

[Document Name] Specification

[Title of the Invention] GRINDING MECHANISM AND GRINDING APPARATUS

[Technical Field]

[0001]

5           The present invention relates to a grinding mechanism and a grinding apparatus.

[Technical Background]

[0002]

          In a case in which a grinding object such as, for example, a resin-sealed substrate  
10   or the like is being ground, in some cases, the grinding object firstly undergoes rough  
grinding and subsequently undergoes finishing grinding.

[0003]

          Conventionally, the rough grinding and finishing grinding are performed  
respectively using mutually separate grinding apparatuses. Alternatively, using a  
15   semiconductor strip grinder equipped with two tables such as that described in Patent  
Document 1, rough grinding may be performed using one table, and finishing grinding  
may be performed using the other table.

[Documents of the Prior Art]

[Patent Documents]

20   [0004]

[Patent Document 1] Japanese Patent Publication No. 6181799

[Disclosure of the Invention]

[Problems to be Solved by the Invention]

[0005]

25           However, in cases in which the rough grinding and the finishing grinding are

performed using separate grinding apparatuses, and also in cases in which, as is described in Patent Document 1, the rough grinding and the finishing grinding are performed on separate tables, after the rough grinding it is necessary to relocate the grinding object to the separate table. In this case, after being relocated, the grinding object must then be  
5 repositioned on the new table. Moreover, even after this repositioning, because the horizontality of the table is not exactly the same before and after the relocation, the flatness of the grinding object that is fixed onto the table in order to be ground is adversely affected, so that the flatness of the grinding object during the rough grinding is different from the flatness of the grinding object during the finishing grinding. As a result of this, there is a  
10 concern that the precision of the grinding will deteriorate. Particularly in cases in which the grinding object is a thin object (for example, 5 mm or less, or 1 mm or less), this flatness (i.e., the grinding precision) is a serious problem.

[0006]

For this reason, a principal object of the present invention is to enable a uniform  
15 flatness to be obtained during both rough grinding and finishing grinding of a grinding object.

[Means for Solving the Problem]

[0007]

Namely, a grinding mechanism according to the present invention is characterized  
20 in being provided with a plurality of tables that hold planar grinding objects, at least one rough grinding unit that performs rough grinding on the grinding object, and at least one finishing grinding unit that performs finishing grinding on the grinding object, wherein the rough grinding unit and the finishing grinding unit are able to be moved to each of the plurality of tables.

25 [Effects of the Invention]

[0008]

According to the present invention which is configured in the above-described manner, it is possible to obtain a uniform flatness during rough grinding and finishing grinding on each of a plurality of tables.

5

[Brief description of the drawings]

[0009]

[FIG. 1] FIG. 1 is a plan view schematically showing a structure of an embodiment  
10 of a grinding apparatus according to the present invention.

[FIG. 2] FIG. 2 is a front view (i.e., looking at a grinding apparatus from the front side thereof) schematically showing a structure of a grinding mechanism of the same embodiment.

[FIG. 3] FIG. 3 is a rear view (i.e., looking at a grinding apparatus from the far side  
15 thereof) schematically showing the structure of the grinding mechanism of the same embodiment.

[FIG. 4] FIG. 4 is a plan view schematically showing: (A) a state in which rough grinding is being performed; and (B) a state in which finishing grinding is being performed in the same embodiment.

20 [FIG. 5] FIG. 5 is a plan view schematically showing a structure: (A) in a case in which finishing grinding units are used in mutual combination; and (B) in a case in which a rough grinding unit and a finishing grinding unit are used in mutual combination in the grinding apparatus according to the present embodiment.

[FIG. 6] FIG. 6 is a plan view schematically showing a structure of a variant  
25 embodiment of the grinding apparatus according to the present invention.

[FIG. 7] FIG. 7 contains a front view and a side view schematically showing a structure of a belt grinding unit of a variant embodiment.

[FIG. 8] FIG. 8 is a schematic view showing a structure of a casing of the belt grinding unit.

5 [FIG. 9] FIG. 9 is a view schematically showing mounting structures for mounting a rough grinding unit, a finishing grinding unit, and a belt grinding unit onto a Z-direction slider.

10 [Best Embodiments for Implementing the Invention]

[0010]

Next, the present invention will be described in greater detail using examples. It should be noted that the present invention is not limited to the following description.

[0011]

15 As is described above, the grinding mechanism of the present invention is characterized in being provided with a plurality of tables that hold planar grinding objects, at least one rough grinding unit that performs rough grinding on the grinding object, and at least one finishing grinding unit that performs finishing grinding on the grinding object, and is characterized in that the rough grinding unit and the finishing grinding unit are able  
20 to be moved to each of the plurality of tables.

By providing this type of grinding mechanism, because a structure is employed in which a rough grinding unit and a finishing grinding unit are able to be moved to each one of a plurality of tables, it is possible to perform both rough grinding and finishing grinding while grinding objects are being held on the respective tables. Consequently, it is not  
25 necessary to relocate a grinding object to a different table, so that the task of repositioning

the grinding object on the different table is also unnecessary, and the flatness in the rough grinding and the finishing grinding can be kept constant at each one of the plurality of tables. As a result, because a plurality of grinding objects can be ground simultaneously, not only is throughput improved, but the grinding precision when grinding the grinding  
5 objects at each table can also be improved.

[0012]

In order to provide a structure in which both rough grinding and finishing grinding can be performed at each table and independently of the other tables, it is desirable that a plurality of the rough grinding units and the finishing grinding units be  
10 provided so as to individually correspond to each one of the plurality of tables.

[0013]

If two tables are provided, then in a case in which rough grinding is performed on one table while finishing grinding is being performed on the other table (in other words, if rough grinding is not being performed simultaneously at both tables, or if finishing  
15 grinding is not being performed simultaneously at both tables), then it is not necessary for individual rough grinding units to be provided for each one of the two tables, or for individual finishing grinding units to be provided for each one of the two tables. For this reason, in order to simplify the structure, it is desirable that at least one of the rough grinding unit or the finishing grinding unit be provided so as to be used in common by at  
20 least two of the tables.

