

[TITLE OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] WORKPIECE CARRYING-IN-AND-OUT METHOD
IN DOUBLE-END SURFACE GRINDING AND DOUBLE-END SURFACE GRINDER

[Technical Field]

[0001]

The present invention relates to a workpiece carrying-in-and-out method in double-end surface grinding and a double-end surface grinder.

[Background Art]

[0002]

When grinding both side surfaces of a thin sheet-like workpiece such as a silicon wafer by a horizontal double-end surface grinder, in a state in which a workpiece is held from the both sides in a board thickness direction by static pressure by a pair of static pressure pads, the both surfaces of the workpiece are ground to a predetermined thickness by a pair of grinding wheels while rotating the workpiece by a carrier.

[0003]

This type of horizontal double-end surface grinder includes a carrying-in-and-out means having a suction cup, and at the time of carrying in and out a workpiece before and after grinding, in a state in which one side surface of the workpiece is sucked by the suction cup, the workpiece is mounted into

a carrier between static pressure pads, and the workpiece in the carrier is taken out (Patent Document 1).

[0004]

That is, at the time of carrying in the workpiece, in a state in which one static pressure pad is at an advanced holding position in the vicinity of the carrier, and the other static pressure pad withdraws up to a withdrawn position, the carrying-in-and-out means sucking the workpiece is inserted between the other static pressure pad and the carrier, to fit the workpiece into the carrier. Then, when the workpiece is fit in the carrier, the suction by the suction cup is released to return the carrying-in-and-out means, and the other static pressure pad is advanced to the advanced holding position to hold the workpiece in the carrier by static pressure, and the workpiece is ground with the pair of grinding wheels while rotating the workpiece via the carrier.

[0005]

When carrying out the workpiece in the carrier, the carrying-in-and-out means is inserted between the other static pressure pad and the carrier which have been withdrawn up to the withdrawn position, and the ground workpiece in the carrier is sucked by the suction cup of the carrying-in-and-out means. Then, when the suction cup sucks onto the workpiece, static

pressure water is supplied from the one static pressure pad, to separate the workpiece from the one static pressure pad, and thereafter, the workpiece which is sucked by the suction cup is taken out of the carrier.

[Prior Art Document]

[Patent Document]

[0006]

[Patent Document 1] Japanese Published Unexamined Patent Application No. 2006-332281

[SUMMARY OF THE INVENTION]

[Problem to be solved by the Invention]

[0007]

In such a conventional workpiece carrying-in-and-out method, when attaching or removing a workpiece to and from a carrier by a carrying-in-and-out means, it creates a state in which the workpiece in the carrier is not held by any means other than the carrier. Therefore, in a case where the workpiece is thin sheet-like such as a silicon wafer, the workpiece may be inclined in the carrier and drop off from the carrier, which leads to the problem that the workpiece comes into contact with static pressure pads or grinding wheels, to cause abrasion, or damage such as breaking, cracking, or the like of the workpiece by impact of dropping.

[0008]

In view of this conventional problem, the object of the present invention is to provide a workpiece carrying-in-and-out method in double-end surface grinding and a double-end surface grinder which are capable of preventing the workpiece in a carrier from dropping off at the time of carrying in and out the workpiece, to prevent beforehand damage to the workpiece.

[Means for Solving the Problem]

[0009]

In accordance with an aspect of the present invention, in double-end surface grinding for grinding both surfaces of the workpiece by a pair of grinding wheels while rotating a thin sheet-like workpiece which is held by static pressure by a pair of static pressure pads, by a carrier, at the time of sucking the workpiece by carrying-in-and-out means, to carry the workpiece into and out from the carrier between the both static pressure pads, the workpiece in the carrier is sucked by one of the static pressure pads at an advanced holding position.

[0010]

After the workpiece in the carrier is sandwiched by the carrying-in-and-out means and the one static pressure pad, in that state, the workpiece may be delivered between the

carrying-in-and-out means and the one static pressure pad. It is preferable that, after the workpiece which is sucked by the carrying-in-and-out means is inserted into the carrier, to be sandwiched by the carrying-in means and the one static pressure pad, the suction of the workpiece by the carrying-in means is released at substantially the same time of suction of the workpiece by the one static pressure pad, or around the time of the suction of the workpiece by the one static pressure pad.

[0011]

It is preferable that, after the other static pressure pad is advanced to the advanced holding position, the suction of the workpiece by the one static pressure pad is released, and a static pressure fluid is supplied to the respective static pressure pads, to hold the workpiece by static pressure. After the holding of the workpiece by static pressure by the both static pressure pads at the advanced holding position is released, and the workpiece in the carrier is sucked by the one static pressure pad, the other static pressure pad may be withdrawn from the advanced holding position.

