[TITLE OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] DOUBLE-DISK SURFACE GRINDING METHOD AND DOUBLE DISK SURFACE GRINDER

[Technical Field]

[0001]

The present invention relates to a double-disk surface grinding method and a double disk surface grinder.

[Background Art]

[0002]

When grinding both side surfaces of a thin disk-shaped workpiece such as a silicon wafer by a horizontal double disk surface grinder, in a state in which a workpiece is held by static pressure from the both sides in a board thickness direction by a pair of right and left static pressure pads, the both surfaces of the workpiece are ground to a predetermined thickness by a pair of right and left grinding wheels while rotating the workpiece by a carrier (Patent Document 1).

[0003]

In this type of horizontal double-disk surface grinding, it is very important for the improvement of grinding precision that a workpiece is held at the middle position between the static pressure pads, to be ground. Then, conventionally, various measures such as moving the right and left both static

pressure pads by the same amount by utilizing a moving mechanism during grinding of a workpiece (Patent Document 1) have been devised.

[0004]

The horizontal double disk surface grinder in Patent Document 1 includes a moving mechanism that moves the right and left both static pressure pads synchronously during grinding, and a workpiece mounting reference position is set to the middle, and the both static pressure pads are moved synchronously at the same speed and by the same amount during grinding of the workpiece with reference to that position.

[0005]

In addition to such a horizontal double disk surface grinder including a moving mechanism, a horizontal double disk surface grinder adopting the following adjustment method has been devised. First, a workpiece is inserted into a carrier, and the workpiece is held by static pressure in a non-contact manner via static pressure water by the right and left both static pressure pads. Thereafter, the carrier is driven to rotate around its center, to rotate the workpiece, thereby stabilizing the workpiece between the both static pressure pads. Then, when the workpiece is in a stable status, the position of the workpiece at this time is measured by air sensors included

in the both static pressure pads, to perform zeroing with the measured position serving as zero, and the zeroed position is stored. Next, after the rotation of the carrier is stopped, the right and left both grinding wheels are advanced, to sandwich the workpiece which is still being held by static pressure by the both static pressure pads, from the right and left both sides by the both grinding wheels, and the positions of the both grinding wheels are adjusted so as to match the stored zeroed position, and a thickness of the workpiece sandwiched is input, to perform an alignment of a grinding position.

[0006]

In addition to this, it has been devised that the positions of the both static pressure pads and the positions of the right and left both surfaces of a workpiece are measured by using a pair of right and left contact-type sizing equipment which is accessible to a static pressure pad and a workpiece, to calculate the middle position between the static pressure pads.

[Prior Art Document]

[Patent Document]

[0007]

[Patent Document 1] Japanese Published Unexamined Patent Application No. 2003-236746

[SUMMARY OF THE INVENTION]

[Problem to be Solved by the Invention]

[0008]

The conventional horizontal double disk surface grinder including a moving mechanism has a fault that it mechanically gets complicated, and even if a workpiece mounting reference position is set to the center, and the both static pressure pads are moved synchronously at the same speed and by the same amount with reference to that position during grinding of a workpiece, it is not guaranteed that the mounting reference position is located at the middle position between the both grinding wheels.

[0009]

Further, the former horizontal double disk surface grinder adopting an adjustment method has a fault that it requires much time to restart grinding and trial grinding of workpieces in a case of a setup change. Because the work shapes are not necessarily constant, the shapes are uneven depending on each workpiece. Further, depending on a setup status, a squareness between the grinding wheel shafts of the both grinding wheels and the workpiece supporting surfaces of the both static pressure pads, or the like is not necessarily adjusted to zero. Therefore, even when a workpiece is held by static pressure via static pressure water by the both static pressure pads, the workpiece

is rotated so as to be inclined depending on a workpiece shape or a setup status, or the like, that is, it is difficult to stably rotate the workpiece at the middle position between the both static pressure pads, and the zeroed position may be largely deviated from the middle position between the both static pressure pads. Accordingly, in such a case, there are problems that it takes much time to restart grinding, and many workpieces are wasted by trial grinding.

[0010]

Moreover, in the latter horizontal double disk surface grinder using contact-type sizing equipment, it is possible to more securely calculate the middle position between the both static pressure pads. Meanwhile, there are problems that it takes time and effort for the calculation, an operator is required to be highly-skilled, and the like.

[0011]

The present invention was made in view of these conventional problems, and an object of the present invention is to provide a double-disk surface grinding method and a double disk surface grinder which are capable of easily and securely aligning a grinding position of a thin disk-shaped workpiece at a middle position between the both static pressure pads, and of grinding with predetermined

grinding precision from an initial product immediately after the setup.