[0014]

In the grinding mechanism of the present invention, as a specific structure that enables a plurality of tables to be moved, consideration may be given to the grinding mechanism being additionally provided with a plurality of table moving units that are  
25 individually provided for each of the plurality of tables, and that move the tables

reciprocatingly in a straight line within a predetermined range in one direction.

In this structure, as a specific structure for moving the rough grinding unit and the finishing grinding unit, consideration may be given to a structure in which the rough grinding unit and the finishing grinding unit move in a direction that crosses the direction in which the tables are moved reciprocatingly by the table moving units. Preferably, consideration may be given to a structure in which the rough grinding unit and the finishing grinding unit move in a direction that is orthogonal to the direction in which the tables are moved reciprocatingly by the table moving units.

[0015]

Because a considerable quantity of rough grinding is performed, clogging of the grindstone used for the rough grinding becomes a problem. Because of this, it is desirable that the rough grinding unit be a horizontal axis type of grinding unit having a grindstone for rough grinding. Note that a horizontal axis type of grinding unit performs grinding in which an axis of rotation of the grindstone is parallel to the table surface.

According to this structure, it is possible to reduce clogging of the grindstone for rough grinding.

[0016]

Moreover, it is also desirable that the finishing grinding unit be a vertical axis type of grinding unit having a grindstone for finishing grinding. Note that a vertical axis type of grinding unit performs grinding in which an axis of rotation of the grindstone is perpendicular to the table surface.

According to this structure, highly precise grinding is possible, and productivity can be increased due to the increased grinding surface area.

[0017]

Depending on the type of grinding object, clogging of the grindstone used for the

rough grinding and of the grindstone used for the finishing grinding may be a serious problem. Moreover, there are also grinding objects for which a high level of grinding precision is not absolutely necessary such as, for example, objects that are only being ground in order to expose a copper wiring portion or a solder portion thereof. In the case of  
5 a grinding object such as this, if both a grindstone for rough grinding and a grindstone for finishing grinding are used, then this leads to an increase in running costs.

In order to appropriately solve this problem, it is desirable that either the rough grinding unit or the finishing grinding unit be a belt-grinding type of grinding unit that uses an endless belt type of grinding belt. A grinding belt is lower in cost compared to a  
10 grindstone for rough grinding and a grindstone for finishing grinding, and enables a major cost reduction to be achieved. In addition, the task of replacing a grinding belt is also easier compared to a grindstone for rough grinding and a grindstone for finishing grinding.  
[0018]

In order to enable a mode of grinding to be selected in accordance with the type of  
15 grinding object, and to also improve the versatility of the grinding mechanism, it is desirable that the rough grinding unit be configured so as to be able to be switched between a horizontal axis type of grinding unit having a grindstone for rough grinding, and a belt-grinding type of grinding unit that uses an endless belt type of grinding belt, and for the finishing grinding unit to be configured so as to be able to be switched between a  
20 vertical axis type of grinding unit having a grindstone for finishing grinding, and a belt-grinding type of grinding unit that uses an endless belt type of grinding belt.  
[0019]

In order to improve the grinding precision by stably supporting the rough grinding unit and the finishing grinding unit, it is desirable that there be further provided a pair of  
25 leg portions that are disposed on either side of the plurality of tables, and a connecting

beam portion that spans a gap between the pair of leg portions, and that the rough grinding unit and the finishing grinding unit be movably supported on the connecting beam.

[0020]

Here, it is desirable that one of the rough grinding unit or the finishing grinding unit be supported on the nearer side of the connecting beam, and that the other one of the rough grinding unit or the finishing grinding unit be supported on the further side of the connecting beam. By employing this structure, any irregularities in the rough grinding due to flexure and the like of the connecting beam can be uniformized, and any irregularities in the finishing grinding due to flexure and the like of the connecting beam can also be uniformized.

[0021]

In addition, in order to improve the versatility of the grinding mechanism, it is desirable that there be further provided a belt-grinding unit that uses an endless belt type of grinding belt and that is separate from the rough grinding unit and the finishing grinding unit, and that this belt-grinding unit be configured so as to be able to move to each one of the plurality of tables.

[0022]

In order to inhibit grinding defects caused by burring, and to improve the quality of a grinding object, it is desirable that the grinding mechanism be further provided with a deburring unit that performs deburring on a grinding object, and that the deburring unit be configured so as to be able to move to each one of the plurality of tables.

[0023]

A grinding apparatus that is provided with the above-described grinding mechanism is an additional aspect of the present invention.

[0024]

[Embodiments of the Present Invention]

Hereinafter, embodiments of the grinding apparatus according to the present invention will be described with reference to the drawings. Note that, in order to make each of the drawings described below easier to understand, the drawings are illustrated in schematic form with portions either omitted or given prominence as is appropriate.

Moreover, component elements having the same structure are given the same descriptive symbols and, when appropriate, any duplicated description thereof is omitted.

[0025]

In the following description, a resin-sealed substrate (i.e., a sealed substrate) is described as an example of a planar grinding object. Examples of the substrate include general substrates such as glass epoxy substrates, ceramic substrates, resin substrates, and metal substrates and the like, and lead frames and the like. In addition to these, the planar grinding object may be an object other than a substrate.

[0026]

[Overall Structure of a Grinding Apparatus 100]

A grinding apparatus 100 of the present embodiment performs surface grinding on a surface of a sealed substrate W (hereinafter, referred to simply as a 'substrate W'). As a result, the grinding apparatus 100 adjusts the height (i.e., adjusts the thickness) of the substrate W, or makes modifications to the substrate such as, for example, improving the heat dissipation of electrical components mounted on the substrate W or the like.