[0012]

It is preferable that a static pressure fluid is supplied from the other static pressure pad, to release the surface tension between the other static pressure pad and the workpiece

at substantially the same time of suction of the workpiece by the one static pressure pad, or around the time of the suction of the workpiece by the one static pressure pad. In some cases, after the workpiece in the carrier is sandwiched by the carrying-in-and-out means and the one static pressure pad, the suction of the workpiece by the one static pressure pad released at substantially the same time of suction of the workpiece by the carrying out means, or around the time of the suction of the workpiece by the carrying out means, and a static pressure fluid is supplied from the one static pressure pad, to separate the workpiece from the one static pressure pad.

[0013]

Further, in accordance with the present invention, in a double-end surface grinder including a carrier that rotates a thin sheet-like workpiece, a pair of static pressure pads which hold the workpiece in the carrier by static pressure, a pair of grinding wheels that grind both surfaces of the workpiece which is held by static pressure by the static pressure pads, and is rotated by the carrier, and carrying-in-and-out means for sucking the workpiece to carry the workpiece into and out from between the pair of static pressure pads, one of the static pressure pads includes suction holes for sucking the workpiece in the carrier at a plurality of places in a

circumferential direction including a vicinity of an engaging protrusion that engages a notch section of the workpiece.

[Effect of the Invention]

[0014]

According to the present invention, there are advantages that it is possible to prevent the workpiece in the carrier from dropping off at the time of carrying in and out the workpiece, and to prevent beforehand damage to the workpiece.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0015]

Fig. 1 is a schematic cross sectional view of a horizontal double-end surface grinder showing an embodiment of the present invention.

Fig. 2 is a side view of the same.

Fig. 3 is a front view of static pressure pads of the same.

Fig. 4 is a cross sectional view of the static pressure pads and a carrier of the same.

Fig. 5 is a front sectional view of a carrying-in means of the same.

Fig. 6 is a side sectional view of the carrying-in means of the same.

Fig. 7 is an explanatory diagram of the operation of the

same.

Fig. 8 is an explanatory diagram of the operation of the same.

Fig. 9 is an explanatory diagram of the operation of the same.

Fig. 10 is an explanatory diagram of the operation of the same.

Fig. 11 is an explanatory diagram of the operation of the same.

Fig. 12 is an explanatory diagram of the operation of the same.

Fig. 13 is an explanatory diagram of the operation of the same.

Fig. 14 is an explanatory diagram of the operation of the same.

Fig. 15 is an explanatory diagram of the operation of the same.

Fig. 16 is an explanatory diagram of the operation of the same.

Fig. 17 is an explanatory diagram of the operation of the same.

Fig. 18 is an explanatory diagram of the operation of the same.

Fig. 19 is an explanatory diagram of the operation of the same.

[Best Mode for Carrying Out the Invention]

[0016]

Hereinafter, embodiments of the present invention are described in detail based on the drawings. Figs. 1 and 2 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 right and left static pressure pads 1 and 2 that are disposed on the right and left sides so as to be opposed to each other, and hold a thin sheet-like workpiece W such as a silicon wafer, a pair of right and left grinding wheels 5 and 6 that are disposed rotatably around the horizontal shaft center so as to correspond to recessed portions 3 and 4 of the static pressure pads 1 and 2, and grind right and left both side surfaces of the workpiece W held by the static pressure pads 1 and 2, a carrier 7 that rotates around the center of the workpiece W held by the static pressure pads 1 and 2, and carrying-in-and-out means 8 and 9 that carry the workpiece W into and out from the carrier 7 between the static pressure pads 1 and 2.

[0017]

The static pressure pads 1 and 2 are movable horizontally

between an advanced holding position X1 grinding position in the vicinity of the workpiece W and a withdrawn position X2 withdrawn from the workpiece W, and at the advanced holding position X1, the static pressure pads 1 and 2 hold the workpiece W by static pressure via a static pressure fluid such as static pressure water (hereinafter called static pressure water) supplied toward holding surfaces 10 and 11 opposed to the workpiece W. In the holding surfaces 10 and 11 of the static pressure pads 1 and 2, as shown in Fig. 3, a plurality of pockets 12 and 13 to which the static pressure water is supplied, and drain grooves 14 and 15 through which the static pressure water from the respective pockets 12 and 13 is discharged to the outside are provided.