[Means for Solving the Problem]

[0012]

~~A double-disk surface grinding method according to the present invention includes, when grinding both surfaces of the workpiece by a pair of grinding wheels while rotating a thin disk-shaped workpiece supported by static pressure by a pair of static pressure pads, detecting a position of the workpiece by workpiece position detecting means while moving the workpiece toward a center side between the both static pressure pads at static pressure supporting positions by the grinding wheels, tentatively determining positions of the grinding wheels when the workpiece position detecting means detects that the workpiece is separated by a predetermined distance from the respective static pressure pads, as grinding advancing end positions, and advancing the both grinding wheels at the same speed from the grinding advancing end positions, to grind the workpiece.~~

A double disk surface grinding method comprising, when grinding both surfaces of a thin disk-shaped workpiece by a pair of grinding wheels while rotating the thin disk-shaped workpiece supported by static pressure by a pair of static pressure pads:

detecting a position of the thin disk-shaped workpiece by workpiece position detecting means while moving the thin disk-shaped workpiece on a side of one of the static pressure pads at static pressure supporting positions toward an advancing direction by one of the grinding wheels on the side of the one of the static pressure pads;

tentatively determining position of the grinding wheel on the side of the one of the static pressure pads when the workpiece position detecting means detects that the thin disk-shaped workpiece is separated by a predetermined distance from the one of static pressure pads, as grinding advancing end position of the grinding wheel on the side of the one of the static pressure pads, and

advancing each of grinding wheels at the same speed from the grinding advancing end positions, to grind the thin disk-shaped workpiece after the tentative determination for each of the grinding wheels is made and the grinding advancing end positions of each of the grinding wheels are tentatively determined.

[0013]

It is preferable that an operation in which, after the workpiece is pressed against one of the static pressure pads at the static pressure supporting positions, the workpiece is

levitated by a predetermined amount from the one static pressure pad by the grinding wheel whose rotation is stopped while advancing the grinding wheel on the one static pressure pad side, and a position of the grinding wheel when the workpiece is levitated by the predetermined amount is tentatively determined as the grinding advancing end position is carried out on each side, and thereafter, the workpiece is supported by static pressure by the both static pressure pads.

[0014]

A static pressure fluid may be supplied from the other static pressure pad, to press the workpiece against the one static pressure pad side. It is preferable that an offset amount of the both grinding wheels is determined in advance, and the both grinding wheels are set so as not to advance by the offset amount during grinding of the workpiece.

[0015]

~~A double disk surface grinder according to the present invention, which grinds both surfaces of the workpiece by a pair of grinding wheels while rotating a thin disk-shaped workpiece supported by static pressure by a pair of static pressure pads, the double disk surface grinder includes a pair of workpiece position detecting means for detecting a position at which the workpiece is separated by a predetermined distance~~

~~from the both static pressure pads at static pressure supporting positions, grinding advancing end position tentatively-determining means for tentatively determining positions of the grinding wheels when the respective workpiece position detecting means detect the position separated by the predetermined distance, as grinding advancing end positions, and grinding cycle control means for advancing the both grinding wheels at the same speed from the grinding advancing end positions tentatively determined by the grinding advancing end position tentatively-determining means, to execute a grinding cycle.~~

~~[Effect of the Invention]~~

The double disk surface grinding method according to Claim 1, wherein an operation in which, after the thin disk-shaped workpiece is pressed against one of the static pressure pads at the static pressure supporting positions, the thin disk-shaped workpiece is levitated by a predetermined amount from the one static pressure pad by the grinding wheel whose rotation is stopped while advancing the grinding wheel on the one static pressure pad side, and a position of the grinding wheel when the thin disk-shaped workpiece is levitated by the predetermined amount is tentatively determined as the grinding advancing end position is carried out on each side, and thereafter, the thin disk-shaped workpiece is supported by

static pressure by the both static pressure pads.

[0016]

According to the present invention, there are advantages that it is possible to easily and securely perform an alignment of a grinding position of a thin disk-shaped workpiece at a middle position between both static pressure pads, and to perform grinding with predetermined grinding precision from an initial product immediately after the setup.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0017]

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

invention.

Fig. 2 is a side view of the same.

Fig. 3 is a block diagram of a control system of the same.

Fig. 4 is an explanatory diagram of the same.

Fig. 5 is an explanatory diagram of the operation of the same.

Fig. 6 is an explanatory diagram of the operation 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 a flowchart of the same.

Fig. 10 is an explanatory diagram of a levitating state of a workpiece of the same.

[Best Mode for Carrying Out the Invention]

[0018]

Hereinafter, embodiments of the present invention are described in detail based on the drawings. The drawings illustrate a horizontal double disk surface grinder adopting the present invention. The horizontal double disk surface grinder includes, as shown in Fig. 1 and Fig. 2, a pair of right and left static pressure pads 1 and 2 which are disposed on

the right and left sides so as to be opposed to each other, that hold a thin disk-shaped workpiece W such as a silicon wafer by static pressure, a pair of right and left grinding wheels 3 and 4 which are disposed rotatably around the horizontal shaft center so as to correspond to recessed portions 1a and 2a of the respective static pressure pads 1 and 2, that grind right and left both side surfaces of the workpiece W held by the static pressure pads 1 and 2, and a carrier 5 that rotates the workpiece W held by the static pressure pads 1 and 2 around substantially the center thereof. The carrier 5 is driven to rotate around substantially the center of the workpiece W by a drive means outside of the drawing.