[0027]

More specifically, as is shown in FIG. 1, the grinding apparatus 100 is provided with various component elements including a substrate supply module 100A that supplies substrates W, a substrate grinding module 100B that grinds the substrates W, a substrate cleaning module 100C that cleans substrates W after they have been ground, and a

substrate storage module 100D that stores the ground substrates W. Each of the respective component elements 100A through 100D can be assembled with, or disassembled from each of the other component elements, and can also be replaced. Moreover, the transporting of the substrates W between each of the modules 100A through 100D is performed by a substrate transporting mechanism 100E and/or a robot arm (not shown in the drawings). Overall operations of the grinding apparatus 100 of the present embodiment are controlled by a controller CTL that includes a control unit 9 (described below).

[0028]

10           The substrate supply module 100A supplies substrates W before they are ground (i.e., pre-grinding substrates). More specifically, the substrate supply module 100A is provided with a pre-grinding substrate supply unit 11 that supplies the substrates W.

[0029]

15           The substrate grinding module 100B performs surface grinding on a surface of the substrates W that have been transported by the substrate transporting mechanism 100E and/or a robot arm (not shown in the drawings). More specifically, the substrate grinding module 100B performs both rough grinding and finishing grinding. This is described below in more detail.

[0030]

20           The substrate cleaning module 100C cleans the substrates W after they have been ground (i.e., post-grinding substrates) by the substrate grinding module 100B. More specifically, the substrate cleaning module 100C includes a rotary-type cleaning unit 13 that cleans the ground substrates W using a cleaning liquid such as, for example, water or the like, and a drying unit 14 that dries the cleaned substrates W. In addition to these, it is also possible to provide an inspection unit 15 having a camera that is used to determine

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whether any faults or the like are present in the substrates W in the substrate cleaning module 100C. Note that this inspection unit 15 may also be provided as a separate inspection module independently of the substrate cleaning module 100C.

[0031]

5           The substrate storage module 100D stores substrates W that have been cleaned by the substrate cleaning module 100C, and then transported by the substrate transporting mechanism 100E and/or robot arm (not shown in the drawings). More specifically, the substrate storage module 100D is provided with a post-grinding substrate storage unit 12 that stores the substrates W. Note that, by providing the post-grinding substrate storage  
10   unit 12 in the substrate supply module 100A, the same module can be used for both the substrate storage module 100D and the substrate supply module 100A.

[0032]

[Substrate Grinding Module 100B (Grinding Mechanism)]

Next, the substrate grinding module 100B (i.e., the grinding mechanism) will be  
15   described in detail.

[0033]

As is shown in FIG. 1 through FIG. 3, the substrate grinding module 100B is provided with a plurality of tables 2 that hold the substrates W, a plurality of table moving units 3 that move each one of the plurality of tables 2 reciprocatingly in a straight line, at  
20   least one rough grinding unit 4 that performs rough grinding on the substrates W, and at least one finishing grinding unit 5 that performs finishing grinding on the substrates W. The rough grinding unit 4 and the finishing grinding unit 5 are able to be moved to each one of the plurality of tables 2. Note that in the present embodiment, a structure is employed in which there are two tables 2 and two table moving units 3.

25   [0034]

Each table 2 holds the substrates W by means of suction, and multiple suction holes (not shown in the drawings) that are used to suction the substrate W are formed in an upper surface thereof. Note that the multiple suction holes are connected to a vacuum pump VP. The tables 2 of the present embodiment are formed having a rectangular parallelepiped shape when looked at in plan view so as to correspond to the substrates W which also have a rectangular parallelepiped shape when looked at in plan view.

[0035]

Each table moving unit 3 moves a table 2 reciprocatingly in a straight line within a predetermined range in one direction (i.e., a Y direction). In addition, each table moving unit 3 is able to move a table 2 reciprocatingly in a straight line independently of the other table moving units 3. More specifically, each table moving unit 3 moves a table 2 reciprocatingly in a straight line between a first position P that is set on a nearer side in the Y direction, and a second position Q that is set on a further side in the Y direction. Here, the first position P is the position to which the substrates W are supplied and from which they are removed, however, the first position P may also be set to a different position from the position to which the substrates W are supplied and from which they are removed.

[0036]

Each table moving unit 3 of the present embodiment is configured so as to move the tables 2 in such a way that a longitudinal direction of the tables 2 matches the direction in which the tables 2 are moved reciprocatingly (i.e., the Y direction). Moreover, in order to attain superior grinding precision, it is desirable that each table moving unit 3 not be provided with a mechanism for rotating the tables 2. The two table moving units 3 are provided next to each other in an X direction, and each table moving unit 3 is provided with a Y-direction rail that is provided so as to extend in the Y direction, a Y-direction slider that slides along the Y-direction rail and to which a table 2 is fixed, and a Y-direction

drive unit (for example, a ball screw and servomotor) that drives the Y-direction slider. Note that as a result of the Y-direction drive unit being controlled by the control unit 9 (described below), the table 2 is moved reciprocatingly in a straight line along the Y-direction rail.

5 [0037]

In the present embodiment, at least one rough grinding unit 4 and at least one finishing grinding unit 5 is provided respectively for each one of the plurality of tables 2 (i.e., for each one of the plurality of table moving units 3). More specifically, in the present embodiment, one rough grinding unit 4 and one finishing grinding unit 5 are provided for  
10 one table 2, and one rough grinding unit 4 and one finishing grinding unit 5 are provided for the other table 2.

[0038]

Each rough grinding unit 4 is moved to within the range of movement within which the substrate W can be moved by the corresponding table moving unit 3, and  
15 performs rough grinding on an upper surface of the substrate W. The rough grinding units 4 are horizontal axis type grinding units having a grindstone 41 for rough grinding, and a rotation shaft of a spindle 42 that causes the grindstone 41 for rough grinding to rotate is set so as to be parallel to the table surface. The grindstone 41 for rough grinding has a circular plate shape, and an outer-side circumferential surface thereof forms a working  
20 surface that is used for grinding.

