 82, and the third carrier sub-unit 83, as already described. Such three units have their technical meaning. To move the wafer W, as described above, the larger number of units or the smaller number of units can be accepted in some cases. For example, one carrier unit can perform these functions.

[0021] The first carrier sub-unit 81 is a carrier robot having a travel base 812 which can travel on two linear tracks 811, a body part 814 rotatable thereon, and two articulated arms and two grip parts provided in the body part 814. The carrier robot appears to be human body and arms. The carrier robot can have right and left arms

when the lower side of the drawing is considered to face forward, in a state indicated by the solid line of Fig. 4.

[0022] A specific operation and function for each of the units will be described below with reference to the drawings. Fig. 5 shows the essential portions of the wafer cassette reception and discharge opening unit 2 and the first carrier sub-unit 81. The first carrier sub-unit 81 is moved to the front of the wafer cassette 211, and then, stretches the left arm to pull out the wafer W placed in the substantially horizontal state from the wafer cassette 211 on the receiving and discharging rack 21 by a left-hand absorption panel 813L. At this time, a right-hand absorption panel 813R is empty.

[0023] The first carrier sub-unit 81 shrinks the arm to be moved in the left direction (Fig. 4), and then, stops in front of the wafer position aligning unit 3. In the wafer position aligning unit 3, the aligned wafer W whose position and direction have been adjusted is loaded (or is placed on a table 31). The right-hand absorption panel 813R, which holds nothing, is stretched to take up the wafer W. The right-hand absorption panel 813R holds the aligned wafer W and the left-hand absorption panel 813L holds the unaligned wafer W.

[0024] The left-hand absorption panel 813L is stretched to place the unaligned wafer W on the table 31 of the wafer position aligning unit 3. This state is shown in Fig. 6. When the wafer W is placed, the first carrier unit 81 is in the state that the right-hand absorption panel 813R holds the wafer W and the left-hand absorption panel 813L holds nothing.

[0025] The wafer position aligning unit 3 has the table 31, positioning devices 32, and an orienting device 33. Fig. 7 is a top view of the essential portion of the wafer position aligning unit 3. The table 31 has a suction mechanism for gripping the wafer by suction. When the wafer W is placed on the table 31, the suction mechanism is not operated. When this is pushed in the lateral direction, this can be moved on the table 31 by light force. The positioning devices 32 are operated in this state. The positioning devices 32 have a contour along the outer-diameter contour of the wafer W. The pair of right and left positioning devices 32 are pressed against each other to sandwich the wafer W therebetween, matching the center of the wafer W with the center of the table 31.

[0026] The suction mechanism is operated after matching the center of the wafer W with the center of the table 31 so that the wafer W is gripped by the table 31 by suction. When the positioning devices 32 are moved backward, the table 31 starts rotating at low speed. The orienting device 33 has a driving mechanism for drivingly controlling a notch detector 331 and the table 31. The notch detector 331 monitors the periphery of the rotating wafer W. When detecting that the notch comes to a predetermined position, the orienting device 33 stops rotation of the table 31.

[0027] As the notch detector 331, it is possible to use any type capable of detecting the notch, such as a photosensor having a light emitting part and a light receiving part and a mechanical type sensor providing a signal when a pin is lightly pressed to be fitted into a notch part.

[0028] As described previously, the wafer W whose direction is decided in this manner is gripped by the right-hand absorption panel R of the first carrier sub-unit 81 by suction to be removed from the wafer position aligning unit 3.

[0029] While the first carrier sub-unit 81 grips the wafer W removed from the wafer position aligning unit 3 in the right-hand absorption panel 813R, it is rotated to be directed to the wafer notch polishing unit 4, and then, loads the wafer W on a table 44 of the wafer notch polishing unit 4. As the wafer notch polishing unit 4, a suitable device can be selected from many types as disclosed in JP-A No. 168947/1996 or JP-B No. 186523/2001.

[0030] An example of the wafer notch polishing unit 4 will be simply described using Figs.8 and 9. Fig. 8 is a perspective view showing three tilting states of the table 44. Fig. 9 is a partial enlarged view of a spindle head 43 and two polishing disks. The wafer notch polishing unit 4 has the table 44 and the spindle head 43 and performs polishing by polishing disks 41 and 42 attached to the rotating spindle of the spindle head 43. The front ends of the two polishing disks are formed to have different angles α and β. The polishing disk 41 having a small angle α mirror-polishes the notch end surface Scn and the polishing disk 42 having a large angle β mirror-polishes the notch bevel surfaces Sbn. The polishing disks move the spindle head 43 in the spindle direction to be brought to the polishing region.

[0031] The table 44 can provide three angle positions, as shown dotted in Fig. 8. The upper and lower notch bevel surfaces Sbn are mirror-polished in two tilting positions and the notch end surface Scn is mirror-polished in the horizontal position. During the polishing operation, the first slurry supply device 49 in the backward position (indicated by the solid line in Fig. 4) is rotated to supply slurry to the polishing part. When the polishing is completed, it is rotated to the initial position not obstructing the carrying operation and is moved backward.

[0032] The wafer W whose notch has been mirror-polished is carried by the second carrier sub-unit 82. Fig. 10 outlines the second carrier sub-unit 82, the wafer notch polishing unit 4, and the wafer circumferential part polishing unit 5. In this example, the second carrier sub-unit 82 is a linear travel type carrier unit and has linear tracks 821 provided in the ceiling of the frame 10 and a travel body 822 suspended therefrom for traveling.

[0033] The travel body 822 has a grip axis 823 movable up and down and a grip part 824 consisting of three grip nails provided in its front end (lower end) . The travel body 822 can be moved above the wafer notch polishing unit 4, the wafer circumferential part polishing unit 5, and the later-described wafer cleaning unit 6. The travel body 822 lowers the grip axis 823 above the wafer notch polishing unit 4, grips the outer periphery of the wafer W on the table 44 whose notch has been polished, and

raises the grip axis 823 again. The travel body 822 is moved along the linear tracks 821 to above the wafer circumferential part polishing unit 5, and is lowered to place the gripped wafer W on a rotating table 55 of the wafer circumferential part polishing unit 5.

[0034] The second slurry supply device 59 is moved backward to the position indicated by the solid line in Fig. 4 not obstructing the wafer carriage, and during polishing, is rotated to the position indicated by the dotted line of Fig. 4 to supply slurry.