[0018]

As shown in Figs. 1 to 3, a plurality of, for example, six suction holes 16 are provided in the circumferential direction in the outer circumferential portion of the holding surface 11 of the one static pressure pad 2 between the pair of static pressure pads 1 and 2. The suction holes 16 are for sucking the workpiece W, and for releasing the suction of the workpiece W, and at least one of the suction holes 16 is disposed in the vicinity of an engaging protrusion 18 that engages a notch section 17 of the workpiece W when the carrier 7 stops

at a reference stopping position as will be described later.

[0019]

In addition, the number of the suction holes 16 may be appropriately determined in consideration of a size and the like of the workpiece W. Further, it is preferable that the plurality of suction holes 16 is disposed at substantially equal spaces in the circumferential direction. Meanwhile, there may be some variations in spaces between the respective suction holes 16 such that a plurality of (for example, two) suction holes 16 may be disposed in the vicinity of the both sides of the engaging protrusion 18, and the like.

[0020]

The respective pockets 12 and 13 are connected to a static pressure water source 19 via a control valve or the like, and the respective suction holes 16 are connected so as to be switchable to an absorption source 21 such as a vacuum source, and a discharge source 22 such as an air source via a control valve circuit 32, a pressure sensor 20 or the like. The grinding wheels 5 and 6 have cup shapes, etc., and are provided on the tip ends of horizontal grinding wheel shafts (not shown), and move horizontally between advancing ends Y1 and withdrawing ends Y2, so as to grind the workpiece W when advancing on the advancing end Y1 side.

[0021]

As shown in Fig. 4, the carrier 7 includes a thin sheet-like carrier plate 24 in which a carrier hole 23 is formed in a substantially concentric fashion in its inner circumference, that is thinner than the workpiece W, and a carrier ring 25 and a presser ring 26 which hold the outer circumferential portion of the carrier plate 24, and the carrier 7 is held rotatably around the center of the workpiece W in the circumferential direction by a plurality of support rollers 27. The workpiece W is able to be fitted into and detached from the carrier hole 23, and the engaging protrusion 18 that engages the notch section 17 of the workpiece W is provided in the carrier hole 23.

[0022]

The carrier ring 25 is set in a substantially concentric fashion with the carrier 7. A ring gear 28 is provided in a concentric fashion to the inner circumference of the presser ring 26, and a drive gear 29 is made to mesh with the ring gear 28 from the inner circumferential side. The drive gear 29 is driven by a drive source, which is outside of the drawing, via a drive shaft 31 inserted through a through hole 30 in the right static pressure pad 2.

[0023]

As shown in Fig. 1, the carrying-in-and-out means 8 and 9 include a movable frame 33 which is provided movably in the horizontal, back and forth direction, and a carrying-in means 8 and a carrying-out means 9 which are provided so as to be separately movable up and down to the movable frame 33, and suck the workpiece W by the suction cups 34 and 35 of the carrying-in means 8 and the carrying-out means 9, to carry the workpiece W into and out from the carrier 7 between the static pressure pads 1 and 2.

[0024]

In addition, the carrying-in means 8 and the carrying-out means 9 are configured to withdraw to withdrawn positions at which there are no interruptions in operation of each other, such that the carrying-out means 9 moves up at the time of carrying in the workpiece W by the carrying-in means 8, and the carrying-in means 8 moves up at the time of carrying out the workpiece W by the carrying-out means 9.

[0025]

As shown in Figs. 5 and 6, the carrying-in means 8 includes a support frame 37 which is provided to the variable frame 33 so as to be movably up and down in the vertical direction, a floating frame 40 which is provided to the support frame 37 so as to be floatable in the in-plane direction of the holding

surfaces 10 and 11 of the static pressure pads 1 and 2 via upper and lower support means 38 and 39, the suction cups 34 which are provided to one side surface on the lower portion side of the floating frame 40, and a guide means 41 that guides the floating frame 40 such that the workpiece W sucked by the suction cups 34 substantially matches the carrier hole 23 of the carrier 7 when the floating frame 40 approaches the carrier 7 side.

[0026]

The support frame 37 is disposed in the vertical direction, and the sheet-like floating frame 40 is mounted to the one side surface of the support frame 37 via the support means 38 so as to be floatable up and down, and back and forth. With respect to the floating frame 40, guide rollers 42 composing the guide means 41 are supported rotatably via brackets 43 by inclined spindles 44 on the front and back both sides in the middle of the vertical direction. When the floating frame 40 approaches the carrier 7 side, the guide rollers 42 come into contact with the outer circumference of the carrier ring 25, to be guided.