[0039]

Each finishing grinding unit 5 is moved to within the range of movement within which the substrate W can be moved by the corresponding table moving unit 3, and performs finishing grinding on the substrate W. The finishing grinding units 5 are vertical  
25 axis type grinding units having a grindstone 51 for finishing grinding, and a rotation shaft

of a spindle 52 that causes the grindstone 51 for finishing grinding to rotate is set so as to be perpendicular to the table surface. Here, the grindstone 51 for finishing grinding is a finer-grained grindstone than the grindstone 41 for rough grinding. Moreover, the grindstone 51 for finishing grinding has a toroidal shape or a circular plate shape, and one end surface in the axial direction thereof forms a working surface that is used for grinding. In addition, the grindstone 51 for finishing grinding has a radius that is larger than the width dimension of the substrates W.

[0040]

More specifically, each rough grinding unit 4 and each finishing grinding unit 5 is configured so as to move in a direction that crosses the direction in which the tables 2 are moved reciprocatingly (i.e., the Y direction) by the table moving units 3. In the present embodiment, each rough grinding unit 4 and each finishing grinding unit 5 are configured so as to move in an X direction, which is orthogonal to the Y direction, between the first position P and the second position Q.

[0041]

The substrate grinding module 100B of the present embodiment is provided with a flat-arch shaped supporting portion 6 that supports each rough grinding unit 4 and each finishing grinding unit 5 such that these are able to move. As is shown in FIG. 2 and FIG. 3, the supporting portion 6 is provided with a pair of leg portions 61 that are provided on two sides of the two tables 2 (i.e., of the two table moving units 3), and a connecting beam portion 62 that spans the gap between the pair of leg portions 61, and the respective rough grinding units 4 and finishing grinding units 5 are movably supported on the connecting beam portion 62. The connecting beam portion 62 is disposed so as to extend in the X direction between the first position P and the second position Q. In the present embodiment, a structure is employed in which the two rough grinding units 4 are supported

on the nearer side of the connecting beam portion 62, and the two finishing grinding units 5 are supported on the further side of the connecting beam portion 62. By employing this type of structure, the positions in the Y direction where rough grinding is performed on two substrates W are mutually the same, and the positions in the Y direction where finishing grinding is performed on two substrates W are also mutually the same. As a result, any irregularities in the rough grinding due to flexure and the like of the connecting beam 62 can be uniformized at each table 2, and any irregularities in the finishing grinding due to flexure and the like of the connecting beam 62 can also be uniformized at each table 2.

[0042]

Here, as is shown in FIG. 2, a rough grinding unit moving unit 7 is provided between the connecting beam portion 62 and the respective rough grinding units 4, and as is shown in FIG. 3, a finishing grinding unit moving unit 8 is provided between the connecting beam portion 62 and the respective finishing grinding units 5. Note that the rough grinding unit moving unit 7 and the finishing grinding unit moving unit 8 are not shown in FIG. 1.

[0043]

The rough grinding unit moving unit 7 moves the respective rough grinding units 4 in the X direction, and is provided, for example, with an X-direction rail that is provided on the connecting beam portion 62 so as to extend in the X direction, an X-direction slider that moves along the X-direction rail, and an X-direction drive unit that drives the X-direction slider. An X-direction slider and an X-direction drive unit are provided respectively for each of the two rough grinding units 4. Note that one X-direction rail is shared by two rough grinding units 4, however, it is also possible for an X-direction rail to be individually provided for each rough grinding unit 4. Each X-direction drive unit is controlled by the control unit 9 (described below) so that the respective rough grinding

units 4 are moved in the X-direction independently of each other.

[0044]

Moreover, the rough grinding unit moving unit 7 is also configured so as to be able to move the respective rough grinding units 4 in a Z direction, and is provided with a Z-direction rail that is provided on the connecting beam portion 62 so as to extend in the Z direction, a Z-direction slider that moves along the Z-direction rail, and a Z-direction drive unit that drives the Z-direction slider. A Z-direction rail, a Z-direction slider and a Z-direction drive unit are provided respectively for each of the two rough grinding units 4. Each Z-direction drive unit is controlled by the control unit 9 (described below) so that the respective rough grinding units 4 move in the X-direction independently of each other.

[0045]

The finishing grinding unit moving unit 8 moves the respective finishing grinding units 5 in the X direction, and is provided, for example, with an X-direction rail that is provided on the connecting beam portion 62 so as to extend in the X direction, an X-direction slider that moves along the X-direction rail, and an X-direction drive unit that drives the X-direction slider. An X-direction slider and an X-direction drive unit are provided respectively for each of the two finishing grinding units 5. Note that one X-direction rail is shared by two finishing grinding units 5, however, it is also possible for an X-direction rail to be individually provided for each finishing grinding unit 5. Each X-direction drive unit is controlled by the control unit 9 (described below) so that the respective finishing grinding units 5 move in the X-direction independently of each other.

[0046]

Moreover, the finishing grinding unit moving unit 8 is also configured so as to be able to move the respective finishing grinding units 5 in a Z direction, and is provided with a Z-direction rail that is provided on the connecting beam portion 62 so as to extend in the

Z direction, a Z-direction slider that moves along the Z-direction rail, and a Z-direction drive unit that drives the Z-direction slider. A Z-direction rail, a Z-direction slider and a Z-direction drive unit are provided respectively for each of the two finishing grinding units

5 Each Z-direction drive unit is controlled by the control unit 9 (described below) so that the respective finishing grinding units 5 move in the X-direction independently of each other.

[0047]

In the above-described structure, as a result of the control unit 9 controlling each unit, rough grinding and finishing grinding are performed on each one of the substrates W  
10 held on the plurality of tables 2.

[0048]

Hereinafter, the rough grinding and finishing grinding of a substrate W held on a single table 2 will be described in detail.