[0019]

The static pressure pads 1 and 2 are movable horizontally between static pressure supporting positions H1 and H2 (refer to Fig. 1) in the vicinity of the workpiece W and withdrawn positions (not shown) withdrawn from the static pressure supporting positions H1 and H2, and when a static pressure fluid such as static pressure water (hereinafter called static pressure water) is supplied toward workpiece supporting surfaces 1b and 2b from the both static pressure pads 1 and 2 at the static pressure supporting positions H1 and H2, the workpiece W is supported by static pressure in a non-contact

manner at the middle position between the both static pressure pads 1 and 2 via the static pressure water, and further, when the static pressure water is supplied from one of the static pressure pads 1 and 2, the workpiece W is pressed toward the other of the static pressure pads 1 and 2 via the static pressure water.

[0020]

On the sides of workpiece supporting surfaces 1b and 2b of the static pressure pads 1 and 2, in addition to a plurality of pockets (not shown) to which the static pressure water is supplied, and drain grooves (not shown) through which the static pressure water from the respective pockets is discharged to the outside, a plurality of (for example, circumferentially three) air sensors 6 and 7 are disposed at predetermined intervals in the circumferential direction in the vicinity of the recessed portions 1a and 2a. The air sensors 6 and 7 compose a workpiece position detecting means that detects a position of the workpiece W, that eject air toward the workpiece W from their air nozzles, to measure clearances between the workpiece W and the workpiece supporting surfaces 1b and 2b of the static pressure pads 1 and 2 according to a change in back pressure at that time.

[0021]

In addition, the air sensors 6 and 7 are merely examples as a workpiece position detecting means, and another means capable of detecting a position of the workpiece W may be used. Further, there are contact type and non-contact type workpiece position detecting means, and any one of those may be used.

[0022]

The grinding wheels 3 and 4 have cup shapes, etc., and are fixed to the tip ends of horizontal grinding wheel shafts 8 and 9, and are movable horizontally between advancing end positions and withdrawing end positions according to the movement of the grinding wheel shafts 8 and 9, and rotate around the grinding wheel shafts 8 and 9, to grind the right and left both surfaces of the workpiece W.

[0023]

The carrier 5 includes a carrier hole 10 into which the workpiece W is inserted detachably, in a substantially concentric fashion, and the carrier 5 is supported rotatably around substantially the center of the workpiece W by a plurality of support rollers 11 which are circumferentially disposed on the outer circumferential side, to be driven to rotate around substantially the center of the workpiece W by a driving means (not shown). The carrier 5 has an engaging section 13 which protrudes into the carrier hole 10, to engage a notch section

12 of the workpiece W.

[0024]

Fig. 3 shows a control device that controls the horizontal surface grinder. This control device includes a static pressure pad control means 15 that controls supply/stop of the static pressure water of the static pressure pads 1 and 2, and movement of the static pressure pads 1 and 2, a grinding wheel shaft control means 16 that controls advancing/withdrawing, rotation/stop, and the like of the grinding wheel shafts 8 and 9, a pair of right and left air sensors (workpiece position detecting means) 6 and 7 that detect levitation amounts C1 and C2 of the workpiece W from the static pressure pads 1 and 2 at the static pressure holding positions H1 and H2 (distances between the static pressure pads 1 and 2 and the workpiece W) (refer to Figs. 5 and 7), a levitation amount setting means 17 that sets a predetermined levitation amount C of the workpiece W from the static pressure pads 1 and 2, a grinding advancing end position tentatively-determining means 18 that tentatively determines the positions of the both grinding wheel shafts 8 and 9 as grinding advancing end positions F1 and F2 (refer to Fig. 5 and Fig. 7) when the levitation amounts C1 and C2 detected by the respective air sensors 6 and 7 reach the predetermined levitation amount C set by the levitation amount setting means

17, a clearance setting means 19 that sets a clearance A between the static pressure pads 1 and 2 at the static pressure holding positions H1 and H2 (refer to Fig. 1), a finished thickness setting means 20 that sets a finished thickness B of the workpiece W, and a grinding cycle control means 21 which computes an advancing amount S of the both grinding wheel shafts 8 and 9 on the basis of the clearance A between the both static pressure pads 1 and 2 set by the clearance setting means 19, and the finished thickness B of the workpiece W set by the finished thickness setting means 20, and advances the both grinding wheels 3 and 4 at substantially the same speed and by the same amount from the grinding advancing end positions F1 and F2 which are tentatively determined by the grinding advancing end position tentatively-determining means 18, to execute a grinding cycle for grinding the workpiece W by the both grinding wheels 3 and 4 at the tip ends thereof.

