

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) and large-scale integration (LSI) circuits formed on the top surface of the wafer so 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, cutting means 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 means in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting means 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.

The present applicant has proposed an automatic replacing apparatus that can automatically replace a cutting blade fitted to cutting means (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 accordingly an object of the present invention to provide an auxiliary apparatus 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, cutting means 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 means in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting means 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 cutting blade storage means for storing a plurality of cutting blades, loading and unloading means for unloading and loading a cutting blade from the cutting blade storage means while holding a front surface of the cutting blade, Y-axis direction positioning means for positioning the loading and unloading means at an action position and a retracted position in the Y-axis direction with respect to the cutting blade storage means, Z-axis moving means for moving the loading and unloading means in the Z-axis direction, X-axis moving means for moving the loading and unloading means in the X-axis direction to make the loading and unloading means act on a cutting blade fitted to a spindle of the cutting means, and cleaning means for cleaning a back surface of the cutting blade held by the

loading and unloading means.

Preferably, the cutting blade storage means includes a driving gear having a rotary shaft extending in the Y-axis direction, a driven gear separated from the driving gear in the Z-axis direction and having a rotary shaft extending in the Y-axis direction, a caterpillar wound around the driving gear and the driven gear, and supporting shafts arranged on the caterpillar at predetermined intervals, configured to be inserted into a central opening portion of a cutting blade and support the cutting blade, and extending in the Y-axis direction, and the cleaning means includes an air nozzle disposed so as to be adjacent to the cutting blade storage means and configured to clean the back surface of the cutting blade held by the loading and unloading means by blowing air to the back surface of the cutting blade.

Preferably, the air nozzle is disposed at a back of the supporting shafts of the cutting blade storage means, and moves a cutting blade supported by a supporting shaft to a distal end of the supporting shaft and positions a front surface of the cutting blade toward the loading and unloading means by blowing air to a back portion of the cutting blade.

Preferably, the loading and unloading means

includes a Z rotary shaft extending in the Z-axis direction, blade holding units radially coupled to the Z rotary shaft and configured to suction-hold 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 means is disposed in a frame body, and the frame body is slidably supported by a guide rail disposed on a raising and lowering table and extending 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 means by the Y-axis direction positioning means.

Preferably, the loading and unloading means 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 disposed on a lower portion of a second moving body and extending in the X-axis direction, the second moving body is slidably supported in a suspended state by a second guide rail disposed on a ceiling portion of the frame body and

extending in the X-axis direction, and the loading and unloading means is configured to be advanced freely in the X-axis direction by the first moving body and the second 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 cutting blade storage means illustrated in FIG. 1;

FIG. 3 is a perspective view of a supporting shaft illustrated in FIG. 2 and cutting blades as viewed from a front side;

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

FIG. 5 is a perspective view of loading and unloading means 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 a perspective view illustrating a state in which a cutting blade is cleaned by cleaning means illustrated in FIG. 1;

FIG. 9 is a perspective view of a cutting apparatus to which the auxiliary apparatus illustrated in FIG. 1 is to be coupled;

FIG. 10 is a perspective view of a chuck table illustrated in FIG. 9;

FIG. 11 is a perspective view of cutting means illustrated in FIG. 9;

FIG. 12 is a perspective view of cutting means in a state in which a blade cover illustrated in FIG. 11 is opened;

FIG. 13 is an exploded perspective view of the cutting means illustrated in FIG. 9;

FIG. 14 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. 9;

FIG. 15 is a perspective view illustrating a state in which the cutting blade storage means and the loading and unloading means of the auxiliary apparatus illustrated in FIG. 1 face each other;

FIG. 16 is a perspective view illustrating a state in which the frame body is advanced toward the cutting blade storage means from the state illustrated in FIG. 15;

FIG. 17 is a perspective view illustrating a state in which the frame body is retreated from the state illustrated in FIG. 16, and the raising and lowering table is raised;

FIG. 18 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. 17; and

FIG. 19 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. 18.

