

AUXILIARY APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an auxiliary apparatus coupled to a cutting apparatus.

Description of the Related Art

A wafer having a plurality of devices such as integrated circuits (ICs) or large-scale integration (LSI) circuits formed on the top surface of the wafer in such a manner as to be demarcated by a plurality of intersecting planned dividing lines is divided into individual device chips by a cutting apparatus. Each of the divided device chips is used in an electric apparatus such as a mobile telephone or a personal computer.

The cutting apparatus includes a chuck table having a holding surface for holding the wafer, a cutting unit to which a cutting blade for cutting the wafer held on the chuck table is fitted by a fixing nut, X-axis feeding means for processing-feeding the chuck table in an X-axis direction, Y-axis feeding means for indexing-feeding the cutting unit in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting unit in a Z-axis direction orthogonal

to the X-axis direction and the Y-axis direction. The holding surface is defined by the X-axis direction and the Y-axis direction. The cutting apparatus can divide the wafer into the individual device chips with high accuracy.

In addition, the present applicant has proposed an automatic replacing apparatus that can automatically replace a cutting blade fitted to a cutting unit with a different one (see, for example, Japanese Patent Laid-Open No. 2007-98536).

SUMMARY OF THE INVENTION

However, there is a problem of difficulty in fitting the automatic replacing apparatus afterward to a cutting apparatus already delivered to a user.

It is therefore an object of the present invention to provide an auxiliary apparatus that can automatically replace a cutting blade with a different one and that can be fitted afterward to a cutting apparatus already delivered to a user.

In accordance with an aspect of the present invention, there is provided an auxiliary apparatus coupled to a cutting apparatus, the cutting apparatus including a chuck table having a holding surface

configured to hold a workpiece, a cutting unit to which a cutting blade configured to cut the workpiece held on the chuck table is fitted by a fixing nut, X-axis feeding means for processing-feeding the chuck table in an X-axis direction, Y-axis feeding means for indexing-feeding the cutting unit in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting unit in a Z-axis direction orthogonal to the X-axis direction and the Y-axis direction, the holding surface being defined by the X-axis direction and the Y-axis direction, the auxiliary apparatus including a cutting blade storage unit configured to store a plurality of cutting blades, a loading and unloading unit configured to unload and load a cutting blade from the cutting blade storage unit, a Y-axis direction positioning unit configured to position the loading and unloading unit at an action position and a retracted position in the Y-axis direction with respect to the cutting blade storage unit, a Z-axis moving mechanism configured to move the loading and unloading unit in the Z-axis direction; and an X-axis moving mechanism configured to move the loading and unloading unit in the X-axis direction to make the loading and unloading unit act on the cutting blade fitted to a spindle of the

cutting unit.

Preferably, the cutting blade storage unit includes a driving gear that has a first rotary shaft extending in the Y-axis direction, a driven gear that is separated from the driving gear in the Z-axis direction and that has a second rotary shaft extending in the Y-axis direction, a caterpillar that is wound around the driving gear and the driven gear, and supporting shafts that are arranged on the caterpillar at predetermined intervals, that are configured to be inserted into a central opening portion of a cutting blade to support the cutting blade, and that extend in the Y-axis direction. Preferably, an interval in the Z-axis direction between the driving gear and the driven gear is adjustable, and a length of the caterpillar is adjustable.

Preferably, the loading and unloading unit includes a Z rotary shaft extending in the Z-axis direction, blade holding units radially coupled to the Z rotary shaft and configured to hold under suction a cutting blade, and a fixing nut holding unit configured to screw and unscrew the fixing nut onto and from a male thread formed on a distal end of the spindle, and two blade holding units are provided for one fixing nut holding unit.

Preferably, the loading and unloading unit is

disposed in a frame body, and the frame body is slidably supported by a guide rail that is disposed on a raising and lowering table and that extends in the Y-axis direction, and is positioned at the action position and the retracted position in the Y-axis direction with respect to the cutting blade storage unit by the Y-axis direction positioning unit.

Preferably, the loading and unloading unit is disposed on a first moving body disposed within the frame body, the first moving body is slidably supported in a suspended state by a first guide rail that is disposed on a lower portion of a second moving body and that extends in the X-axis direction, the second moving body is slidably supported in a suspended state by a second guide rail that is disposed on a ceiling portion of the frame body and that extends in the X-axis direction, and the loading and unloading unit is configured to be advanced freely in the X-axis direction by the first moving body and the second moving body.

Preferably, a bottom portion of the frame body is provided with a dressing board housing portion configured to house a dressing board for dressing a cutting blade, and the first moving body is provided with holding means for holding the dressing board housed in the dressing

board housing portion.

Preferably, the bottom portion of the frame body is provided with an end surface correcting jig housing portion configured to house an end surface correcting jig configured to shape a peripheral end surface of a mount flange that is formed at a distal end of the spindle of the cutting unit and that supports a back portion of the cutting blade, and the end surface correcting jig is held by the holding means provided to the first moving body.

The auxiliary apparatus according to the present invention can be fitted afterward to a cutting apparatus already delivered to a user.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an auxiliary apparatus according to an embodiment of the present invention;

FIG. 2 is an exploded perspective view of a cutting blade storage unit illustrated in FIG. 1;

FIG. 3 is a perspective view of a supporting shaft illustrated in FIG. 2;

FIG. 4 is a sectional view of a supporting shaft illustrated in FIG. 2;

FIG. 5 is a perspective view of a loading and unloading unit illustrated in FIG. 1;

FIG. 6 is an exploded perspective view of a frame body, a raising and lowering table, and a base frame illustrated in FIG. 1;

FIG. 7 is an exploded perspective view of the frame body illustrated in FIG. 1;

FIG. 8 is an exploded perspective view of the frame body provided with holding means;

FIG. 9 is a perspective view of dressing boards and end surface correcting jigs illustrated in FIG. 8;

FIG. 10 is a perspective view of a cutting apparatus to which the auxiliary apparatus illustrated in FIG. 1 is to be coupled;

FIG. 11 is a perspective view of a chuck table illustrated in FIG. 10;

FIG. 12 is a perspective view of cutting units illustrated in FIG. 10;

FIG. 13 is a perspective view of a cutting unit illustrated in FIG. 12 that is in a state in which a blade cover is opened;

FIG. 14 is an exploded perspective view of a cutting unit illustrated in FIG. 10;

FIG. 15 is a perspective view illustrating a state in which the auxiliary apparatus illustrated in FIG. 1 is coupled to the cutting apparatus illustrated in FIG. 10;

FIG. 16 is a perspective view illustrating a state in which the cutting blade storage unit and the loading and unloading unit of the auxiliary apparatus illustrated in FIG. 1 face each other;

FIG. 17 is a perspective view illustrating a state in which the frame body is advanced toward the cutting blade storage unit from the state illustrated in FIG. 16;

FIG. 18 is a perspective view illustrating a state in which the frame body is retreated from the state illustrated in FIG. 17 and the raising and lowering table is raised;

FIG. 19 is a perspective view illustrating a state in which a first moving body is advanced toward the cutting apparatus from the state illustrated in FIG. 18;

FIG. 20 is a perspective view illustrating a state in which a second moving body is advanced toward the

cutting apparatus from the state illustrated in FIG. 19;

FIG. 21 is a perspective view illustrating a state in which dressing boards are being loaded by the loading and unloading unit illustrated in FIG. 8; and

FIG. 22 is a perspective view illustrating a state in which end surface correcting jigs are being loaded by the loading and unloading unit illustrated in FIG. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An auxiliary apparatus according to an embodiment of the present invention will hereinafter be described with reference to the drawings. Described with reference to FIG. 1, the auxiliary apparatus indicated in entirety by a reference numeral 2 includes at least a cutting blade storage unit 4 that stores a plurality of cutting blades; a loading and unloading unit 6 that unloads and loads a cutting blade from the cutting blade storage unit 4; a Y-axis direction positioning unit 8 that positions the loading and unloading unit 6 at an action position and a retracted position in a Y-axis direction with respect to the cutting blade storage unit 4; a Z-axis moving mechanism 10 that moves the loading and unloading unit 6 in a Z-axis direction; and an X-axis moving mechanism 12 that moves the loading and unloading unit 6

in an X-axis direction to make the loading and unloading unit 6 act on a cutting blade fitted to a spindle of a cutting unit of a cutting apparatus. Incidentally, the X-axis direction is a direction indicated by an arrow X in FIG. 1, the Y-axis direction is a direction indicated by an arrow Y in FIG. 1 and is a direction orthogonal to the X-axis direction, and the Z-axis direction is a direction indicated by an arrow Z in FIG. 1 and is an upward-downward direction orthogonal to the X-axis direction and the Y-axis direction. In addition, a plane defined by the X-axis direction and the Y-axis direction is substantially horizontal.