[0035] The rotating table 55 has a vacuum chuck. The wafer W is fixed by this to be rotated. The wafer circumferential part polishing unit 5 has, in the periphery of the rotating table 55, three polishing tools of a first polishing tool 51, a second polishing tool 52, and a third polishing tool 53 which are semi-cylindrical, or more. The first polishing tool 51 pressingly polishes the lower circumferential bevel surface Sb; the second polishing tool 52, the circumferential end surface Sc; and the third polishing tool 53, the upper circumferential bevel surface Sb. They have a warped polishing surface substantially along the curvature of the respective polished surfaces. To avoid interference when carrying the wafer, the polishing tools are moved backward to the unpolished position.

[0036] After the circumferential bevel surfaces Sb and the circumferential end surface Sc are mirror polished, the polishing tools 51, 52, and 53 are moved backward to the dotted line positions in Fig. 10 and the wafer W is removed from the rotating table 55 by the second carrier sub-unit 82 again. When the second carrier sub-unit 82 grips the wafer W, it moves above the wafer cleaning unit 6 on the right side of the wafer circumferential part polishing unit 5. The respective center positions of the wafer loading of the wafer notch polishing unit 4, the wafer circumferential part polishing unit 5, and the wafer cleaning unit 6 are arranged in a straight line. The interval between the two formers is equal to that between the two latters to simplify control for the wafer carriage.

[0037] Fig. 11 is a top view showing an overview of the wafer cleaning unit 6. Fig. 12 is a partial side view of assistance in explaining the wafer cleaning unit 6, the wafer drying unit 7, and the third carrier sub-unit 83. Aplurality of wafer support rollers 61 are circularly arranged in the wafer cleaning unit 6. The wafer support rollers 61 can be moved forward and backward while holding the equivalent relation related to the center of arrangement. Each of the wafer support rollers 61 has a cylindrical part 612 and a flange part 611. All (or one) of the wafer support rollers 61 (or every other one) can be rotatably driven by a driving source, not shown.

[0038] When all the wafer support rollers 61 are in the backward position, the wafer W is placed on the flange part 611. Then, all the wafer support rollers 61 are moved forward while holding the above-described equivalent relation. When the notch of the wafer W happens to coincide with one of the wafer support rollers 61, the roller will not be included into the notch. The wafer support rollers 61 are moved forward, and then, the cylindrical parts 612 are contacted with the circumferential end surface of the wafer W. The wafer W can be rotatably driven by the wafer support rollers 61.

[0039] A pair of cleaning rollers 62 are arranged in the upper and lower sides of the wafer W. Each of the cleaning rollers 62 is rotatably supported on the front end side of a pair of roller arms 621. The other end of the roller arms 621 is fixed to an arm axis 622. The arm axis 622 can be rotated with respect the frame 10 by an arm driving device 623. The cleaning rollers 62 are mechanically driven by a roller driving device 624 or any transmission mechanism, for example, a pulley and a belt.

[0040] When the wafer W can be rotatably driven by the wafer support rollers 61, the arm driving device 623 is driven to rotate the roller arm 621. The wafer W is sandwiched between the two cleaning rollers 62. The wafer support rollers 61 are in the position not interfering with the cleaning rollers 62.

[0041] The roller driving device 624 starts rotatably driving the cleaning rollers 62. The wafer support rollers 61 start rotatably driving the wafer W. A cleaning liquid nozzle 63 pours the cleaning liquid to the wafer W. While the wafer W itself is rotating, it is cleaned with the rotating cleaning rollers 62 and the cleaning liquid. The slurry attached in the previous process is removed.

[0042] The outer surfaces of the cleaning rollers 62 are made of sponge or unwoven cloth and have suitable resilient force. The cleaning rollers 62 can be moved backward to the position not obstructing the carriage operation of the inside carrier unit (the second carrier sub-unit 82 and the third carrier sub-unit 83) by the rotation of the roller arms 621.

[0043] The wafer W which has been cleaned in the wafer cleaning unit 6 is taken out from the wafer cleaning unit 6 by the third carrier sub-unit 83. The third carrier sub-unit 83 is substantially the same linear travel type carrier unit as the second carrier sub-unit and has linear tracks 831 provided in the ceiling of the frame 10 and a travel body 832 suspended therefrom for traveling. The travel body 832 has a grip axis 833 movable up and down and a grip part 834 consisting of three grip nails provided in its front end (lower end). The travel body 832 can be moved above the wafer cleaning unit 6 and the wafer drying unit 7.

[0044] The travel body 832 lowers the grip axis 833 above the wafer cleaning unit 6, grips the outer periphery of the cleaned wafer W on the wafer support rollers 61, and raises the grip axis 833 again. The travel body 832 is moved along the linear tracks 831 to above the wafer drying unit 7, and is lowered to place the gripped wafer W on a plurality of grip nails 751 of a rotating table 75 of the wafer drying unit 7. The respective grip nails 751 are provided at equal intervals from the center of the rotating table 75 and are moved to the center to support the wafer W. When the cleaning liquid is splashed by centrifugal force, the grip nails 751 have a construction for reducing the area contacted with the wafer W so

as not to stay the cleaning liquid in the contact part.

[0045] A driving device 752 rotates the rotating table 75 at high speed. The cleaning liquid attached to the wafer W is therefore splashed by centrifugal force to dry the wafer W. An annular cover 76 can be moved up and down and is moved below and backward to load or remove the wafer W. When the cover 76 is moved upward, a drying operation (dehydration by centrifugal force) is performed.

[0046] After the wafer W is dried, the cover 76 is lowered and the first carrier sub-unit 8/1 removes the wafer W from the rotating table 75. The first carrier sub-unit 81 is moved to the side of the wafer drying unit 7 and is rotated to be directed toward the wafer drying unit 7. The right-hand absorption panel 813R and the left-hand absorption panel 813L of the first carrier sub-unit 81 are both empty. Either of the absorption panels 813 may be used for removing the wafer W.

[0047] The first carrier sub-unit 81 from which the wafer W is removed is rotated and is moved on the linear tracks 811 according to the position on the receiving and discharging rack 21 on which the wafer cassette 211 to contain the removed wafer W is placed. The wafer W is loaded into the same slot of the same wafer cassette 211 from which the wafer W is removed initially. The wafer W together with the wafer cassette 211 received by the wafer outer peripheral part polishing apparatus 1 is in the same slot of the same wafer cassette 211 after mirror-polishing the wafer outer peripheral part. In the singly controlled wafer W, the wafer cassette 211 and the order to contain the wafers W therein are not changed. The control can be simplified to reduce a control load.