[0049]

15 When each substrate W is to undergo rough grinding, as is shown in FIG. 4 (A), the control unit 9 causes a rough grinding unit 4 to move to within the range of movement of the substrate W, and performs the rough grinding in a predetermined sequence.

[0050]

The control unit 9 performs rough grinding on the entire upper surface of the  
20 substrate W by controlling the table moving unit 3 so as to move the substrate W reciprocatingly in a straight line, while controlling the rough grinding unit moving unit 7 so that the rough grinding unit 4 is moved in the X direction. For example, the control unit 9 causes the table 2 to move at least once in a straight line, so that rough grinding is performed on the necessary portions of the substrate W in the longitudinal direction  
25 thereof. Thereafter, the rough grinding unit 4 is shifted sideways in the X direction so that

the rough grinding unit 4 is in contact with portions of the substrate W that have not yet been ground, and the table 2 is made to move at least once in a straight line, so that rough grinding is performed in the longitudinal direction once again on the necessary portions of the substrate W. By repeating this process, rough grinding is performed on the entire upper surface of the substrate W.

[0051]

In the above-described rough grinding, the control unit 9 adjusts the amount of rough grinding performed on the substrate W by performing feedback control on the position in the Z direction of the rough grinding unit 4.

10 [0052]

More specifically, based on detected signals from either one or a plurality of contact sensors 10 (see FIG. 1) that are in contact with the substrate W, the control unit 9 performs feedback control on the position in the Z direction of the rough grinding unit 4 such that the thickness of the substrate W reaches a predetermined target value. Contact sensors 10 are provided for each of the tables 2. Here, the thickness of the substrate W may be determined from a difference between the position in the Z direction of the upper surface of the table and the position in the Z direction of the upper surface of the substrate W, or alternatively, may be determined based on the amount of grinding which is determined from the position in the Z direction of the upper surface of the substrate W before grinding and the position in the Z direction of the upper surface of the substrate W after grinding. Note that the sensors used to detect the thickness of the substrate W or the amount of grinding are not limited to being contact sensors, and may instead be another type of displacement sensor such as an optical sensor or the like.

[0053]

25 When each substrate W is to undergo finishing grinding after completing the

rough grinding, as is shown in FIG. 4 (B), the control unit 9 causes a finishing grinding unit 5 to move to within the range of movement of the substrate W, and performs the finishing grinding in a predetermined sequence.

[0054]

5           The control unit 9 performs finishing grinding on the entire upper surface of the substrate W by controlling the finishing grinding unit moving unit 8 so that the grindstone 51 for finishing grinding of the finishing grinding unit 5 is disposed at a position where it is in contact with the substrate W, and controlling the table moving unit 3 so that the substrate W is moved in a straight line. For example, the control unit 9 controls the finishing  
10 grinding unit moving unit 8 so that, after the grindstone 51 for finishing grinding has been disposed at a position where it is in contact with the substrate W over the entire width direction thereof, the control unit 9 controls the table moving unit 3 so that the substrate W is moved at least once in a straight line, and finishing grinding is performed on the substrate W in the longitudinal direction thereof.

15   [0055]

          In the above-described finishing grinding, the control unit 9 adjusts the amount of finishing grinding performed on the substrate W by performing feedback control on the position in the Z direction of the finishing grinding unit. More specifically, based on detected signals from the contact sensors 10 that are in contact with the substrate W, the  
20 control unit 9 performs feedback control on the position in the Z direction of the finishing grinding unit 5 such that the thickness of the substrate W reaches a predetermined target value. Here, the thickness of the substrate W may be determined from a difference between the position in the Z direction of the upper surface of the table and the position in the Z direction of the upper surface of the substrate W, or alternatively, may be determined  
25 based on the amount of grinding which is determined from the position in the Z direction

of the upper surface of the substrate W before the grinding and the position in the Z direction of the upper surface of the substrate W after the grinding.

[0056]

Here, when rough grinding and finishing grinding are performed on substrates W being held on two tables 2, a structure is employed in which the respective rough grinding units 4 and the respective finishing grinding units 5 do not interfere with each other. In the present embodiment, as is shown in FIG. 2, the grindstones 41 for rough grinding of the two rough grinding units 4 (i.e., the horizontal axis type grinding units) are disposed such that inner sides thereof face towards each other, and such that the spindles 42 thereof are positioned on the outer sides thereof.

[0057]

Moreover, when one of the rough grinding unit 4 or finishing grinding unit 5 is grinding a substrate W on each table 2, the control unit 9 retracts the other one of the rough grinding unit 4 or finishing grinding unit 5 to the opposite side (i.e., the outer side) of the other table 2. As a result, movements of the grinding unit 4 or 5 that is performing grinding on the other table 2 are not obstructed. In addition, it is also possible to employ a structure in which, when one of the rough grinding unit 4 or finishing grinding unit 5 is grinding a substrate W, the other one of the rough grinding unit 4 or finishing grinding unit 5 is retracted by being raised up in the Z direction.

[0058]

[Grinding Method]

Next, an example of a grinding method implemented by the grinding apparatus 100 of the present embodiment will be described. In this example, a case is supposed in which rough grinding is performed simultaneously on two tables 2, and subsequently, finishing grinding is performed simultaneously on the two tables 2.

[0059]

Firstly, the substrate transporting mechanism 100E receives substrates W from the pre-grinding substrate supply unit 11 of the substrate storage module 100A, and transports them sequentially to the two tables 2 of the substrate grinding module 100B.

5 Here, the tables 2 use suction to hold the transported substrates W.

In the present embodiment, in order to achieve a high level of grinding precision, the table moving unit 3 is not provided with a mechanism for rotating the tables 2. For this reason, the grinding apparatus 100 is provided with an alignment mechanism that aligns the orientation of the substrates W in the substrate transporting mechanism 100E with the  
10 orientation of the substrates W on the table moving unit 3 (see FIG. 1). The alignment mechanism may be, for example, a rotation mechanism that is provided in the substrate transporting mechanism 100E, or may be a transporting mechanism such as a robot arm or the like that moves a substrate W from the substrate transporting mechanism 100E to the table 2 while simultaneously correctly adjusting the orientation of the substrate W.