[0025]

In addition, the advancing speeds in the case where the both grinding wheels 3 and 4 are advanced from the grinding advancing end positions F1 and F2 are preferably the same speed on the right and left sides, and the advancing amounts are preferably the same amount on the right and left sides. However, the advancing speeds and the advancing amounts may be

substantially the same within an allowable range of grinding precision of the workpiece W. Further, in the case where the advancing speeds of the respective grinding wheels 3 and 4 are accelerated or decelerated in multiple stages, the right and left grinding wheels may be accelerated or decelerated so as to be substantially synchronized (in substantial synchronization). Accordingly, there is no need to advance the respective grinding wheels 3 and 4 always at a constant speed.

[0026]

The static pressure pad control means 15 is capable of controlling supply/stop of static pressure water with respect to the static pressure pads 1 and 2 individually, and is capable of holding the workpiece W by static pressure in the carrier 5 by supplying static pressure water simultaneously from the both static pressure pads 1 and 2 by the control, and is capable of supplying static pressure water from one of the static pressure pads 1 and 2, to press the workpiece W in the carrier 5 against the other of the pressure pads 1 and 2. In addition, static pressure water may be supplied as appropriate at the time of carrying in and out the workpiece W.

[0027]

The grinding advancing end position

tentatively-determining means 18 carries out an operation of pressing the workpiece W against one of the static pressure pads 1 and 2 at the static pressure supporting positions H1 and H2, and thereafter an operation of advancing one grinding wheel shaft 8 or 9 on the same side of the one static pressure pad 1 or 2, to levitate the workpiece W from the static pressure pads 1 and 2 by the grinding wheels 3 and 4 at the tip ends of the respective grinding wheel shafts 8 and 9 on the right and left sides respectively by the static pressure pad control means 15, the grinding wheel shaft control means 16, and the like, so as to tentatively determine the positions of the grinding wheels 3 and 4 when the levitation amounts C1 and C2 of the workpiece W on the right and left sides reach the predetermined levitation amount C, as the right and left grinding advancing end positions F1 and F2.

[0028]

At the time of determining a grinding position of the workpiece W, first, the workpiece W is pressed against one of the static pressure pads 1 and 2. Next, in that state, the one grinding wheel shaft 8 or 9 is advanced to bring the one of the grinding wheels 3 and 4 into contact with the workpiece W. Thereafter, the workpiece W is pressed by the grinding wheel 3 or 4 whose rotations are stopped, to levitate the workpiece

W from the one static pressure pad 1 or 2. Then, the position when the levitation amount C1 or C2 of the workpiece W reaches the predetermined levitation amount C are determined as the grinding advancing end positions F1 and F2 of the one grinding wheel shaft 8 or 9. This operation is carried out on the right and left sides respectively in the same way.

[0029]

With this, the middle position between the right and left grinding wheels 3 and 4 is located at a substantially middle position between the both static pressure pads 1 and 2. Therefore, provided that the both surfaces of the workpiece W are ground in that state by the both grinding wheels 3 and 4, it is possible to grind the workpiece W at a substantially middle position between the both static pressure pads 1 and 2. Accordingly, there are advantages that it is possible to easily and securely align a grinding position of the thin disk-shaped workpiece W at a substantially middle position between both static pressure pads 1 and 2, and to perform grinding with predetermined grinding precision from an initial product immediately after the setup.

[0030]

In addition, the middle position between the both grinding wheels 3 and 4 is preferably the middle position between the

both static pressure pads 1 and 2. However, as long as the effect on the grinding precision of the workpiece W is within an allowable range, there may be a slight misalignment between the middle position between the both grinding wheels 3 and 4 and the middle position between the both static pressure pads 1 and 2. Accordingly, the middle position between the both grinding wheels 3 and 4 may be located at a substantially middle position between the both static pressure pads 1 and 2 within the allowable range of grinding precision of the workpiece W.

[0031]

This horizontal surface grinder is adjusted in advance such that the right and left grinding wheel shafts 8 and 9 are located coaxially, the workpiece supporting surfaces 1b and 2b of the right and left both static pressure pads 1 and 2 are at a right angle to the both grinding wheel shafts 8 and 9, and the workpiece supporting surfaces 1b and 2b of the both static pressure pads 1 and 2 are parallel to one another. In addition, the clearance A between the both static pressure pads 1 and 2 is determined according to a thickness of the workpiece W, grinding conditions therefor, and the like.

[0032]

Next, a description is made with reference to a flowchart of Fig. 9. First, the workpiece W is inserted into the carrier

5 (Step S1). The insertion of the workpiece W may be directly carried out manually, and in the case where there is a carrying-in-and-out means, the insertion may be automatically carried out by the carrying-in-and-out means.

[0033]

For example, in the case where the workpiece W is automatically inserted into the carrier 5 by the carrying-in-and-out means, the right static pressure pad 2 is located in advance at the static pressure supporting position H2 in the vicinity of the carrier 5, and the workpiece W is inserted into the carrier 5 from the left side by the carrying-in-and-out means in that state, to sandwich the workpiece W by the carrying-in-and-out means and the right static pressure pad 2, and thereafter, the workpiece W is vacuum-sucked onto the right static pressure pad 2 side. Then, after the carrying-in-and-out means is withdrawn to the outside, the left static pressure pad 1 is moved to the static pressure supporting position H1, to pinch the workpiece W from the both sides in order for the workpiece W not to drop off from the carrier 5. In addition, the static pressure supporting positions H1 and H2 of the both static pressure pads 1 and 2 correspond to the clearance A set by the clearance setting means 19.