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. Making description with reference to FIG. 1, the auxiliary apparatus indicated in entirety by a reference numeral 2 includes at least cutting blade storage means 4 for storing a plurality of cutting blades, loading and unloading means 6 for unloading and loading a cutting blade from the cutting blade storage means 4 while holding a front surface of the cutting blade, Y-axis direction positioning means 8 for positioning the loading and unloading means 6 at an action position and a retracted position in a Y-axis direction with respect to the cutting blade storage means 4, Z-axis moving means 10 for moving the loading and unloading means 6 in a Z-axis direction, X-axis moving means 12 for moving the loading and unloading means 6 in an X-axis direction to make the loading and unloading means 6 act on a cutting blade fitted to a spindle of cutting means of a cutting apparatus, and cleaning means 13 for cleaning a back surface of the cutting blade held by the loading and unloading means 6.

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 means 4 includes a driving gear 16 having a rotary shaft 14 extending in the Y-axis direction, a driven gear 20 separated from the driving gear 16 in the Z-axis direction and having a rotary shaft 18 extending in the Y-axis direction, a caterpillar 22 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, support the cutting blade, and extend in the Y-axis direction.

Making description with reference to FIG. 1 and FIG. 2, the cutting blade storage means 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 so 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 coupled to the rotary shaft 18 of the driven gear 20 and extending in the Z-axis direction and a motor that rotates the ball screw.

The caterpillar 22 is formed by 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. Incidentally, though the caterpillar 22 illustrated in the figure is depicted such that the link pieces are arranged without gaps, there are gaps between the link pieces, so that air blown from an air

nozzle 142 to be described later can pass through between link pieces.

The cutting blade storage means 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 means 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 blades 36 illustrated in FIG. 3 are viewed from the front sides of

the cutting blades 36. A 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, the end surface being radially outward of the shaft portion 34.

The loading and unloading means 6 will be described with reference to FIG. 5. The loading and unloading means 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 suction-hold 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 means 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, the side walls being 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 means 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 at which 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 means 4, the blade holding unit 48 suction-holds the cutting blade 36 by generating a suction force in each suction hole 62 by the suction means.

Continuing the description 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 alternately provided with a plurality of suction holes 70 and a plurality of pins 72 at intervals in a circumferential direction. Each suction hole 70 is connected to suction means (not illustrated). The pins 72 are positioned in positions (positions illustrated in FIG. 5) to be projected 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 so 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 generating a suction force in each suction hole 70 by the suction means and thereby suction-holding the fixing nut, and rotating 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 motor is rotated by the rotating body 66 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 means 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 so as to be movable in the Y-axis direction. The raising and lowering table 76 is supported by a base frame 78 so as to be raisable and lowerable in the Z-axis direction.

Making description 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 at an interval in the X-axis direction.

The raising and lowering table 76 includes a top 88 in a rectangular 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 is 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 means 8. The Y-axis direction positioning means 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 means 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 means 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 means 6 is disposed is slidably supported by the guide rails 92 disposed on the raising and lowering table 76 and extending 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 means 4 by the Y-axis direction positioning means 8.

The above-described action position is a position at which a blade holding unit 48 of the loading and unloading means 6 is close to the cutting blade storage means 4, and is a position at which the blade holding unit 48 can suction-hold a cutting blade 36 supported by the cutting blade storage means 4. In addition, the above-described retracted position is a position at which the blade holding unit 48 of the loading and unloading means 6 is more separated from the cutting blade storage means 4 than 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.

Continuing the description with reference to FIG. 6, the Z-axis moving means 10 is coupled to the raising and lowering table 76 and the base frame 78. The Z-axis moving means 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 means 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 means 10 thereby moves the frame body 74 in which the loading and unloading means 6 is disposed in the Z-axis direction.

