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(54) **Method for grinding thin sheet-like workpiece and double-end surface grinder**

Verfahren zum Schleifen eines dünnen blattartigen Werkstücks und doppelendiger Oberflächenschleifer

Procédé de meulage d'une pièce à usiner mince en forme de feuille et broyeur de surface à double extrémité

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Description

[Technical Field]

[0001] The present invention relates to a method for grinding a thin sheet-like workpiece and a double-end surface grinder that are used when grinding a thin sheet-like workpiece such as a silicon wafer.

[Background Art]

[0002] When grinding a thin sheet-like workpiece such as a silicon wafer by using a horizontal double-end surface grinder, while rotating the workpiece supported by static pressures of a pair of left and right static pressure pads in a non-contact manner around its center, the workpiece is ground to a predetermined finished thickness by a pair of left and right grinding wheels rotating around a horizontal shaft.

[0003] As a method for supporting the workpiece rotatably, there is a direct-contact support method (Patent Documents 1 and 2) for supporting the workpiece by direct contact with the outer periphery of the workpiece and a carrier support method (Patent Document 3) for supporting the workpiece via a carrier and a carrier ring, and the direct-contact support method includes a roller support method (Patent Document 1) and a belt support method (Patent Document 2).

[0004] In the roller support method (Patent Document 1), the outer periphery of a disk-shaped workpiece is supported rotatably by a plurality of support rollers in the circumferential direction, and a workpiece is rotated around its center by any of the support rollers. In the belt support method (Patent Document 2), the outer periphery of a disk-shaped workpiece is supported rotatably by two support belts in the circumferential direction, and the workpiece is rotated around its center by the support belts.

[0005] In the carrier support method (Patent Document 3), a workpiece is fitted into a fitting hole of a thin sheet-like carrier the outer periphery of which is fixed to a carrier ring, the carrier ring is supported by contact with a plurality of support rollers disposed at substantially even intervals at the outer periphery of the carrier ring, and by a drive gear that meshes with a ring gear on the inner peripheral side of the carrier ring, the workpiece is rotated around its center via the carrier ring and the carrier.

[0006] Moreover, a double-disc grinding apparatus (Patent Document 4) is known having at least: a rotatable ring-shaped holder for supporting a sheet-like wafer having a notch for indicating a crystal orientation from an outer circumference side along a radial direction, the holder having a protruding portion to be engaged with the crystal-orientation-indicating notch; and a pair of grindstones for simultaneously grinding both surfaces of the wafer supported by the holder, wherein the holder is provided with at least one protruding portion separately from the protruding portion to be engaged with the crystal-orientation-indicating notch, and the both surfaces of the wafer are simultaneously ground by the pair of the grindstones while the wafer is supported and rotated with the at least one protruding portion being engaged with a wafer-supporting notch formed on the wafer.

[Prior Art Document]

[Patent Documents]

[0007]

[Patent Document 1] Japanese Published Unexamined Patent Application No. H10-175144
[Patent Document 2] Japanese Published Unexamined Patent Application No. H10-156681
[Patent Document 3] Japanese Published Unexamined Patent Application No. 2005-205528
[Patent Document 4] US 2011/039476 A1

[SUMMARY OF THE INVENTION]

[Problem to be Solved by the Invention]

[0008] In the conventional direct-contact support method, the outer periphery of the workpiece is directly supported by support rollers or support belts, and the workpiece is driven and rotated by the support rollers or support belts, so that this method cannot be adopted when grinding a thin sheet-like workpiece with high precision.

[0009] On the other hand, in the carrier support method, a thin sheet-like carrier the outer periphery of which is fixed to a carrier ring is used, and in a state where a workpiece is fitted in a fitting hole of the carrier, the carrier ring supported by support rollers on the outer periphery is driven and rotated, so that a thin workpiece can be ground with high precision as compared with the direct-contact support method. However, the conventional carrier support method adopts a contact support method in which the carrier ring is supported by contact with a plurality of support rollers disposed at substantially even intervals on the outer periphery of the carrier ring, so that the following problem occurs.

[0010] That is, conventionally, a guide ring is sandwiched and supported by contact with a plurality of support rollers, so that runouts of the support rollers are transmitted to the carrier ring and synthesized, and due to this combination, the rotation precision of the workpiece is deteriorated. If the attachment precision of the pivots of the support rollers, especially parallelism to the rotation center of the carrier ring is defective, such a problem occurs that a force other than rotation is transmitted to the carrier ring and the carrier ring and the workpiece tilt.

[0011] As the support rollers, support rollers that were cast molded by using a resin material such as high-hardness urethane and finished by machining so that they hardly damage the carrier ring and reliably support the

carrier ring without slippage, may be used, however, in this case, the support rollers are made of resin, so that the following problem occurs. That is, it is difficult to stably obtain circularity required for the support rollers, the quality of the support rollers is easily deteriorated with elapse of time, and further, the support rollers are easily worn.

[0012] The present invention was made in view of these conventional problems, and an object thereof is to provide a method for grinding a thin sheet-like workpiece and a double-end surface grinder that can reduce influences of external forces on a carrier ring and improve workpiece grinding precision, and can maintain high grinding precision over a long period of time without causing problems such as friction.

[Means for Solving the Problem]

[0013] In a method for grinding a thin sheet-like workpiece according to the present invention, in a state where a thin sheet-like workpiece fitted to a carrier is supported by static pressures of a pair of static pressure pads in a non-contact manner, when grinding both surfaces of the workpiece by a pair of grinding wheels while rotating the workpiece via the carrier, an outer peripheral surface of a carrier ring disposed on the outer periphery of the carrier and substantially concentrically with the rotation center of the carrier is supported by static pressures of a plurality of static pressure carrier guides in the circumferential direction in a non-contact manner.

[0014] A double-end surface grinder according to the present invention grinds both surfaces of a thin sheet-like workpiece fitted to a carrier by a pair of grinding wheels while rotating the workpiece via the carrier in a state where the workpiece is supported by static pressures of a pair of static pressure pads in a non-contact manner, wherein the double-end surface grinder includes, in the circumferential direction, a plurality of static pressure carrier guides that support an outer peripheral surface of a carrier ring disposed on the outer periphery of the carrier and substantially concentrically with the rotation center of the carrier by static pressures in a non-contact manner.

[0015] The carrier ring may have a cylindrical outer peripheral surface, and the static pressure carrier guides may be disposed at substantially even intervals in proximity to the outer peripheral surface. The static pressure carrier guides may be fixed. Alternatively, the static pressure carrier guide may be floatable.

[0016] Each of the static pressure carrier guides is pivotally supported by a floating shaft substantially parallel to the rotation center of the carrier ring, and each static pressure carrier guide may be provided with a static pressure pocket that supplies a static pressure fluid to the portion between the static pressure carrier guide and the outer peripheral surface of the carrier ring substantially symmetrically about the floating shaft in the rotation direction of the carrier ring.

[0017] The double-end surface grinder may include a support arm that is pivotally supported swingably by a pivot substantially parallel to the rotation center of the carrier ring and supports at least a part of the static pressure carrier guides movably in the directions approaching and separating
from the carrier ring, a drive means that turns the support arm around the pivot, and a stopper means that stops the support arm at a predetermined position.

[0018] The static pressure carrier guides may be changeable between a fixed state and a floating state where the static pressure carrier guides float around the floating shafts substantially parallel to the rotation center of the carrier ring.

[0019] The double-end surface grinder may include the static pressure carrier guides that are three or more in number and disposed at substantially even intervals at the outer periphery of the carrier ring, and a space adjusting means that adjusts spaces between the static pressure surfaces of the three or more static pressure carrier guides and the outer peripheral surface of the carrier ring by adjusting the position of at least one of the three or more static pressure carrier guides in the substantially diametrical direction of the carrier ring.

[Effect of the Invention]

[0020] According to the present invention, a carrier ring is supported by static pressures of static pressure carrier guides, so that influences of external forces to be applied to the carrier ring can be reduced, the workpiece grinding precision can be improved, and high grinding precision can be maintained over a long period of time without causing problems such as friction.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0021]

[Fig. 1] is a schematic side view of a horizontal double-end surface grinder showing an embodiment of the present invention.
[Fig. 2] is a schematic sectional view of the same.
[Fig. 3] is an enlarged side view of an essential portion of the same.
[Fig. 4] is an enlarged sectional view of a support portion of an upper side static pressure carrier guide of the same.
[Fig. 5] is a sectional view of a fixed state of the static pressure carrier guide of the same.
[Fig. 6] is a sectional view taken along line X-X in Fig. 3 of the same.
[Fig. 7] is a sectional view of the static pressure carrier guide of the same.
[Fig. 8] is a bottom view of the static pressure carrier guide of the same.
[Fig. 9] is a static pressure circuit diagram of the static pressure carrier guides of the same.
[Fig. 10] is a sectional view taken along line Y-Y in

Fig. 3 of the same.

[Fig. 11] is a sectional view showing a floating state of the static pressure carrier guide of the same.

[Fig. 12] is a diagram showing results of measurement of circularity of the carrier ring.

[Fig. 13] is a diagram showing results of measurement of edge runout of the carrier ring in a conventional contact support method.

[Fig. 14] is a diagram showing results of measurement of edge runout of the carrier ring in a non-contact support method according to the present invention.