[0027]

The support means 38 has a pair of upper and lower support portions 45 and 46 which are provided between the support frame 37 and the floating frame 40, and a biasing section 51 which is provided between the support frame 37 and the floating frame

40, and biases the floating frame 40 downward.

[0028]

The support portions 45 and 46 include opening portions 47 and 48 such as through holes or notch sections formed in the floating frame 40, and receiving members 49 and 50 which are inserted through the opening portions 47 and 48 to be fixed to the support frame 37, and receive the floating frame 40. With respect to the contact edges 47a and 48a on the upper sides of the opening portions 47 and 48, the upper one thereof is a circular arc in the back and forth direction, and the lower one thereof is horizontal in the back and forth direction, and a circular arc receiving surface 49a of the receiving member 49 is brought into contact with the circular arc contact edge 47a from the lower side. In addition, the horizontal contact edge 48a is in proximity to the upper side of a circular arc receiving surface 50a of the receiving member 50, and the both come into contact with each other when the floating frame 40 floats at a maximum. The receiving members 49 and 50 have latching parts 49b and 50b so that the floating frame 40 can be attached to and detached from the upper side.

[0029]

The biasing section 51 has a body to be pressed 52 which is provided horizontally in the back and forth direction to

the upper end of the floating frame 40, a plurality of pressing bodies 53 in the back and forth direction, which are held downward by the support frame 37, and come into contact with the upper side of the body to be pressed 52, and springs 54 that bias the pressing bodies 53 downward, and those are provided at three places on the vertical line and on the front and back both sides of the support portions 45 and 46. The central pressing body 53 is in contact with a recessed portion 52a of the body to be pressed 52, and the front and back pressing bodies 53 are in contact so as to be slidable with the body to be pressed 52. Accordingly, the floating frame 40 after floating returns with the upper side support part 45 serving as a fulcrum.

[0030]

The pressing bodies 53 and the springs 54 are provided in a protruded part 55 on the side surface of the support frame 37. In addition, with respect to the support portions 45 and 46, the opening portions 47 and 48 and the receiving members 49 and 50 may be respectively provided to the support frame 37 and the floating frame 40. Further, as the biasing section 51, a tension spring may be adopted in place of a compression spring.

[0031]

The suction cups 34 are for vacuum-sucking the workpiece

W, and the suction cups 34 are disposed at three places on the upper side of substantially the central portion of the workpiece W, and on the front and back both sides on the lower side thereof. In addition to the numbers of the suction cups 34, a space between the suction cups 34, and the like may be appropriately determined in consideration of a size and the like of the workpiece W.

[0032]

As shown in Fig. 1, the carrying-out means 9 includes a vertical support frame 56, and a suction cup 35 mounted to the lower end portion of the support frame 56. The suction cup 35 is singularly provided so as to correspond to substantially the center of the workpiece W. However, two or more, that is a plurality of suction cups 35 may be provided.

[0033]

Next, the workpiece carrying-in-and-out method in the horizontal double-end surface grinder is described. Double-end surface grinding of the workpiece W is performed as one cycle from a carrying-in process of carrying in the workpiece W, via a grinding process of grinding the workpiece W, to a carrying-out process of carrying out the ground workpiece W.

[0034]

Fig. 7 shows a state before carrying in the workpiece

W, and the right and left grinding wheels 5 and 6, the left static pressure pad 1, and the right static pressure pad 2 are respectively located at the withdrawing ends Y2, at the withdrawn position X2, and at the advanced holding position X1 in the vicinity of the carrier 7.

[0035]

Then, at the time of carrying in the workpiece W to mount it to the carrier 7 between the static pressure pads 1 and 2, first, the workpiece W is sucked by the suction cups 34 of the carrying-in means 8. Next, as shown in Fig. 8, the carrying-in means 8 is made to enter between the carrier 7 and the left static pressure pad 1, to bring the workpiece W to be opposed to the shaft center of the carrier hole 23 of the carrier 7. Then, the carrying-in means 8 is moved toward the carrier 7, to insert the workpiece W into the carrier hole 23 of the carrier 7 as shown in Fig. 9.

[0036]

At this time, as shown in Fig. 2, because the carrier 7 is positioned such that the engaging protrusion 18 thereof is located at a predetermined position, and the workpiece W is sucked so as to be located such that the notch section 17 corresponds to the engaging protrusion 18 of the carrier 7, it is possible to cause the notch section 17 of the workpiece

W to engage with the engaging protrusion 18 of the carrier 7 by moving the carrying-in means 8 toward the carrier 7.