Making description with reference to FIG. 7, the loading and unloading means 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 disposed on a lower portion of a second moving body 114 and extending in the X-axis direction. The second moving body 114 is slidably supported in a suspended state by second guide rails 118 disposed on the ceiling portion 84 of the frame body 74 and extending 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 means 6 is inserted into the circular hole 122. The Z rotary shaft 46 is non-rotatably fixed to the main body 120. When the motor of the loading and unloading means 6, the motor being coupled to the Z rotary shaft 46 is driven, the casing 52 of the loading and unloading means 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 an optional orientation.

A pair of guided members 124 in which grooves 124a extending in the X-axis direction are formed is provided to the upper surface of the main body 120 of the first moving body 112 at 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 is provided to the lower surface of the main body 128 at 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.

First X-axis moving means for moving 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 means in the present embodiment is formed by 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 means 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 is 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 is provided to the lower surface of the ceiling portion 84 of the frame body 74 at 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.

Second X-axis moving means 136 for moving 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 means 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 means 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 means 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 means 12 in the present embodiment includes the air cylinder 130 as the first X-axis moving means and the second X-axis moving means 136 including the ball screw 138 and the motor 140. In the present embodiment, the loading and unloading means 6 can be quickly advanced in the X-axis direction by moving the first moving body 112 by the air cylinder 130 as the first X-axis moving means, and the X-axis direction position of the loading and unloading means 6 can be finely adjusted easily by moving the second moving body 114 by the second X-axis moving means 136. Thus, the loading and unloading means 6 is configured to be advanced freely in the X-axis direction by the first moving body 112 and the second moving body 114.

Making description with reference to FIG. 1, FIG. 2, and FIG. 8, the cleaning means 13 includes the air nozzle 142 that is disposed so as to be adjacent to the cutting blade storage means 4, and that cleans the back

surface of the cutting blade 36 held by the loading and unloading means 6 by blowing air onto the back surface of the cutting blade 36. The air nozzle 142 is connected to high pressure air supply means (not illustrated).

The air nozzle 142 in the present embodiment is disposed at the back of the supporting shafts 24 of the cutting blade storage means 4. Specifically, as illustrated in FIG. 1 and FIG. 2, below the driving gear 16 of the cutting blade storage means 4, the air nozzle 142 projects in the Y-axis direction from the supporting wall 28. In addition, a distal end of the air nozzle 142 is positioned so as to face a supporting shaft 24 located at a lowermost end in the orbit of the supporting shafts 24 as the caterpillar 22 rotates.

As illustrated in FIG. 8, the cleaning means 13 cleans the back surface of a cutting blade 36 by blowing air from the air nozzle 142 to the back surface of the cutting blade 36 suction-held by a blade holding unit 48 of the loading and unloading means 6.

When air is blown from the air nozzle 142 to the cutting blade 36, the caterpillar 22 is actuated such that the supporting shaft 24 is not located at the distal end of the air nozzle 142. This prevents the air blown from the air nozzle 142 from being blocked by the

supporting shaft 24. In addition, as described above, though the caterpillar 22 illustrated in the figures is depicted such that the link pieces are arranged without gaps, there are gaps between the link pieces, so that the air blown from the air nozzle 142 can pass through between link pieces. Thus, the cleaning of the cutting blade 36 by the air is not hindered by the link pieces of the caterpillar 22.

Further, the air nozzle 142 of the cleaning means 13 can also move the cutting blade 36 supported by the supporting shaft 24 to a distal end of the supporting shaft 24 and position the front surface of the cutting blade 36 toward the loading and unloading means 6 by blowing air to a back portion of the cutting blade 36.

Making description with reference to FIG. 4, when a cutting blade 36 located on a distal end side of the shaft portion 34 of the supporting shaft 24 is unloaded by the loading and unloading means 6, cutting blades 36 remaining on the shaft portion 34 can be pushed out to the distal end side of the shaft portion 34 by supplying air from the air nozzle 142 to the flow passage 32a of the base portion 32 of the supporting shaft 24 via a flow passage 22a of the caterpillar 22. However, due to the action of the ball plungers 42, the cutting blades 36 do

not drop off the shaft portion 34. Incidentally, in this case, the flow passage 22a of the caterpillar 22 is positioned at a position facing the air nozzle 142.