As illustrated in FIG. 2, the cutting blade storage unit 4 includes a driving gear 16 that has a rotary shaft 14 extending in the Y-axis direction; a driven gear 20 that is separated from the driving gear 16 in the Z-axis direction and has a rotary shaft 18 extending in the Y-axis direction; a caterpillar 22 that is wound around the driving gear 16 and the driven gear 20; and supporting shafts 24 that are arranged on the caterpillar 22 at predetermined intervals, are inserted into a central opening portion of a cutting blade to support the cutting blade, and extend in the Y-axis direction.

Described with reference to FIG. 1 and FIG. 2, the

cutting blade storage unit 4 in the present embodiment includes a base plate 26 (see FIG. 1), a supporting wall 28 extending upward from the upper surface of the base plate 26, and a motor 30 fixed to one surface of the supporting wall 28. As illustrated in FIG. 2, the rotary shaft 14 of the driving gear 16 is coupled to the motor 30, and the motor 30 rotates the driving gear 16 with the Y-axis direction as an axis.

As illustrated in FIG. 2, the driven gear 20 is disposed above the driving gear 16, and the rotary shaft 18 of the driven gear 20 is supported by the supporting wall 28 in such a manner as to be rotatable with the Y-axis direction as an axis and raisable and lowerable in the Z-axis direction. The supporting wall 28 is provided with raising and lowering means (not illustrated) for raising and lowering the driven gear 20 in the Z-axis direction. It suffices for the raising and lowering means to have a configuration including a ball screw that is coupled to the rotary shaft 18 of the driven gear 20 and that extends in the Z-axis direction and a motor that rotates the ball screw.

The caterpillar 22 includes a large number of link pieces (whose reference numeral is omitted) coupled to one another. The caterpillar 22 is wound around the

driving gear 16 and the driven gear 20. The caterpillar 22 is rotated according to rotation of the driving gear 16 by the motor 30.

The cutting blade storage unit 4 in the present embodiment allows an interval in the Z-axis direction between the driving gear 16 and the driven gear 20 to be adjusted by changing the position in the Z-axis direction of the driven gear 20 by the raising and lowering means. In addition, the cutting blade storage unit 4 allows also the length of the caterpillar 22 to be adjusted by increasing or decreasing the quantity of the link pieces of the caterpillar 22 as appropriate.

As illustrated in FIG. 2, a plurality of the supporting shafts 24 are arranged on the caterpillar 22 at predetermined intervals. In addition, as is understood by reference to FIG. 3 in conjunction with FIG. 2, a supporting shaft 24 includes a cylindrical base portion 32 coupled to the caterpillar 22 and a cylindrical shaft portion 34 extending in the Y-axis direction from an end surface of the base portion 32. The diameter of the shaft portion 34 is smaller than the diameter of the base portion 32.

FIG. 3 also illustrates cutting blades 36 supported by the supporting shaft 24. The cutting blade 36 includes

an annular base 38 and an annular cutting edge 40 fixed to an outer circumferential portion of the base 38. The base 38 can be formed of a suitable metallic material such as an aluminum alloy. A central portion of the base 38 is provided with a circular central opening portion 38a. The cutting edge 40 is formed of abrasive grains of diamond or the like and a binding material such as metal or resin and is formed with a predetermined thickness (for example, approximately 10 to 30 μm). The cutting edge 40 projects radially outward from an outer circumferential edge of the base 38.

The supporting shaft 24 has the shaft portion 34 inserted into the central opening portion 38a of the cutting blade 36. The supporting shaft 24 supports a plurality of (for example, five) cutting blades 36 by the shaft portion 34. In the present embodiment, as is understood by reference to FIG. 2, half of the plurality of supporting shafts 24 support cutting blades 36. In addition, as illustrated in FIG. 3, a plurality of ball plungers 42 for preventing the cutting blades 36 supported by the shaft portion 34 from springing out are fitted to a distal end side of the shaft portion 34 at intervals in a circumferential direction.

As illustrated in FIG. 4, flow passages 32a are

formed within the respective base portions 32 of the supporting shafts 24, and a plurality of flow passages 22a communicating with one end portion of each flow passage 32a are formed in the caterpillar 22. As illustrated in FIG. 3, another end portion of each flow passage 32a opens in an end surface of the base portion 32 which is radially outward of the shaft portion 34. In addition, as illustrated in FIG. 2, the supporting wall 28 is provided with an air nozzle 44 that projects in the Y-axis direction below the driving gear 16. The air nozzle 44 is connected to high pressure air supply means (not illustrated). In the present embodiment, a supporting shaft 24 positioned at a lowermost end in the orbit of the supporting shafts 24 as the caterpillar 22 rotates and a distal end of the air nozzle 44 face each other.

When a cutting blade 36 located on the distal end side of the shaft portion 34 is unloaded, the cutting blades 36 remaining on the shaft portion 34 can be pushed out to the distal end side of the shaft portion 34 by supply of high pressure air to the flow passages 32a of the base portion 32 of the supporting shaft 24 located at the lowermost end, from the air nozzle 44 via a flow passage 22a of the caterpillar 22. However, due to the

action of the ball plungers 42, the cutting blade 36 does not drop off from the shaft portion 34.

The loading and unloading unit 6 will be described with reference to FIG. 5. The loading and unloading unit 6 includes at least a Z rotary shaft 46 extending in the Z-axis direction; blade holding units 48 that are radially coupled to the Z rotary shaft 46 and hold under suction a cutting blade 36; and fixing nut holding units 50 that screw and unscrew a fixing nut onto and from a male thread formed on the distal end of a spindle of the cutting apparatus.

As illustrated in FIG. 5, the loading and unloading unit 6 in the present embodiment further includes a casing 52, and the casing 52 includes a top 54 in a regular hexagonal shape and six side walls 56 in a rectangular plate shape which hang down from the peripheral edge of the top 54. The above-described Z rotary shaft 46 projects from the upper surface of the top 54. A motor (not illustrated) coupled to the Z rotary shaft 46 is housed within the casing 52.

In the present embodiment, of the six side walls 56 of the casing 52, four side walls 56 are fitted with the blade holding units 48, and two side walls 56 are fitted with the fixing nut holding units 50. The two fixing nut

holding units 50 are provided to a pair of side walls 56 opposed to each other. The loading and unloading unit 6 thus has two blade holding units 48 for one fixing nut holding unit 50.