[0048] In this example, two wafer cassettes 211 are placed on the receiving and discharging rack 21. When one wafer cassette 211 which has polished all the wafers W is fed to the next process, the wafers W in the other wafer cassette 211 can be mirror-polished. The overall throughput can therefore be improved without causing time loss.

[0049] The first carrier sub-unit 81 in this embodiment is a carrier robot having two articulated arms and two grip parts. The first carrier sub-unit 81 can be rotated with the arms folded. The rotating radius can be thus reduced. The carrier unit of this type is placed between a line consisting of the wafer notch polishing unit 4, the wafer circumferential part polishing unit 5, and the wafer cleaning unit 6, and a line consisting of the wafer cassette reception and discharge opening unit 2 and the wafer position aligning unit 3. Anot-so-large area is necessary. The entire wafer outer peripheral part polishing apparatus can be smaller to reduce the installing area. Carrier units of other types can be naturally used for the first carrier sub-unit 81.

[0050] In the above embodiment, the wafer notch polishing unit 4 and the wafer circumferential part polishing unit 5 mirror-polish the wafer W in that order. The order may be reversed. Otherwise, the mirror-polishing may be repeated alternately. In order that the wafer notch is mirror-polished after polishing the wafer circumferential part, the notch direction must be decided. When the mirror-polishing is performed in the wafer circumferential part polishing unit 5, a servomotor rotatably drives the wafer. The direction to stop the rotation can be decided. When the later-described wafer with orientation flat is mirror-polished, such servomotor is typically used to prevent the outer peripheral grip nails for wafer carriage from failing gripping when coming to the orientation flat part. To decide the direction of the wafer, a pin may be used during carriage.

[0051] In addition, the wafer notch polishing unit 4 and the wafer circumferential part polishing unit 5 singly mirror-polish the notch part or both the end surface and the slopes of the circumferential part. The end surface and the slopes may be mirror-polished in other units, respectively. Further, either of the two arms of the first carrier sub-unit 81 may take out or load the wafer.

[0052] The case that the semiconductor wafer has the wafer circumferential part and the notch is described above. There is known a semiconductor wafer provided with a linear arc cutaway called orientation flat, but not with such notch. When the wafer provided with the orientation flat is polished, there is used an orientation flat polishing apparatus in which the side of a cylindrical polishing tool is brought into contact with the orientation flat to supply slurry to the polishing part for mirror-polishing. When the wafer outer peripheral part polishing apparatus 1 along the present invention polishes such wafer with orientation flat, the orientation flat polishing apparatus, in place of the wafer notch polishing unit 4, may be used as an orientation flat polishing unit.

Claims

1. A wafer polishing apparatus comprising:

a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers;

a wafer position aligning unit making alignment for positioning saidwafer so that its center comes to apredetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction;

a wafer notch polishing unit mirror-polishing notch bevel surfaces and a notch end surface of a notch of the wafer;

a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer;

a wafer cleaning unit cleaning contamination attached to the wafer by said polishing opera-

tion with a cleaning liquid;
a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in said wafer cleaning unit; and
a wafer carrier unit performing the following processings:

taking out the wafer from the slot of said wafer cassette placed on said receiving and discharging rack of said wafer cassette reception and discharge opening unit to load the wafer into said wafer position aligning unit,
taking out the positioned and oriented wafer from said wafer position aligning unit to load the wafer into said wafer notch polishing unit,
taking out the wafer having the mirror-polished notch bevel surfaces and notch end surface from said wafer notch polishing unit to load the wafer into said wafer circumferential part polishing unit,
taking out the wafer having the mirror-polished circumferential bevel surfaces and circumferential end surface from said wafer circumferential part polishing unit to load the wafer into said wafer cleaning unit,
taking out the cleaned wafer from said wafer cleaning unit to load the wafer into said wafer drying unit, and
taking out the wafer from which the cleaning liquid is removed from said wafer drying unit to load the wafer into the same slot from which the wafer in said wafer cassette on said wafer cassette reception and discharge opening unit is taken out.

2. A wafer polishing apparatus comprising:

a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers;
a wafer position aligning unit making alignment for positioning said wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction;
a wafer notch polishing unit mirror-polishing notch bevel surfaces and a notch end surface of a notch of the wafer;
a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer;
a wafer cleaning unit cleaning contamination attached to the wafer by said polishing operation with a cleaning liquid;
a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in said wafer cleaning unit; and
a wafer carrier unit having a first carrier sub-unit, a second carrier sub-unit, and a third carrier sub-unit, wherein said first carrier sub-unit takes out the wafer from the slot of said wafer cassette placed on said receiving and discharging rack of said wafer cassette reception and discharge opening unit to load the wafer into said wafer position aligning unit, takes out the positioned and oriented wafer from said wafer position aligning unit to load the wafer into said wafer notch polishing unit, and takes out the wafer from which the cleaning liquid is removed from said wafer drying unit to load the wafer into the same slot from which the wafer in said wafer cassette on said wafer cassette reception and discharge opening unit is taken out;
said second carrier sub-unit takes out the wafer having the mirror-polished notch bevel surfaces and notch end surface from said wafer notch polishing unit to load the wafer into said wafer circumferential part polishing unit, and takes out the wafer having the mirror-polished circumferential bevel surfaces and circumferential end surface from said wafer circumferential part polishing unit to load the wafer into said wafer cleaning unit; and
said third carrier sub-unit takes out the cleaned wafer from said wafer cleaning unit to load the wafer into said wafer drying unit.

3. A wafer polishing apparatus according to claim 2, wherein said first carrier sub-unit can be moved so as to face said wafer cassette of the wafer cassette reception and discharge opening unit, said wafer position aligning unit, and said wafer drying unit, and has a body part rotatable so as to be directed to the units and two independent arms provided in the body part.