A cutting apparatus 170 to which the above-described auxiliary apparatus 2 is coupled will next be described with reference to FIGS. 9 to 14. As illustrated in FIG. 9, the cutting apparatus 170 includes a chuck table 172 having a holding surface for holding a workpiece, cutting means 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 means 174 in the Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means 180 for cutting-feeding the cutting means 174 in the Z-axis direction orthogonal to the X-axis direction and the Y-axis direction.

Making description with reference to FIG. 9 and FIG. 10, the cutting apparatus 170 includes an X-axis movable plate 184 provided to the upper surface of a base 182 (see FIG. 9) so 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. 10, a porous suction chuck 190 in a circular shape, the suction chuck being connected to suction means (not illustrated), is disposed in an upper end part of the chuck table 172. The chuck table 172 suction-holds the workpiece placed on the upper surface of the suction chuck 190 by generating 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.

As illustrated in FIG. 10, the X-axis feeding means 176 includes a ball screw 198 coupled to the X-axis movable plate 184 and extending 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. 9, the cutting apparatus 170 includes a gate type frame 202 disposed so 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 at an interval in the Y-axis direction and a beam 206 stretched between upper ends of the pair of columns 204 and extending in the Y-axis direction.

A pair of the cutting means 174 is provided to the side surface of one side of the beam 206 (side surface on a back side in FIG. 9) at an interval in the Y-axis direction. The cutting apparatus 170 in the present embodiment is provided with the pair of cutting means 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 means 174

may be one.

As illustrated in FIG. 11, each cutting means 174 includes a Y-axis movable member 208 in a rectangular shape, the Y-axis movable member being supported by the side surface of one side of the beam 206 so as to be movable in the Y-axis direction, a Z-axis movable member 210 having an L-shaped section, the Z-axis movable member being supported by the Y-axis movable member 208 so 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 at an interval in the Z-axis direction is formed in the side surface of one side of the Y-axis movable member 208 (side surface on a near side in FIG. 11). 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 at 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 at an interval in the Y-axis direction is formed on the side surface of another side of the Y-axis movable member 208 (side surface on a back side in FIG. 11). 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) coupled to the Z-axis movable member 210 and extending 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.

Making description with reference to FIG. 12, 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. 12 at a time of replacement of the cutting blade 36, and is positioned at a closed position illustrated in FIG. 11 at a time of cutting processing.

As illustrated in FIG. 13, 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, the peripheral surface being set to a more 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 to insert the pins 72 of a fixing nut holding unit 50 of the loading and unloading means 6 are formed in a side surface of the fixing nut 222 at equal intervals in a circumferential direction.

As illustrated in FIG. 9, a pair of imaging means 230 for imaging the workpiece held on the chuck table 172 is fitted to the side surface of another side of the beam 206 of the frame 202 (side surface on a near side in FIG. 9) so 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 is fitted to the side surface of the other side of the beam 206 of the frame 202. The moving means 232 each 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 by using 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. Next, a cutting region of the workpiece is detected by imaging the workpiece from above the imaging means 230.

Next, the orientation of the cutting region of the workpiece with respect to the cutting blades 36 of the cutting means 174 is adjusted by rotating 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 is 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. In addition, 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 not 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. 14, the auxiliary apparatus 2 that can automatically replace the cutting blades 36 of the cutting apparatus 170 is coupled to the cutting apparatus 170. In the following, description will be made of a method of replacing the cutting blades 36 by using the auxiliary apparatus 2.