15 [0060]

Thereafter, the rough grinding units 4 corresponding to each table 2 are moved to predetermined grinding positions. The table moving unit 3 then moves the tables 2 reciprocatingly in a straight line, and rough grinding is performed on the substrates W. In this rough grinding, based on detected signals from the contact sensors 10, feedback  
20 control is performed on the positions in the Z direction of the rough grinding units 4 such that the thickness of the substrates W reaches a predetermined target value.

[0061]

After the rough grinding has ended, the rough grinding units 4 are retracted to positions outside the range of movement of the tables 2. Next, the finishing grinding units  
25 5 corresponding to each table 2 are moved to predetermined grinding positions. The table

moving unit 3 then moves the tables 2 reciprocatingly in a straight line, and finishing grinding is performed on the substrates W that have completed the rough grinding. In this finishing grinding, based on detected signals from the contact sensors 10, feedback control is performed on the positions in the Z direction of the finishing grinding units 5 such that the thickness of the substrates W reaches a predetermined target value.

[0062]

After the finishing grinding has ended, the substrate transporting mechanism 100E and/or the robot arm (not shown in the drawings) transport the substrates W in sequence to the substrate cleaning module 100C. After the substrates W have been cleaned and inspected in the substrate cleaning module 100C, they are transported to the post-grinding substrate storage unit 12 of the substrate storage module 100D by the substrate transporting mechanism 100E and/or the robot arm (not shown in the drawings).

[0063]

Other grinding methods that may be considered include offsetting the grinding timings at two tables 2 by performing rough grinding and finishing grinding alternately on two tables 2, in other words, by performing rough grinding at one table 2 at the same time as finishing grinding is being performed at the other table 2. Alternatively, performing rough grinding and finishing grinding independently of each other at each table 2 may also be considered as another grinding method.

[0064]

In the case of these methods, the procedure followed when performing rough grinding and finishing grinding at the respective tables 2 is similar to that described above, however, each time the finishing grinding ends, the substrate transporting mechanism 100E and/or the robot arm (not shown in the drawings) transport the substrate W that has completed the finishing grinding to the substrate cleaning module 100C, and transport a

pre-grinding substrate W from the pre-grinding substrate supply unit 11 to the table 2 that is not holding a substrate W.

[0065]

[Effects Obtained from the Present Embodiment]

5           According to the grinding apparatus 100 of the present embodiment, because a structure is employed in which the rough grinding units 4 and the finishing grinding units 5 are able to be moved to each one of the plurality of tables 2, it is possible to perform both rough grinding and finishing grinding on a substrate W while that substrate W is being held on a particular table 2. As a result, it is unnecessary for a substrate W to have to be  
10   relocated to a different table 2, so that it is also unnecessary for the task of repositioning the substrate W on the new table to be performed. As a consequence, the flatness of the rough grinding and the finishing grinding performed at each of the plurality of tables 2 can be uniformized. As a result, by grinding a plurality of substrates W simultaneously, it becomes possible to improve throughput at the same time as the precision of the grinding  
15   of the substrates W at each table 2 is also improved.

[0066]

[Additional Variant Embodiments]

Note that the present invention is not limited to the above-described embodiment.

[0067]

20           For example, as is shown in FIG. 5, it is also possible to employ a structure in which at least one of the rough grinding units 4 and the finishing grinding units 5 are used in common by at least two of the tables 2. For example, as is shown in FIG. 5 (A), a structure may be employed in which rough grinding units 4 are provided respectively for each one of two tables 2, and a single finishing grinding unit 5 is provided to be used in  
25   common by two tables 2. As is shown in FIG. 5 (B), a structure in which a single rough

grinding unit 4 and a single finishing grinding unit 5 are each used in common by two tables 2, and the rough grinding and the finishing grinding are performed alternately at the two tables 2 may also be employed. Furthermore, although not shown in the drawings, a structure in which a finishing grinding unit 5 is provided respectively for each one of two tables 2, and a single rough grinding unit 4 is provided so as to be used in common by two tables 2 may also be employed.

[0068]

Moreover, it is also possible for one of the two rough grinding units 4 to be provided on the nearer side and the other on the further side of the connecting beam portion 62, and for one of the two finishing grinding units 5 to be provided on the nearer side and the other on the further side of the connecting beam portion 62. If this type of structure is employed, then in a case in which rough grinding is performed simultaneously at two tables 2, or alternatively, in a case in which finishing grinding is performed simultaneously at the two tables 2, structurally, the two rough grinding units 4, or the two finishing grinding units 5 can be prevented from interfering with each other's operations.

[0069]

Furthermore, in addition to the above-described embodiment, as is shown in FIG. 6, it is also possible to provide a deburring unit 16 that is moved to within the range of movement within which the substrates W can be moved by the table moving unit 3, and performs deburring on the substrates W. In the same way as the rough grinding units 4 and the finishing grinding units 5, a structure in which the deburring unit 16 is also movably supported on the connecting beam portion 62 may be considered. A structure in which the deburring unit 16 is formed, for example, by brushes may be considered. Here, if the deburring unit 16 is provided, then by combining it with a structure in which a single rough grinding unit 4 or a single finishing grinding unit 5 is used in common by two tables 2, the

installation of the deburring unit 16 can be easily achieved. This deburring unit 16 can also be used in common by two tables 2.