4. A wafer polishing apparatus comprising:

a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers;
a wafer position aligning unit making alignment for positioning said wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction;
a wafer notch polishing unit mirror-polishing

notch bevel surfaces and a notch end surface of a notch of the wafer;
a wafer circumferential part polishing unit mirror-polishing circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer;
a wafer cleaning unit cleaning contamination attached to the wafer by said polishing operation with a cleaning liquid;
a wafer drying unit performing drying for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in said wafer cleaning unit; and
a wafer carrier unit performing the following processings:

taking out the wafer from the slot of said wafer cassette placed on said receiving and discharging rack of said wafer cassette reception and discharge opening unit to load the wafer into said wafer position aligning unit,
taking out the positioned and oriented wafer from said wafer position aligning unit to load the wafer into one of said wafer notch polishing unit and said wafer circumferential part polishing unit,
taking out said wafer from one of said wafer notch polishing unit and said wafer circumferential part polishing unit into the other unit to load the wafer,
taking out the mirror-polished wafer from said wafer notch polishing unit or said wafer circumferential part polishing unit to load the wafer into said wafer cleaning unit,
taking out the cleaned wafer from said wafer cleaning unit to load the wafer into said wafer drying unit, and
taking out the wafer from which the cleaning liquid is removed from said wafer drying unit to load the wafer into the same slot from which the wafer in said wafer cassette is taken out.

5. A wafer polishing method, wherein in a wafer polishing apparatus comprising:

a wafer cassette reception and discharge opening unit provided with a receiving and discharging rack for placing a wafer cassette containing wafers;
a wafer position aligning unit positioning said wafer so that its center comes to a predetermined position when the wafer is loaded and orienting the wafer so that its notch is directed in a predetermined direction;
one or more wafer notch polishing units mirror-polishing both or either of notch bevel surfaces and a notch end surface of a notch of the wafer;
one or more wafer circumferential part polishing units mirror-polishing both or either of circumferential bevel surfaces and a circumferential end surface provided in a circumferential part of the wafer;
a wafer cleaning unit cleaning contamination attached to the wafer by said polishing operation with a cleaning liquid;
a wafer drying unit for removing the cleaning liquid from the wafer to which the cleaning liquid is attached by cleaning in said wafer cleaning unit; and
a wafer carrier unit carrying said wafer between said units,
said wafer carrier unit contains the wafer which has been processed in said units into the same slot of the same wafer cassette from which the wafer is taken out.

6. A wafer polishing method according to claim 5, wherein said wafer notch polishing unit is replaced by an orientation flat polishing unit for mirror-polishing orientation flat bevel surfaces and an orientation flat end surface of orientation flat.