As illustrated in FIG. 14, 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 by using the auxiliary apparatus 2, the caterpillar 22 of the cutting blade storage means 4 is first rotated, and thereby a supporting shaft 24 supporting a new cutting blade 36 to be loaded into the cutting apparatus 170 is 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. 15, a side wall 56 of the casing 52 to which side wall a blade holding unit 48 is fitted is set along the X-axis direction by rotating the casing 52 by the motor coupled to the Z rotary shaft 46 of the loading and unloading means 6. The blade holding unit 48 is thereby faced toward the cutting blade storage means 4. In addition, 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 means 12 and the Z-axis moving means 10 so 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. 16, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning means 8, and thereby the loading and unloading means 6 is positioned at the action position at which 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 suction-held by the blade holding unit 48 by generating a suction force in each suction hole 62 of the blade holding unit 48.

After the cutting blade 36 is suction-held by the blade holding unit 48, the loading and unloading means 6 is separated from the cutting blade storage means 4 in the Y-axis direction by actuating the Y-axis direction positioning means 8. The cutting blade 36 is thereby pulled out from the shaft portion 34. Next, air is

supplied from the air nozzle 142 to the flow passages 32a of the base portion 32 of the supporting shaft 24 via the flow passage 22a of the caterpillar 22. Thus, cutting blades 36 left on the supporting shaft 24 can be moved to the distal end of the supporting shaft 24 by blowing air to a back portion of the remaining cutting blades 36 supported by the supporting shaft 24.

After the cutting blades 36 left on the shaft portion 34 are moved to the distal end of the supporting shaft 24, the supporting shaft 24 is moved from between the cutting blade 36 suction-held by the blade holding unit 48 and the distal end of the air nozzle 142 by rotating the caterpillar 22 of the cutting blade storage means 4. Next, air is blown from the air nozzle 142 to the back surface of the cutting blade 36 suction-held by the blade holding unit 48 (see FIG. 8). The back surface of the cutting blade 36 can be thereby cleaned. In addition, when the air is blown to the cutting blade 36, the air is blown to the whole of the back surface of the cutting blade 36 by actuating the X-axis moving means 12 and the Z-axis moving means 10.

After the cutting blade 36 is cleaned, the loading and unloading means 6 is separated from the cutting blade storage means 4 in the Y-axis direction by actuating the

Y-axis direction positioning means 8. Next, a blade holding unit 48 on an opposite side from the blade holding unit 48 suction-holding the cutting blade 36 is faced toward the cutting blade storage means 4 by rotating the casing 52 of the loading and unloading means 6 by 180°. In addition, a supporting shaft 24 supporting a new cutting blade 36 to be loaded into the cutting apparatus 170 is positioned in front of the blade holding unit 48 by rotating the caterpillar 22 of the cutting blade storage means 4.

Next, the Y-axis direction positioning means 8 is actuated, and thereby the loading and unloading means 6 is positioned at the action position at which the cutting blade 36 of the supporting shaft 24 can be held by the blade holding unit 48 on the opposite side. Next, the cutting blade 36 located on the distal end side of the shaft portion 34 is suction-held by the blade holding unit 48 by generating a suction force in each suction hole 62 of the blade holding unit 48 on the opposite side. Consequently, the pair of blade holding units 48 opposed to each other among the four blade holding units 48 suction-holds the new cutting blades 36. Then, similarly to the above, cutting blades 36 left on the supporting shaft 24 are moved to the distal end of the

supporting shaft 24 by blowing air to a back portion of the cutting blades 36, and the back surface of the cutting blade 36 suction-held by the blade holding unit 48 on the opposite side is cleaned by blowing air from the air nozzle 142 to the cutting blade 36.

Next, as illustrated in FIG. 17, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning means 8, and the raising and lowering table 76 is moved in the Z-axis direction by the Z-axis moving means 10. Consequently, the loading and unloading means 6 is separated from the cutting blade storage means 4 and positioned at the retracted position, and the Y-axis direction position and the Z-axis direction position of the loading and unloading means 6 with respect to the cutting apparatus 170 are adjusted. The Y-axis direction position of the loading and unloading means 6 after the position adjustment is between the pair of cutting means 174 of the cutting apparatus 170, and the Z-axis direction position of the loading and unloading means 6 after the position adjustment is above the holding surface of the chuck table 172.