The blade holding units 48 are formed in a cylindrical shape. An end surface 58 of a blade holding unit 48 is provided with a circular central opening portion 60 capable of receiving the shaft portion 34 of the above-described supporting shaft 24 and a distal end portion of the spindle of the cutting apparatus and a plurality of suction holes 62 arranged on the periphery of the central opening portion 60 at equal intervals in a circumferential direction. Each suction hole 62 is connected to suction means (not illustrated).

In a state in which the blade holding unit 48 is positioned at a position where the end surface 58 of the blade holding unit 48 is in contact with the base 38 of a cutting blade 36 stored in the cutting blade storage unit 4, the blade holding unit 48 holds under suction the cutting blade 36 by generation of a suction force in each suction hole 62 by the suction means.

Continuously described with reference to FIG. 5, the fixing nut holding unit 50 includes a cylindrical housing 64 fixed to a side wall 56 of the casing 52; an

annular rotating body 66 rotatably housed within the housing 64; and a motor (not illustrated) that rotates the rotating body 66.

A central opening portion 68 capable of receiving the distal end portion of the spindle of the cutting apparatus is formed in the rotating body 66. An end surface 66a of the rotating body 66 is provided with a plurality of suction holes 70 and a plurality of pins 72 alternately at intervals in a circumferential direction. Each suction hole 70 is connected to suction means (not illustrated). The pins 72 are positioned at positions (positions illustrated in FIG. 5) where the pins 72 project from the end surface 66a of the rotating body 66 by springs (not illustrated) included in the rotating body 66, and are housed into the rotating body 66 with the springs contracted when the pins 72 are pushed to the inside of the rotating body 66. In addition, the pins 72 are arranged in such a manner as to correspond to the positions of pin holes formed in a fixing nut.

The fixing nut holding unit 50 can screw and unscrew the fixing nut for fixing a cutting blade 36 to the spindle of the cutting apparatus onto and from the male thread formed at the distal end of the spindle by generation of a suction force in each suction hole 70 by

the suction means to thereby hold under suction the fixing nut and rotation of the rotating body 66 by the motor in a state in which the pins 72 are inserted in the pin holes formed in the fixing nut.

Incidentally, even in a case where the positions of the pins 72 of the fixing nut holding unit 50 and the positions of the pin holes of the fixing nut are displaced from each other when the fixing nut is to be unscrewed (removed) from the spindle, when the rotating body 66 is rotated by the motor after the pins 72 are housed within the rotating body 66 by positioning the end surface 66a of the rotating body 66 at the end surface of the fixing nut fitted to the spindle, the pins 72 are pushed out by the springs at a time when the positions of the pins 72 match the positions of the pin holes, so that the pins 72 are inserted into the pin holes.

In the present embodiment, as illustrated in FIG. 1, the loading and unloading unit 6 that can be configured as described above is disposed within a frame body 74. The frame body 74 is supported by a raising and lowering table 76 in such a manner as to be movable in the Y-axis direction. The raising and lowering table 76 is supported by a base frame 78 in such a manner as to be raisable and lowerable in the Z-axis direction.

Described with reference to FIG. 6 in conjunction with FIG. 1, the frame body 74 includes a bottom portion 80 in a rectangular plate shape; four columns 82 extending upward from four corners of the upper surface of the bottom portion 80; and a plate-shaped ceiling portion 84 (see FIG. 1) fixed to an upper end of each column 82. The undersurface of the bottom portion 80 is provided with a pair of guided members 86 in which grooves 86a extending in the Y-axis direction are formed with an interval in the X-axis direction.

The raising and lowering table 76 includes a top 88 in a rectangular plate shape and four cylindrical leg portions 90 extending downward from four corners of the undersurface of the top 88. The upper surface of the top 88 is provided with a pair of guide rails 92 extending in the Y-axis direction at an interval in the X-axis direction. The pair of guide rails 92 are slidably fitted to the grooves 86a of the pair of guided members 86 of the frame body 74.

In addition, the upper surface of the top 88 of the raising and lowering table 76 is provided with the Y-axis direction positioning unit 8. The Y-axis direction positioning unit 8 includes a ball screw 94 extending in the Y-axis direction between the pair of guide rails 92

and a motor 96 that rotates the ball screw 94. A nut portion (not illustrated) of the ball screw 94 is fixed to the lower surface of the bottom portion 80 of the frame body 74.

The Y-axis direction positioning unit 8 converts rotary motion of the motor 96 into rectilinear motion by the ball screw 94, and transmits the rectilinear motion to the frame body 74. The Y-axis direction positioning unit 8 thereby moves the frame body 74 in the Y-axis direction along the pair of guide rails 92. Thus, the frame body 74 in which the loading and unloading unit 6 is disposed is slidably supported by the guide rails 92 that are disposed on the raising and lowering table 76 and extend in the Y-axis direction, and is positioned at the action position and the retracted position in the Y-axis direction with respect to the cutting blade storage unit 4 by the Y-axis direction positioning unit 8.

The above-described action position is a position where a blade holding unit 48 of the loading and unloading unit 6 is close to the cutting blade storage unit 4, and is a position where the blade holding unit 48 can hold under suction a cutting blade 36 supported by the cutting blade storage unit 4. In addition, the above-described retracted position is a position where the

blade holding unit 48 of the loading and unloading unit 6 is more separated from the cutting blade storage unit 4 than at the above-described action position.

As illustrated in FIG. 6, the base frame 78 includes a frame 98 and a rectangular base plate 100 fixed to an upper portion of the frame 98. Four circular holes 102 into which the leg portions 90 of the raising and lowering table 76 are slidably inserted are formed at four corners of the base plate 100. In addition, a female screw 104 is formed in a central portion of the base plate 100.

Continuously described with reference to FIG. 6, the Z-axis moving mechanism 10 is coupled to the raising and lowering table 76 and the base frame 78. The Z-axis moving mechanism 10 includes a ball screw 106 extending in the Z-axis direction, a motor 108 that rotates the ball screw 106, and a coupling plate 110 fixed to an upper end of the motor 108. The ball screw 106 is screwed in the female screw 104 of the base plate 100. The coupling plate 110 is fixed to the lower surface of the top 88 of the raising and lowering table 76 by suitable coupling means such as bolts (not illustrated).

The Z-axis moving mechanism 10 converts rotary motion of the motor 108 into rectilinear motion by the

ball screw 106, and thus raises or lowers the raising and lowering table 76 with respect to the base frame 78. The Z-axis moving mechanism 10 thereby moves, in the Z-axis direction, the frame body 74 in which the loading and unloading unit 6 is disposed.

Described with reference to FIG. 7, the loading and unloading unit 6 is disposed on a first moving body 112 disposed within the frame body 74. The first moving body 112 is slidably supported in a suspended state by first guide rails 116 that are disposed on a lower portion of a second moving body 114 and that extend in the X-axis direction. The second moving body 114 is slidably supported in a suspended state by second guide rails 118 that are disposed on the ceiling portion 84 of the frame body 74 and that extend in the X-axis direction.

The first moving body 112 has a main body 120 in a rectangular plate shape. A circular hole 122 is formed in a central portion of the main body 120. The Z rotary shaft 46 of the loading and unloading unit 6 is inserted into the circular hole 122. The Z rotary shaft 46 is fixed to the main body 120 in a non-rotatable manner. When the motor of the loading and unloading unit 6 which motor is coupled to the Z rotary shaft 46 is driven, the casing 52 of the loading and unloading unit 6 rotates

with respect to the first moving body 112, so that the blade holding units 48 and the fixing nut holding units 50 are positioned in any orientation.

A pair of guided members 124 in which grooves 124a extending in the X-axis direction are formed are provided to the upper surface of the main body 120 of the first moving body 112 with an interval in the Y-axis direction, and a block 126 in which a through hole 126a extending in the X-axis direction is formed is fixed to the upper surface of the main body 120 of the first moving body 112.