[Best Mode for Carrying Out the Invention]

[0022] Hereinafter, embodiments of the present invention are described in detail with reference to the drawings . The drawings illustrate a horizontal double-end surface grinder adopting the present invention. This horizontal double-end surface grinder includes, as shown in Fig. 1 and Fig. 2, a pair of left and right static pressure pads 1 that are disposed on the left and right so as to face each other and support a thin sheet-like workpiece W by static pressures in a non-contact manner, a pair of left and right grinding wheels 3 that are disposed rotatably around wheel shafts in the left-right direction corresponding to notched portions 2 of the static pressure pads 1 and move in the central axis direction of a cutting axis to grind both left and right side surfaces of the workpiece W supported by the static pressure pads 1, a carrier 4 that rotates the workpiece W fitted thereto around the center of the cutting axis in a state where the workpiece W is held by the static pressure pads 1, a carrier ring 5 that supports the outer periphery of the carrier 4, and a plurality of static pressure carrier guides 6a and 6b that are disposed at substantially even intervals at the outer periphery of the carrier ring 5 and support the carrier ring 5 rotatably by static pressures in a non-contact manner from the outer periphery.

[0023] The static pressure pads 1 are disposed on facing end sides of a pair of left and right movable bases 8 movable in the central axis direction of the cutting axis, and movable in the cutting axis direction between advanced positions at which the static pressure pads hold the workpiece W and withdrawn positions at which the static pressure pads withdraw from the workpiece W, and at the advanced positions, the static pressure pads support the workpiece W by static pressures in a non-contact manner via a static pressure fluid such as static pressure water supplied to the static pressure surface sides facing the workpiece W.

[0024] The carrier 4 is a thin sheet-like disk thinner than the finished thickness of the workpiece W, and has, substantially concentrically, a fitting hole 9 in which the workpiece W is removably fitted. The carrier 4 is supported by the carrier ring 5 disposed on the outer periphery of the carrier substantially concentrically, and a presser ring 10 that is fixed to the inside of the carrier ring 5 and presses the outer periphery of the carrier 4 to the carrier ring 5 side. The carrier ring 5 has an outer peripheral surface 12 formed into a cylindrical surface substantially concentrically with the rotation center of the carrier 4, and end faces on both sides in the axial center direction face stepped portions 11 on the outer peripheral side of the static pressure surfaces of the static pressure pads 1 via spaces. The carrier 4, the carrier ring 5, and the presser ring 10 constitute a carrier means 7, and when inserting or extracting the workpiece W, the workpiece W is inserted or extracted integrally with the carrier means 7.

[0025] The carrier ring 5 is made of a ceramic material such as alumina that is thin in thickness and is easily increased in circularity, however, it may be made of a metal such as a stainless steel. On the inner periphery of the presser ring 10, a ring gear 13 is provided, and by a drive gear 14 that meshes with the ring gear 13, the carrier means 7 including the carrier 4 and the carrier ring 5 is driven to rotate.

[0026] The static pressure carrier guides 6a and 6b are fitted to a facing end side facing the carrier 4 of one movable base 8, and three or more carrier guides are disposed at substantially even intervals in the circumferential direction at the outer periphery of the carrier ring 5. For example, in the present embodiment, four static pressure carrier guides 6a and 6b are disposed at substantially evenly-spaced four positions, and as shown in Fig. 3, Fig. 4, and Fig. 6, the static pressure carrier guides 6a and 6b are pivotally attached to the movable base 8 via floating shafts 15a and 15b, and fitted via fixing means 16a and 16b and restricting means 17a and 17b changeably between a fixed state and a floating state.

[0027] In each static pressure carrier guide 6a or 6b, as shown in Fig. 7 and Fig. 8, a shaft hole 20 through which the floating shaft 15a or 15b is inserted is formed at substantially the center in the rotation direction of the carrier ring 5 (hereinafter, referred to as rotation direction, simply), and two pin holes 21 disposed on both sides of the shaft hole 20, a static pressure surface 22 facing the outer peripheral surface 12 of the carrier ring 5 via a small space, two static pressure pockets 23 provided on the static pressure surface 22 side, and a release groove 24 disposed between the two static pressure pockets 23 are provided. The floating shafts 15a and 15b, the pin holes 21, the shaft holes 20 are substantially parallel to the rotation center axis of the carrier ring 5 and the cutting axis, and the pin holes 21 are disposed substantially symmetrically about the shaft hole 20 on both sides in the rotation direction.

[0028] The static pressure surface 22 of each of the static pressure carrier guides 6a and 6b is formed into arc shapes along the outer peripheral surface 12 of the carrier ring 5, and face the outer peripheral surface 12 of the carrier ring 5 via a small space (for example, approximately 10 to 30 micrometers) in the diametrical direction. The static pressure pockets 23 are for supplying a static pressure fluid such as static pressure water to the portions between the static pressure surfaces 22 of

the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5, and are formed by recesses recessed from the static pressure surfaces 22 and long in the rotation direction, and disposed substantially symmetrically on both sides in the rotation direction with respect to the floating shafts 15a and 15b and the shaft holes 20. Each static pressure pocket 23 is connected to a static pressure fluid supply source 29 via a flexible hose 26, etc., on the side opposite to the static pressure surface 22 from a communication hole 25 formed inside.

[0029] Among the static pressure carrier guides 6a and 6b, two static pressure carrier guides 6a and 6b facing each other in the diametrical direction of the carrier ring 5 are connected to the static pressure fluid supply source 29 via the same circuit 27 as shown in Fig. 9. In each circuit 27, a pressure regulation valve 30 and a flow meter 31 are interposed, and they manage the pressure and flow volume.

[0030] The upper side two static pressure carrier guides 6a are fitted to the support arms 34 pivotally attached swingably to the movable base 8 by pivots 33, and when attaching or removing the carrier means 7, the support arms 34 are swung around the pivots 33 by drive means 19 to move the upper side static pressure carrier guides 6a in the directions approaching or separating from the carrier ring 5. The pivots 33 are substantially parallel to the floating shafts 15a.

[0031] On one end side of the support arm 34, the static pressure carrier guide 6a is fitted inside a housing 35, and to the other end side, a cylinder 36 constituting the drive means 19 is joined. As shown in Fig. 4 and Fig. 6, the housing 35 is provided so as to penetrate in the diametrical direction of the carrier ring 5 between side walls 35a and 35b of the support arm 34, and inside this housing 35, the static pressure carrier guide 6a is housed, and the static pressure carrier guide 6a is pivotally supported by the floating shaft 15a inserted through the support arm 34 by penetrating through the side walls 35a and 35b on both sides of the housing 35. The static pressure carrier guide 6a inside the housing 35 is fixable at a proper angle to the support arm 34 by a fixing means 16a as shown in Fig. 3 and Fig. 6, and becomes floatable within a floating range restricted by the restring means 17a when the fixing means 16 is released.

[0032] The fixing means 16a includes a fixation pin 39 press-fitted in one pine hole 21 of the static pressure carrier guide 6a, and a fixing bracket 38 that has a pin hole 38b which the fixation pin 39 is fitted in and extracted from, and is removably fitted to the side surface of the support arm 34. The fixing bracket 38 is removably pivotally attached to the support arm 34 by a fixation bolt 40 on the base portion side, and the angle thereof is adjustable around the fixation bolt 40 by an adjusting bolt 41 that penetrates through a slot 38a of the fixing bracket and is screwed to the support arm 34 side. The pin hole 38b is provided on the tip end portion of the fixing bracket38, and in this pinhole 38b, the fixation pin 39 removably fits. The restricting means 17a is constituted by the other pin hole 21 of the static pressure carrier guide 6a and a restricting pin 42 penetrating through the housing 35 and inserted through the pin hole 21, and a space corresponding to the floating range is provided between the restricting pin 42 and the pin hole 21.

[0033] A cylinder 36 is interposed between a joint pin 44 of the support arm 34 and the pivot pin 45 of the movable base 8, and swings the support arm 34 around the pivot 33 to move the static pressure carrier guide 6a in the directions approaching or separating from the carrier ring 5 (substantially the diametrical direction) . On one end side of the support arm 34, a stopper means 47 that stops the support arm 34 at a predetermined position is provided.

[0034] The stopper means 47 includes, as shown in Fig. 3 and Fig. 6, a contact portion 48 fixed to the movable base 8, and a screw-type stopper 49 screwed adjustably to one end side of the support arm 34, and by adjusting the stopper 49, the distance between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b on both sides in the diametrical direction of the carrier ring 5 changes and the space can be adjusted so that the carrier ring 5 is positioned at substantially the center between the static pressure carrier guides 6a and 6b. Therefore, the stopper means 47 also serves as a space adjusting means that adjusts the space between the static pressure surface 22 of the static pressure carrier guide 6a and the outer peripheral surface 12 of the carrier ring 5.

[0035] As shown in Fig. 3, Fig. 5, Fig. 10, and Fig. 11, the lower side two static pressure carrier guides 6b are fitted via the floating shafts 15b, the fixing means 16b including fixing brackets 50 (refer to Fig. 3, Fig. 5, and Fig. 10), and the restricting means 17b (refer to Fig. 11) changeably between a fixed state and a floating state.

[0036] The floating shaft 15b is fixed to the movable base 8. The fixing bracket 50 is fitted so that one end side in the longitudinal direction thereof is invertible with respect to the floating shaft 15b and the angle of the fixing bracket is adjustable around the floating shaft 15b, and on the other end side, a fixing hole 53 and a floating recess 54 with a diameter larger than that of the fixing hole 53 are provided. The static pressure carrier guide 6b is pivotally supported by the floating shaft 15b, and in one pin hole 21, an engagement pin 55 is press-fitted. The amount of projection of the engagement pin 55 to the fixing bracket 50 side is set so that the engagement pin does not engage with the fixing hole 53 when the floating recess 54 is directed toward the static pressure carrier guide 6b side.

[0037] The fixing means 16b for fixing the static pressure carrier guide 6b is constituted by, as shown in Fig. 3, Fig. 5, and Fig. 10, the engagement pin 55 and the pin hole 21 of the fixing bracket 50, and by inserting the engagement pin 55 in the pin hole 21, the static pressure carrier guide 6b is fixed.

[0038] The restricting means 17b that restricts the floating range of the static pressure carrier guide 6b is

constituted by, as shown in Fig. 11, the engagement pin 55 and the floating recess 54 of the fixing bracket 50, and when the engagement pin 55 enters the floating recess 54, the space between these corresponds to the floating range of the static pressure carrier guide 6b.

