

CUTTING BLADE IDENTIFYING METHOD AND PROCESSING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a cutting blade identifying method and a processing apparatus.

Description of the Related Art

A cutting apparatus for dividing a workpiece such as a semiconductor wafer into individual chips uses a cutting blade for cutting the workpiece (see, for example, Japanese Patent Laid-Open No. 2011-79098).

SUMMARY OF THE INVENTION

Normally, a blade case accommodating a cutting blade is provided thereon with blade information indicative of, for example, specifications of the blade. When the cutting blade is taken out of the blade case, however, the specifications of the cutting blade become unknown.

The blade information includes information indicative of the kind of the cutting blade inclusive of kinds of a bond and abrasive grains, an abrasive grain diameter, a length of a cutting edge, a thickness of the cutting edge, etc. In the case of a used cutting blade,

the blade information includes use data such as a cut length and an abrasion amount, in addition to the aforementioned information indicative of the kind of the cutting blade. If processing is conducted using a cutting blade based on erroneous blade information, defective processing would be generated.

Particularly, in the cutting apparatus described in Japanese Patent Laid-Open No. 2011-79098 and the like that has a blade replacing apparatus, a plurality of cutting blade taken out of cases are accommodated in a blade stocker, and, therefore, it is necessary that specifications of a cutting blade can be managed even for the cutting blade alone.

In view of this, in the cutting apparatus described in Japanese Patent Laid-Open No. 2011-79098, a technique of management by printing a bar code, for recording blade information, on a base part of a cutting blade provided with a base is adopted. This approach, however, has a problem that it is necessary to print on all the cutting blades by a prescribed method, which lacks flexibility.

Accordingly, it is an object of the present invention to provide a cutting blade identifying method and a processing apparatus by which blade information concerning a cutting blade can easily be identified.

In accordance with an aspect of the present invention, there is provided a cutting blade identifying method including a blade management step of registering an image obtained by imaging a cutting edge of a cutting blade and blade information including either one of a kind and use history of the cutting blade in a mutually associated state in a blade management section, an imaging step of imaging the cutting edge of the cutting blade of which the blade information is to be confirmed, and a blade information confirming step of searching the blade management section for an image of the cutting edge coinciding with the image obtained by imaging in the imaging step and confirming the associated blade information.

Preferably, the cutting blade identifying method is carried out in a processing apparatus, the processing apparatus including a spindle for fixing a cutting blade to a tip thereof, a holding table that holds a workpiece, a blade stocker in which a plurality of cutting blades are accommodated, a blade replacing section that conveys the cutting blade between the spindle and the blade stocker and attaches or detaches the cutting blade, and an imaging section that images a cutting edge of the cutting blade. The blade management step is performed for

the cutting blade which is accommodated in the blade stocker, and the imaging step and the blade information confirming step are performed for the cutting blade conveyed from the blade stocker by the blade replacing section for mounting to the spindle.

In accordance with another aspect of the present invention, there is provided a processing apparatus including a spindle for fixing, to a tip thereof, a cutting blade for processing a workpiece held by a holding table, a blade stocker in which a plurality of cutting blades are accommodated, a blade replacing section that conveys the cutting blade between the spindle and the blade stocker and attaches or detaches the cutting blade, an imaging section that images a cutting edge of the cutting blade, a blade management section that stores an image of the cutting edge of the cutting blade to be accommodated in the blade stocker and blade information including either one of a kind and use history of the cutting blade in a mutually associated state, and a data processing section. The imaging section images the cutting edge of the cutting blade conveyed from the blade stocker by the blade replacing section for mounting to the spindle, and the data processing section searches the blade management section for an image

coinciding with the image obtained by imaging and confirms the associated blade information.

The cutting blade identifying method according to an aspect of the present invention and the processing apparatus according to another aspect of the present invention produce an effect such that blade information concerning a cutting blade can easily be identified.

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 some preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view depicting a configuration example of a processing apparatus according to a first embodiment;

FIG. 2 is a sectional view of a cutting unit of the processing apparatus illustrated in FIG. 1;

FIG. 3 is a plan view of a cutting blade according to the first embodiment;

FIG. 4 is a plan view depicting, in an enlarged

form, part IV of FIG. 3;

FIG. 5 is a perspective view depicting a configuration example of a blade replacing unit of the processing apparatus illustrated in FIG. 1;

FIG. 6 is a perspective view depicting a configuration example of a blade stocker of the blade replacing unit illustrated in FIG. 5;

FIG. 7 is a perspective view depicting a configuration example of a blade attaching/detaching unit of the blade replacing unit illustrated in FIG. 5;

FIG. 8 is a perspective view of a blade chuck of the blade attaching/detaching unit illustrated in FIG. 7;

FIG. 9 is a perspective view of a nut holder of the blade attaching/detaching unit illustrated in FIG. 7;

FIG. 10 is a diagram depicting an example of management data stored by a blade management section of a control unit illustrated in FIG. 1;

FIG. 11 is a flow chart depicting a flow of a cutting blade identifying method according to the first embodiment;

FIG. 12 is a perspective view depicting a blade management step of the cutting blade identifying method illustrated in FIG. 11;