The second moving body 114 has a main body 128 in a rectangular plate shape. A pair of the first guide rails 116 are provided to the lower surface of the main body 128 with an interval in the Y-axis direction. The first guide rails 116 are slidably fitted to the grooves 124a of the pair of guided members 124 of the first moving body 112. The first moving body 112 is slidably supported in a suspended state by the first guide rails 116 provided to the second moving body 114.

A first X-axis moving mechanism that moves the first moving body 112 in the X-axis direction with respect to the second moving body 114 is provided under the main body 128 of the second moving body 114. The

first X-axis moving mechanism in the present embodiment includes an air cylinder 130. A cylinder tube 130a of the air cylinder 130 is fixed to the lower surface of the main body 128, and extends in the X-axis direction between the pair of first guide rails 116. A distal end of a piston rod 130b of the air cylinder 130 is fitted and coupled to the through hole 126a of the block 126 of the first moving body 112.

The air cylinder 130 as the first X-axis moving mechanism moves the first moving body 112 with respect to the second moving body 114 in the X-axis direction along the first guide rails 116 by advancing or retreating the piston rod 130b.

A pair of guided members 132 in which grooves 132a extending in the X-axis direction are formed are provided to the upper surface of the main body 128 of the second moving body 114 at an interval in the Y-axis direction, and a block 134 in which a female thread 134a extending in the X-axis direction is formed is fixed to the upper surface of the main body 128 of the second moving body 114.

A pair of the second guide rails 118 are provided to the lower surface of the ceiling portion 84 of the frame body 74 with an interval in the Y-axis direction.

The second guide rails 118 are slidably fitted to the grooves 132a of the pair of guided members 132 of the second moving body 114. The second moving body 114 is slidably supported in a suspended state by the second guide rails 118 provided to the ceiling portion 84.

A second X-axis moving mechanism 136 that moves the second moving body 114 in the X-axis direction with respect to the ceiling portion 84 is provided under the ceiling portion 84 of the frame body 74. The second X-axis moving mechanism 136 in the present embodiment includes a ball screw 138 extending in the X-axis direction between the pair of second guide rails 118 and a motor 140 that rotates the ball screw 138. The ball screw 138 is screwed in the female thread 134a of the block 134 of the second moving body 114. The motor 140 is fixed to the lower surface of the ceiling portion 84.

The second X-axis moving mechanism 136 converts rotary motion of the motor 140 into rectilinear motion by the ball screw 138, and transmits the rectilinear motion to the second moving body 114. The second X-axis moving mechanism 136 thereby moves the second moving body 114 with respect to the ceiling portion 84 in the X-axis direction along the second guide rails 118.

The X-axis moving mechanism 12 in the present

embodiment includes the air cylinder 130 as the first X-axis moving mechanism and the second X-axis moving mechanism 136 including the ball screw 138 and the motor 140. In the present embodiment, the loading and unloading unit 6 can be swiftly advanced in the X-axis direction by moving the first moving body 112 by the air cylinder 130 as the first X-axis moving mechanism, and the X-axis direction position of the loading and unloading unit 6 can be finely adjusted easily by moving the second moving body 114 by the second X-axis moving mechanism 136. Thus, the loading and unloading unit 6 is configured to be advanced freely in the X-axis direction by the first moving body 112 and the second moving body 114.

It is to be noted that the auxiliary apparatus 2 is not limited to having the above-described form, and may be in a form further including such a configuration as that illustrated in FIG. 8 and FIG. 9. In the form illustrated in FIG. 8 and FIG. 9, the bottom portion 80 of the frame body 74 is provided with dressing board housing portions 144 (see FIG. 9) housing dressing boards 142 for dressing cutting blades 36, and the first moving body 112 is provided with holding means 146 (see FIG. 8) for holding dressing boards 142 housed in dressing board housing portions 144.

The dressing boards 142 may be obtained by forming green carbide or alundum-based abrasive grains into a rectangular plate shape with use of a binding material such as a resin bond. One side of the dressing boards 142 is approximately 5 cm, for example. As illustrated in FIG. 9, the dressing board housing portions 144 in the present embodiment include three rectangular recesses provided to each of end portions on both sides in the Y-axis direction of the upper surface of a tray 148 in a rectangular shape. The tray 148 is disposed on the upper surface of the bottom portion 80 of the frame body 74.

As illustrated in FIG. 8, a pair of the holding means 146 in the present embodiment are provided to end portions on both sides in the Y-axis direction of the first moving body 112. The holding means 146 each include a fixed piece 150 fixed to an end portion in the Y-axis direction of the main body 120 of the first moving body 112; a rising and lowering piece 152 supported by the lower surface of the fixed piece 150 in such a manner as to be raisable and lowerable in the Z-axis direction; raising and lowering means (not illustrated) for raising and lowering the rising and lowering piece 152; and a plurality of suction pads 154 arranged on the lower surface of the rising and lowering piece 152. The raising

and lowering means can, for example, include a suitable actuator such as an air cylinder. Each suction pad 154 is connected to suction means.

The holding means 146 brings each suction pad 154 into contact with a dressing board 142 housed in a dressing board housing portion 144, by lowering the rising and lowering piece 152 by the raising and lowering means, and holds under suction the dressing board 142 by each suction pad 154 by generation of a suction force in each suction pad 154 by the suction means.

In addition, the bottom portion 80 of the frame body 74 is provided with end surface correcting jig housing portions 158 (see FIG. 9) that each house an end surface correcting jig 156 that shapes a peripheral end surface of a mount flange that is formed at the distal end of the spindle of a cutting unit and that supports a back portion of a cutting blade 36. The end surface correcting jig 156 includes a board 160 in a rectangular shape and a grindstone 162 fixed to the upper surface of the board 160. As illustrated in FIG. 9, the end surface correcting jig housing portions 158 in the present embodiment are formed by a pair of rectangular recesses provided in end portions on both sides in the Y-axis direction of the upper surface of the tray 148.

The end surface correcting jig 156 housed in the end surface correcting jig housing portion 158 is held under suction by the suction pad 154 of the holding means 146 provided to the first moving body 112.

A cutting apparatus 170 to which the above-described auxiliary apparatus 2 is coupled will next be described with reference to FIGS. 10 to 15.

As illustrated in FIG. 10, the cutting apparatus 170 includes a chuck table 172 having a holding surface for holding a workpiece; cutting units 174 to which a cutting blade for cutting the workpiece held on the chuck table 172 is fitted by a fixing nut; X-axis feeding means 176 for processing-feeding the chuck table 172 in the X-axis direction; Y-axis feeding means 178 for indexing-feeding the cutting units 174 in the Y-axis direction orthogonal to the X-axis direction; and Z-axis feeding means 180 for cutting-feeding the cutting units 174 in the Z-axis direction orthogonal to the X-axis direction and the Y-axis direction.

Described with reference to FIG. 10 and FIG. 11, the cutting apparatus 170 includes an X-axis movable plate 184 provided to the upper surface of a base 182 (see FIG. 10) in such a manner as to be movable in the X-axis direction; a column 186 fixed to the upper surface

of the X-axis movable plate 184; and a cover plate 188 fixed to an upper end of the column 186. A circular opening 188a is formed in the cover plate 188. The chuck table 172 is rotatably mounted on the upper end of the column 186, and extends upward through the circular opening 188a of the cover plate 188. The chuck table 172 is rotated by a motor (not illustrated) included in the column 186, with the Z-axis direction as an axis.