[0037]

Further, even in the case where the workpiece W does not match the carrier hole 23 due to variations in position in the vertical, and back and forth directions of the carrying-in means 8, if the carrying-in means 8 is moved toward the carrier 7, the pair of guide rollers 42 of the floating frame 40 come into contact with the outer circumference of the carrier ring 25, to be guided. Therefore, the floating frame 40 which is supported so as to be floatable by the support frame 37 via the support means 38 makes a floating motion following the carrier ring 25. Therefore, when the carrying-in means 8 moves toward the carrier 7, it is possible to make the workpiece W match the carrier hole 23, and insert the workpiece W into the carrier hole 23.

[0038]

When the workpiece W enters the carrier hole 23, the workpiece W is brought into contact with the holding surface 11 of the right static pressure pad 2 at the advanced holding position X1, and the workpiece W in the carrier 7 is sandwiched from the both sides between the right static pressure pad 2 and the carrying-in means 8 as shown in Fig. 9, and is thereafter

absorbed by the suction holes 16 of the right static pressure pad 2, to cause the workpiece W to be sucked onto the holding surface 11 of the static pressure pad 2. It is confirmed according to the presence or absence of a suction signal from the pressure sensor 20 whether or not the right static pressure pad 2 sucks the workpiece W.

[0039]

In the case where the notch section 17 of the workpiece W runs on the engaging protrusion 18 of the carrier 7, because one of the suction holes 16 disposed in the vicinity of the notch section 17 among the plurality of suction holes 16 of the right static pressure pad 2 absorbs the ambient air, it is impossible to suck the workpiece W by the right static pressure pad 2, and no suction signal of the pressure sensor 20 is output. Therefore, after the carrier 7 is rotated at a slight angle (predetermined angle) together with the workpiece W, the workpiece W is again sucked by the right static pressure pad 2.

[0040]

In this way, by disposing the suction holes 16 at a plurality of places including the vicinity of the notch section 17 of the workpiece W, it is possible to easily figure out whether or not the notch section 17 of the workpiece W runs on the engaging

protrusion 18 of the carrier 7.

[0041]

When the workpiece W is mounted into the carrier 7, it is necessary to engage the engaging protrusion 18 of the carrier 7 and the notch section 17 of the workpiece W. However, in the case of a status in which the notch section 17 does not engage with the engaging protrusion 18 by a mistake in suction of the workpiece W by the carrying-in means 8, the automatic cycle of a carrying-in work is stopped, and an operator is informed of it.

[0042]

When the right static pressure pad 2 sucks the workpiece W, the suction of the workpiece W by the suction cups 34 of the carrying-in means 8 is released at substantially the same time of suction, and the workpiece W is delivered from the carrying-in means 8 to the right static pressure pad 2. Accordingly, even if the carrying-in means 8 is withdrawn from the place between the static pressure pads 1 and 2, it is possible to hold the workpiece W in the carrier 7 by the right static pressure pad 2 as shown in Fig. 10.

[0043]

In this way, after the workpiece W is sandwiched from the both sides by the right static pressure pad 2 and the

carrying-in means 8, the suction of the workpiece W by the carrying-in means 8 is released at substantially the same time of sucking the workpiece W by the right static pressure pad 2, the workpiece W is delivered from the carrying-in means 8 to the right static pressure pad 2, and the suction is continued by the right static pressure pad 2 after the delivery, thereby it is possible to prevent the workpiece W from being inclined in the carrier 7, the workpiece W from dropping off from the carrier 7, and the like regardless of whether the workpiece W is thin sheet-like.

[0044]

In addition, delivery of the workpiece W from the carrying-in means 8 to the right static pressure pad 2 may be carried out in a state in which the workpiece W is sandwiched from the both sides by the right static pressure pad 2 and the carrying-in means 8, and the suction of the workpiece W by the carrying-in means 8 may be released after sucking the workpiece W by the right static pressure pad 2. Further, reversely, the suction of the workpiece W by the carrying-in means 8 may be released, and the work W may be thereafter sucked by the right static pressure pad 2.