FIG. 13 is a sectional view depicting an imaging

step of the cutting blade identifying method illustrated in FIG. 11;

FIG. 14 is a diagram depicting an example of management data stored by a blade management section of a control unit of a processing apparatus according to a second embodiment;

FIG. 15 is a diagram depicting a configuration of a blade identifying apparatus for carrying out a cutting blade identifying method according to a third embodiment;

FIG. 16 is a plan view depicting a region of a surface of a cutting blade that is imaged by an imaging unit of the blade identifying apparatus illustrated in FIG. 15; and

FIG. 17 is a diagram depicting management data stored by the blade management section of the blade identifying apparatus illustrated in FIG. 15.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described in detail below referring to the drawings. The present invention is not to be limited to the contents of the following embodiments. In addition, the components described below include those easily perceived by a person skilled in the art and substantially the same ones.

Further, the configurations described below may be combined, as required. Besides, various omissions, replacements, and modifications of the configurations are possible within such ranges as not to depart from the gist of the present invention.

[First Embodiment]

A processing apparatus according to a first embodiment of the present invention will be described based on the drawings. FIG. 1 is a perspective view depicting a configuration example of the processing apparatus according to the first embodiment. FIG. 2 is a sectional view of a cutting unit of the processing apparatus illustrated in FIG. 1. FIG. 3 is a plan view of a cutting blade according to the first embodiment. FIG. 4 is a plan view depicting, in an enlarged form, part IV of FIG. 3. FIG. 5 is a perspective view depicting a configuration example of a blade replacing unit of the processing apparatus illustrated in FIG. 1.

(Processing Apparatus)

The processing apparatus 1 according to the first embodiment is a cutting apparatus for cutting a workpiece 200 illustrated in FIG. 1. The workpiece 200 is a wafer such as a disk-shaped semiconductor wafer or an optical device wafer of which a parent material is silicon,

sapphire, gallium or the like. The workpiece 200 is formed with devices 203 in regions partitioned in a grid pattern by a plurality of streets 202 formed in a grid pattern on a front surface 201 thereof.

In addition, the workpiece 200 in the present invention may be what is generally called a TAIKO (registered trademark) wafer in which a central portion is thinned and a thick part is formed in an outer peripheral portion, or, other than wafers, may be a rectangular package substrate having a plurality of devices sealed with a resin, a ceramic substrate, a ferrite substrate, or a substrate including at least one of nickel and iron, or the like. In the first embodiment, the workpiece 200 has a back surface 204 adhered to an adhesive tape 206 with an annular frame 205 mounted to an outer peripheral edge thereof and is supported by the annular frame 205.

The processing apparatus 1 illustrated in FIG. 1 is a cutting apparatus for holding the workpiece 200 by a holding table 10 and cutting (corresponding to processing) the workpiece 200 along the streets 202 by a cutting blade 21. As depicted in FIG. 1, the processing apparatus 1 includes the holding table 10 that holds under suction the workpiece 200 by a holding surface 11,

a cutting unit 20 that cuts the workpiece 200 held by the holding table 10 by the cutting blade 21, an imaging unit 30 that images the workpiece 200 held by the holding table 10, a blade replacing unit 7, and a control unit 100.

In addition, as illustrated in FIG. 1, the processing apparatus 1 includes a moving unit 40 that relatively moves the holding table 10 and the cutting unit 20. The moving unit 40 includes an X-axis moving unit 41 that performs processing feeding of the holding table 10 in an X-axis direction parallel to a horizontal direction, a Y-axis moving unit 42 that performs indexing feeding of the cutting unit 20 in a Y-axis direction parallel to a horizontal direction and orthogonal to the X-axis direction, a Z-axis moving unit 43 that performs cutting-in feeding of the cutting unit 20 in a Z-axis direction parallel to the vertical direction orthogonal to both the X-axis direction and the Y-axis direction, and a rotationally moving unit 44 that rotates the holding table 10 around an axis parallel to the Z-axis direction. As depicted in FIG. 1, the processing apparatus 1 is a two-spindle dicer, or what is generally called a facing dual type cutting apparatus having two cutting units 20.

The X-axis moving unit 41 moves the holding table 10 in the X-axis direction which is the processing feeding direction, to thereby perform relative processing feeding of the holding table 10 and the cutting unit 20 in the X-axis direction. The Y-axis moving unit 42 moves the cutting unit 20 in the Y-axis direction which is the indexing feeding direction, to thereby perform relative indexing feeding of the holding table 10 and the cutting unit 20 in the Y-axis direction. The Z-axis moving unit 43 moves the cutting unit 20 in the Z-axis direction which is the cutting-in feeding direction, to thereby perform relative cutting-in feeding of the holding table 10 and the cutting unit 20 in the Z-axis direction.

The X-axis moving unit 41, the Y-axis moving unit 42, and the Z-axis moving unit 43 include a known ball screw provided to be rotatable around an axis, a known motor for rotating the ball screw around the axis, and known guide rails for supporting the holding table 10 or the cutting unit 20 movably in the X-axis direction, the Y-axis direction, or the Z-axis direction.