FIG. 1B

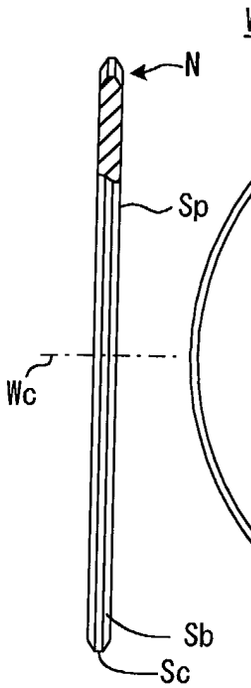

FIG. 1A

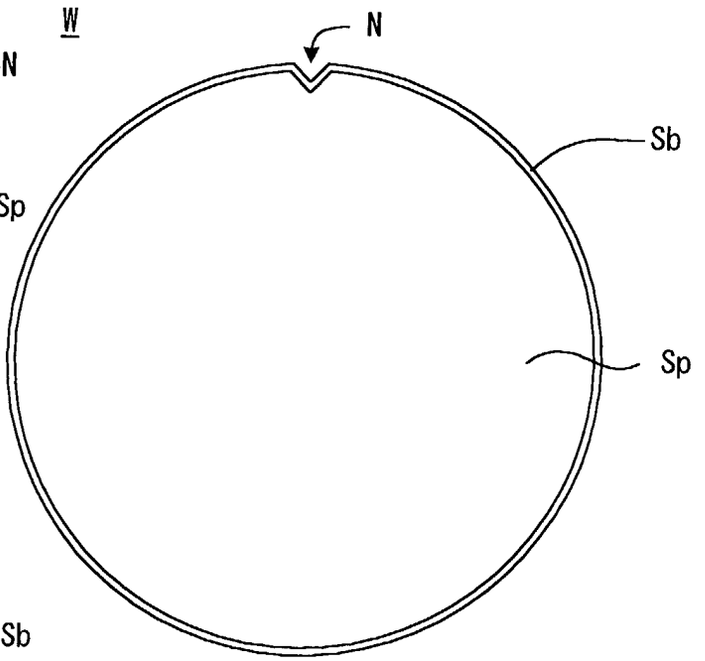

FIG. 2

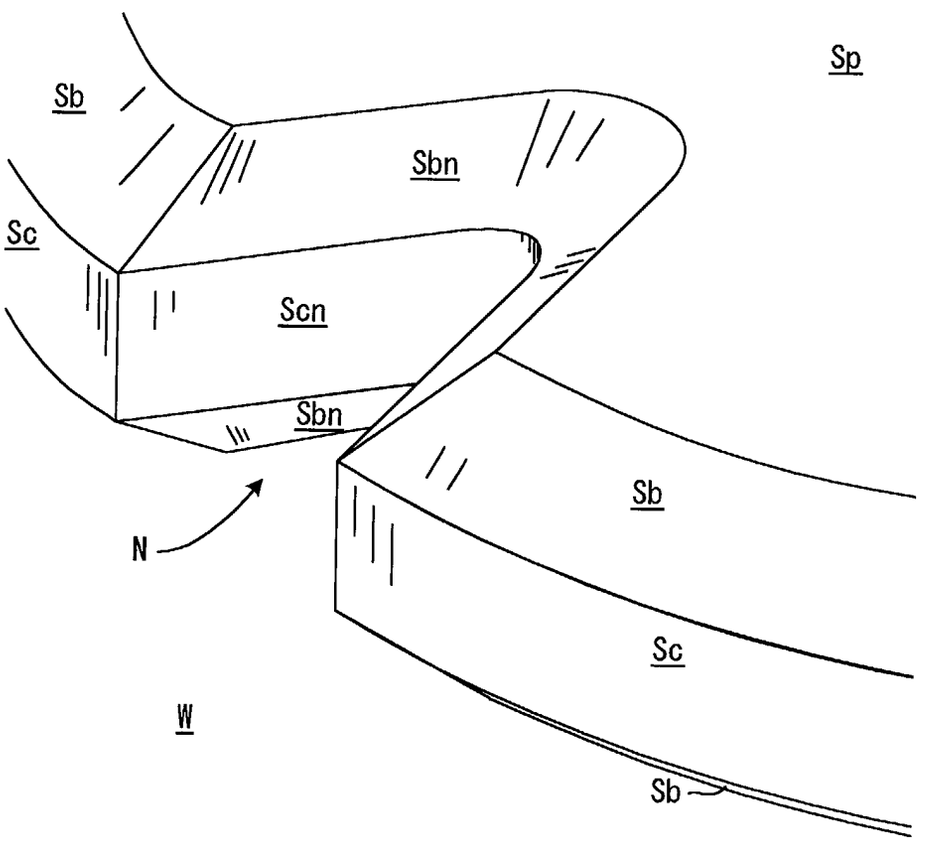