As illustrated in FIG. 11, a porous suction chuck 190 in a circular shape which is connected to suction means (not illustrated) is disposed in an upper end part of the chuck table 172. The chuck table 172 holds under suction the workpiece placed on the upper surface of the suction chuck 190, by generation of a suction force in the upper surface of the suction chuck 190 by the suction means. Thus, the upper surface of the suction chuck 190 in the chuck table 172 constitutes a holding surface that holds the workpiece. The holding surface is positioned on an XY plane defined by the X-axis direction and the Y-axis direction. In addition, on the periphery of the chuck table 172, a plurality of clamps 192 are arranged at intervals in a circumferential direction.

Continuously described with reference to FIG. 11, a pair of rectangular sub-tables 194 are arranged in the

upper surface of the cover plate 188 with an interval in the Y-axis direction. A plurality of suction holes 196 connected to suction means (not illustrated) are formed in the upper surface of each sub-table 194. The sub-table 194 holds under suction a dressing board 142 or an end surface correcting jig 156 held under suction by the suction pad 154 of the holding means 146 provided to the first moving body 112 and loaded onto the sub-table 194, by generation of a suction force in each suction hole 196 by the suction means.

As illustrated in FIG. 11, the X-axis feeding means 176 includes a ball screw 198 that is coupled to the X-axis movable plate 184 and that extends in the X-axis direction and a motor 200 that rotates the ball screw 198. The X-axis feeding means 176 converts rotary motion of the motor 200 into rectilinear motion by the ball screw 198, and transmits the rectilinear motion to the X-axis movable plate 184. The X-axis feeding means 176 thereby moves the X-axis movable plate 184 along guide rails 182a of the base 182 and processing-feeds the chuck table 172 in the X-axis direction.

As illustrated in FIG. 10, the cutting apparatus 170 includes a gate type frame 202 disposed in such a manner as to straddle the chuck table 172. The frame 202

includes a pair of columns 204 extending upward from the upper surface of the base 182 with an interval in the Y-axis direction and a beam 206 that is stretched between upper ends of the pair of columns 204 and that extends in the Y-axis direction. A pair of the cutting units 174 are provided to the side surface of one side of the beam 206 (side surface on a back side in FIG. 10) with an interval in the Y-axis direction. The cutting apparatus 170 in the present embodiment is provided with the pair of cutting units 174 such that cutting blades 36 face each other, and can subject the workpiece held on the chuck table 172 to simultaneous cutting processing by a pair of the cutting blades 36. Incidentally, the number of cutting units 174 may be one.

As illustrated in FIG. 12, each cutting unit 174 includes a Y-axis movable member 208 in a rectangular shape which is supported by the side surface of one side of the beam 206 in such a manner as to be movable in the Y-axis direction; a Z-axis movable member 210 having an L-shaped section which is supported by the Y-axis movable member 208 in such a manner as to be raisable and lowerable in the Z-axis direction; and a spindle housing 212 fixed to a lower end of the Z-axis movable member 210.

A pair of guided grooves 208a extending in the Y-axis direction with an interval in the Z-axis direction are formed in the side surface of one side of the Y-axis movable member 208 (side surface on a near side in FIG. 12). The guided grooves 208a are slidably coupled to a pair of guide rails (not illustrated) extending in the Y-axis direction on the side surface of one side of the beam 206 with an interval in an upward-downward direction.

The Y-axis feeding means 178 includes a ball screw 214 extending in the Y-axis direction at the side surface of one side of the beam 206 and a motor 216 that rotates the ball screw 214. The ball screw 214 is coupled to the Y-axis movable member 208. The Y-axis feeding means 178 converts rotary motion of the motor 216 into rectilinear motion by the ball screw 214, and transmits the rectilinear motion to the Y-axis movable member 208. The Y-axis feeding means 178 thereby indexing-feeds the Y-axis movable member 208 in the Y-axis direction along the guide rails attached to the side surface of one side of the beam 206.

A pair of guide rails (not illustrated) extending in the Z-axis direction with an interval in the Y-axis direction are formed on the side surface of another side

of the Y-axis movable member 208 (side surface on a back side in FIG. 12). The Z-axis movable member 210 has a pair of guided grooves (not illustrated) slidably coupled to the pair of guide rails of the Y-axis movable member 208.

The Z-axis feeding means 180 includes a ball screw (not illustrated) that is coupled to the Z-axis movable member 210 and that extends in the Z-axis direction and a motor 218 that rotates the ball screw. The Z-axis feeding means 180 converts rotary motion of the motor 218 into rectilinear motion by the ball screw, and transmits the rectilinear motion to the Z-axis movable member 210. The Z-axis feeding means 180 thereby cutting-feeds the Z-axis movable member 210 in the Z-axis direction along the guide rails of the Y-axis movable member 208.

Described with reference to FIG. 13, the spindle housing 212 supports a spindle 220 in a cylindrical shape rotatably with the Y-axis direction as an axis, and houses a motor (not illustrated) that rotates the spindle 220. A cutting blade 36 that cuts the workpiece is detachably fixed to a distal end of the spindle 220 by a fixing nut 222.

A blade cover 224 that covers the cutting blade 36 is fitted to a distal end of the spindle housing 212. The

blade cover 224 includes a first cover member 224a fixed to the distal end of the spindle housing 212 and a second cover member 224b movably fitted to a distal end of the first cover member 224a. The second cover member 224b is moved in the X-axis direction by a suitable actuator (not illustrated) such as an air cylinder. The second cover member 224b is positioned at an open position illustrated in FIG. 13 at a time of replacement of the cutting blade 36, and is positioned at a closed position illustrated in FIG. 12 at a time of cutting processing.

As illustrated in FIG. 14, the distal end side peripheral surface of the spindle 220 is provided with an annular mount flange 226 projecting outward in a radial direction. An annular recess 226a is formed in a radially inward part of the distal end surface of the mount flange 226. A part on a peripheral side of the distal end surface of the mount flange 226 is an annular receiving portion 226b that protrudes in an axial direction. In addition, a male thread 228 is formed on the peripheral surface of the spindle 220 which peripheral surface is more on a distal end side than the mount flange 226.

When the central opening portion 38a of the cutting blade 36 is fitted to the distal end portion of the spindle 220 and the male thread 228 of the spindle 220

and the fixing nut 222 are screwed (fastened) together, the cutting blade 36 is sandwiched between the receiving portion 226b of the mount flange 226 and the fixing nut 222, and is detachably fixed to the distal end of the spindle 220. In addition, a plurality of pin holes 222a into which the pins 72 of a fixing nut holding unit 50 of the loading and unloading unit 6 are to be inserted are formed in a side surface of the fixing nut 222 at equal intervals in a circumferential direction.

As illustrated in FIG. 10, a pair of imaging means 230 for imaging the workpiece held on the chuck table 172 are fitted to the side surface of another side of the beam 206 of the frame 202 (side surface on a near side in FIG. 10) in such a manner as to be movable in the Y-axis direction, and a pair of moving means 232 for moving the imaging means 230 in the Y-axis direction are fitted to the side surface of the other side of the beam 206 of the frame 202. The moving means 232 includes a ball screw 234 extending in the Y-axis direction at the side surface of the other side of the beam 206 and a motor 236 that rotates the ball screw 234. The ball screw 234 is coupled to the imaging means 230. The moving means 232 converts rotary motion of the motor 236 into rectilinear motion, and transmits the rectilinear motion to the imaging means

230. The moving means 232 thereby moves the imaging means 230 in the Y-axis direction along guide rails 206a attached to the side surface of the other side of the beam 206. Incidentally, the number of imaging means 230 may be one.

When cutting processing is to be performed on the workpiece such as a wafer with use of the cutting apparatus 170, the workpiece is first sucked by the chuck table 172. Next, the chuck table 172 is moved to a position below the imaging means 230 by the X-axis feeding means 176, and the positions in the Y-axis direction of the imaging means 230 are adjusted by the moving means 232. Then, a cutting region of the workpiece is detected by imaging the workpiece from above the imaging means 230.