[0034]

Next, static pressure water 2c is supplied in the direction of the arrows in Fig. 4 from, for example, the right static pressure pad 2 of the both right and left static pressure pads 1 and 2 located at the static pressure supporting positions H1 and H2 (Step S3), and as shown in Fig. 4, the workpiece W in the carrier 5 is pressed against the work supporting surface 1b of the left static pressure pad 1 located at the static pressure supporting position H1 by the static pressure water 2c (Step S4).

[0035]

Thereafter, the left grinding wheel shaft 8 is advanced toward the direction of arrow X in Fig. 5 at a constant speed in a state in which the rotation of the grinding wheel 3 is stopped (Step S5). Then, after the left grinding wheel 3 is matched to the workpiece supporting surface 1b of the left static pressure pad 1, to come into contact with the workpiece W, the workpiece W is pressed in the right direction (the direction of arrow X) in the teeth of the supply of the static pressure water 2c, to levitate the workpiece W from the workpiece supporting surface 1b of the left static pressure pad 1 as shown in Fig. 5 (Step S6). Then, the levitation amount C1 of the workpiece W at that time is measured by the air sensor 7 of the right static pressure pad 2 (Step S7).

[0036]

When the air sensor 7 measures the levitation amount C1 of the workpiece W, in the grinding advancing end position tentatively-determining means 18, an output value of the levitation amount C1 by the air sensor 7 and a setting value of the predetermined levitation amount C set by the levitation amount setting means 17 are compared, to judge whether or not the workpiece W is levitated by the predetermined levitation amount C from the left static pressure pad 1 (Step S8). Then, when the workpiece W is levitated to the predetermined levitation amount C, the output value from the air sensor 7 is matched to the setting value of the predetermined levitation amount C, and therefore, the left grinding wheel shaft 8 is stopped advancing at the same time of judging the predetermined levitation amount C (Step S9), and as shown in Fig. 5, the position of the left grinding wheel shaft 8 at that point in time is tentatively determined as the left grinding advancing end position F1 (Step S10).

[0037]

In addition, the predetermined levitation amount C of the workpiece W may be arbitrarily set. However, given that a clearance between the both static pressure pads 1 and 2 is A, and a thickness of the workpiece W before grinding is D,

it must be C<(A-D)/2.

[0038]

When the workpiece W is levitated by the predetermined levitation amount C from the left static pressure pad 1, the left grinding wheel shaft 8 is withdrawn by a predetermined amount to the withdrawn position (Step S11), and the supply of the static pressure water 2c from the right static pressure pad 2 is stopped (Step S12).

[0039]

Next, as shown in Fig. 6, after static pressure water 1c is supplied in the direction of the arrows from the left static pressure pad 1, to press the workpiece W against the right static pressure pad 2 located at the static pressure supporting position H2 by the static pressure water 1c (Steps S13 and S14), as shown in Fig. 7, by carrying out an operation of advancing the right grinding wheel shaft 9 whose rotation is stopped in the direction of arrow Y in Fig. 7 at a constant speed, and the like, the grinding advancing end position F2 of the right grinding wheel shaft 9 is tentatively determined in the same method (Steps S15 to S20). Thereafter, the right grinding wheel shaft 9 is withdrawn by the same amount as the withdrawn amount of the left grinding wheel shaft 8 (Step S21). In addition, in order to even out the moving distances until

the respective grinding wheel shafts 8 and 9 are stopped after the air sensors 6 and 7 detect the predetermined levitation amount C, the advancing speeds of the both grinding wheel shafts 8 and 9 are set to the same speed.

[0040]

Next, as shown in Fig. 8, the static pressure water 2c is supplied from the right static pressure pad 2 (Step S22), the workpiece W is supported by static pressure via the static pressure waters 1c and 2c by the both static pressure pads 1 and 2 at the static pressure supporting positions H1 and H2, and the both grinding wheels 3 and 4 in a rotating state are advanced from the grinding advancing end positions F1 and F2 toward the workpiece W side, to execute a grinding cycle for grinding the workpiece W by the both grinding wheels 3 and 4 (Step S23). The advancing speeds of the both grinding wheel shafts 8 and 9, and the rotating speeds of the both grinding wheels 3 and 4 are the same.

[0041]

Because the clearance A between the right and left both static pressure pads 1 and 2 is determined according to setting by the clearance setting means 19, and the finished thickness B of the workpiece W is determined according to setting by the finished thickness setting means 20, while the grinding cycle

control means 21 is computing the advancing amount S of the grinding wheel shafts 8 and 9 on the basis of the clearance A between the both static pressure pads 1 and 2 and the finished thickness B of the workpiece W, the both grinding wheel shafts 8 and 9 are advanced at the same speed from the right and left grinding advancing end positions F1 and F2, to grind the workpiece W by the both grinding wheels 3 and 4 at the tip ends thereof.