[0045]

Next, after the left static pressure pad 1 is advanced

to the advanced holding position X1 as shown in Fig. 11, the suction of the workpiece W by the right static pressure pad 2 is released. At this time, because the workpiece W in the carrier 7 is sandwiched from the both sides by the both static pressure pads 1 and 2, even if the suction of the workpiece W by the right static pressure pad 2 is released, there is no risk that the workpiece W may drop off from the carrier 7, and the like. Thereafter, as shown in Fig. 12, static pressure water is supplied to the both static pressure pads 1 and 2, to hold the work W in the carrier 7 by static pressure. Then, while the carrier 7 is driven by the drive gear 29, to rotate the workpiece W held by static pressure, the both grinding wheels 5 and 6 are advanced to grind the both sides of the workpiece W as shown in Fig. 13.

[0046]

After the completion of grinding of the workpiece W, as shown in Fig. 14, the both grinding wheels 5 and 6 are withdrawn to the withdrawing ends Y2, to stop the rotation of the carrier 7. At this time, the carrier 7 is stopped at a home position in order to facilitate the next insertion of the workpiece W. Thereafter, when the supply of the static pressure water from the both static pressure pads 1 and 2 is stopped, the workpiece W is sucked by the right static pressure pad 2 at substantially

the same time of the stop or after the stop. At this time as well, it is confirmed by the pressure sensor 20 whether or not the right static pressure pad 2 sucks the workpiece W. Then, in the case where a mistake in suction that the right static pressure pad 2 fails to suck the workpiece W is caused, the workpiece W is likely to be broken. Therefore, the automatic cycle driving is stopped, and an operator is informed of it.

[0047]

After suction of the workpiece W by the right static pressure pad 2, before withdrawing the left static pressure pad 1 to the withdrawn position X2, static pressure water is supplied from the left static pressure pad 1 as shown in Fig. 15, to remove the surface tension between the left static pressure pad 1 and the workpiece W. That is, because a gap between the workpiece W and the left static pressure pad 1 is approximately 0.1 mm in reality, even when the right static pressure pad 2 sucks the workpiece W, the surface tension between the workpiece W and the left static pressure pad 1 is not removed.

[0048]

Then, first, static pressure water is supplied from the left static pressure pad 1, to remove the surface tension between the left static pressure pad 1 and the workpiece W, and thereafter, the left static pressure pad 1 is withdrawn to the withdrawn

position X2. Thereby, it is possible to withdraw the left static pressure pad 1 to the withdrawn position X2 while preventing the breakage of the workpiece W by the surface tension between the both at the time of withdrawing the left static pressure pad 1.

[0049]

After the left static pressure pad 1 is withdrawn to the withdrawn position X2, the carrying-out means 9 is made to enter between the carrier 7 and the left static pressure pad 1 as shown in Fig. 16. Then, as shown in Fig. 17, the carrying-out means 9 is moved toward the carrier 7, to sandwich the workpiece W in the carrier 7 from the both sides by the carrying-out means 9 and the right static pressure pad 2.

[0050]

Next, as shown in Fig. 18, the workpiece W in the carrier 7 is sucked by the suction cup 35 of the carrying-out means 9. At the same time of suction or after suction of the workpiece W by the suction cup 35, the suction holes 16 of the right static pressure pad 2 are switched from the absorption source 21 to the discharge source 22, to discharge air from the suction holes 16, so as to break a vacuum between the right static pressure pad 2 and the workpiece W. Further, at the same time of the vacuum break or after the vacuum break, static pressure water

is supplied from the right static pressure pad 2, to separate the workpiece W from the right static pressure pad 2.

[0051]

Thereafter, as shown in Fig. 19, the carrying-out means 9 is withdrawn to take out the ground workpiece W from the carrier 7. In addition, the discharge of air and the supply of the static pressure water from the right static pressure pad 2 are terminated at an appropriate point of time after the workpiece W is separated.

[0052]

In this way, in a state in which the workpiece W is sandwiched from the both sides by the right static pressure pads 1 and 2 and the carrying-out means 9, first, the workpiece W is sucked by the suction cups 34 of the carrying-out means 9, and thereafter, the suction by the right static pressure pads is released, to deliver the workpiece W from the right static pressure pad 2 to the carrying-out means 9, thereby it is possible to prevent the workpiece W from dropping off from the carrier 7.

[0053]

Further, after the suction of the workpiece W by the right static pressure pad 2 is released, air is discharged from the suction holes 16 to break vacuum contact. However, this vacuum

break is carried out at lower pressure of, for example, approximately 0.1 to 0.2 MPa. In this way, by breaking a vacuum at lower pressure, it is possible to eliminate a phenomenon such that a great deal of force rapidly acts on the workpiece W by a rapid vacuum break at the time of releasing vacuum contact, to oscillate the workpiece W, and the like, and it is possible to prevent breakage of the workpiece W.