The holding table 10 is disk-shaped, and its holding surface 11 for holding the workpiece 200 is formed of a porous ceramic. In addition, the holding table 10 is provided to be movable in the X-axis

direction between a processing region 63 on a lower side of the cutting unit 20 and a conveying-in/out region 64 where the workpiece 200 is conveyed in or out by spacing from the lower side of the cutting unit 20, by the X-axis moving unit 41, and is provided to be movable around an axis parallel to the Z-axis direction by the rotationally moving unit 44. The holding table 10 is connected to a vacuum suction source (not illustrated), and suction by the vacuum suction source causes the workpiece 200 held on the holding surface 11 to be held under suction. In the first embodiment, the holding table 10 holds under suction the back surface 204 of the workpiece 200 with the adhesive tape 206 disposed therebetween. In addition, a plurality of clamp sections 12 for clamping the annular frame 205 are provided in the periphery of the holding table 10, as depicted in FIG. 1.

The cutting unit 20 is cutting means in which the cutting blade 21 for cutting the workpiece 200 held by the holding table 10 is detachably mounted. Each cutting unit 20 is provided to be movable in the Y-axis direction by the Y-axis moving unit 42 and to be movable in the Z-axis direction by the Z-axis moving unit 43, in relation to the workpiece 200 held by the holding table 10.

The cutting unit 20 on one side is provided at a

column section on one side of a gate-formed support frame 3 erected from the apparatus main body 2 through the Y-axis moving unit 42 and the Z-axis moving unit 43 and the like. The cutting unit 20 on the other side is provided at a column section on the other side of the support frame 3 through the Y-axis moving unit 42 and the Z-axis moving unit 43 and the like. Note that the support frame 3 has a configuration in which upper ends of the column sections are connected by a horizontal beam. The cutting unit 20 permits the cutting blade 21 to be positioned at any position on the holding surface 11 of the holding table 10 by the Y-axis moving unit 42 and the Z-axis moving unit 43.

As illustrated in FIG. 2, the cutting unit 20 includes the cutting blade 21, a spindle housing 22 provided to be movable in the Y-axis direction and the Z-axis direction by the Y-axis moving unit 42 and the Z-axis moving unit 43, a spindle 23 serving as a rotational shaft provided in the spindle housing 22 to be rotatable around an axis, a fixing flange 24, a pressing flange 25, and a fixing nut 26.

The cutting blade 21 is an extremely thin grindstone having a substantially ring-like shape. In the first embodiment, as depicted in FIG. 3, the cutting

blade 21 is what is generally called a washer blade including only an annular cutting edge 211 for cutting the workpiece 200. The cutting edge 211 of the cutting blade 21 is formed in a disk shape provided in its center with a circular mounting hole 212 for mounting to the spindle 23. The cutting edge 211 is formed from abrasive grains of diamond, cubic boron nitride (CBN) or the like and a bond material (binder) such as a metal or a resin, and is formed in a predetermined thickness.

Besides, as depicted in FIG. 3, the cutting blade 21 has the abrasive grains 214 and the bond material exposed on a surface 213 of the cutting edge 211. The pattern configured by the abrasive grains 214 and the bond material exposed on the surface 213 depicted as an example in FIG. 4 of the cutting edge 211 of the cutting blade 21 differs even among the cutting blades 21 of the same kind, and differs from position to position in the same cutting blade 21.

The spindle housing 22 is supported to be movable in the Z-axis direction by the Z-axis moving unit 43 and is supported to be movable in the Y-axis direction by the Y-axis moving unit 42 through the Z-axis moving unit 43. The spindle housing 22 accommodates a part exclusive of a tip portion of the spindle 23 and a spindle motor (not

illustrated) and the like and supports the spindle 23 in the manner of being rotatable around an axis.

The spindle 23 is for fixing the cutting blade 21 to a tip thereof. The spindle 23 serves as a rotational shaft rotated by the spindle motor (not illustrated), and its tip portion protrudes from a tip surface 221 of the spindle housing 22. The tip portion of the spindle 23 is gradually tapered off, and a threaded hole 231 opening in a tip surface is provided.

The fixing flange 24 includes a cylindrical boss section 241, and a flange section 242 projected radially outward from a central position in the axial direction of the boss section 241. The boss section 241 is fixed to the tip portion of the spindle 23. As depicted in FIG. 2, the boss section 241 is provided at an inner peripheral surface thereof with a stepped section 243 and a tapered section 244. The stepped section 243 is provided at the tip side spaced from the spindle housing 22 more than the flange section 242, and stepwise reduces the inside diameter of the boss section 241 from the tip spaced from the spindle housing 22 toward a base end side near the spindle housing 22. The surface of the stepped section 243 is formed to be flat along the direction orthogonal to the axis of the boss section 241, namely, the axis of

the fixing flange 24.