[0042]

At this time, given that the advancing amount S when advancing the grinding wheel shafts 8 and 9 from the right and left grinding advancing end positions F1 and F2 is (A-B)/2, the clearance between the right and left grinding advancing end positions F1 and F2 which are tentatively determined is smaller, by an amount corresponding to the right or left levitation amount C1 or C2, than the clearance A between the right and left both static pressure pads 1 and 2. Therefore, the both grinding wheels 3 and 4 grind the workpiece W too much, which leads to generation of defective products thinner than the predetermined finished thickness B.

[0043]

Then, in order to inhibit generation of such defective products, an offset amount G is input to the grinding cycle

control means 21, the both grinding wheel shafts 8 and 9 are advanced at a constant speed while the advancing amount S when advancing the right and left grinding wheel shafts 8 and 9 from the grinding advancing end positions F1 and F2 is being computed by S = (A-B-G)/2 in order for the both grinding wheel shafts 8 and 9 not to advance by the offset amount G.

[0044]

This offset amount G is preferably the same as the predetermined levitation amount C of the workpiece W. However, because the predetermined levitation amount C of the workpiece W varies according to the advancing speeds of the grinding wheel shafts 8 and 9, the use of the air sensors 6 and 7, and the like, in reality, the offset amount G is set to be greater than the predetermined levitation amount C of the workpiece W for the safety. In addition, provided that the predetermined levitation amount C of the workpiece W according to the advancing speed of the grinding wheel shafts 8 and 9, and each condition of the air sensors 6 and 7 and the like is compiled into a database, and the offset amount G is determined on the basis of the database, it is possible to determine a more precise offset amount G.

[0045]

After grinding the workpiece W by such a grinding cycle, it is judged whether or not the ground workpiece W is finished

with the predetermined grinding precision (Step S24), and when it is finished at the predetermined grinding precision, the grinding is continuously performed (Step S25). Further, when the grinding precision is low, a predetermined adjusting operation such as adjustment of the grinding position by again calculating the grinding advancing end positions F1 and F2 of the grinding wheel shafts 8 and 9, or tilt adjustment of the grinding wheel shafts 8 and 9 is carried out (Step S26), so as to obtain the predetermined grinding precision.

[0046]

Provided that the grinding position of the workpiece W is determined in this way, an operation in which, after the workpiece W is inserted into the carrier 5, and the workpiece W is pressed against one of the static pressure pads 1 and 2, one grinding wheel shaft 8 or 9 on the same side is advanced, to levitate the workpiece W from the one static pressure pad 1 or 2 by one of the grinding wheels 3 and 4, is carried out on the right and left sides respectively, thereby it is possible to align the workpiece W at the middle position between the right and left static pressure pads 1 and 2. Accordingly, it is possible to easily and precisely perform an alignment regardless of the level of skill of an operator, and it is possible to reproduce substantially the same grinding position every

time, which makes it possible to reduce generation of defective products as low as possible.

[0047]

Further, because it is possible to grind the workpiece W by the both grinding wheels 3 and 4 at the middle position between the both static pressure pads 1 and 2, there is the advantage that no trial grinding is required, which makes it possible to reduce the amount of trial grinding workpieces W. Additionally, because an alignment of the workpiece W is performed without rotating the grinding wheels 3 and 4, the workpiece W is not damaged, and the workpieces W for trial grinding may be directly used as products.

[0048]

Moreover, even when the workpiece W warps or is wavy, because the static pressure water 1c or 2c is supplied from one static pressure pad 1 or 2, to press the entire surface of the workpiece W against the other of the static pressure pads 1 and 2, it is possible to perform a precise alignment with no effect by a shape of the workpiece W. Even when the thickness of the workpiece W is not found, it is possible to align the workpiece W at the middle point between the both static pressure pads 1 and 2. Because existing equipment used for static pressure supporting may be utilized for the supply of

the static pressure waters 1c and 2c from the static pressure pads 1 and 2, there are no problems such as bringing about an increase in production cost for an entire horizontal surface grinder.

[0049]

Further, in the case where the grinding wheels 3 and 4 are advanced to levitate the workpiece W, when the grinding wheels 3 and 4 are in rotating state, the wind pressure or the like due to the rotation may become a disturbance, and in addition, the grinding wheels 3 and 4 may grind the workpiece W, to advance the grinding wheel shafts 8 and 9 too much, and the like. However, by advancing the grinding wheel shafts 8 and 9 in a state in which the rotations of the grinding wheels 3 and 4 are stopped, while resolving the problems such as a disturbance due to the rotation of the grinding wheels 3 and 4, and grinding of the workpiece W, it is possible to levitate the workpiece W from the static pressure pads 1 and 2 by utilizing the grinding wheels 3 and 4.