Subsequently, the orientation of the cutting region of the workpiece with respect to the cutting blades 36 of the cutting units 174 is adjusted by rotation of the chuck table 172, on the basis of the cutting region of the workpiece which cutting region is detected by the imaging means 230. Next, the chuck table 172 is moved in the X-axis direction by the X-axis feeding means 176, and the spindle housings 212 are moved in the Y-axis direction by the Y-axis feeding means 178. The pair of

cutting blades 36 are thereby positioned above the cutting region of the workpiece.

Next, predetermined cutting processing is performed on the cutting region of the workpiece by lowering the spindle housings 212 by the Z-axis feeding means 180 and thereby making the cutting edges 40 of the cutting blades 36 rotated at high speed cut into the cutting region of the workpiece and processing-feeding the chuck table 172 in the X-axis direction while supplying cutting water to a part that the cutting edges 40 of the cutting blades 36 are made to cut into. The above-described cutting processing is performed on all of cutting regions of the workpiece by repeating the cutting processing as appropriate while indexing-feeding the spindle housings 212 in the Y-axis direction by the Y-axis feeding means 178. The already cut workpiece for which a cutting step is ended is transported for a subsequent step.

The cutting blades 36 are worn when the cutting step is performed repeatedly. When the wear of the cutting blades 36 reaches a predetermined amount, cutting accuracy is no longer maintained. Thus, the cutting blades 36 fitted to the spindles 220 need to be replaced with new cutting blades 36. In addition, even in a case where the wear of the cutting blades 36 fitted to the

spindles 220 has not reached the predetermined amount, when the cutting processing is to be performed on a workpiece of a material different from the material of the workpiece previously subjected to the cutting processing, the cutting blades 36 fitted to the spindles 220 may need to be replaced with cutting blades 36 corresponding to the different material of the workpiece.

In the present embodiment, as illustrated in FIG. 15, the auxiliary apparatus 2 that can automatically replace the cutting blades 36 of the cutting apparatus 170 with different ones is coupled to the cutting apparatus 170. In the following, description will be made of a method of replacing the cutting blades 36 with different ones by using the auxiliary apparatus 2.

As illustrated in FIG. 15, the auxiliary apparatus 2 is disposed on a far side in the X-axis direction of the cutting apparatus 170. The auxiliary apparatus 2 can be fitted afterward to the cutting apparatus 170 already delivered to a user. When the cutting blades 36 fitted to the cutting apparatus 170 are to be replaced with different ones by use of the auxiliary apparatus 2, the caterpillar 22 of the cutting blade storage unit 4 is first rotated, and a supporting shaft 24 supporting a new cutting blade 36 to be loaded into the cutting apparatus

170 is thereby positioned at a predetermined position (for example, the position of a lowermost end in the orbit of the supporting shafts 24).

Next, as illustrated in FIG. 16, a side wall 56 of the casing 52 to which a blade holding unit 48 is fitted is set along the X-axis direction by rotation of the casing 52 by the motor coupled to the Z rotary shaft 46 of the loading and unloading unit 6. The blade holding unit 48 is thereby faced toward the cutting blade storage unit 4. In addition, the X-axis direction position and the Z-axis direction position of the blade holding unit 48 are adjusted by actuation of the X-axis moving mechanism 12 and the Z-axis moving mechanism 10 such that the shaft portion 34 of the supporting shaft 24 at the above-described predetermined position can be inserted into the central opening portion 60 (see FIG. 5) of the blade holding unit 48.

Next, as illustrated in FIG. 17, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning unit 8, and the loading and unloading unit 6 is thereby positioned at the action position where the cutting blade 36 supported by the supporting shaft 24 can be held by the blade holding unit 48. Consequently, the shaft portion 34 of the supporting shaft 24 at the above-

described predetermined position is inserted into the central opening portion 60 of the blade holding unit 48, and the end surface 58 of the blade holding unit 48 is brought into contact with the end surface of the cutting blade 36 located on the distal end side of the shaft portion 34. Next, the cutting blade 36 located on the distal end side of the shaft portion 34 is held under suction by the blade holding unit 48 by generation of a suction force in each suction hole 62 of the blade holding unit 48.

Then, the Y-axis direction positioning unit 8 is actuated, and the loading and unloading unit 6 is thereby separated from the cutting blade storage unit 4 in the Y-axis direction and positioned at the retracted position. Subsequently, a blade holding unit 48 on a side opposite from the blade holding unit 48 holding under suction the cutting blade 36 is faced toward the cutting blade storage unit 4 by rotation of the casing 52 of the loading and unloading unit 6 by 180°. Next, the Y-axis direction positioning unit 8 is actuated, and the loading and unloading unit 6 is thereby positioned at the action position at which a cutting blade 36 of the supporting shaft 24 can be held by the blade holding unit 48 on the opposite side. Then, the cutting blade 36 located on the

distal end side of the shaft portion 34 is held under suction by the blade holding unit 48 on the opposite side by generation of a suction force in each suction hole 62 of the blade holding unit 48. Consequently, the pair of blade holding units 48 opposed to each other among the four blade holding units 48 hold under suction the new cutting blades 36.

Next, as illustrated in FIG. 18, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning unit 8, and the raising and lowering table 76 is moved in the Z-axis direction by the Z-axis moving mechanism 10. Consequently, the loading and unloading unit 6 is separated from the cutting blade storage unit 4 and positioned at the retracted position, and the Y-axis direction position and the Z-axis direction position of the loading and unloading unit 6 with respect to the cutting apparatus 170 are adjusted. The Y-axis direction position of the loading and unloading unit 6 that has undergone the position adjustment is between the pair of cutting units 174 of the cutting apparatus 170, and the Z-axis direction position of the loading and unloading unit 6 that has undergone the position adjustment is above the holding surface of the chuck table 172.

Next, as illustrated in FIG. 19, the first moving

body 112 is moved in the X-axis direction by the air cylinder 130 as the first X-axis moving mechanism. The loading and unloading unit 6 is thereby advanced toward a position between the pair of cutting units 174 of the cutting apparatus 170. Then, as illustrated in FIG. 20, the second moving body 114 is moved in the X-axis direction by the second X-axis moving mechanism 136. The X-axis direction position of the loading and unloading unit 6 with respect to the pair of cutting units 174 is thereby adjusted. Specifically, the X-axis direction position of the center of the new pair of cutting blades 36 held under suction by the pair of blade holding units 48 of the loading and unloading unit 6 is matched with the X-axis direction position of the center of the pair of cutting blades 36 fitted to the pair of cutting units 174. In addition, the Z-axis moving mechanism 10 of the auxiliary apparatus 2 or the Z-axis feeding means 180 of the cutting apparatus 170 is actuated to match the Z-axis direction position of the center of the cutting blades 36 of the blade holding units 48 with the Z-axis direction position of the center of the cutting blades 36 of the cutting units 174.

Next, the pair of fixing nut holding units 50 are faced toward the cutting blades 36 of the pair of cutting

units 174 by rotation of the casing 52 of the loading and unloading unit 6 by 60°. Incidentally, the casing 52 may be rotated by 60° in advance before the first and second moving bodies 112 and 114 are advanced.

Next, the second cover member 224b of the blade cover 224 of each of the pair of cutting units 174 is positioned at the open position (see FIG. 13). Subsequently, the fixing nut 222 fixing the cutting blade 36 to the spindle 220 is brought into contact with the end surface 66a of the rotating body 66 of the fixing nut holding unit 50 by movement of the cutting unit 174 in the Y-axis direction by the Y-axis feeding means 178 of the cutting apparatus 170. Then, the pins 72 of the fixing nut holding unit 50 are pushed by the fixing nut 222 and housed into the rotating body 66, and the distal end of the spindle 220 is housed into the central opening portion 68 of the rotating body 66.