The tapered section 432 is formed ranging over from the center to a base end in the axial direction of the boss section 241 and gradually increases the inside diameter of the boss section 241 from the center toward the base end side in the axial direction. The fixing flange 24 is fixed to a tip portion of the spindle 23 by a step in which a tip portion of the spindle 23 is inserted into the base end side of the boss section 241, and a fixing screw 28 passed through a washer 27 laid on the surface of the stepped section 243 is put into screw engagement with the threaded hole 231 provided in the tip surface of the spindle 23. When the fixing flange 24 is fixed to the tip portion of the spindle 23, the tapered section 432 makes close contact with the tip portion of the spindle 23. In addition, the boss section 241 is formed with a male screw 245 at a tip of an outer peripheral surface thereof.

The flange section 242 is an annular member projecting radially outward from a central portion in the axial direction of the boss section 241. The outside diameter of the flange section 242 is smaller than the outside diameter of the cutting blade 21. The flange section 242 is formed along the whole circumference of an

outer edge thereof with a support surface 246 which faces the cutting blade 21 and supports the cutting blade 21. The support surface 246 is formed to be flat along the direction orthogonal to the axis of the fixing flange 24. The flange section 242 supports the cutting blade 21 by putting the cutting blade 21 in close contact with the support surface 246. The support surface 246 may be formed with an end face projecting in the extending direction of the boss section 241 only at an outer edge thereof, and may reduce the area of contact with the support surface by supporting the cutting blade 21 on the end face, such that the cutting blade 21 can be held more perpendicularly.

The pressing flange 25 is formed in an annular shape having in its center a mounting hole 251 to be mounted to the boss section 241 of the fixing flange 24. The pressing flange 25 is smaller in outside diameter of the cutting blade 21. The pressing flange 25 has a blade supporting boss section 252 facing the fixing flange 24 when a tip side of the boss section 241 of the fixing flange 24 is passed through the mounting hole 251. The blade supporting boss section 252 has an outside diameter equal to the inside diameter of the mounting hole 212 of the cutting blade 21. The blade supporting boss section

252 is inserted in and passed through the mounting hole 212 of the cutting blade 21 from the base end side and supports the cutting blade 21 on an outer peripheral surface thereof.

In addition, the pressing flange 25 has, around the whole circumference on the outer periphery side of the blade supporting boss section 252, a clamping surface 253 that clamps the cutting blade 21 between itself and the support surface 246 of the fixing flange 24 when a tip side of the boss section 241 of the fixing flange 24 is passed through the mounting hole 251. The clamping surface 253 is formed to be flat in the direction orthogonal to the axis of the pressing flange 25. The pressing flange 25 has the clamping surface 253 that clamps the cutting blade 21 between itself and the support surface 246 of the fixing flange 24.

Besides, the pressing flange 25 is formed with a suction passage 255 ranging between an end face 254 on the tip side and the clamping surface 253. The suction passage 255 is a hole penetrating the pressing flange 25 ranging from the end face 254 to the clamping surface 253, and, by being sucked from the end face 254 side, holds under suction the cutting blade 21 on the clamping surface 253.

The fixing nut 26 is formed in an annular shape and is formed at its inner peripheral surface with a female screw 261 for screw engagement with the male screw 245 of the boss section 241. With the boss section 241 of the fixing flange 24 passed through the mounting hole 251 of the pressing flange 25, and with the female screw 261 screw engaged with the male screw 245 of the boss section 241 of the fixing flange 24 clamping the cutting blade 21 between the support surface 246 and the clamping surface 253, the fixing nut 26 is fastened to the boss section 241. The fixing nut 26, by fastening to the boss section 241, fixes the cutting blade 21 between the fixing flange 24 and the pressing flange 25 through the pressing flange 25. As depicted in FIG. 2, the fixing nut 26 is provided in its end face with four pin fitting holes 262 at regular intervals along the circumferential direction. Note that the pin fitting holes 262 may be formed to penetrate the fixing nut 26, such that fitting pins 115 fit in more depth and transmit a rotating force.

In the cutting unit 20 configured in this way, the fixing flange 24 has a tip portion of the spindle 23 passed inside the base end side of the boss section 241, and is fixed to a tip portion of the spindle 23 by the fixing nuts 26 or the like, and an inner peripheral

surface of the mounting hole 212 of the cutting blade 21 is supported on an outer peripheral surface of the blade supporting boss section 252. In the cutting unit 20, a tip side of the boss section 241 of the fixing flange 24 is passed inside the mounting hole 251 of the pressing flange 25, the male screw 245 is put into screw engagement with the female screw 261, and the pressing flange 25 and the cutting blade 21 are fixed to a tip portion of the spindle 23 by the fixing nut 26.

Note that the spindle 23, the fixing flange 24, the cutting blade 21, the pressing flange 25, and the fixing nut 26 of the cutting unit 20 are disposed at such positions as to be coaxial with one another. The axes of the spindle 23, the fixing flange 24, the cutting blade 21, the pressing flange 25, and the fixing nut 26 of the cutting unit 20 are set parallel to the Y-axis direction.

The imaging unit 30 is fixed to the cutting unit 20 such as to be moved as one body with the cutting unit 20. The imaging unit 30 includes an imaging element for imaging a region to be divided of the workpiece 200 yet to be cut which is held by the holding table 10. The imaging element is, for example, a charge-coupled device (CCD) imaging element or a complementary metal-oxide semiconductor (CMOS) imaging element. The imaging unit 30

images the workpiece 200 held by the holding table 10 to obtain an image for, for example, performing alignment between the workpiece 200 and the cutting blade 21, and outputs the thus obtained image to the control unit 100.