FIG. 3

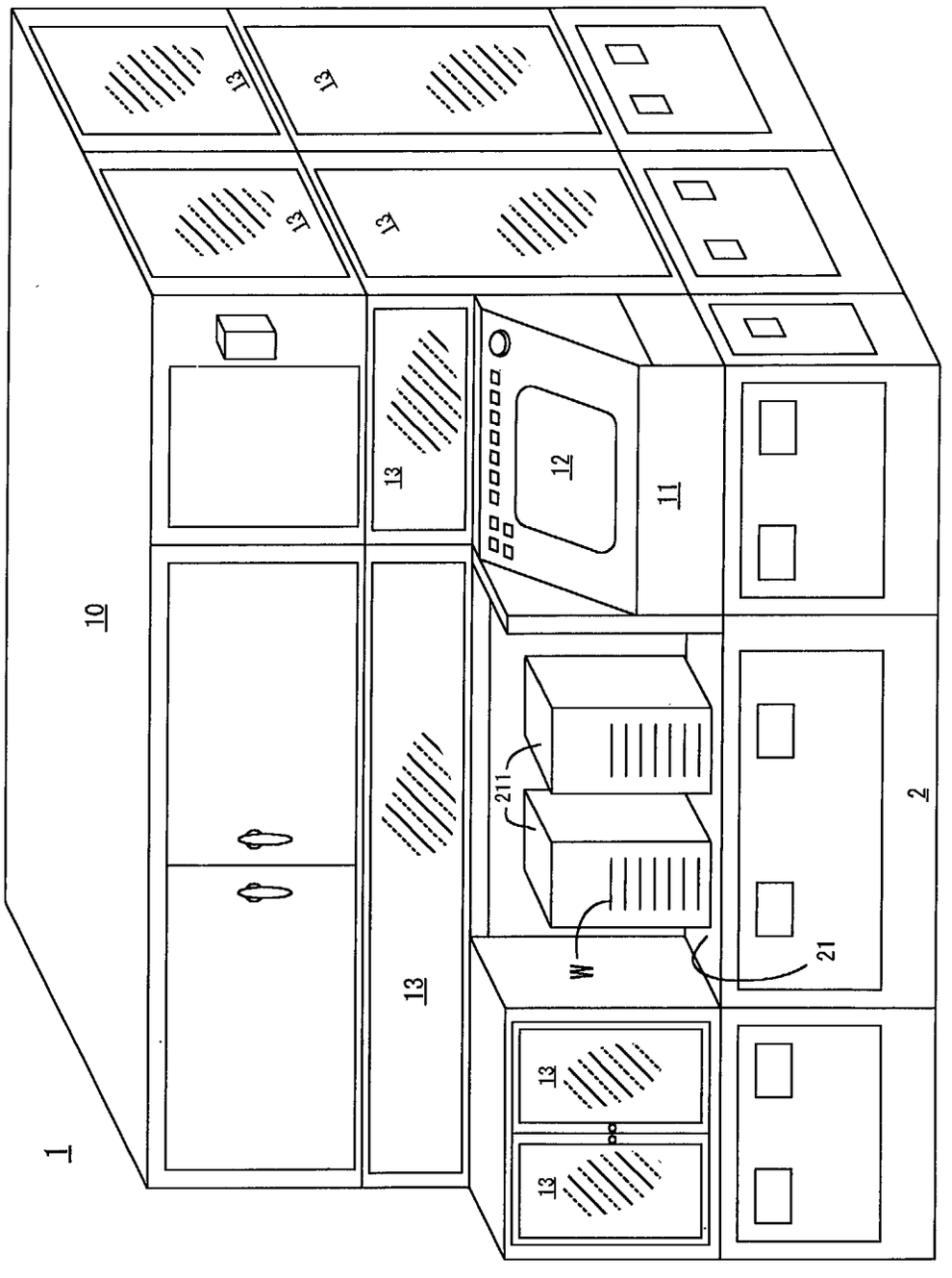

FIG. 4

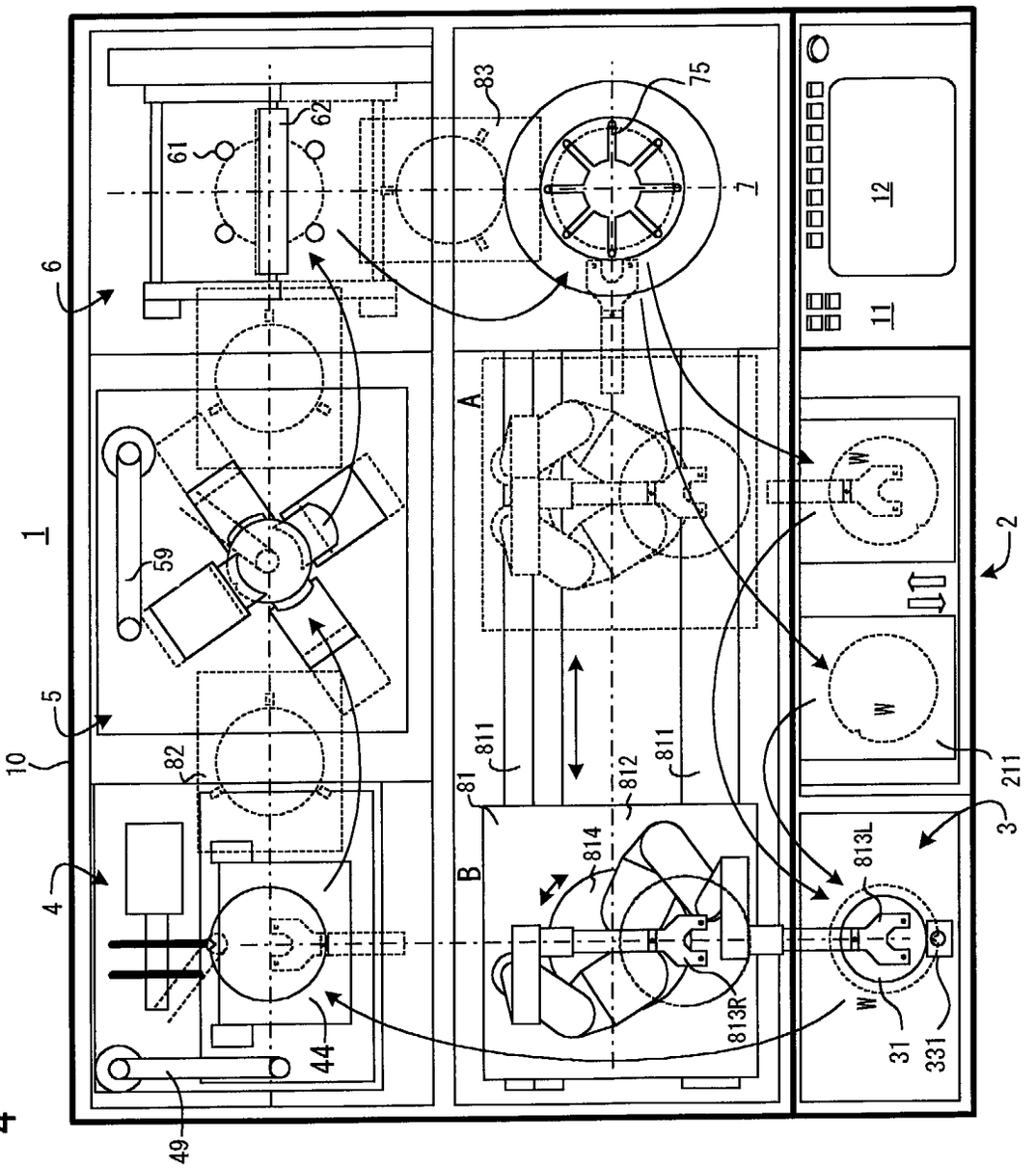
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FIG. 5