[0054]

Moreover, by merely breaking a vacuum, the workpiece W is sucked as is by the right static pressure pad 2 due to the surface tension of the water between the right static pressure pad 2 and the workpiece W. However, it is possible to eliminate the effect of the surface tension by supplying static pressure water from the right static pressure pad 2, and it is possible to prevent breakage of the workpiece W when the workpiece W is sucked by the carrying-out means 9.

[0055]

Thereafter, the workpiece W sucked by the carrying-out means 9 is extracted out from the carrier hole 23 of the carrier 7, to be carried out from the place between the static pressure pads 1 and 2 to the outside.

[0056]

In this way, provided that the workpiece W is sucked by

the right static pressure pad 2, it is possible to prevent the workpiece W from being inclined in the carrier 7 and coming into contact with the grinding wheels 5 and 6, and the like, and prevent the workpiece W from dropping off from the carrier 7, which makes it possible to prevent the damage to the workpiece W, the grinding wheels 5 and 6, and the like in carrying-in-and-out.

[0057]

Further, it is recommended that the suction holes 16 are formed in the right static pressure pad 2, and the suction holes 16 are connected to the absorption source 21 and the discharge source 22 via a control valve or the like. Therefore, there are advantages that it is possible to easily and inexpensively achieve the invention without introducing new equipment, and it is possible to prevent the double-end surface grinder itself from growing in size.

[0058]

Moreover, in a state in which the workpiece W is sandwiched by the both static pressure pads 1 and 2 at the advanced holding positions X1, when the workpiece W is sucked by the right static pressure pad 2, and the left static pressure pad 1 is withdrawn, static pressure water is supplied from the static pressure pad 1, and further, when the carrying-out means 9 sucking the

workpiece W is withdrawn after releasing the suction by the right static pressure pad 2, air and static pressure water are supplied from the right static pressure pad 2. Thereby it is possible to smoothly withdraw the static pressure pad 1 and the carrying-out means 9 while preventing the damage to the workpiece W due to the surface tension of water, which makes it possible to shorten a cycle time of grinding.

[0059]

The embodiments of the present invention have been described in detail above, however, the present invention should not be limited to these embodiments, and can be variously modified within the scope not departing from the spirit of the present invention. For example, the embodiments illustrate a horizontal double-end surface grinder, however, the present invention is also applicable to a vertical double-end surface grinder. Further, the workpiece W may be another one other than a silicon wafer or the like.

[0060]

Further, in the embodiments, there is shown the case where the suction holes 16 are provided in the right static pressure pad 2 of the pair of static pressure pads 1 and 2, to suck the workpiece W onto the right static pressure pad 2 side. However, the suction holes 16 may be provided in the left static pressure

pad 1, to suck the workpiece W onto the left static pressure pad 1 side.

[0061]

After the workpiece W sucked by the carrying-in means 8 is inserted into the carrier 7, to be sandwiched by the carrying-in means 8 and the right static pressure pad 2, the suction of the workpiece W by the carrying-in means 8 may be released at substantially the same time of suction of the workpiece W by the right static pressure pad 2, or the suction of the workpiece W by the carrying-in means 8 may be released around the time of the suction of the workpiece W by the right static pressure pad 2.

[0062]

Further, in the case where static pressure water is supplied from the left static pressure pad 1, to release the surface tension between the left static pressure pad 1 and the workpiece W, the static pressure water may be supplied from the left static pressure pad 1 at substantially the same time of suction of the workpiece W by the right static pressure pad 2, or static pressure water may be supplied from the left static pressure pad 1 around the time of the suction of the workpiece W by the right static pressure pad 2.

[0063]

After the workpiece W in the carrier 7 is sandwiched by the carrying-out means 9 and the right static pressure pad 2, the suction of the workpiece W by the right static pressure pad 2 may be released at substantially the same time of suction of the workpiece W by the carrying-out means 9, or the suction of the workpiece W by the right static pressure pad 2 may be released around the time of the suction of the workpiece W by the carrying-out means 9, and static pressure water may be supplied from the right static pressure pad 2.

[0064]

In the case where static pressure water is supplied to the right static pressure pad 2 at the time of carrying out the workpiece W, a usual static pressure water supply system for static pressure holding may be utilized, to supply the static pressure water via a supply valve thereof, or static pressure water may be supplied from another supply system different from the static pressure water supply system for static pressure holding. Further, the carrying-in means 8 and the carrying-out means 9 may be separately provided, or the both may be combined as one means.