Next, when the rotating body 66 is rotated by the motor of the fixing nut holding unit 50 and the pins 72 thereby coincide with the pin holes 222a of the fixing nut 222, the pins 72 are fitted into the pin holes 222a, so that rotary motion of the rotating body 66 is transmitted to the fixing nut 222 via the pins 72. The fixing nut 222 is consequently loosened. The fixing nut

222 can thereby be unscrewed (removed) from the male thread 228 of the spindle 220 of the cutting unit 174. In addition, the removed fixing nut 222 is held under suction by the fixing nut holding unit 50 by generation of a suction force in each suction hole 70 of the fixing nut holding unit 50.

Next, the cutting unit 174 is separated from the loading and unloading unit 6 by the Y-axis feeding means 178, and an unloaded blade holding unit 48 not holding under suction a cutting blade 36 is faced toward the cutting blade 36 of the cutting unit 174 by rotation of the casing 52 of the loading and unloading unit 6 by 60°.

Then, the cutting unit 174 is brought close to the loading and unloading unit 6 by the Y-axis feeding means 178, so that the spindle 220 of the cutting unit 174 is inserted into the central opening portion 60 of the blade holding unit 48, and the end surface 58 of the unloaded blade holding unit 48 is brought into contact with the end surface of the cutting blade 36 of the cutting unit 174. Subsequently, the cutting blade 36 of the cutting unit 174 is held under suction by the blade holding unit 48 by generation of a suction force in each suction hole 62 of the blade holding unit 48.

Then, the cutting unit 174 is separated from the

loading and unloading unit 6 by the Y-axis feeding means 178, and a blade holding unit 48 holding under suction a new cutting blade 36 is faced toward the spindle 220 of the cutting unit 174 by rotation of the casing 52 of the loading and unloading unit 6 by 60°.

Next, the cutting unit 174 is brought close to the loading and unloading unit 6 by the Y-axis feeding means 178, so that the spindle 220 is inserted into the central opening portion 38a of the new cutting blade 36, and the end surface of the cutting blade 36 is brought into contact with the receiving portion 226b of the mount flange 226 of the spindle 220. Then, the new cutting blade 36 is transferred from the blade holding unit 48 to the spindle 220 by the suction force of the blade holding unit 48 being cancelled.

Subsequently, the cutting unit 174 is separated from the loading and unloading unit 6 by the Y-axis feeding means 178, and the fixing nut holding unit 50 holding under suction the removed fixing nut 222 is faced toward the spindle 220 of the cutting unit 174 by rotation of the casing 52 of the loading and unloading unit 6 by 60°.

Next, the cutting unit 174 is brought close to the loading and unloading unit 6 by the Y-axis feeding means

178, so that the fixing nut 222 held under suction by the fixing nut holding unit 50 is fitted to the distal end portion of the spindle 220. Then, the fixing nut 222 is rotated by actuation of the motor of the fixing nut holding unit 50 in a direction opposite from that when the fixing nut 222 is removed, so that the fixing nut 222 is screwed (fastened) to the male thread 228 of the spindle 220. Consequently, the new cutting blade 36 to be fitted to the cutting unit 174 can be sandwiched between the receiving portion 226b of the mount flange 226 of the spindle 220 and the fixing nut 222, and fixed to the spindle 220. Then, after the suction force of the fixing nut holding unit 50 is cancelled, the second cover member 224b of the blade cover 224 of the cutting unit 174 is positioned at the closed position. Incidentally, the removal and attachment of the fixing nut 222 and the cutting blades 36 as described above may be performed at the same time for the pair of cutting units 174, or may be performed separately for the pair of cutting units 174.

Next, the first and second moving bodies 112 and 114 are retracted, and one of the removed pair of cutting blades 36 is faced toward the cutting blade storage unit 4 by rotation of the casing 52 of the loading and

unloading unit 6 by 60°. In addition, an unloaded supporting shaft 24 not supporting cutting blades 36 is positioned at a predetermined position (for example, the position of a lowermost end in the orbit of the supporting shafts 24) by rotation of the caterpillar 22 of the cutting blade storage unit 4.

Then, the X-axis direction position and the Z-axis direction position of the blade holding unit 48 are adjusted by actuating the X-axis moving mechanism 12 and the Z-axis moving mechanism 10 such that the shaft portion 34 of the supporting shaft 24 at the above-described predetermined position can be inserted into the central opening portion 38a of the one cutting blade 36 held under suction by the blade holding unit 48.

Next, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning unit 8. Consequently, the shaft portion 34 of the supporting shaft 24 at the above-described predetermined position is inserted into the central opening portion 38a of the one cutting blade 36 held under suction by the blade holding unit 48, and the end surface of the one cutting blade 36 is brought into contact with the end surface of the base portion 32 of the supporting shaft 24. Subsequently, the one of the removed pair of cutting blades 36 is

transferred to the supporting shaft 24 by the suction force of the blade holding unit 48 being cancelled.

In addition, the loading and unloading unit 6 is separated from the cutting blade storage unit 4 by the Y-axis direction positioning unit 8, and a blade holding unit 48 on an opposite side which holds under suction the other of the removed pair of cutting blades 36 is faced toward the cutting blade storage unit 4 by rotation of the casing 52 of the loading and unloading unit 6 by 180°. Next, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning unit 8, so that the shaft portion 34 of the supporting shaft 24 at the above-described predetermined position is inserted into the central opening portion 38a of the other cutting blade 36 held under suction by the blade holding unit 48 on the opposite side and the end surface of the other cutting blade 36 is brought into contact with the end surface of the cutting blade 36 supported by the supporting shaft 24. Then, the other of the removed pair of cutting blades 36 is transferred to the supporting shaft 24 by the suction force of the blade holding unit 48 being cancelled.

As described above, the auxiliary apparatus 2 in the present embodiment can be fitted afterward to the

cutting apparatus 170 already delivered to the user, and replace the cutting blades 36 fitted to the cutting units 174 of the cutting apparatus 170 with different ones.

Description will next be made of a method of loading dressing boards 142 or end surface correcting jigs 156 into the cutting apparatus 170 in a case where the auxiliary apparatus 2 has the configuration illustrated in FIG. 8 and FIG. 9.

In a case where dressing boards 142 are to be loaded into the cutting apparatus 170 by use of the auxiliary apparatus 2, the pair of rising and lowering pieces 152 are first lowered by the raising and lowering means of the holding means 146, and the suction pads 154 are thereby respectively brought into contact with two dressing boards 142 among the dressing boards 142 housed in the dressing board housing portions 144. Next, the dressing boards 142 are held under suction by the respective suction pads 154 by generation of a suction force in each suction pad 154 by the suction means. Next, the rising and lowering pieces 152 holding under suction the dressing boards 142 are raised.

Next, the Y-axis direction position and the Z-axis direction position of the loading and unloading unit 6 with respect to the cutting apparatus 170 are adjusted by

the Y-axis direction positioning unit 8 and the Z-axis moving mechanism 10. Thereafter, as illustrated in FIG. 21, the loading and unloading unit 6 is advanced toward the cutting apparatus 170 by the X-axis moving mechanism 12 (the air cylinder 130 and the second X-axis moving mechanism 136 as the first X-axis moving mechanism). The dressing boards 142 held under suction by the rising and lowering pieces 152 are thereby positioned above the sub-tables 194.