Next, as illustrated in FIG. 18, the first moving body 112 is moved in the X-axis direction by the air cylinder 130 as the first X-axis moving means. The

loading and unloading means 6 is thereby advanced toward between the pair of cutting means 174 of the cutting apparatus 170. Next, as illustrated in FIG. 19, the second moving body 114 is moved in the X-axis direction by the second X-axis moving means 136. The X-axis direction position of the loading and unloading means 6 with respect to the pair of cutting means 174 is thereby adjusted.

Specifically, the X-axis direction position of the center of the new pair of cutting blades 36 suction-held by the pair of blade holding units 48 of the loading and unloading means 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 means 174. In addition, the Z-axis moving means 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 means 174.

Next, the pair of fixing nut holding units 50 is faced toward the cutting blades 36 of the pair of cutting means 174 by rotating the casing 52 of the loading and unloading means 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 means 174 is positioned at the open position (see FIG. 12). Next, 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 moving the cutting means 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 be thereby unscrewed (removed) from the male thread 228 of the spindle 220 of the cutting means 174.

In addition, the removed fixing nut 222 is suction-held by the fixing nut holding unit 50 by generating a suction force in each suction hole 70 of the fixing nut holding unit 50.

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

Next, the cutting means 174 is brought close to the loading and unloading means 6 by the Y-axis feeding means 178, so that the spindle 220 of the cutting means 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 means 174. Next, the cutting blade 36 of the cutting means 174 is suction-held by the blade holding unit 48 by generating a suction force in each suction hole 62 of the blade holding unit 48.

Next, the cutting means 174 is separated from the loading and unloading means 6 by the Y-axis feeding means 178, and a blade holding unit 48 suction-holding a new

cutting blade 36 is faced toward the spindle 220 of the cutting means 174 by rotating the casing 52 of the loading and unloading means 6 by 60°.

Next, the cutting means 174 is brought close to the loading and unloading means 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. Next, the new cutting blade 36 is transferred from the blade holding unit 48 to the spindle 220 by releasing the suction force of the blade holding unit 48.

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

Next, the cutting means 174 is brought close to the loading and unloading means 6 by the Y-axis feeding means 178, so that the fixing nut 222 suction-held by the fixing nut holding unit 50 is fitted to the distal end portion of the spindle 220. Next, the fixing nut 222 is

rotated by actuating the motor of the fixing nut holding unit 50 in an opposite direction 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 means 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.

Next, after the suction force of the fixing nut holding unit 50 is released, the second cover member 224b of the blade cover 224 of the cutting means 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 means 174, or may be performed separately for the pair of cutting means 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 air nozzle 142 of the cleaning means 13 by rotating the casing 52 of the loading and unloading means 6 by 60°. At this time, the caterpillar 22 of the cutting blade storage means 4 is

rotated in advance such that no supporting shaft 24 is located between the one of the removed cutting blades 36 and the distal end of the air nozzle 142. Then, the back surface of the one of the removed cutting blades 36 is cleaned by blowing air from the air nozzle 142 to the whole of the back surface of the one cutting blade 36 while the X-axis moving means 12 and the Z-axis moving means 10 are being actuated.

Next, 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 rotating the caterpillar 22 of the cutting blade storage means 4. Next, 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 means 12 and the Z-axis moving means 10 so 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 suction-held by the blade holding unit 48.

Next, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning means 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 suction-held 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. Next, the one of the removed pair of cutting blades 36 is transferred to the supporting shaft 24 by releasing the suction force of the blade holding unit 48.

In addition, the loading and unloading means 6 is separated from the cutting blade storage means 4 by the Y-axis direction positioning means 8, and a blade holding unit 48 on an opposite side, the blade holding unit suction-holding the other of the removed pair of cutting blades 36, is faced toward the cutting blade storage means 4 by rotating the casing 52 of the loading and unloading means 6 by 180°.