[0039] On one end side of the fixing bracket 50, a two-split seizing portion 56 that seizes the base portion of the floating shaft 15b, and a fastening bolt 57 that fastens this seizing portion 56 are provided, and the angle of the fixing bracket 50 is adjustable with respect to the floating shaft 15b. The fixing hole 53 and the floating recess 54 are formed to be long in the longitudinal direction of the fixing bracket 50 so that the angle of the fixing bracket 50 is adjustable around the floating shaft 15b.

[0040] When grinding a workpiece W, the workpiece W fitted to the carrier 4 is supported by static pressures of the pair of static pressure pads 1 from both left and right sides in a non-contact manner, and by supplying a static pressure fluid to the outer peripheral surface 12 of the carrier ring 5 from the static pressure pockets 23 of the static pressure carrier guides 6a and 6b disposed at substantially evenly-spaced four positions at the outer periphery of the carrier ring 5, the carrier ring 5 is supported by static pressures of the static pressure carrier guides 6a and 6b via the static pressure fluid in a non-contact manner, and the carrier ring 5 is driven by the drive gear 14 via the ring gear 13 to rotate the workpiece W fitted to the carrier 4 around its rotation center, and accordingly, both surfaces of the workpiece W are ground to a predetermined finished size by the pair of grinding wheels 3.

[0041] Accordingly, the carrier ring 5 can be supported by static pressures of the static pressure carrier guides 6a and 6b at the outer periphery in a non-contact manner. Specifically, the static pressure fluid supplied from the static pressure carrier guides 6a and 6b is present between the static pressure carrier guides and the outer peripheral surface 12 of the carrier ring 5, and by the static pressure carrier guides 6a and 6b, the carrier ring 5 can be supported by static pressures in a non-contact manner from the outer peripheral side via the static pressure fluid. On the other hand, the static pressure fluid supplied from the static pressure pads 1 is present between the static pressure carrier guides and the both end faces of the carrier ring 5 as in the conventional case, and by the static pressure pads 1, the carrier ring 5 can be supported by static pressures in a non-contact manner via the static pressure fluid.

[0042] Therefore, all of the outer periphery and both end faces of the carrier ring 5 are supported by static pressures in a non-contact manner, and in comparison with the conventional contact support method in which the carrier ring 5 is supported by guide rollers, external forces to be applied to the workpiece W from the carrier ring 5 via the carrier 4 during a grinding cycle are reduced, so that the rotation precision (mainly, edge runout) of the workpiece W can be improved. Therefore, the grinding precision for the workpiece W can be improved.

[0043] In addition, the carrier ring 5 is supported rotatably in a non-contact manner by static pressures of the static pressure carrier guides 6a and 6b via the static pressure fluid, so that problems such as wear, etc., caused by mutual contact between members as in the case of the contact support method do not occur, and high rotation precision can be maintained semipermanently. Therefore, deterioration in grinding precision for the workpiece W, an increase in the number of maintenance works, and occurrence of expenses for consumables due to wear, etc., can be prevented.

[0044] Among the static pressure carrier guides 6a and 6b disposed at substantially evenly-spaced four positions at the outer periphery of the carrier ring 5, the static pressure carrier guides 6a and 6b disposed so as to face each other in the diametrical direction of the carrier ring 5 are connected to the same circuit 27 in which the pressure and flow volume of the static pressure fluid are sufficiently high as shown in Fig. 9, so that when the spaces between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 change, a force acts to equalize the pressure inside the same circuit 27, and the carrier ring 5 tries to maintain its stable position, so that stable rotation precision can be obtained.

[0045] Specifically, if the pressure balance between the pair of static pressure carrier guides 6a and 6b facing each other is lost for some reason and, for example, the space between the lower side static pressure carrier guide 6b and the carrier ring 5 becomes narrower, the pressure inside the static pressure pockets 23 of this static pressure carrier guide 6b increases. On the other hand, the space between the upper side static pressure carrier guide 6a and the carrier ring 5 becomes larger, and the pressure inside the static pressure pockets 23 of this static pressure carrier guide 6a decreases. Therefore, according to the pressure difference between the static pressure pockets 23 of the static pressure carrier guides 6a and 6b, the carrier ring 5 maintains its stable position by moving so that the spaces between the static pressure carrier guides 6a and 6b become equal.

[0046] The outer peripheral surface 12 of the carrier ring 5 is a cylindrical surface substantially concentric with the rotation center of the carrier 4, and is shaped so as not to have a groove, etc., for releasing the pressure of the static pressure fluid, and the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b are in proximity to the outer peripheral surface 12 of the carrier ring 5 via small spaces, so that the carrier ring 5 can be stably supported by the static pressure fluid, and stable rotation precision of the carrier ring 5 can be obtained. In addition, on the static pressure surface 22 of each of the static pressure carrier guides 6a and 6b, two static pressure pockets 23 are provided in the rotation direction of the carrier ring 5, and are divided into two by the release groove 24 between the two static pressure pockets, so that the pressures of the static pressure fluid on both sides in the rotation direction of the carrier ring 5 can be

balanced by each static pressure carrier guide 6a or 6b alone.

[0047] When attaching or removing the carrier means 7, each of the support arms 34 is swung in the arrow "a" direction shown in Fig. 3 around the pivot 33 by the cylinder 36 as shown by the alternate long and two short dashed line in Fig. 3 so that the upper side two static pressure carrier guides 6a separate in the diametrical direction from the carrier ring 5. After the carrier ring 5 is inserted into the predetermined position, the support arm 34 is turned in the direction opposite to the arrow "a" direction around the pivot 33 by the cylinder 36. When the space between the static pressure surface 22 of the upper side static pressure carrier guide 6a and the outer peripheral surface 12 of the carrier ring 5 becomes the predetermined space, the stopper 49 comes into contact with the contact portion 48 and restricts the support arm 34 from turning.

[0048] Thus, by moving the upper side static pressure carrier guide 6a by driving the support arm 34 by the cylinder 36, the distance between the pair of static pressure carrier guides 6a and 6b disposed so as to face each other in the diametrical direction of the carrier ring 5 is changed, so that the carrier ring 5 can be easily inserted and extracted, and this operation can be easily automatized.

[0049] By adjusting the position at which the screw-type stopper 49 of the stopper means 47 comes into contact with the contact portion 48, the spaces between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 can be arbitrarily adjusted. Specifically, by adjusting the stopper 49, the position of the support arm 34 when the stopper 47 comes into contact with the contact portion 48 changes, and the distance between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b on both sides in the diametrical direction of the carrier ring 5 changes. Then, when the static pressure fluid is supplied from the static pressure carrier guides 6a and 6b on both sides in the diametrical direction of the carrier ring 5 to the outer periphery of the carrier ring 5, the carrier ring 5 is positioned at substantially the center between the static pressure carrier guides 6a and 6b, and the distances between the outer peripheral surface 12 of the carrier ring 5 and the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b on both sides in the diametrical direction of the carrier ring become substantially equal to each other. Therefore, according to the distance between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b on both sides in the diametrical direction of the carrier ring 5, the distances between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 can be adjusted.

[0050] The static pressure carrier guides 6a and 6b are changeable between a fixed state and a floating state, and by changing the states as appropriate, they can be used appropriately. For example, when the circularity of the carrier ring 5 is high and the carrier ring 5 can be reliably supported by static pressures, the static pressure carrier guides 6a and 6b are fixed, and when the circularity of the carrier ring 5 is low, the static pressure carrier guides 6a and 6b can be floated. It is also possible that the lower side two static pressure carrier guides 6b are fixed and the upper side two static pressure carrier guides 6a are floated.

[0051] Fig. 3 and Fig. 6 show a state where the static pressure carrier guides 6a and 6b are fixed. To fix the upper side static pressure carrier guide 6a, as shown in Fig 3, Fig. 5, Fig. 6, and Fig. 10, the fixation pin 39 of the static pressure carrier guide 6a is inserted in the pin hole 38b of the fixing bracket 38, and the fixing bracket 38 is pivotally attached to the support arm 34 by the fixation bolt 40. In this state, when the fixing bracket 38 is turned around the fixation bolt 40 in the range within the slot 38a, the static pressure carrier guide 6a turns around the floating shaft 15a and the space between the static pressure surface 22 of the static pressure carrier guide 6a and the outer peripheral surface 12 of the carrier ring 5 differs between both sides of the floating shaft 15a, so that at a position at which the space becomes substantially equal between both sides of the floating shaft 15a, the adjusting bolt 41 is tightened to fix the static pressure carrier guide.

[0052] An adjustment allowance when fixing the static pressure carrier guide 6a is normally within the range of the space between the pinhole 21 and the restricting pin 42, so that the restricting pin 42 may be left inserted in the pin hole 21. The size of the space between the static pressure surface 22 of the static pressure carrier guide 6a and the outer peripheral surface 12 of the carrier ring 5 is appropriately adjusted by the stopper means 47.

[0053] To fix the lower side static pressure carrier guide 6b, as shown in Fig. 5 and Fig. 10, the engagement pin 55 is inserted in the fixing hole 53 for fixing the static pressure carrier guide 6b and the fixing bracket 50, and the angle of the fixing bracket 50 is adjusted by turning around the floating shaft 15b so that the space between the static pressure surface 22 of the static pressure carrier guide 6b and the outer peripheral surface 12 of the carrier ring 5 becomes substantially equal between both sides of the floating shaft 15b, and then the fastening bolt 57 is tightened to fix the fixing bracket 50 to the floating shaft 15b. Accordingly, the lower side static pressure carrier guide 6b is fixed.