Next, the lower surfaces of the dressing boards 142 are brought into contact with the upper surfaces of the sub-tables 194 by the rising and lowering pieces 152 being lowered. Then, the dressing boards 142 are held under suction by the sub-tables 194 by generation of a suction force in each suction hole 196 of the sub-tables 194, and the suction force of the holding means 146 is cancelled. Thus, the auxiliary apparatus 2 can be fitted afterward to the cutting apparatus 170 already delivered to the user, and load the dressing boards 142 into the cutting apparatus 170.

Then, the spindle housings 212 are moved in the Y-axis direction by the Y-axis feeding means 178, so that the cutting blades 36 fitted to the cutting units 174 are positioned above the dressing boards 142. The spindle

housings 212 are thereafter lowered by the Z-axis feeding means 180, so that the dressing boards 142 are cut by the cutting edges 40 of the cutting blades 36 rotated at high speed. Thus, dressing (setting) that corrects the cutting edges 40 of the cutting blades 36 can be performed.

In addition, in a case where the end surface correcting jigs 156 are to be loaded into the cutting apparatus 170 by use of the auxiliary apparatus 2, the pair of rising and lowering pieces 152 are first lowered by the raising and lowering means of the holding means 146, and the suction pads 154 are thereby respectively brought into contact with the upper surfaces of the boards 160 of the pair of end surface correcting jigs 156 housed in the end surface correcting jig housing portions 158. Next, the end surface correcting jigs 156 are held under suction by the respective suction pads 154 by generation of a suction force in each suction pad 154 by the suction means. Next, the rising and lowering pieces 152 holding under suction the end surface correcting jigs 156 are raised.

Next, the Y-axis direction position and the Z-axis direction position of the loading and unloading unit 6 with respect to the cutting apparatus 170 are adjusted by the Y-axis direction positioning unit 8 and the Z-axis

moving mechanism 10. Thereafter, as illustrated in FIG. 22, the loading and unloading unit 6 is advanced toward the cutting apparatus 170 by the X-axis moving mechanism 12. The end surface correcting jigs 156 held under suction by the rising and lowering pieces 152 are thereby positioned above the sub-tables 194.

Next, the lower surfaces of the boards 160 of the end surface correcting jigs 156 are brought into contact with the upper surfaces of the sub-tables 194 by the rising and lowering pieces 152 being lowered. Next, the end surface correcting jigs 156 are held under suction by the sub-tables 194 by generation of a suction force in each suction hole 196 of the sub-tables 194, and the suction force of the holding means 146 is cancelled. Thus, the auxiliary apparatus 2 can be fitted afterward to the cutting apparatus 170 already delivered to the user, and load the end surface correcting jigs 156 into the cutting apparatus 170.

Then, the fixing nuts 222 and the cutting blades 36 are removed from the spindles 220 of the cutting units 174 by the blade holding units 48 and the fixing nut holding units 50 of the loading and unloading unit 6. Thereafter, the receiving portions 226b of the mount flanges 226 of the spindles 220 are faced toward the

grindstones 162 of the end surface correcting jigs 156 by actuation of the Z-axis feeding means 180. Next, the receiving portions 226b of the mount flanges 226 of the spindles 220 being rotated are brought into contact with the grindstones 162 of the end surface correcting jigs 156 by movement of the spindle housings 212 in the Y-axis direction by the Y-axis feeding means 178. Thus, the receiving portions 226b (peripheral end surfaces) of the mount flanges 226 can be ground and shaped flat by the grindstones 162.

Incidentally, in the present embodiment, description has been made of an example in which the loading and unloading unit 6 of the auxiliary apparatus 2 has the four blade holding units 48 and the two fixing nut holding units 50 in correspondence with the pair of cutting units 174 provided to the cutting apparatus 170. However, in a case where the cutting apparatus 170 is provided with a single cutting unit 174, it suffices for the loading and unloading unit 6 to have two blade holding units 48 and one fixing nut holding unit 50. In addition, in the case where the cutting apparatus 170 is provided with the single cutting unit 174, there may be one holding means 146 for holding a dressing board 142 and an end surface correcting jig 156.

The present invention is not limited to the details of the above described preferred embodiment. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. An auxiliary apparatus coupled to a cutting apparatus, the cutting apparatus including a chuck table having a holding surface configured to hold a workpiece, a cutting unit to which a cutting blade configured to cut the workpiece held on the chuck table is fitted by a fixing nut, X-axis feeding means for processing-feeding the chuck table in an X-axis direction, Y-axis feeding means for indexing-feeding the cutting unit in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting unit in a Z-axis direction orthogonal to the X-axis direction and the Y-axis direction, the holding surface being defined by the X-axis direction and the Y-axis direction, the auxiliary apparatus comprising:

a cutting blade storage unit configured to store a plurality of cutting blades;

a loading and unloading unit configured to unload and load a cutting blade from the cutting blade storage unit;

a Y-axis direction positioning unit configured to position the loading and unloading unit at an action position and a retracted position in the Y-axis direction with respect to the cutting blade storage unit;

a Z-axis moving mechanism configured to move the loading and unloading unit in the Z-axis direction; and

an X-axis moving mechanism configured to move the loading and unloading unit in the X-axis direction to make the loading and unloading unit act on the cutting blade fitted to a spindle of the cutting unit.

2. The auxiliary apparatus according to claim 1, wherein

the cutting blade storage unit includes

a driving gear that has a first rotary shaft extending in the Y-axis direction,

a driven gear that is separated from the driving gear in the Z-axis direction and has a second rotary shaft extending in the Y-axis direction,

a caterpillar that is wound around the driving gear and the driven gear, and

supporting shafts that are arranged on the caterpillar at predetermined intervals, are configured to be inserted into a central opening portion of a cutting blade to support the cutting blade, and extend in the Y-axis direction.

3. The auxiliary apparatus according to claim 2, wherein

an interval in the Z-axis direction between the

driving gear and the driven gear is adjustable, and a length of the caterpillar is adjustable.

4. The auxiliary apparatus according to claim 1, wherein

the loading and unloading unit includes

a Z rotary shaft extending in the Z-axis direction,

blade holding units radially coupled to the Z rotary shaft and configured to hold under suction a cutting blade, and

a fixing nut holding unit configured to screw and unscrew the fixing nut onto and from a male thread formed on a distal end of the spindle, and

two blade holding units are provided for one fixing nut holding unit.

5. The auxiliary apparatus according to claim 4, wherein

the loading and unloading unit is disposed in a frame body, and the frame body is slidably supported by a guide rail that is disposed on a raising and lowering table and that extends in the Y-axis direction, and is positioned at the action position and the retracted position in the Y-axis direction with respect to the cutting blade storage unit by the Y-axis direction

positioning unit.

6. The auxiliary apparatus according to claim 5, wherein

the loading and unloading unit is disposed on a first moving body disposed within the frame body, the first moving body is slidably supported in a suspended state by a first guide rail that is disposed on a lower portion of a second moving body and that extends in the X-axis direction, the second moving body is slidably supported in a suspended state by a second guide rail that is disposed on a ceiling portion of the frame body and that extends in the X-axis direction, and the loading and unloading unit is configured to be advanced freely in the X-axis direction by the first moving body and the second moving body.

7. The auxiliary apparatus according to claim 6, wherein

a bottom portion of the frame body is provided with a dressing board housing portion configured to house a dressing board for dressing a cutting blade, and the first moving body is provided with holding means for holding the dressing board housed in the dressing board housing portion.

8. The auxiliary apparatus according to claim 7,

wherein

the bottom portion of the frame body is provided with an end surface correcting jig housing portion configured to house an end surface correcting jig configured to shape a peripheral end surface of a mount flange that is formed at a distal end of the spindle of the cutting unit and that supports a back portion of the cutting blade, and the end surface correcting jig is held by the holding means provided to the first moving body.