In addition, the processing apparatus 1 includes an X-axis direction position detection unit (not illustrated) for detecting the position of the holding table 10 in the X-axis direction, a Y-axis direction position detection unit (not illustrated) for detecting the position of the cutting unit 20 in the Y-axis direction, and a Z-axis direction position detection unit (not illustrated) for detecting the position of the cutting unit 20 in the Z-axis direction. The X-axis direction position detection unit and the Y-axis direction position detection unit may include a linear scale parallel to the X-axis direction or the Y-axis direction, and a reading head. The Z-axis direction position detection unit detects the position of the cutting unit 20 in the Z-axis direction by pulses of a motor. The X-axis direction position detection unit, the Y-axis direction position detection unit, and the Z-axis direction position detection unit output the position of the holding table 10 in the X-axis direction or the position of the cutting unit 20 in the Y-axis direction

or the Z-axis direction to the control unit 100. Note that, in the first embodiment, the position of each component of the processing apparatus 1 in the X-axis direction, the Y-axis direction, and the Z-axis direction is determined as a position with reference to a predetermined reference position (not illustrated).

In addition, the processing apparatus 1 includes a cassette elevator 50 on which a cassette 51 accommodating the workpieces 200 before and after cutting is placed and which moves the cassette 51 in the Z-axis direction, a cleaning unit 60 that cleans the workpiece 200 after cutting, and a conveying unit 61 that puts the workpiece 200 into and out of the cassette 51 and that conveys the workpiece 200.

(Blade Replacing Unit)

The blade replacing unit 7 depicted in FIG. 5 is for attaching and detaching the cutting blade 21 together with the pressing flange 25 to and from the boss section 241 of the fixing flange 24 fixed to a tip portion of the spindle 23 of the cutting unit 20 position at an attaching/detaching position, to thereby replace the cutting blade 21. Note that the attaching and detaching position is a position of which the positions in the X-axis direction, the Y-axis direction, and the Z-axis

direction are predetermined and is a position where each cutting unit 20 is positioned when the cutting blade 21 is attached and detached together with the pressing flange 25 by the blade replacing unit 7. In addition, in the first embodiment, the blade replacing unit 7 replaces the cutting blade 21 mounted to the boss section 241 of the fixing flange 24, together with the pressing flange 25. In short, the blade replacing unit 7 attaches and detaches the cutting blade 21 to and from the boss section 241 of the fixing flange 24, together with the pressing flange 25.

As illustrated in FIG. 1, the blade replacing unit 7 is disposed at a position which is on a back surface side in FIG. 1 of the support frame 3 and which is spaced from the conveying-in/out region 64 more than the processing region 63. As depicted in FIG. 5, the blade replacing unit 7 includes a blade stocker 70 that accommodates a plurality of cutting blades 21 before and after replacement together with the pressing flanges 25, a second imaging unit 76 which is an imaging section, and a blade attaching/detaching unit 80 as a blade replacing section that attaches and detaches the cutting blade 21 to and from the spindle 23 of the cutting unit 20 together with the pressing flange 25 and that conveys the

cutting blade 21 together with the pressing flange 25 between the blade stocker 70 and the cutting unit 20 and attaches and detaches the cutting blade 21 together with the pressing flange 25.

In the first embodiment, the blade stocker 70 is provided in one-to-one correspondence with the cutting unit 20. In other words, in the first embodiment, the blade replacing unit 7 includes a pair of blade stockers 70.

In addition, in the first embodiment, the blade stocker 70 on one side holds a plurality of cutting blades 21 before and after replacement of the spindle 23 of the cutting unit 20 on one side in the state of being supported by the blade supporting boss section 252 of the pressing flange 25, and the blade stocker 70 on the other side holds a plurality of cutting blades 21 before and after replacement of the spindle 23 of the cutting unit 20 on the other side in the state of being supported by the blade supporting boss section 252 of the pressing flange 25. Thus, each blade stocker 70 accommodates a plurality of cutting blades 21.

Note that the cutting blades 21 accommodated in each blade stocker 70 include, in addition to unused ones, those which have been used but are usable because they do

not reach the useful life, and those of the same kind and/or different kinds.

Next, each component of the blade replacing unit 7 will be described hereinbelow.

(Blade Stocker)

FIG. 6 is a perspective view depicting a configuration example of the blade stocker of the blade replacing unit illustrated in FIG. 5. The blade stocker 70 is for holding the cutting blade 21 for replacement which is yet to be mounted to the corresponding cutting unit 20, together with the pressing flange 25, and for holding the cutting blade 21 after replacement which has been detached from the corresponding cutting unit 20, together with the pressing flange 25. Note that since the pair of blade stockers 70 are equal in configuration, the blade stocker 70 on the depth side in FIG. 5 will hereinafter described as a representative, and the same parts of the pair of blade stockers 70 will be denoted by the same reference symbols and descriptions thereof will be omitted.