[0054] Thus, even when the static pressure carrier guides 6a and 6b are fixed, two static pressure pockets 23 are present in the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b, and the static pressure fluid is supplied from these static pressure pockets 23 to the outer peripheral surface 12 of the carrier ring 5, so that the carrier ring 5 can be supported by static pressures via the static pressure fluid. The static pressure carrier guides 6a and 6b are in a fixed state, so that the carrier ring 5 can be prevented from wobbling and

the carrier ring 5 can be reliably supported by static pressures.

[0055] To float the upper side static pressure carrier guide 6a, by removing the fixing bracket 38, the fixation pin 39 of the static pressure carrier guide 6a comes off the pin hole 38b of the fixing bracket 38, so that fixation of the static pressure carrier guide 6a by the fixing means 16a can be released. Accordingly, the static pressure carrier guide 6a can be floated around the floating shaft 15a within the range of the space between the restricting pin 42 and the pin hole 21.

[0056] To float the lower side static pressure carrier guide 6b, as shown in Fig. 11, by inverting the fixing bracket 50, the static pressure carrier guide 6b is fitted in a floatable manner in the range of the restricting means 17b. First, the static pressure carrier guide 6b is removed from the floating shaft 15b, and the fixing bracket 50 is inverted and fitted to the floating shaft 15b. Next, the static pressure carrier guide 6b is fitted over the floating shaft 15b, and the engagement pin 55 is engaged with the floating recess 54 of the fixed bracket 50.

[0057] Then, the fixing bracket 50 is adjusted around the floating shaft 15b so that the space between the static pressure surface 22 of the static pressure carrier guide 6b and the outer peripheral surface 12 of the carrier ring 5 becomes substantially equal between both sides of the floating shaft 15b, and the fixing bracket is fixed by a fastening bolt 57. Accordingly, within the range between the engagement pin 55 and the floating recess 54, the static pressure carrier guide 6b can be floated around the floating shaft 15b.

[0058] Thus, after the static pressure carrier guides 6a and 6b are made floatable, when the static pressure fluid is supplied from the static pressure pockets 23 of the static pressure carrier guides 6a and 6b to the outer peripheral surface 12 of the carrier ring 5, the carrier ring 5 can be supported by static pressures via the static pressure fluid. When the spaces between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 differ between both sides of the floating shafts 15a and 15b, the static pressure carrier guides 6a and 6b float around the floating shafts 15a and 15b so that the spaces become substantially equal between both sides of the floating shafts 15a and 15b. Therefore, the static pressure carrier guides 6a and 6b can be prevented from coming into contact with the carrier ring 5. Further, the restricting means 17a and 17b that restrict floating ranges of the static pressure carrier guides 6a and 6b are provided, so that unstable swing, etc., of the static pressure carrier guides 6a and 6b around the floating shafts 15a and 15b can be prevented.

[0059] In addition to the use by fixing or floating all of the static pressure carrier guides 6a and 6b, for example, use in a state where the lower side two static pressure carrier guides 6b are fixed and the upper side two static pressure carrier guides 6a fitted to the support arms 34 are floatable around the floating shafts 15a, is also possible. In this case, even while the attaching/removing operation of the carrier ring 5 is facilitated, the spaces between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 are made small, and the carrier ring 5 can be stably supported by static pressures.

[0060] Specifically, when attaching the upper side static pressure carrier guide 6a to the support arm 34 that turns around the pivot 33, if the static pressure carrier guide 6a is fixed to the support arm 34, the static pressure carrier guide 6a may come into contact with the carrier ring 5 due to accumulation of errors, etc., and it becomes hard to make small the spaces between the static pressure carrier guides 6a and 6b and the carrier ring 5. However, by fitting the static pressure carrier guide 6a to the support arm 34 in a floatable manner, the upper side static pressure carrier guide 6a can be prevented from coming into contact with the carrier ring 5 by floating of the upper side static pressure carrier guide 6a while the spaces between the static pressure surfaces 22 of the static pressure carrier guides 6a and 6b and the outer peripheral surface 12 of the carrier ring 5 are made small.

[0061] Incidentally, when the non-contact support method according to the present invention and the conventional contact support method using conventional support rollers were inspected by using a carrier ring 5 made of ceramic, in the non-contact support method according to the present invention, the edge runout of the carrier ring 5 could be reduced to approximately 1/5 as compared with the conventional contact support method. Fig. 12 shows results of measurement of circularity of the carrier ring 5. Fig. 13 and Fig. 14 shows results of measurements of edge runout of the carrier ring 5 in the conventional contact support method and in the non- contact support method according to the present invention, respectively.

[0062] As the carrier ring 5, as shown in Fig. 12, a carrier ring that was made of ceramic and has an outer periphery circularity of 5 micrometers (measured value: 4. 5 micrometers) was used and edge runouts of the carrier ring 5 in the conventional contact support method and in the non-contact support method according to the present invention were measured. In the case of the conventional contact support method, a measured value of the edge runout is approximately 15 micrometers as shown in Fig. 13, and from this value, when the outer periphery circularity (approximately 5 micrometers) of the carrier ring 5 is deducted, the edge runout is approximately 10 micrometers. On the other hand, the measured value of the runout in the case of the non- contact support method is approximately 7 micrometers as shown in Fig. 14, and from this, when the outer periphery circularity (approximately 5 micrometers) of the carrier ring 5 is deducted, the edge runout is approximately 2 micrometers.

[0063] Therefore, in the non-contact support method according to the present invention, the edge runout of the carrier ring 5 can be reduced to approximately 1/5 as compared with the conventional contact support method.

Therefore, the rotation precision of the carrier ring 5 is directly transmitted to the workpiece W in contact with the inner periphery of the carrier ring via the carrier 4, and acts on the grinding point of the workpiece W sandwiched and fixed by the pair of grinding wheels 3 in a grinding cycle and immediately influences grinding of the workpiece W, however, by adopting the non-contact support method according to the present invention, the influence of the edge runout of the carrier ring 5 can be reduced, and stable grinding precision for the workpiece W can be obtained.

[0064] Embodiments of the present invention are described in detail above, however, the present invention is not limited to the embodiments, and can be variously changed without departing from the spirit of the present invention. For example, in the embodiment, the static pressure carrier guides 6a and 6b can be changed between a fixed state and a floating state, however, it is also possible that all static pressure carrier guides 6a and 6b are fixed or floated, or the plurality of lower side static pressure carrier guides 6b are fixed and the plurality of upper side static pressure carrier guides 6a are floated.

[0065] The static pressure carrier guides 6a and 6b are preferably disposed at substantially even intervals at the outer periphery of the carrier ring 5, however, they do not need to be disposed at substantially even intervals as long as the carrier ring 5 can be supported by static pressures of the plurality of static pressure carrier guides 6a and 6b. When the static pressure carrier guides 6a and 6b are disposed at substantially even intervals, the static pressure carrier guides 6a and 6b are three or more in number. When the number of static pressure carrier guides 6a and 6b is three, for example, two static pressure carrier guides 6b are disposed on the lower side, and the upper side one static pressure carrier guide 6a is provided movably in the diametrical direction of the carrier ring 5.

[0066] When the static pressure pockets 23 are provided in the static pressure surface 22 of each of the static pressure carrier guides 6a and 6b substantially symmetrically about the floating shaft 15a or 15b in the rotation direction, two-divided static pressure pockets are provided in the rotation direction as illustrated in the embodiment, or one static pressure pocket 23 long in the rotation direction is provided continuously. It is also possible that the drive means 19 that drives the support arm 34 is constituted by a motor in addition to the cylinder 36, and the support arm 34 is driven by the motor via a torsion axis or gear.

[0067] When the static pressure carrier guides 6a and 6b are moved in the directions approaching or separating from the carrier ring 5, it is possible that the movable base 8 is provided with a guide mechanism in the substantially diametrical direction of the carrier ring 5, and the static pressure carrier guides 6a and 6b may be provided movably along the guide mechanism. In the embodiment, the stopper means 47 that stops the support arm 34 at a predetermined position is also used as a space adjusting means that adjusts the space between the static pressure surface 22 of the static pressure carrier guide 6a or 6b and the outer peripheral surface 12 of the carrier ring 5, however, these means may be provided separately.

[0068] All of the static pressure carrier guides 6a and 6b may be connected to the static pressure fluid supply source 29 via the same circuit 27, or the static pressure carrier guides 6a and 6b may be individually connected to the supply source 29 via independent pressure control circuits. Further, in the embodiment, a horizontal surface grinder is illustrated, however, the present invention can also be carried out in a vertical surface grinder. As the workpiece W, any workpiece can be used as long as it is a thin sheet-like workpiece.

[Description of Symbols]

[0069]

1	Static pressure pad
2	notched portions
3	Grinding wheel
4	Carrier
5	Carrier ring
6a, 6b	Static pressure carrier guide
7	carrier means
8	left and right movable bases
9	fitting hole
10	presser ring
11	axial center direction face stepped portions
12	Outer peripheral surface
13	ring gear
14	drive gear
15a, 15b	Floating shaft
16a, 16b	Fixing means
17a, 17b	Restricting means
19	Drive means
20	shaft hole
21	Pin hole
22	Static pressure surface
23	Static pressure pocket
24	Release groove
25	Communication hole
26	Flexible hose
27	Circuit
29	Supply source
30	Pressure regulation valve
31	Flow meter
33	Pivot
34	Support arm
35	Housing
35a, 35b	Side wall
36	Cylinder
38	Fixing bracket
38a	slot
38b	Pin hole
39	Fixation pin

40	Fixation bolt
41	Adjusting bolt
42	Restricting pin
44	Joint pin
45	pivot pin
47	Stopper means (space adjusting means)
48	Contact portion
49	Screw-type stopper
50	Fixing brackets
53	Fixing hole
54	Floating recess
55	engagement pin
56	two-split seizing portion
57	fastening bolt
W	Workpiece

Claims

1. A method for grinding a thin sheet-like workpiece, wherein when grinding both surfaces of a thin sheet-like workpiece (W) by a pair of grinding wheels (3) while rotating the workpiece (W) via a carrier (4) in a state where the thin sheet-like workpiece (W) fitted to the carrier (4) is supported by static pressures of a pair of static pressure pads (1) in a non-contact manner, **characterized in that** an outer peripheral surface (12) of a carrier ring (5) disposed on the outer periphery of the carrier (4) and substantially concentrically with the rotation center of the carrier (4) is supported by static pressures of a plurality of static pressure carrier guides (6a, 6b) in the circumferential direction in a non-contact manner.