[0070]

The rough grinding unit 4 of the above-described embodiment uses the grindstone 41 for rough grinding, while the finishing grinding unit 5 uses the grindstone 51 for finishing grinding, however, as is shown in FIG. 7, it is also possible for the rough grinding unit 4 or the finishing grinding unit 5 to be a belt grinder (hereinafter, referred to as a 'belt grinding unit 17') that utilizes an endless belt type of grinding belt 171. Note that the grinding belt 171 is formed by joining together both ends of a belt-shaped abrasive cloth on whose surface abrasive grains have been adhered, so as to form a loop-shaped belt.

This grinding belt 171 is low in cost compared to the grindstone 41 for rough grinding and the grindstone 51 for finishing grinding, so that a considerable cost reduction can be achieved. In addition, the task of replacing the grinding belt 171 is easier compared to replacing the grindstone 41 for rough grinding and the grindstone 51 for finishing grinding.

Furthermore, the grinding belt 171 is effective in cases in which the grinding object is one that does not require a high level of grinding precision such as, for example, substrates W that would have a serious clogging problem if the grindstone 41 for rough grinding or the grindstone 51 for finishing grinding were to be used, and substrates W that are only being ground in order, for example, to expose a copper wiring portion or a solder portion, or in cases in which burring created on the grinding object needs to be removed.

[0071]

The belt grinding unit 17 has a drive wheel 174 that is driven to rotate by a drive shaft 173 of a spindle 172, a contact wheel 175, and the endless belt type of grinding belt 171 that is entrained between the wheels 174 and 175. Note that it is also possible for there to be additionally provided a tension wheel 176 that imparts tension to the grinding belt

171. Each of these components 172 to 176 is supported on a base component 170.

[0072]

Moreover, as is shown in FIG. 8, the belt grinding unit 17 also has a cover body 177 that covers the grinding belt 171 such that a portion of the grinding belt 171 is exposed.

5 A lower wall portion 177a of the cover body 177 (i.e., a wall surface thereof that faces the substrate W) is formed having a planar shape, and an aperture portion 177H through which the grinding belt 171 is exposed is formed in the lower wall portion 177a. Here, because the lower wall portion 177a of the cover body 177 is formed having a planar shape that faces the substrate W, any grinding liquid such as water that is supplied from the outside  
10 flows through a space formed between a lower surface of the lower wall portion 177a and the upper surface of the substrate W, and can be efficiently supplied to the portion being ground.

[0073]

In addition, a discharge hole 177c that enables grinding liquid that has penetrated  
15 the interior of the cover body 177 to be discharged to the outside is formed in the lower wall portion 177a or in a lower-side portion of a side wall portion 177b that is connected to the lower wall portion 177a of the cover body 177. Note that, in the same way as for the belt grinding unit 17, it is also possible for cover bodies that cover the rough grinding units 4 and the finishing grinding units 5 in such a way that a portion of the grindstones 41 and  
20 51 are exposed to be provided.

[0074]

As an alternative to a structure in which belt grinding units 17 are used for the rough grinding units 4 and the finishing grinding units 5, it is also possible for the substrate grinding module 100B (i.e., the grinding mechanism) to be additionally provided with the  
25 belt grinding unit 17 which uses the endless belt type of grinding belt 171 as well as with

the rough grinding units 4 and the finishing grinding units 5. This belt grinding unit 17 is formed so as to be able to be moved to each one of the plurality of tables 2 and, in the same way as the rough grinding units 4 and the finishing grinding units 5, may be movably supported on the connecting beam portion 62.

5 [0075]

In addition, it is also possible to employ a structure in which the rough grinding units 4 can be switched between horizontal axis type grinding units having the grindstones 41 for rough grinding and belt-grinding type grinding units that use the endless belt type grinding belts 171, and in which the finishing grinding units 5 can also be switched  
 10 between vertical axis type grinding units having the grindstones 51 for finishing grinding and belt-grinding type grinding units that use the endless belt type grinding belts 171. By making it possible to switch between these different types of grinding units, it becomes possible to select a grinding mode in accordance with the type of substrate W, and to thereby improve the versatility of the substrate grinding module 100B (i.e., the grinding  
 15 mechanism).

[0076]

In this case, as is shown in FIG. 9, it is possible to employ a structure in which a Z-direction moving portion of each rough grinding unit 4 and finishing grinding unit 5 is attached using an attachment component 19a or 19b to the Z-direction slider 18. For  
 20 example, each rough grinding unit 4 may be attached to the Z-direction slider 18 via the attachment component 19a for rough grinding units 4. In the same way, each finishing grinding unit 5 may be attached to the Z-direction slider via the attachment component 19b for finishing grinding units 5. Note that, in FIG. 9, an example is shown in which the belt grinding unit 17 is attached to the Z-direction slider 18 without using an attachment  
 25 component, however, it is also possible for the belt grinding unit 17 to be attached to the

Z-direction slider 18 using an attachment component for a belt grinding unit. By using the attachment components 19a and 19b that correspond to the respective grinding units 4 and 5 in this way, it is possible to switch between a rough grinding unit 4 (i.e., a horizontal axis type) and a belt grinding unit 17, and to also switch between a finishing grinding unit 5 (i.e., a vertical axis type) and a belt grinding unit 17. In FIG. 9, because both the rough grinding unit 4 and the finishing grinding unit 5 use the same Z-direction slider 18 of the Z-direction moving unit, it is possible to switch between a rough grinding unit 4 (i.e., a horizontal axis type), a finishing grinding unit 5 (i.e., a vertical axis type), and a belt grinding unit 17. In addition to this, it is also possible to employ a structure in which the same spindle is used in common as both the horizontal axis type spindle 42 and the spindle 172 of the belt grinding unit 17, and the grindstone 41 for rough grinding and the grinding belt 171 are mutually interchangeable on this common spindle.

[0077]

Furthermore, in addition to the above-described embodiments, it is also possible to provide a polishing grinding unit that has a finer grained polishing grindstone than the grindstone 51 for finishing grinding of the finishing grinding unit 5. This polishing grinding unit is formed so as to be able to be moved to each one of the plurality of tables 2 and, in the same way as the rough grinding units 4 and the finishing grinding units 5, may be movably supported on the connecting beam portion 62.