[0050]

A plurality of air sensors 6 and 7 are disposed at, for example, three places in the circumferential direction in the vicinity of the recessed portion 2a, it is possible to detect the levitation amount C1 or C2 of the workpiece W by use of

a sum or an average of output values from the three air sensors 6 and 7, an output from the air sensors 6 and 7 which first reaches a setting value, output values from one or two of the three air sensors 7. However, because one of the air sensors 6 and 7 disposed on the end side in the circumferential direction is used in this embodiment, there is the advantage that it is possible to easily measure the levitation amount C1 or C2 of the workpiece W.

[0051]

That is, in the case where the one grinding wheel 3 is advanced to press the workpiece W, the workpiece W is pressed against by the static pressure water 2c supplied from the other static pressure pad 2. Meanwhile, the workpiece W receives the static pressure water 2c on its substantially entire surface, and on the other hand, the grinding wheel 3 is in the recessed portion 1a of the static pressure pad 1, to press the lower half of the workpiece W. Therefore, as shown in Fig. 10, the workpiece W pressed by the grinding wheel 3 levitates from the static pressure pad 1 while the upper side thereof is going to be inclined to a fulcrum P, and the levitation of the lower side of the workpiece W which is most distant from the fulcrum P is maximized. Accordingly, there is the advantage that it is easy to find a change in the levitation amount C1 or C2 of

the workpiece W, to be able to easily measure it by measuring by the one air sensor 7 on the end side which is disposed so as to correspond to the lower side whose levitating is high, of the workpiece W.

[0052]

Further, in the case where the levitation amount C1 or C2 of the workpiece W is measured by the air sensor 6 or 7, the air sensor 6 or 7 provided to the static pressure pad 1 or 2 on the same side of the grinding wheel 3 or 4 which levitates the workpiece W may be used, or the air sensor 6 or 7 provided to the static pressure pad 1 or 2 on the opposite side may be used.

[0053]

In this case, provided that the air sensor 6 or 7 on the opposite side is used, there is an advantage that even a sensor by which values approximate to zero are out of its measurable range may be used. For example, when the predetermined levitation amount C is a slight amount approximate to zero, which is out of the measurable range, in the case where the air sensor 6 or 7 of the static pressure pad 1 or 2 on the same side is used, even when the levitation amount C1 or C2 of the workpiece W reaches the predetermined levitation amount C, it is impossible to measure it because the amount is out of the

measurable range. However, in the case where the amount is measured by the air sensor 6 or 7 of the static pressure pad 1 or 2 on the opposite side to the grinding wheel 3 or 4, even when a sensor by which values approximate to zero are out of its measurable range is used, a space between the static pressure pad 1 or 2 on the opposite side and the workpiece W is within the measurable range other than the values approximate to zero. Therefore, it is possible to measure the slight levitation amount C1 or C2 of the workpiece W by the air sensors 6 or 7.

[0054]

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, in the embodiments, the grinding wheels 3 and 4 in a stopped state are advanced to press the workpiece W. However, the grinding wheels 3 and 4 may be rotated at rotating speeds to an extent that the workpiece W is not ground. Accordingly, the grinding wheels 3 and 4 preferably press the workpiece W in a stopped state, but are not necessarily in a state in which the rotations are completely stopped.

[0055]

Further, in the case where an existing horizontal surface grinder is adopted, provided that a program of an alignment method as in this embodiment is input to the control device after a grinding wheel replacing work periodically occurring in the production process, it is possible to automatically carry out a work from carrying-in of the workpiece W to carrying-out of the workpiece W after the completion of grinding by combining the carrying-in-and-out means of the workpiece W, and it is possible for an operator to carry out another work away from the machine during that time.

[0056]

Further, a workpiece W of normal dimensions may be used before starting the grinding cycle, and the right and left both grinding wheel shafts 8 and 9 may be advanced by the same amount, and again, an alignment of the both grinding wheels 3 and 4 and the workpiece W may be carried out manually, to thereafter start the grinding cycle. Provided that a grinding cycle using an in-process sizing equipment is used as a grinding cycle, it is possible to omit operations of setting of an offset amount and the like, which makes it possible to more easily grind the workpiece W into normal dimensions.

[0057]

In the grinding cycle using an in-process sizing equipment,

even if a clearance between the right and left both static pressure pads 1 and 2 is not found, it is possible to determine the middle position between the both static pressure pads 1 and 2, and it is possible to obtain the normal dimensions of the workpiece W. Further, the middle position between the right and left both static pressure pads 1 and 2 is not influenced by the clearance A between the right and left both static pressure pads 1 and 2 because the positions of the both grinding wheels 3 and 4 are determined with reference to the workpiece supporting surfaces 1b and 2b of the both static pressure pads 1 and 2.

[0058]

By simultaneously using a technology that, at the same time as a zero point signal at the point in time when the workpiece W reaches the finished dimensions is received from the in-process sizing equipment, output values from the air sensors 6 and 7 of the static pressure pads 1 and 2 are obtained, and it is monitored whether or not there is a difference on the right and left sides in the output values of the air sensors 6 and 7, to correct a grinding position caused by an abrasion difference between the both grinding wheels 3 and 4, provided that the output values from the air sensors 6 and 7 at the time of trial grinding and the output values from the air sensors 6 and 7 before setup (before replacing grinding wheels, and

the like) are compared, to correct so as to be the output values from the air sensors 6 and 7 before setup, it is possible to reproduce the grinding position before setting. Therefore, it is possible to restart the production without producing defective products, which makes it possible to stabilize the grinding precision over a long period of time.