2. A double-end surface grinder, that grinds both surfaces of a thin sheet-like workpiece (W) by a pair of grinding wheels (3),while rotating the workpiece (W) via a carrier (4)(4) in a state where the thin sheet-like workpiece (W) fitted to the carrier (4) is supported by static pressures of a pair of static pressure pads (1) in a non-contact manner, **characterized in that** the double-end surface grinder comprises- a plurality of static pressure carrier guides (6a, 6b) that are provided in the circumferential direction to support an outer peripheral surface (12) of a carrier ring (5) disposed on the outer periphery of the carrier (4) and substantially concentrically with the rotation center of the carrier (4) by static pressures in a non-contact manner.

3. The double-end surface grinder according to Claim 2, **characterized in that** the carrier ring (5) has a cylindrical outer peripheral surface, and the static pressure carrier guides (6a, 6b) are disposed at substantially even intervals in proximity to the outer peripheral surface (12).

4. The double-end surface grinder according to Claim 2 or 3, **characterized in that** the static pressure carrier guides (6a, 6b) are fixed.

5. The double-end surface grinder according to Claim 2 or 3, **characterized in that** the static pressure carrier guides (6a, 6b) are floatable.

6. The double-end surface grinder according to any of Claims 2 to 5, **characterized in that** each of the static pressure carrier guides (6a, 6b) are pivotally supported by a floating shafts (15a, 15b) substantially parallel to the rotation center of the carrier ring (5), and in each of the static pressure carrier guides (6a, 6b), static pressure pockets (23) that supplies a static pressure fluid to the portion between the static pressure carrier guide (6a, 6b) and the outer peripheral surface (12) of the carrier ring (5) are provided substantially symmetrically about the floating shafts (15a, 15b) in a rotation direction of the carrier ring (5).

7. The double-end surface grinder according to any of Claims 2 to 6, **characterized in that** the double-end surface grinder comprises a support arm (34) that is pivotally supported swingably by a pivot (33) substantially parallel to the rotation center of the carrier ring (5), and supports at least a part of the static pressure carrier guides (6a, 6b) movably in the directions approaching and separating from the carrier ring (5)(5), a drive means (19) that turns the support arm (34) around the pivot (33), and a stopper means (47) that stops the support arm (34) at a predetermined position.

8. The double-end surface grinder according to any of Claims 2 to 7, **characterized in that** the static pressure carrier guides (6a, 6b) are changeable between a fixed state and a floating state where the static pressure carrier guides (6a, 6b) float around the floating shafts (15, 15b) substantially parallel to the rotation center of the carrier ring (5).

9. The double-end surface grinder according to any of Claims 2 to 8, **characterized in that** the double-end surface grinder comprises the static pressure carrier guides (6a, 6b) that are three or more in number and disposed at substantially even intervals at the outer periphery of the carrier ring (5), and a space adjusting means that adjusts spaces between static pressure surfaces (22) of the three or more static pressure carrier guides (6a, 6b) and the outer peripheral surface (12) of the carrier ring (5) by adjusting the position of at least one of the three or more static pressure carrier guides (6a, 6b) in the substantially diametrical direction of the carrier ring (5).

Patentansprüche

1. Verfahren zum Schleifen eines dünnen, blattartigen Werkstücks, wobei beim Schleifen beider Oberflächen eines dünnen blattartigen Werkstücks (W) mit einem Paar Schleifscheiben (3) unter Rotation des Werkstücks (W) über einen Träger (4) in einem Zustand, in dem das am Träger (4) angebrachte dünne, blattartige Werkstück (W) von statischen Drücken eines Paars statischer Druckkissen (1) auf berührungslose Weise gehalten wird, **dadurch gekennzeichnet, dass** eine Außenumfangsfläche (12) eines Trägerrings (5), der am Außenumfang des Trägers (4) angeordnet und im Wesentlichen zum Rotationszentrum des Trägers (4) konzentrisch ist, von statischen Drücken einer Vielzahl von statischen Druckträgerführungen (6a, 6b) in der Umfangsrichtung auf berührungslose Weise gehalten wird.

2. Doppelend-Oberflächenschleifer, der beide Oberflächen eines dünnen, blattartigen Werkstücks (W) mit einem Paar Schleifscheiben (3) unter Rotation des Werkstücks (W) über einen Träger (4) (4) in einem Zustand schleift, in dem das am Träger (4) angebrachte dünne, blattartige Werkstück (W) von statischen Drücken eines Paars statischer Druckkissen (1) auf berührungslose Weise gehalten wird, **dadurch gekennzeichnet, dass** der zweiseitige Oberflächenschleifer eine Vielzahl von statischen Druckträgerführungen (6a, 6b) umfasst, die in der Umfangsrichtung bereitgestellt sind, um eine Außenumfangsfläche (12) eines Trägerrings (5), der am Außenumfang des Trägers (4) angeordnet und im Wesentlichen zum Rotationszentrum des Trägers (4) konzentrisch ist, auf berührungslose Weise durch statische Drücke zu halten.

3. Doppelend-Oberflächenschleifer nach Anspruch 2, **dadurch gekennzeichnet, dass** der Trägerring (5) eine zylinderförmige Außenumfangsfläche aufweist, und die statischen Druckträgerführungen (6a, 6b) in im Wesentlichen gleichmäßigen Intervallen in Nähe zur Außenumfangsfläche (12) angeordnet sind.

4. Doppelend-Oberflächenschleifer nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die statischen Druckträgerführungen (6a, 6b) feststehend sind.

5. Doppelend-Oberflächenschleifer nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die statischen Druckträgerführungen (6a, 6b) schwimmfähig sind.

6. Doppelend-Oberflächenschleifer nach einem der Ansprüche 2 bis 5, **dadurch gekennzeichnet, dass** jede der statischen Druckträgerführungen (6a, 6b) schwenkbar von einer schwimmenden Wellen (15a, 15b) getragen wird, die im Wesentlichen zum Rotationszentrum des Trägerrings (5) parallel sind, und in jeder der statischen Druckträgerführungen (6a, 6b) statische Drucktaschen (23), die dem Abschnitt zwischen der statischen Druckträgerführung (6a, 6b) und der Außenumfangsfläche (12) des Trägerrings (5) ein statisches Druckfluid zuführen, im Wesentlichen symmetrisch um die schwimmenden Wellen (15a, 15b) herum in einer Rotationsrichtung des Trägerrings (5) bereitgestellt sind.

7. Doppelend-Oberflächenschleifer nach einem der Ansprüche 2 bis 6, **dadurch gekennzeichnet, dass** der Doppelend-Oberflächenschleifer einen Haltearm (34), der schwingbar von einem Zapfen (33) schwenkbar gehalten wird, welcher im Wesentlichen zum Rotationszentrum des Trägerrings (5) parallel ist und mindestens eine Teil der statischen Druckträgerführungen (6a, 6b) in den Richtungen beweglich hält, die sich dem Trägerring (5) (5) annähern und von demselben entfernen, ein Antriebsmittel (19), das den Haltearm (34) um den Zapfen (33) herum dreht, und ein Stoppmittel (47), das den Haltearm (34) an einer vorbestimmten Position stoppt, umfasst.

8. Doppelend-Oberflächenschleifer nach einem der Ansprüche 2 bis 7, **dadurch gekennzeichnet, dass** die statischen Druckträgerführungen (6a, 6b) zwischen einem feststehenden Zustand und einem schwimmenden Zustand, in dem die statischen Druckträgerführungen (6a, 6b) im Wesentlichen parallel zum Rotationszentrum des Trägerrings (5) um die schwimmenden Wellen (15, 15b) herum schwimmen, veränderbar sind.

9. Doppelend-Oberflächenschleifer nach einem der Ansprüche 2 bis 8, **dadurch gekennzeichnet, dass** der Doppelende-Oberflächenschleifer die statischen Druckträgerführungen (6a, 6b), die drei oder mehr an der Zahl und in im Wesentlichen gleichmäßigen Intervallen am Außenumfang des Trägerrings (5) angeordnet sind, und ein Abstandseinstellmittel, das Abstände zwischen statischen Druckflächen (22) der drei oder mehr statischen Druckträgerführungen (6a, 6b) und der Außenumfangsfläche (12) des Trägerrings (5) durch Einstellen der Position von mindestens einer der drei oder mehr statischen Druckträgerführungen (6a, 6b) in der im Wesentlichen diametralen Richtung des Trägerrings (5) einstellt, umfasst.

Revendications

1. Procédé de rectification d'une pièce de travail semblable à une feuille mince, dans lequel lors de la rectification des deux surfaces d'une pièce de travail

semblable à une feuille mince (W) par un couple de meules (3) tout en faisant tourner la pièce de travail (W) via un support (4) dans un état où la pièce de travail semblable à une feuille mince (W) ajustée au support (4) est soutenue par des pressions statiques d'un couple de coussins de pression statique (1) d'une façon sans contact, **caractérisé en ce que** une surface périphérique extérieure (12) d'un anneau porteur (5) disposé sur la périphérie extérieure du support (4) et de manière sensiblement concentrique avec le centre de rotation du support (4) est soutenue par des pressions statiques d'une pluralité de guides de support de pression statique (6a, 6b) dans la direction circonférentielle d'une façon sans contact.