[0078]

In the above-described embodiments, a structure is employed in which two tables 2 are arranged adjacent to each other, however, it is also possible to employ a structure in which three or more tables 2 are arranged adjacent to each other.

[0079]

In the above-described embodiments, a structure is employed in which a single

type of grinding object W is ground on each of the plurality of tables 2, however, it is also possible to employ a structure in which, by varying the type of grinding object W being ground on each of the plurality of tables 2, a plurality of different types of grinding object W can be ground simultaneously. In this case, the rough grinding units 4 and finishing grinding units 5 that are provided for each table 2 can be appropriately chosen to suit the respective types of grinding object W.

[0080]

Moreover, the rough grinding unit 4 of the above-described embodiments is a horizontal axis type of grinding unit, however, it may instead be a vertical axis type of grinding unit. In the same way, the finishing grinding unit 5 of the above-described embodiments is a vertical axis type of grinding unit, however, it may instead be a horizontal axis type of grinding unit. In addition, by switching the grindstone attached to the spindle of the grinding unit between, for example, a grindstone for rough grinding and a grindstone for finishing grinding, the rough grinding units and the finishing grinding units can be set up in a variety of different ways.

[0081]

Moreover, it is also possible for a rotating unit that rotates the grinding units to be provided between each grinding unit and grinding unit moving unit. This rotating unit rotates the axis of rotation of the grinding unit 90 degrees so as to switch the grinding unit between being a horizontal axis type and a vertical axis type of grinding unit.

[0082]

In addition, the supporting portion 6 of the above-described embodiments is shaped as a flat arch, however, it may instead be formed in a cantilever shape having a single leg portion and a beam portion that extends out from this leg portion.

25 [0083]

Furthermore, it should be understood that the present invention is not limited to the above-described embodiment, and that various modifications and the like may be made thereto insofar as they do not depart from the spirit or scope of the present invention.

[Description of the Reference Numerals]

5 [0084]

100 ... Grinding Apparatus

W ... Planar Grinding object

100B ... Substrate Grinding Module (Grinding Mechanism)

2 ... Table

10 3 ... Table Moving Unit

4 ... Rough Grinding Unit

41 ... Grindstone for Rough Grinding

5 ... Finishing Grinding Unit

51 ... Grindstone for Finishing Grinding

15 61 ... Pair of Leg Portions

62 ... Connecting Beam Portion

7 ... Rough Grinding Unit Moving Unit

8 ... Finishing Grinding Unit Moving Unit

9 ... Control Unit

20 16 ... Deburring Unit

17 ... Belt Grinding Unit

171 ... Grinding Belt

What is claimed is:

1. A grinding mechanism comprising:  
a plurality of tables that hold planar grinding objects;  
5 at least one rough grinding unit that performs rough grinding on the grinding object; and  
at least one finishing grinding unit that performs finishing grinding on the grinding object, wherein  
the rough grinding unit and the finishing grinding unit are able to be moved to  
10 each of the plurality of tables.
2. The grinding mechanism according to Claim 1, wherein at least one of the rough grinding unit or the finishing grinding unit is provided on each one of the plurality of tables.
3. The grinding mechanism according to Claim 1, wherein at least one of the rough  
15 grinding unit or the finishing grinding unit is provided so as to be used in common by at least two of the tables.
4. The grinding mechanism according to any one of Claim 1 through Claim 3, further comprising a plurality of table moving units that are individually provided for each of the plurality of tables, and that move the tables reciprocatingly in a straight line within a  
20 predetermined range in one direction, and  
the rough grinding unit and the finishing grinding unit move in a direction that crosses the direction in which the tables are moved reciprocatingly by the table moving units.
5. The grinding mechanism according to any one of Claim 1 through Claim 4,  
25 wherein the rough grinding unit is a horizontal axis type of grinding unit having a

grindstone for rough grinding, and

the finishing grinding unit is a vertical axis type of grinding unit having a grindstone for finishing grinding.

6. The grinding mechanism according to any one of Claim 1 through Claim 4,

5 wherein either the rough grinding unit or the finishing grinding unit is a belt-grinding type of grinding unit that uses an endless belt type of grinding belt.

7. The grinding mechanism according to any one of Claim 1 through Claim 4,

wherein the rough grinding unit is configured so as to be able to be switched between a horizontal axis type of grinding unit having a grindstone for rough grinding, and a

10 belt-grinding type of grinding unit that uses an endless belt type of grinding belt, and

the finishing grinding unit is configured so as to be able to be switched between a vertical axis type of grinding unit having a grindstone for finishing grinding, and a belt-grinding type of grinding unit that uses an endless belt type of grinding belt.

8. The grinding mechanism according to any one of Claim 1 through Claim 7,

15 further comprising:

a pair of leg portions that are provided on either side of the plurality of tables; and

a connecting beam portion that spans a gap between the pair of leg portions,

wherein

the rough grinding unit and the finishing grinding unit are movably supported on

20 the connecting beam.

9. The grinding mechanism according to Claim 8, wherein one of the rough grinding unit or the finishing grinding unit is supported on the nearer side of the connecting beam, while the other one of the rough grinding unit or the finishing grinding unit is supported on the further side of the connecting beam.

25 10. The grinding mechanism according to any one of Claim 1 through Claim 9,

further comprising a belt-grinding unit that uses an endless belt type of grinding belt and that is separate from the rough grinding unit and the finishing grinding unit, and

the belt-grinding unit is configured so as to be able to move to each one of the plurality of tables.

5 11. The grinding mechanism according to any one of Claim 1 through Claim 10, further comprising a deburring unit that performs deburring on a grinding object, and

the deburring unit is configured so as to be able to move to each one of the plurality of tables.

12. A grinding apparatus comprising the grinding mechanism according to any one of

10 Claim 1 through Claim 11.