[0065]

In the embodiment, the configuration in which the suction cups 34 are included so as to be floatable via the floating

frame 40 in the carrying-in means 8, and the suction cups 34 are guided such that the carrier 7 and the workpiece W match each other via the guide means 41 at the time of mounting the workpiece W is adopted. However, provided that the positional accuracy of the workpiece W sucked by the carrying-in means 8 is improved with respect to the carrier 7 stopping at the reference stopping position by improving the stiffness of the carrying-in means 8, improving the accuracy of the driving motor of the carrying-in means 8, and the like, it is possible to omit the floating frame 40 and the like on the carrying-in means 8 side.

[Description of Reference Numerals]

[0066]

W	Workpiece
1, 2	Static pressure pad
5, 6	Grinding wheel
7	Carrier
8	Carrying-in means
9	Carrying-out means
16	Suction hole
17	Notch section
18	Engaging protrusion
37	Support frame

- 40 Floating frame
- 41 Guide means
- 42 Guide roller
- X1 Advanced holding position
- X2 Withdrawn position

[TITLE OF DOCUMENT] WHAT IS CLAIMED IS:

[Claim 1]

A workpiece carrying-in-and-out method in double-end surface grinding for grinding both surfaces of the workpiece by a pair of grinding wheels while rotating a thin sheet-like workpiece which is held by static pressure by a pair of static pressure pads, by a carrier, the workpiece carrying-in-and-out method wherein, at the time of sucking the workpiece by carrying-in-and-out means, to carry the workpiece into and out from the carrier between the both static pressure pads, the workpiece in the carrier is sucked by one of the static pressure pads at an advanced holding position.

[Claim 2]

The workpiece carrying-in-and-out method in double-end surface grinding according to Claim 1, wherein after the workpiece in the carrier is sandwiched by the carrying-in-and-out means and the one static pressure pad, in that state, the workpiece is delivered between the carrying-in-and-out means and the one static pressure pad.

[Claim 3]

The workpiece carrying-in-and-out method in double-end surface grinding according to Claim 1, wherein, after the workpiece sucked by the carrying-in-and-out means is inserted

into the carrier, to be sandwiched by the carrying-in-and-out means and the one static pressure pad, the suction of the workpiece by the carrying-in-and-out means is released at substantially the same time of suction of the workpiece by the one static pressure pad, or around the time of suction of the workpiece by the one static pressure pad.

[Claim 4]

The workpiece carrying-in-and-out method in double-end surface grinding according to Claim 3, wherein, after the other static pressure pad is advanced to the advanced holding position, the suction of the workpiece by the one static pressure pad is released, and a static pressure fluid is supplied to the respective static pressure pads, to hold the workpiece by static pressure.

[Claim 5]

The workpiece carrying-in-and-out method in double-end surface grinding according to any of Claims 1 to 4, wherein, after the holding of the workpiece by static pressure by the both static pressure pads at the advanced holding position is released, and the workpiece in the carrier is sucked by the one static pressure pad, the other static pressure pad is withdrawn from the advanced holding position.

[Claim 6]

The workpiece carrying-in-and-out method in double-end surface grinding according to Claim 4, wherein a static pressure fluid is supplied from the other static pressure pad, to release the surface tension between the other static pressure pad and the workpiece at substantially the same time of suction of the workpiece by the one static pressure pad, or around the time of suction of the workpiece by the one static pressure pad.

[Claim 7]

The workpiece carrying-in-and-out method in double-end surface grinding according to Claim 6, wherein, after the workpiece in the carrier is sandwiched by the carrying-in-and-out means and the one static pressure pad, the suction of the workpiece by the one static pressure pad is released at substantially the same time of suction of the workpiece by the one static pressure pad, or around the time of suction of the workpiece by the carrying-in-and-out method, and a static pressure fluid is supplied from the one static pressure pad, to separate the workpiece from the one static pressure pad.

[Claim 8]

A double-end surface grinder comprising:

a carrier that rotates a thin sheet-like workpiece;

a pair of static pressure pads which hold the workpiece

in the carrier by static pressure;

a pair of grinding wheels that grind both surfaces of the workpiece which is held by static pressure by the static pressure pads, and is rotated by the carrier; and

carrying-in-and-out means for sucking the workpiece to carry the workpiece into and out from between the pair of static pressure pads, the double-end surface grinder wherein

one of the static pressure pads includes suction holes for sucking the workpiece in the carrier at a plurality of places in a circumferential direction including a vicinity of an engaging protrusion that engages a notch section of the workpiece.