2. Rectifieuse plane à double extrémité, qui rectifie les deux surfaces d'une pièce de travail semblable à une feuille mince (W) par un couple de meules (3), tout en faisant tourner la pièce de travail (W) via un support (4) (4) dans un état où la pièce de travail semblable à une feuille mince (W) ajustée au support (4) est soutenue par des pressions statiques d'un couple de coussins de pression statique (1) d'une façon sans contact, **caractérisée en ce que** la rectifieuse plane à double extrémité comprend - une pluralité de guides de support de pression statique (6a, 6b) qui sont prévus dans la direction circonférentielle pour soutenir une surface périphérique extérieure (12) d'un anneau porteur (5) disposé sur la périphérie extérieure du support (4) et de manière sensiblement concentrique avec le centre de rotation du support (4) par des pressions statiques d'une façon sans contact.

3. Rectifieuse plane à double extrémité selon la revendication 2, **caractérisée en ce que** l'anneau porteur (5) a une surface périphérique extérieure cylindrique, et les guides de support de pression statique (6a, 6b) sont disposés à des intervalles sensiblement égaux à proximité de la surface périphérique extérieure (12).

4. Rectifieuse plane à double extrémité selon la revendication 2 ou 3, **caractérisée en ce que** les guides de support de pression statique (6a, 6b) sont fixes.

5. Rectifieuse plane à double extrémité selon la revendication 2 ou 3, **caractérisée en ce que** les guides de support de pression statique (6a, 6b) sont flottants.

6. Rectifieuse plane à double extrémité selon l'une quelconque des revendications 2 à 5, **caractérisée en ce que** chacun des guides de support de pression statique (6a, 6b) est soutenu de manière pivotante par un arbres flottants (15a, 15b) sensiblement parallèles au centre de rotation de l'anneau porteur (5), et dans chacun des guides de support de pression statique (6a, 6b), des poches de pression statique (23) qui fournissent un fluide de pression statique à la portion entre le guide de support de pression statique (6a, 6b) et la surface périphérique extérieure (12) de l'anneau porteur (5) sont prévues de façon sensiblement symétrique autour des arbres flottants (15a, 15b) dans un sens de rotation de l'anneau porteur (5).

7. Rectifieuse plane à double extrémité selon l'une quelconque des revendications 2 à 6, **caractérisée en ce que** la rectifieuse plane à double extrémité comprend un bras de soutien (34) qui est soutenu de manière pivotante de façon à pouvoir basculer par un pivot (33) sensiblement parallèle au centre de rotation de l'anneau porteur (5), et qui soutient au moins une partie des guides de support de pression statique (6a, 6b) de façon mobile dans les sens d'approche et de séparation de l'anneau porteur (5) (5), un moyen d'entraînement (19) qui tourne le bras de soutien (34) autour du pivot (33), et un moyen formant butée (47) qui arrête le bras de soutien (34) à une position prédéterminée.

8. Rectifieuse plane à double extrémité selon l'une quelconque des revendications 2 à 7, **caractérisée en ce que** les guides de support de pression statique (6a, 6b) peuvent être changés entre un état fixe et un état flottant où les guides de support de pression statique (6a, 6b) flottent autour des arbres flottants (15, 15b) sensiblement parallèles au centre de rotation de l'anneau porteur (5).

9. Rectifieuse plane à double extrémité selon l'une quelconque des revendications 2 à 8, **caractérisée en ce que** la rectifieuse plane à double extrémité comprend les guides de support de pression statique (6a, 6b) qui sont au nombre de trois ou plus et qui sont disposés à des intervalles sensiblement égaux au niveau de la périphérie extérieure de l'anneau porteur (5), et un moyen de réglage d'espace qui règle des espaces entre des surfaces de pression statique (22) des trois ou plus guides de support de pression statique (6a, 6b) et la surface périphérique extérieure (12) de l'anneau porteur (5) en réglant la position d'au moins un des trois ou plus guides de support de pression statique (6a, 6b) dans la direction sensiblement diamétrale de l'anneau porteur (5).

Fig. 1

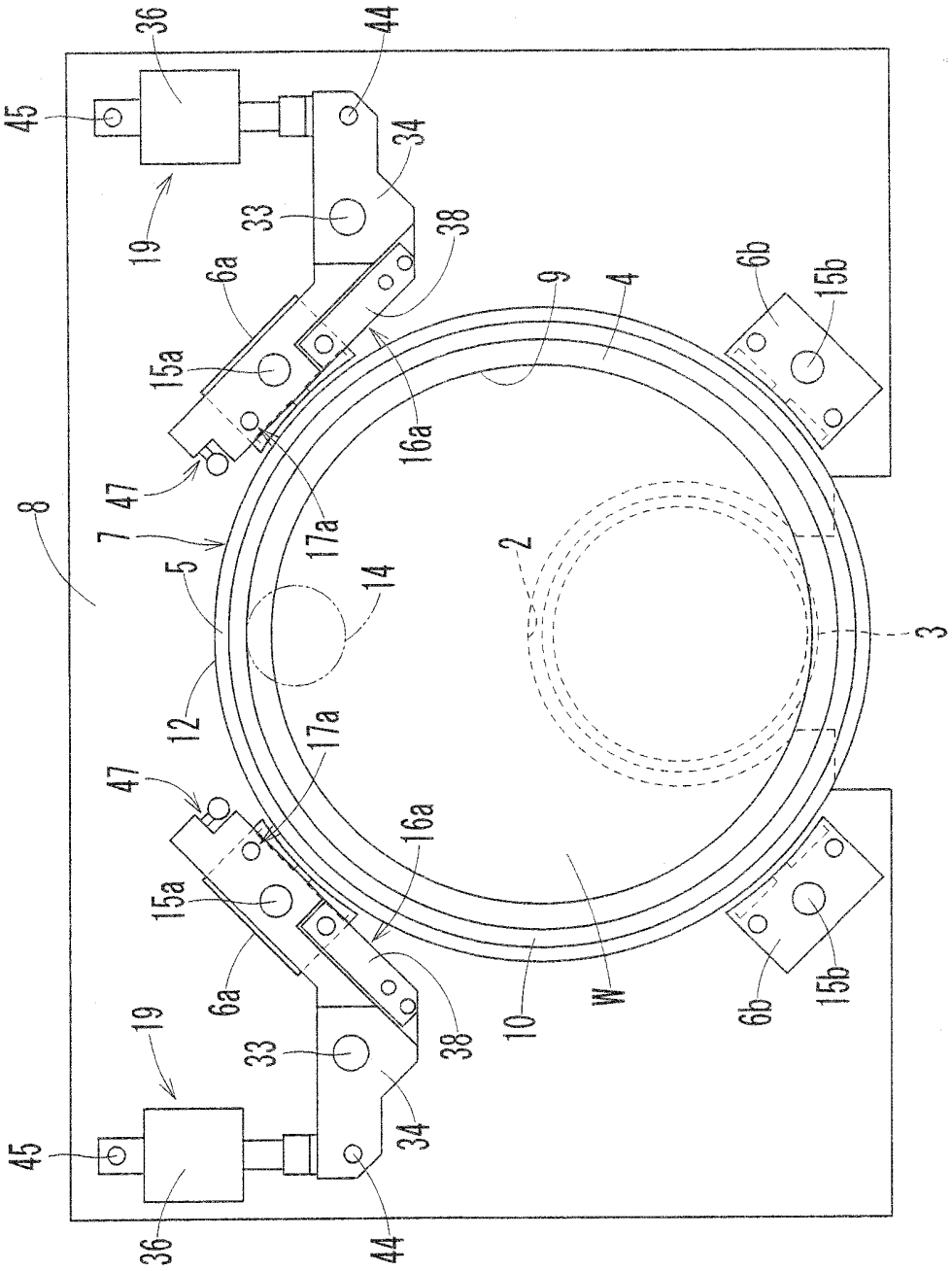
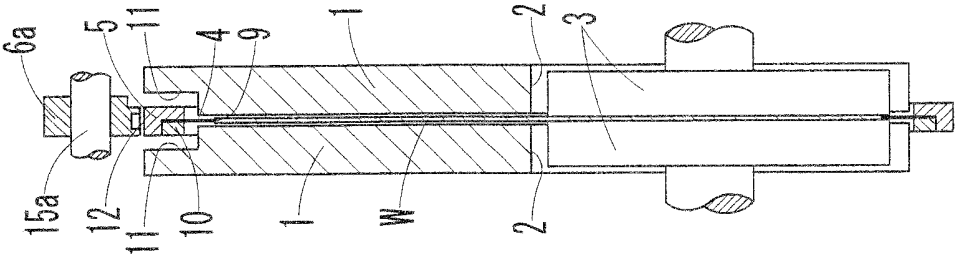

36
44
45
34
19
33
38
6a
6b
15b
9
4
15a
16a
47
17a
7
8
5
14
2
3
12
W
10
6b
15b
6a
15a
47
17a
16a
38
33
19
34
45
36
44