As illustrated in FIG. 6, the blade stocker 70 includes a support column 71 disposed on the apparatus main body 2, and a support member 73 attached to an upper end of the support column 71 through a rotational shaft

72. The support member 73 is disposed to face the corresponding blade attaching/detaching unit 80 in the Y-axis direction, a plurality of (in the first embodiment, four) blade holding sections 74 are concentrically disposed on a front surface side facing the corresponding blade attaching/detaching unit 80, and the support member 73 can hold a plurality of (in the first embodiment, four) cutting blades 21 attached to and detached from the corresponding cutting unit 20.

The blade holding section 74 is for holding the cutting blade 21 together with the pressing flange 25. The blade holding section 74 includes a cylindrical blade fitting section 741 passed through the mounting hole 251 in the pressing flange 25, and a positioning section 742 for positioning the pressing flange 25 that is provided on an outer peripheral surface of the blade fitting section 741 and has the blade fitting section 741 passed through the boss section 241. The positioning section 742 includes a ball provided to be capable of projecting from and recessing in an outer peripheral surface of the blade fitting section 741, and a spring pressing the ball toward the radially outer side. Until the force on the radially inner side acting on the ball reaches a predetermined value, the ball fits in an inner edge of

the mounting hole 251 of the pressing flange 25, whereby a positioning function is realized. Each blade holding section 74 is preliminarily given a number (hereinafter referred to holding section number) by which the blade holding sections 74 can be identified.

With the blade stocker 70 configured in this way, the cutting blade 21 is laid on the blade holding section 74, the blade fitting section 741 is passed through the mounting hole 251 of the pressing flange 25 having the cutting blade 21 supported on the outer peripheral surface of the blade supporting boss section 252, and the blade fitting section 741 is fitted to the inner edge of the mounting hole 251, whereby the cutting blade 21 is held together with the pressing flange 25. Specifically, when the blade fitting section 741 is passed through the mounting hole 251 of the pressing flange 25, the ball of the positioning section 742 of the blade holding section 74 once sinks in the blade fitting section 741, and the ball of the positioning section 742 returned after the pressing flange 25 comes over is fitted in the inner edge of the mounting hole 251, whereby the cutting blade 21 is held together with the pressing flange 25. Besides, in the first embodiment, the axis of the blade fitting section 741 is parallel to the Y-axis direction.

In addition, each blade holding section 74 is formed with a through-hole 77 depicted in FIG. 6. The through-hole 77 is penetrating the blade holding section 74. The through-hole 77 is disposed at a position for facing a part of a region 215 (depicted in FIG. 2) overlapping with the flange section 242 of the fixing flange 24, of the surface 213 of the cutting edge 211 of the cutting blade 21. The through-hole 77 exposes a part of the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 held by the blade holding section 74.

The rotational shaft 72 having the support member 73 attached to an upper end of the support column 71 has its one end disposed at the upper end of the support column 71, and has its other end connected to the center of a back surface of the support member 73. The one end side of the rotational shaft 72 is connected to a driving shaft of a motor 75 disposed inside the support column 71, and the support member 73 is configured to be intermittently rotatable with the rotational shaft 72 as a center. In the first embodiment, the support member 73 is configured to be intermittently rotatable by 90 degrees at a time. By the intermittent rotation of the rotational shaft 72, the support member 73 selectively

positions each blade holding section 74 at a preset predetermined transfer position 744 on a moving path thereof. A height in the Z-axis direction of the axis of the blade holding section 74 positioned at the transfer position 744 is equal to a height in the Z-axis direction of the axis of the cutting unit 20 positioned at the attaching/detaching position.

The second imaging unit 76 is for imaging the surface 213 of the cutting edge 211 of the cutting blade 21. The second imaging unit 76 includes an imaging element that faces the through-hole 77 of the blade holding section 74 at the transfer position 744 and that images through the through-hole 77 the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 held by the blade holding section 74 at the transfer position 744. The imaging element is, for example, a CCD imaging element or a CMOS imaging element. The second imaging unit 76 images through the through-hole 77 a part of the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 and outputs the thus obtained image to the control unit 100.

(Blade Attaching/Detaching Unit)

FIG. 7 is a perspective view depicting a configuration example of a blade attaching/detaching unit

of the blade replacing unit illustrated in FIG. 5. FIG. 8 is a perspective view of a blade chuck of the blade attaching/detaching unit illustrated in FIG. 7. FIG. 9 is a perspective view of a nut holder of the blade attaching/detaching unit illustrated in FIG. 7.

The blade attaching/detaching unit 80 is for conveying the cutting blade 21 together with the pressing flange 25 between the spindle 23 of each cutting unit 20 and the blade stocker 70 and for attaching and detaching the cutting blade 21 to and from the spindle 23 together with the pressing flange 25. As illustrated in FIG. 7, the blade attaching/detaching unit 80 includes a unit main body 81, a moving unit 82 that moves the unit main body 81 in the X-axis direction, a pair of blade replacing mechanism 90, a pair of nut holders 110, and an attaching/detaching moving mechanism 120.