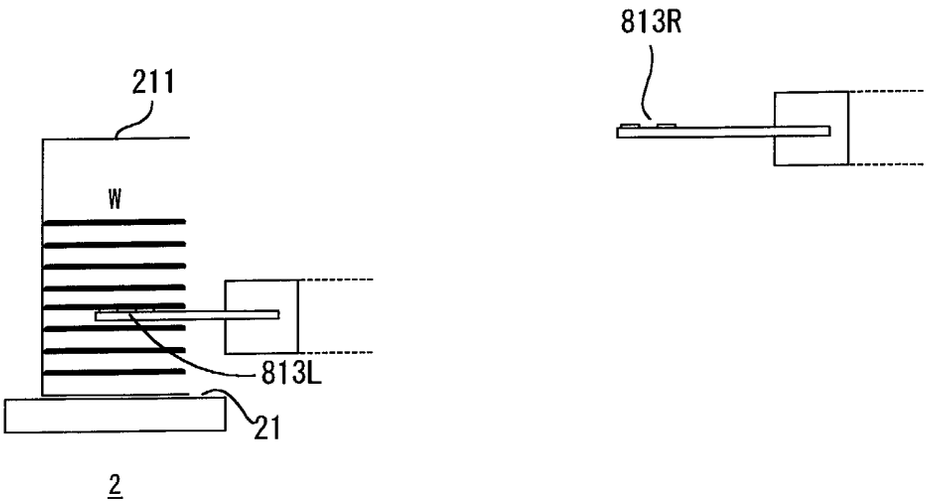

FIG. 6

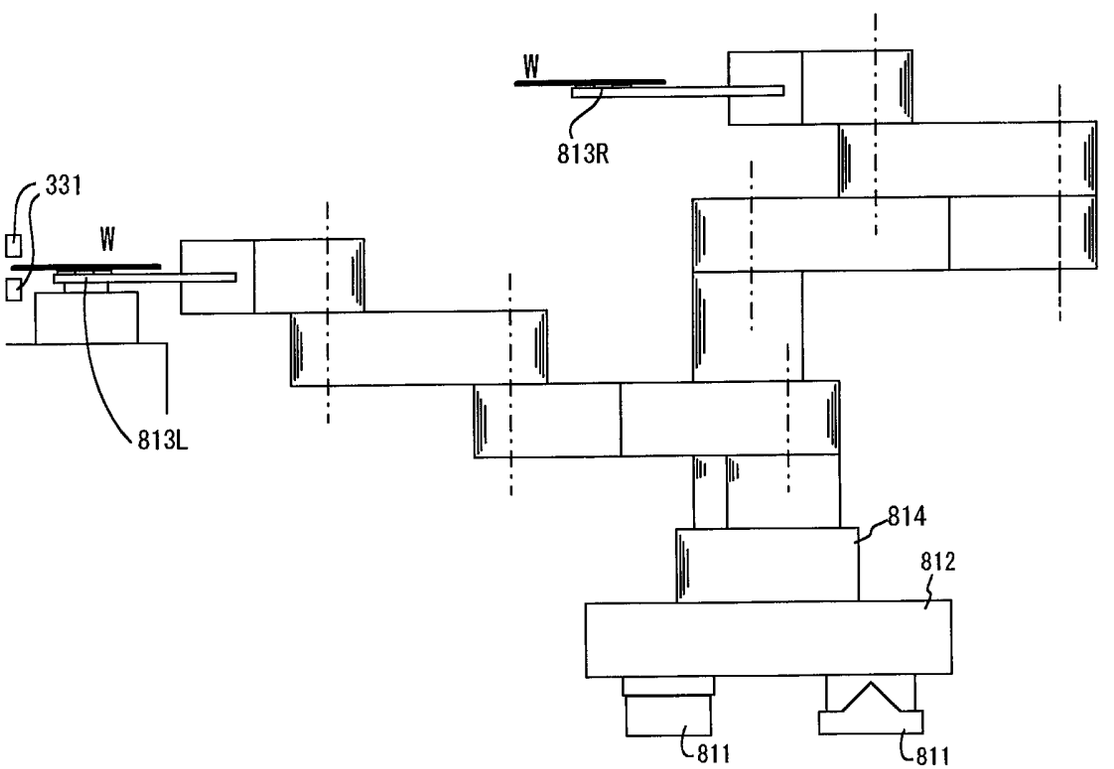

FIG. 7

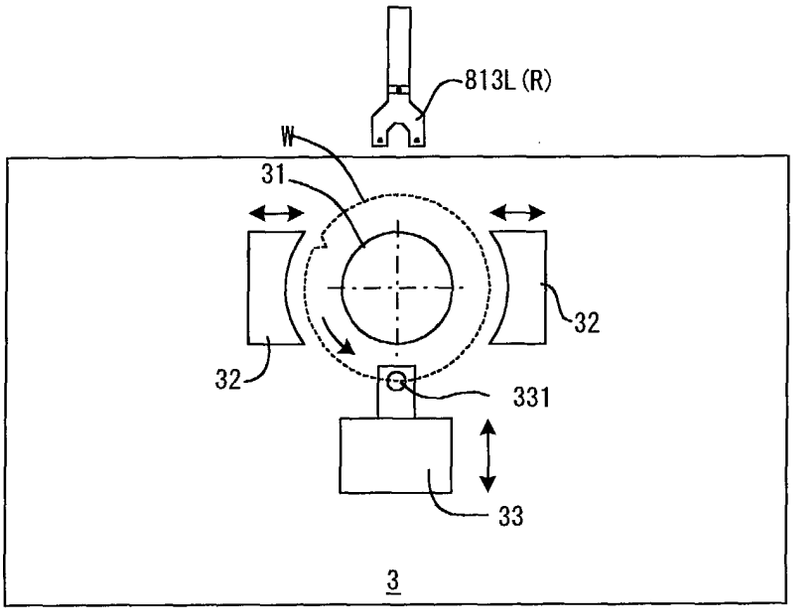

FIG. 8

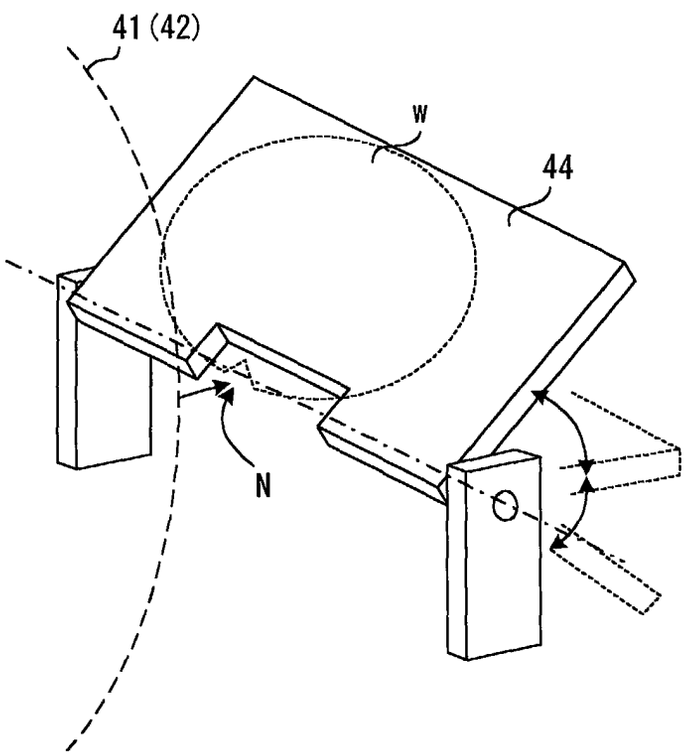

FIG. 9

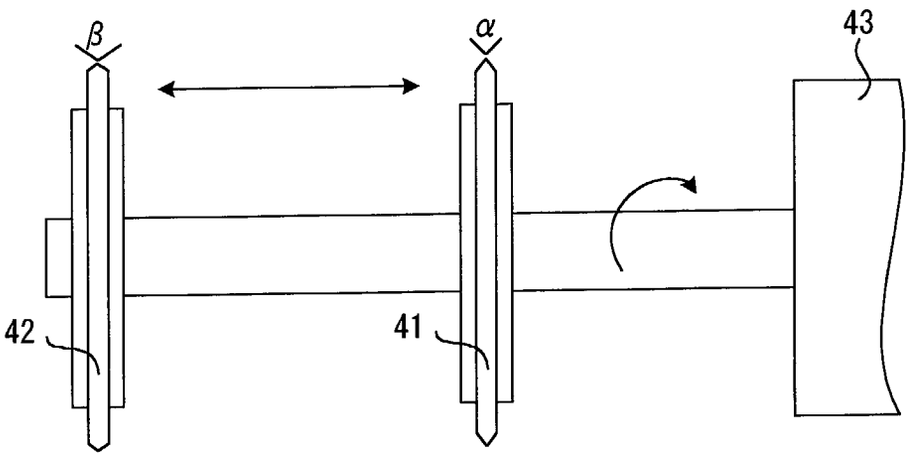

FIG. 10