Fig. 2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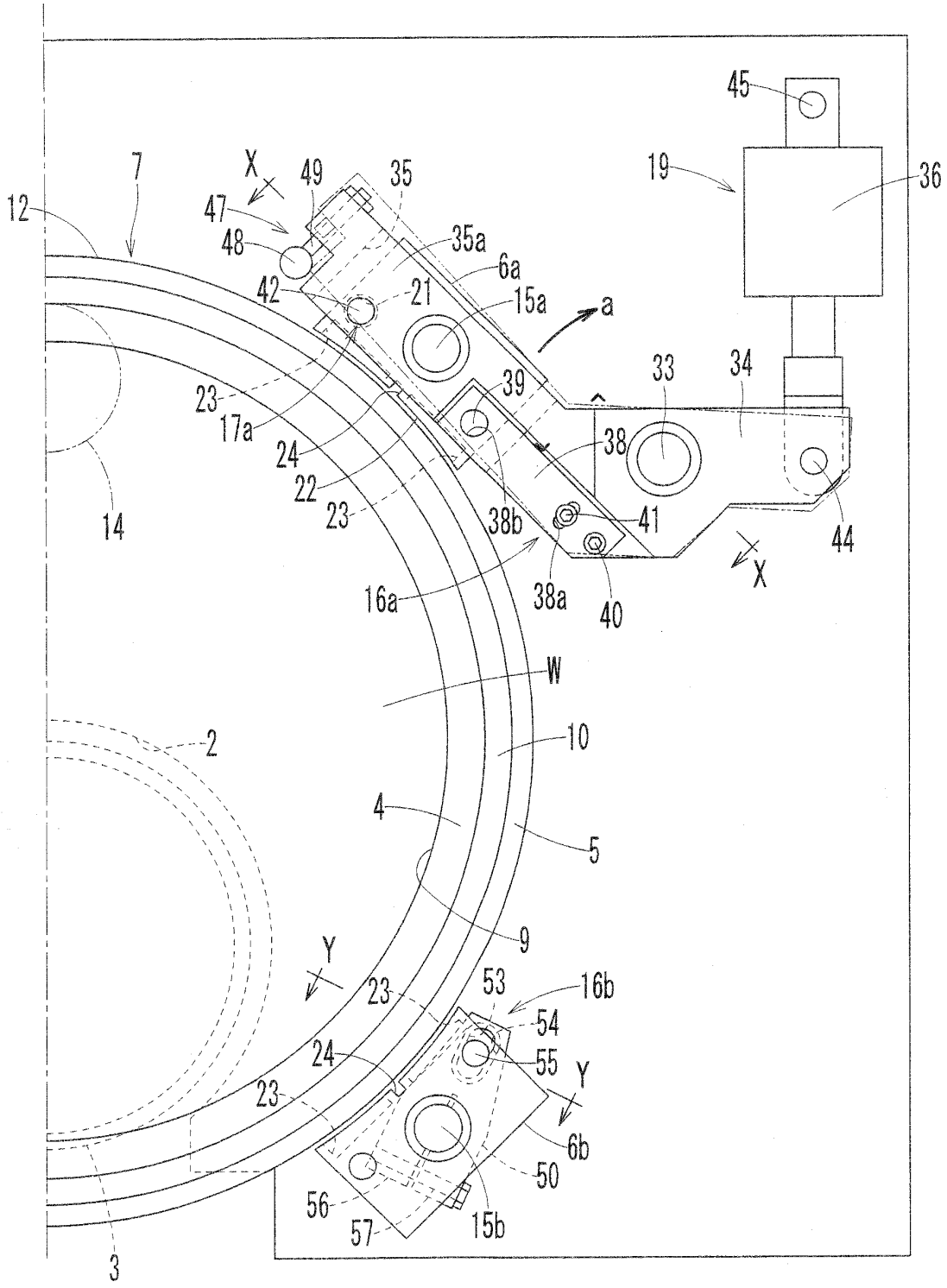
11
4
9
1
2
3
15a
12
11
10
1
W
2

Fig. 3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7
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49
35
12
47
48
35a
6a
42
21
15a
a
23
17a
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33
34
24
38
22
23
38b
41
44
14
16a
38a
40
X
W
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55
Y
23
6b
50
56
57
15b
3

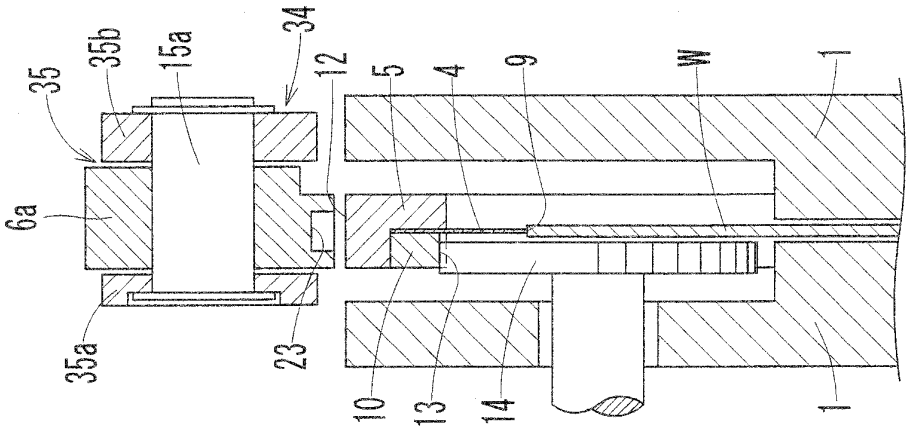
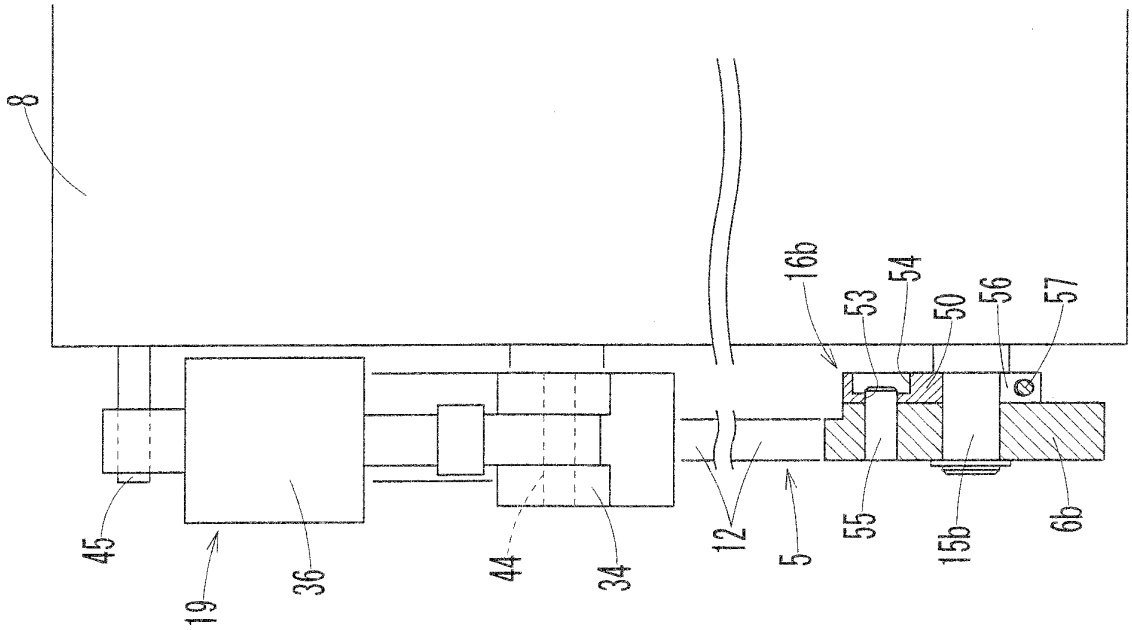

35
35b
15a
34
12
5
4
9
W
1
6a
35a
23
10
13
14
1

Fig. 4


8
16b
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56
57
45
19
36
44
34
12
5
55
15b
6b