As depicted in FIG. 5, the moving unit 82 includes a screw shaft 821 that makes screw engagement with a nut 811 provided on the unit main body 81 and extends in the X-axis direction, and a motor 822 that rotates the screw shaft 821 around an axis to thereby move the unit main body 81 in the X-axis direction. The screw shaft 821 is supported by a fixing plate 812 fixed to the apparatus main body 2 or the like through the fixing plate 812 such

as to be rotatable around an axis. The motor 822 is attached to the fixing plate 812.

The blade replacing mechanisms 90 and the nut holders 110 are in one-to-one correspondence, and the blade stockers 70 and the cutting units 20 are also in one-to-one correspondence. The blade replacing mechanism 90 is for attaching and detaching the cutting blade 21 to and from the fixing flange 24 fixed to a tip portion of the spindle 23 of the corresponding cutting unit 20, together with the pressing flange 25.

Besides, in the first embodiment, the blade replacing mechanism 90 holds the cutting blade 21 for replacement which is held by the corresponding blade stocker 70, together with the pressing flange 25, and holds the cutting blade 21 after replacement which is detached from the corresponding cutting unit 20, together with the pressing flange 25. In addition, the blade replacing mechanism 90 mounts the cutting blade 21 for replacement which is held to the cutting unit 20, together with the pressing flange 25, and causes the cutting blade 21 after replacement detached from the corresponding cutting unit 20 to be held by the corresponding blade stocker 70 together with the pressing flange 25.

As illustrated in FIGS. 5 and 7, each blade replacing mechanism 90 includes a rotary arm 91 extending rectilinearly, and a pair of blade chucks 92 provided at both end portions of the rotary arm 91.

The rotary arm 91 is formed in a rectilinearly extending arm shape. The rotary arm 91 has its center in the longitudinal direction intermittently rotated around an axis parallel to the Y-axis direction by a rotationally moving unit 121 of the attaching/detaching moving mechanism 120, and is slid in the Y-axis direction by a sliding moving unit 122 of the attaching/detaching moving mechanism 120. In the first embodiment, the rotary arm 91 is intermittently rotated by 180 degrees at a time by the rotationally moving unit 121, such that its longitudinal direction is parallel to the X-axis direction.

The blade chucks 92 are disposed at both end portions in the longitudinal direction of the rotary arm 91. The axis of each blade chuck 92 is parallel to the Y-axis direction. As depicted in FIG. 8, the blade chuck 92 includes a thick disk-shaped chuck main body 921. The chuck main body 921 is rotated around an axis by a motor 911 attached to the rotary arm 91. The chuck main body 921 is formed with a ring-shaped suction groove 923 in an

end face 922 facing the blade holding section 74 of the blade stocker 70 and the cutting unit 20 at the attaching/detaching position.

The suction groove 923 is connected to a suction source 925 through an on-off valve 924. With the on-off valve 924 opened and with suction applied to the inside of the suction groove 923 by the suction source 925, the blade chuck 92 holds under suction the pressing flange 25 on the end face 922 of the chuck main body 921. In addition, when the blade chuck 92 holds under suction the pressing flange 25 on the end face 922 of the chuck main body 921, the suction groove 923 comes to communicate with the suction passage 255 and applies suction to the inside of the suction passage 255. With the on-off valve 924 opened and with suction applied to the inside of the suction groove 923 by the suction source 925, the blade chuck 92 holds under suction the pressing flange 25 on the end face 922 of the chuck main body 921 and holds under suction the cutting blade 21 on the clamping surface 253 of the pressing flange 25. Besides, in the first embodiment, the blade chuck 92 is provided, in the center of the end face 922, with a boss section penetration hole 926 into which a tip side of the boss section 241 of the fixing flange 24 can enter.

A height in the Z-axis direction of the axis of each blade chuck 92 is equal to the height in the Z-axis direction of the axis of the blade holding section 74 positioned at the transfer position 744 and the height in the Z-axis direction of the axis of the cutting unit 20 positioned at the attaching/detaching position.

The nut holder 110 attaches and detaches the fixing nut 26 of the corresponding cutting unit 20 to and from the fixing flange 24. The nut holder 110 is disposed on the unit main body 81, and is disposed at a position of being aligned with the corresponding blade replacing mechanism 90 in the X-axis direction. The axis of the nut holder 110 is parallel to the Y-axis direction.

As depicted in FIG. 9, the nut holder 110 includes a box-shaped holder main body 111, a thick disk-shaped support base 112 provided at a surface of the holder main body 111 that faces the spindle 23 of the corresponding cutting unit 20, claws 113 attached to the support base 112, and a plurality of fitting pins 115 provided on an end face 114 of the support base 112 that faces the cutting unit 20 at the attaching/detaching position.

The support base 112 is rotated around an axis by a motor 116 provided in the nut holder 110. The claws 113 are provided in plurality in the state of being spaced

along the circumferential direction on the end face 114 of the support base 112. In the first embodiment, four claws 113 are provided at regular intervals in the circumferential direction on the end face 114 of the support base 112. The plurality of claws 113 are provided to be movable in the radial direction of the end face 114 by a driving mechanism (not illustrated) provided in the support base 112 or the like. By approaching one another, the claws 113 grasp the outer peripheral surface of the fixing nut 26, and by spacing away from one another, the claws 113 release the grasping of the fixing nut 26.