Next, the caterpillar 22 of the cutting blade storage means 4 is rotated such that no supporting shaft 24 is located between the other of the removed cutting blades 36 and the distal end of the air nozzle 142. Then, the back surface of the other of the removed cutting blades 36 is cleaned by blowing air from the air nozzle 142 to the whole of the back surface of the other cutting

blade 36 while the X-axis moving means 12 and the Z-axis moving means 10 are being actuated.

Next, a supporting shaft 24 that can support (on which there is room for supporting) a cutting blade 36 is positioned at a predetermined position by rotating the caterpillar 22 of the cutting blade storage means 4.

Next, the frame body 74 is moved in the Y-axis direction by the Y-axis direction positioning means 8 to insert the shaft portion 34 of the supporting shaft 24 at the above-described predetermined position into the central opening portion 38a of the other cutting blade 36 suction-held by the blade holding unit 48 on the opposite side, and bring the end surface of the other cutting blade 36 into contact with the end surface of the cutting blade 36 supported by the supporting shaft 24. Next, the other of the removed pair of cutting blades 36 is transferred to the supporting shaft 24 by releasing the suction force of the blade holding unit 48.

As described above, the auxiliary apparatus 2 according to 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 means 174 of the cutting apparatus 170.

Further, the auxiliary apparatus 2 according to the

present embodiment blows air from the air nozzle 142 of the cleaning means 13 to a new cutting blade 36, which is stored in the cutting blade storage means 4, for replacement or a cutting blade 36 removed from the cutting apparatus 170. Thus, the auxiliary apparatus 2 can remove foreign matter such as cutting waste from the cutting blade 36 by cleaning the back surface of the cutting blade 36. Hence, when the cutting blade 36 is mounted in the cutting apparatus 170, the cutting blade 36 is positioned at an appropriate position without foreign matter being interposed between the cutting blade 36 and the mount flange 226. In addition, uneven wear of the cutting blade 36 and the mount flange 226 is prevented.

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, cutting means 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 means in a Y-axis direction orthogonal to the X-axis direction, and Z-axis feeding means for cutting-feeding the cutting means 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:

cutting blade storage means for storing a plurality of cutting blades;

loading and unloading means for unloading and loading a cutting blade from the cutting blade storage means while holding a front surface of the cutting blade;

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

Z-axis moving means for moving the loading and unloading means in the Z-axis direction;

X-axis moving means for moving the loading and unloading means in the X-axis direction to make the loading and unloading means act on a cutting blade fitted to a spindle of the cutting means; and

cleaning means for cleaning a back surface of the cutting blade held by the loading and unloading means.

2. The auxiliary apparatus according to claim 1, wherein

the cutting blade storage means includes a driving gear having a rotary shaft extending in the Y-axis direction, a driven gear separated from the driving gear in the Z-axis direction and having a rotary shaft extending in the Y-axis direction, a caterpillar wound around the driving gear and the driven gear, and supporting shafts arranged on the caterpillar at predetermined intervals, configured to be inserted into a central opening portion of a cutting blade and support the cutting blade, and extending in the Y-axis direction, and

the cleaning means includes an air nozzle disposed so as to be adjacent to the cutting blade storage means and configured to clean the back surface of the cutting

blade held by the loading and unloading means by blowing air to the back surface of the cutting blade.

3. The auxiliary apparatus according to claim 2, wherein

the air nozzle is disposed at a back of the supporting shafts of the cutting blade storage means, and moves a cutting blade supported by a supporting shaft to a distal end of the supporting shaft and positions a front surface of the cutting blade toward the loading and unloading means by blowing air to a back portion of the cutting blade.

4. The auxiliary apparatus according to claim 1, wherein

the loading and unloading means includes a Z rotary shaft extending in the Z-axis direction, blade holding units radially coupled to the Z rotary shaft and configured to suction-hold 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 means is disposed in a frame body, and the frame body is slidably supported by a guide rail disposed on a raising and lowering table and extending 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 means by the Y-axis direction positioning means.

6. The auxiliary apparatus according to claim 5, wherein

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