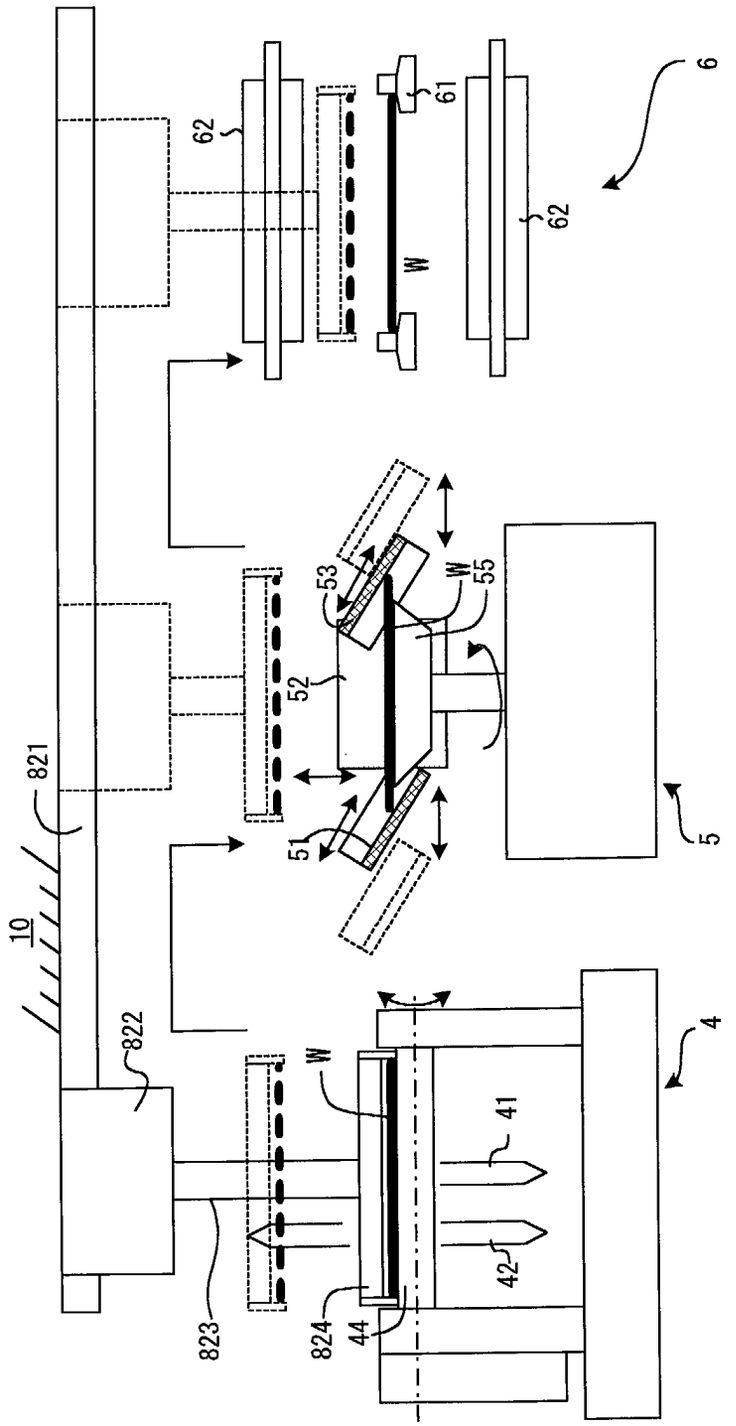

FIG. 11

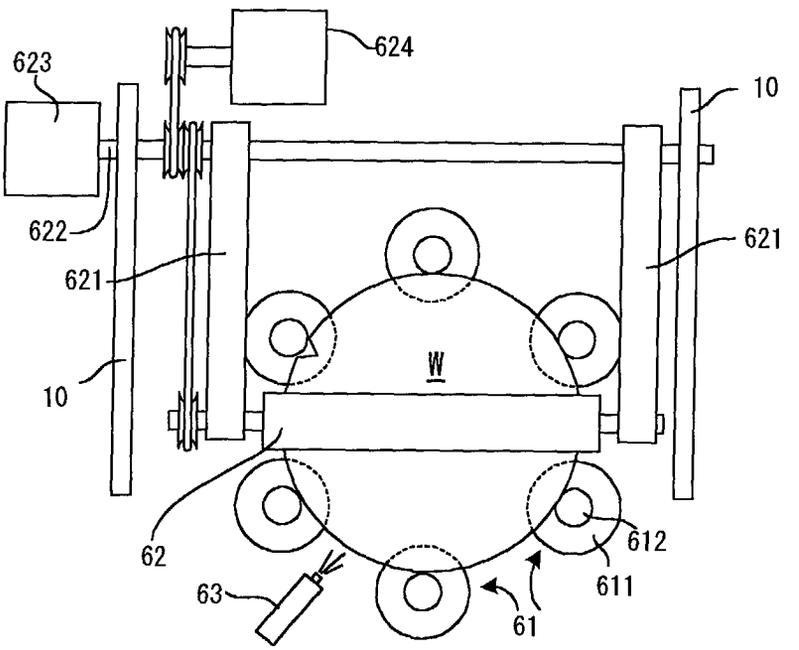
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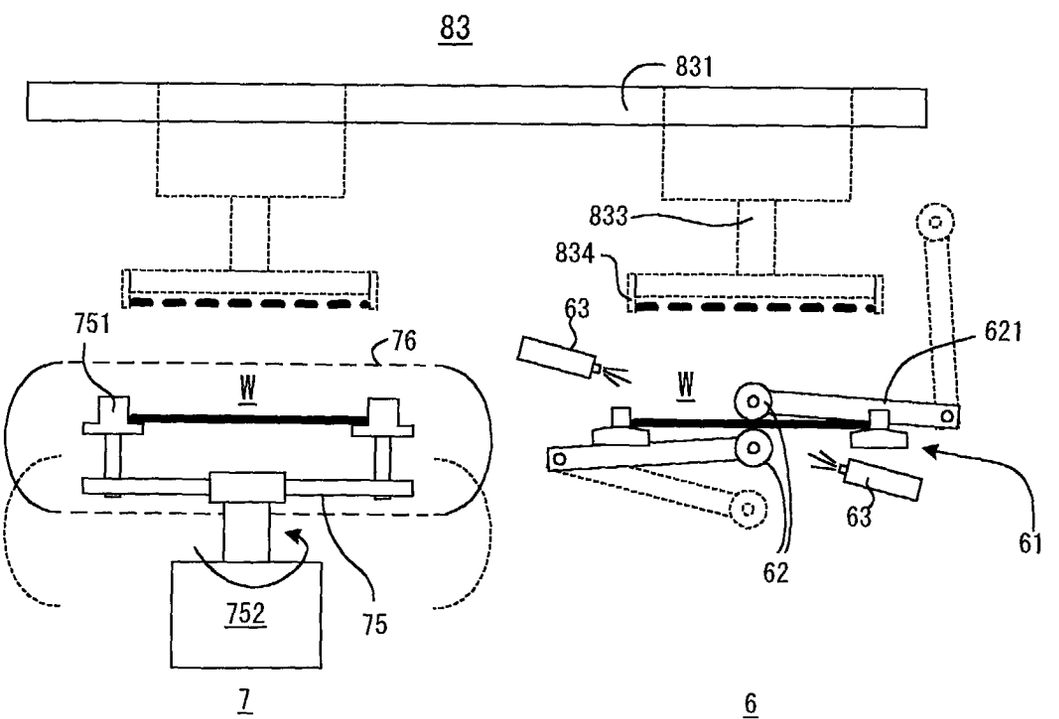
FIG. 12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