Fig. 5

Fig. 6

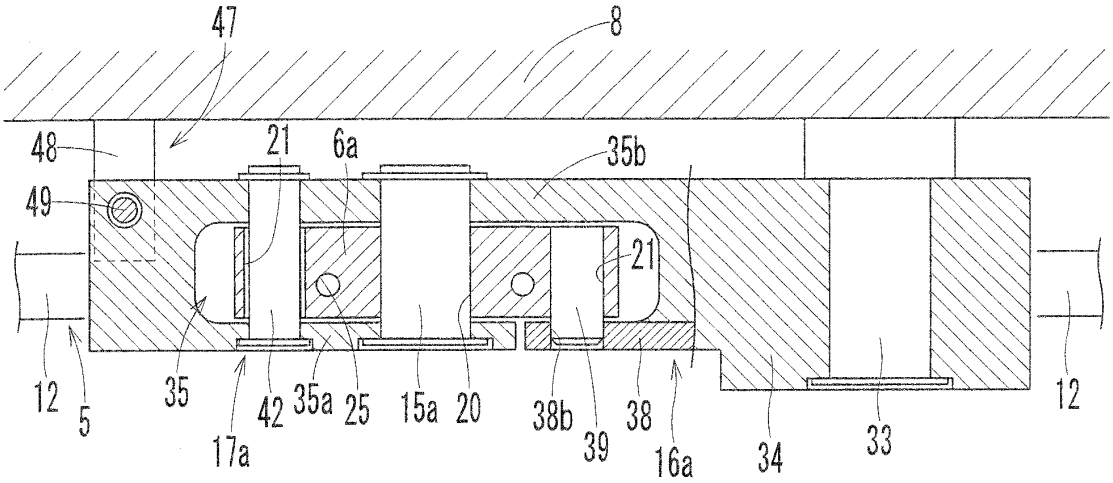


Fig. 7

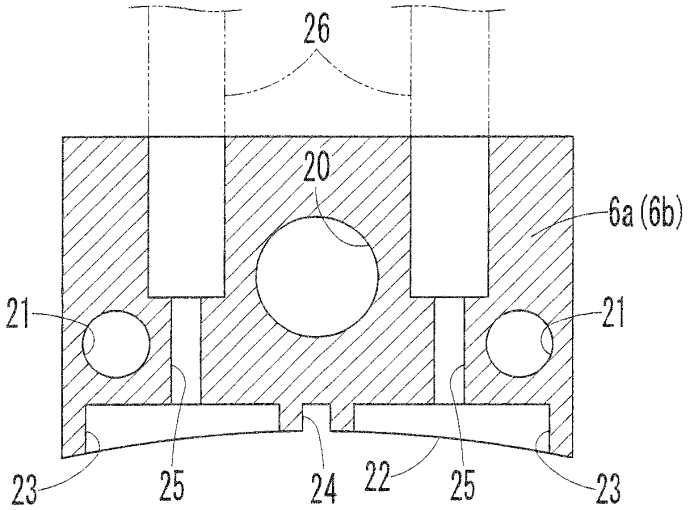


Fig. 8

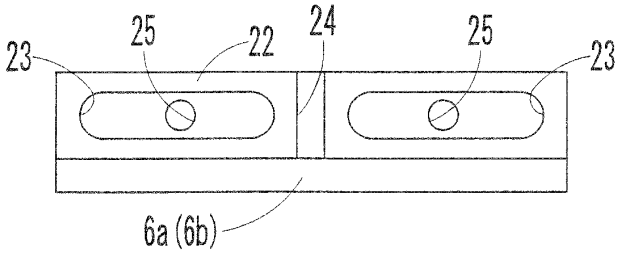


Fig. 9

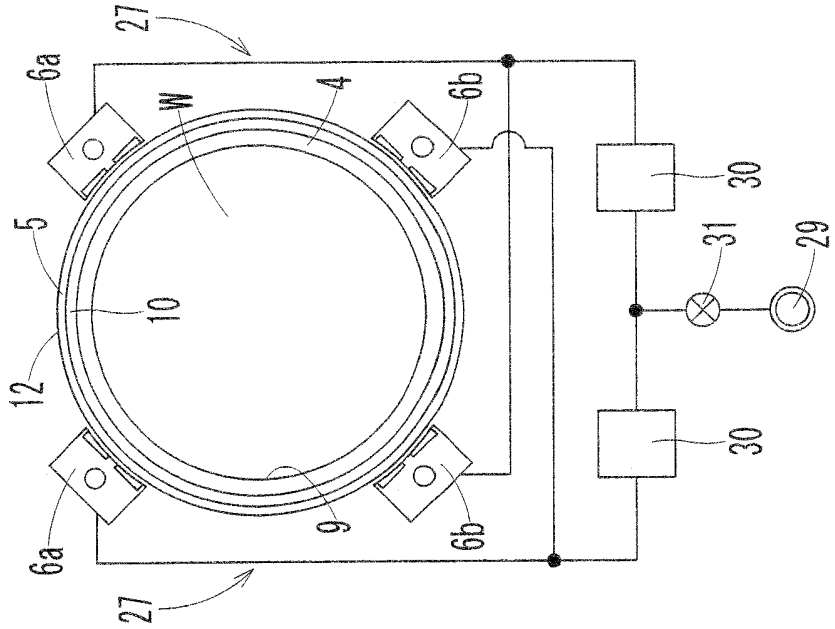


Fig. 10

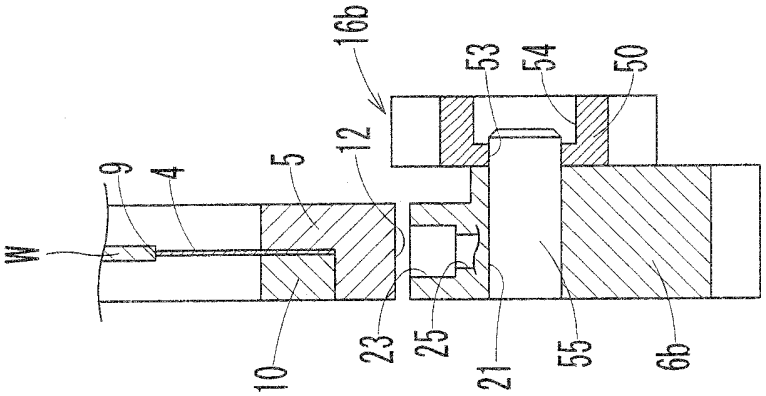


Fig. 11

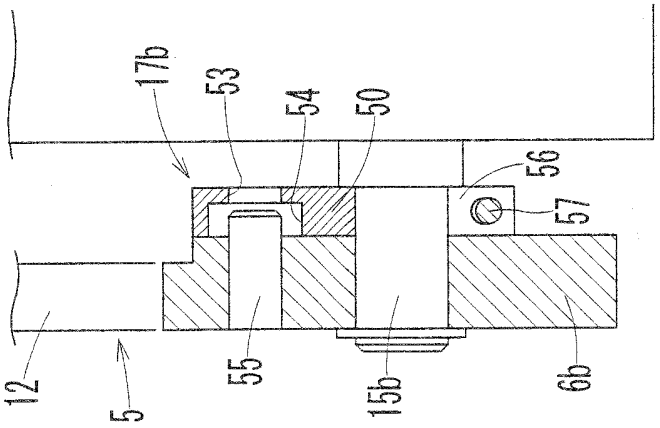


Fig. 12

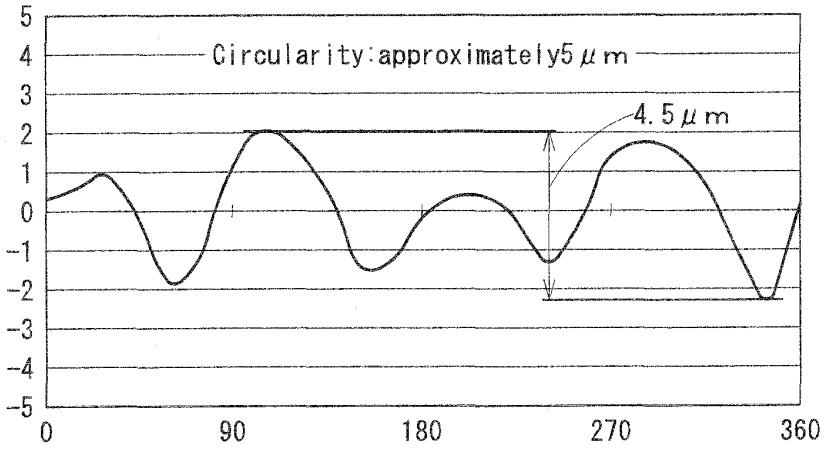


Fig. 13

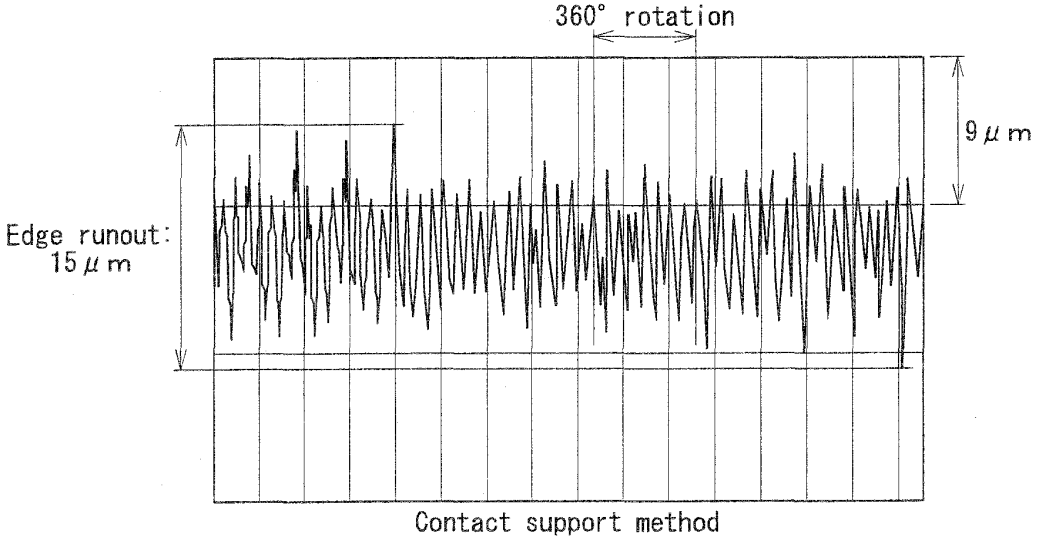
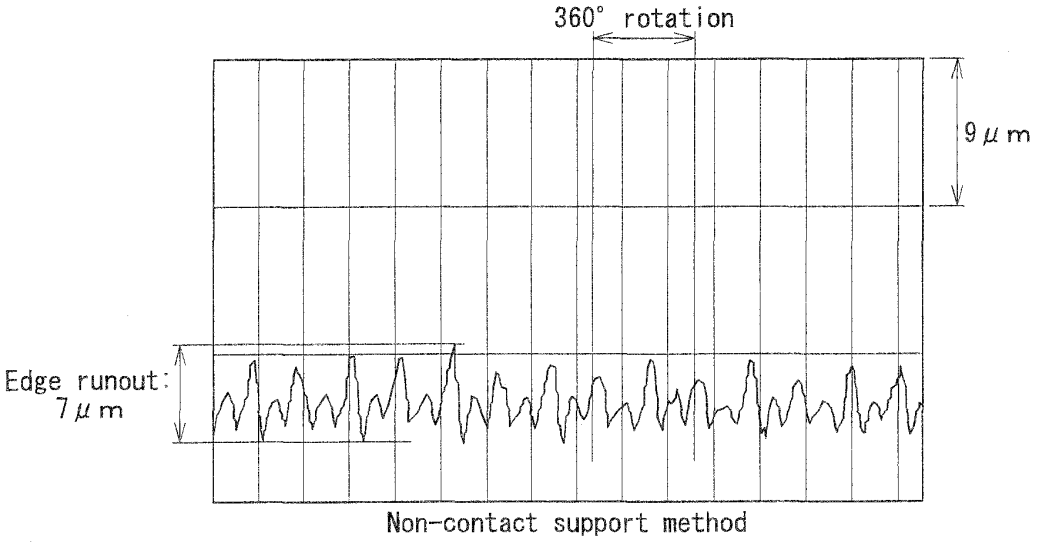


Fig. 14



REFERENCES CITED IN THE DESCRIPTION

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