[0059]

Moreover, by using a technology of correcting a misalignment in grinding position before trial grinding, it is possible to stabilize the grinding precision until the next setup by comparison with the output values from the air sensors 6 and 7 before setup in real time during trial grinding, to correct the misalignment.

[0060]

In the present embodiment, the air sensors 6 and 7 included in the static pressure pads 1 and 2 are used as the workpiece position detecting means. Meanwhile, provided that an in-process sizing equipment used during grinding of the workpiece W is adopted, it is possible to obtain the middle position between the right and left both static pressure pads 1 and 2. Any workpiece position detecting means, which is capable of measuring distances between the static pressure pads 1 and 2 and the workpiece W (the levitation amounts C1 and C2)

may be used.

[0061]

The grinder is preferably a horizontal double disk surface grinder in which the both static pressure pads 1 and 2 and the both grinding wheels 3 and 4 are disposed right and left. However, because static pressure water is supplied from the both static pressure pads 1 and 2 to press the workpiece W, so as to levitate the workpiece W by the grinding wheels 3 and 4, the present invention may be achieved in the same way by a vertical double disk surface grinder in which the both static pressure pads 1 and 2 and the both grinding wheels 3 and 4 are disposed up and down.

[Description of Reference Numerals]

[0062]

W Workpiece

1, 2 Static pressure pad

3, 4 Grinding wheel

7 Carrier

8, 9 Grinding wheel shaft

17 Levitation amount setting means

18 Grinding advancing end position tentatively-determining means

19 Clearance setting means

20	Finished thickness setting means
21	Grinding cycle control means
C	Predetermined levitation amount
F1, F2	Grinding advancing end position
S	Advancing amount

[TITLE OF DOCUMENT] WHAT IS CLAIMED IS:

[Claim 1]

A double disk surface grinding method comprising, when grinding both surfaces of a thin disk-shaped workpiece by a pair of grinding wheels while rotating the thin disk-shaped workpiece supported by static pressure by a pair of static pressure pads:

detecting a position of the thin disk-shaped workpiece by workpiece position detecting means while moving the thin disk-shaped workpiece on a side of one of the static pressure pads at static pressure supporting positions toward an advancing direction by one of the grinding wheels on the side of the one of the static pressure pads;

tentatively determining position of the grinding wheel on the side of the one of the static pressure pads when the workpiece position detecting means detects that the thin disk-shaped workpiece is separated by a predetermined distance from the one of static pressure pads, as grinding advancing end position of the grinding wheel on the side of the one of the static pressure pads, and

advancing each of grinding wheels at the same speed from the grinding advancing end positions, to grind the thin disk-shaped workpiece after the tentative determination for

each of the grinding wheels is made and the grinding advancing end positions of each of the grinding wheels are tentatively determined.

[Claim 2]

The double disk surface grinding method according to Claim 1, wherein an operation in which, after the thin disk-shaped workpiece is pressed against one of the static pressure pads at the static pressure supporting positions, the thin disk-shaped workpiece is levitated by a predetermined amount from the one static pressure pad by the grinding wheel whose rotation is stopped while advancing the grinding wheel on the one static pressure pad side, and a position of the grinding wheel when the thin disk-shaped workpiece is levitated by the predetermined amount is tentatively determined as the grinding advancing end position is carried out on each side, and thereafter, the thin disk-shaped workpiece is supported by static pressure by the both static pressure pads.

[Claim 3]

The double disk surface grinding method according to Claim 2, wherein a static pressure fluid is supplied from the other static pressure pad, to press the thin disk-shaped workpiece against the side of the one of the static pressure pads.

[Claim 4]

The double disk surface grinding method according to any of Claims 1 to 3, wherein an offset amount of the both grinding wheels is determined in advance, and the both grinding wheels are set so as not to advance by the offset amount during grinding of the thin disk-shaped workpiece.

[Claim 5]

A double disk surface grinder which grinds both surfaces of a thin disk-shaped workpiece by a pair of grinding wheels while rotating the thin disk-shaped workpiece supported by static pressure by a pair of static pressure pads, the double disk surface grinder comprising:

a pair of workpiece position detecting means for detecting a position at which the thin disk-shaped workpiece is separated by a predetermined distance from the both static pressure pads at static pressure supporting positions;

grinding advancing end position tentatively-determining means for tentatively determining positions of the grinding wheels when the respective workpiece position detecting means detect the position separated by the predetermined distance, as grinding advancing end positions; and

grinding cycle control means for advancing the both grinding wheels at the same speed from the grinding advancing end positions tentatively determined by the grinding advancing

end position tentatively-determining means, to execute a grinding cycle.