The fitting pins 115 are supported by the support base 112 such that they can be projected and recessed from the end face 114, and, in the first embodiment, four fitting pins 115 are provided at regular intervals along the circumferential direction on the end face 114. The fitting pin 115 can be fitted in a pin fitting hole 262 of the fixing nut 26 when the fitting pin 115 is projected from the end face 114.

The nut holder 110 is configured such that with the support base 112 rotated around an axis by the motor 116, in a state in which the end face 114 is in close contact with the end face of the fixing nut 26 and the fixing nut 26 is grasped by the claws 113, the fitting pins 115 are

fitted into the pin fitting holes 262. The nut holder 110 is configured such that with the support base 112 rotated around an axis by the motor 116, in a state in which the fitting pins 115 are fitted in the pin fitting holes 262, the fixing nut 26 is attached to and detached from the male screw 245 of the boss section 241 of the fixing flange 24.

A height in the Z-axis direction of the axis of each nut holder 110 is equal to the height in the Z-axis direction of the axis of the cutting unit 20 positioned at the attaching/detaching position.

The attaching/detaching moving mechanism 120 includes the rotationally moving unit 121 that intermittently rotates the rotary arm 91 by 180 degrees at a time around an axis, the sliding moving unit 122 that slides the rotary arm 91 in the Y-axis direction relative to the unit main body 81, and a second sliding moving unit 123 that slides the holder main body 111 of the nut holder 110 in the Y-axis direction relative to the unit main body 81.

(Control Unit)

FIG. 10 is a diagram depicting an example of management data stored by a blade management section of the control unit illustrated in FIG. 1.

The control unit 100 is for controlling the components of the processing apparatus 1 and for causing the processing apparatus 1 to perform processing operation on the workpiece 200. Note that the control unit 100 is a computer including an arithmetic processing apparatus having a microprocessor such as a central processing unit (CPU), a storage apparatus having a memory such as a read only memory (ROM) and a random access memory (RAM), and an input/output interface apparatus. The arithmetic processing apparatus of the control unit 100 performs arithmetic processing according to a computer program stored in the storage apparatus and outputs control signals for controlling the processing apparatus 1 to the components of the processing apparatus 1 through the input/output interface apparatus.

The control unit 100 is connected to a display unit 101 including a liquid crystal display or the like for displaying the state of a processing operation and an image and the like, an input unit 102 operated by the operator at the time of registering processing contents information or the like, and an alarm unit 103. The input unit 102 includes at least one of a touch panel provided at the display unit 101 and an external input apparatus such as a keyboard. The alarm unit 103 gives an alarm to

the operator by issuing at least one of sound and light.

In addition, as illustrated in FIG. 1, the control unit 100 includes a blade management section 104 and a data processing section 105. The blade management section 104 is for storing management data 300 depicted in FIG. 10, in which an image of a part of a region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 to be accommodated in the blade stocker 70 and blade information are associated with each other.

In the first embodiment, the management data 300 is in one-to-one correspondence with each cutting unit 20. Therefore, in the first embodiment, two pieces of management data 300 are stored in the blade management section 104. In the first embodiment, as depicted in FIG. 10, each management data 300 includes each holding section number of the blade holding section 74 of the blade stocker 70 corresponding to the corresponding cutting unit 20, blade information concerning the cutting blade 21 accommodated in each blade holding section 74, and an image of a part of a region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in each blade holding section 74, in one-to-one correspondence, that is, in a mutually associated state. Note that, while the blade information includes

information indicative of the kind of the cutting blade 21, the blade information, in the present invention, may include information indicative of use history of the cutting blade 21. In short, in the present invention, it is sufficient that the blade information includes either of the information indicative of the kind of the cutting blade 21 and information indicative of the use history of the cutting blade 21.

Note that the information indicative of the kind of the cutting blade 21 includes information indicative of the kind of the bond material of the cutting blade 21, the kind of the abrasive grains 214, the abrasive grain diameter, the length of the tool edge of the cutting edge 211, the thickness of the cutting edge 211, or the like. The information indicative of the use history of the cutting blade 21 includes information indicative of a cut length, an abrasion amount, or the like. Note that the blade information is registered in the blade management section 104, by accepting of an operator's operation of the input unit 102 by the control unit 100, or by accepting by the control unit 100 of the reading results from the reading apparatus having read the blade information given to an outer surface of a blade case accommodating the cutting blade 21.

The image is obtained by imaging through the through-hole 77 by the second imaging unit 76 after the cutting blade 21 is accommodated in each blade holding section 74 and is registered in the blade management section 104 by accepting by the control unit 100 of the image obtained by the second imaging unit 76.

When the blade stocker 70 of the blade replacing unit 7 detaches the cutting blade 21 from the blade holding section 74 and holds the cutting blade 21, the data processing section 105 extracts and searches the management data 300 in the blade management section 104 for an image coinciding with the image obtained by imaging by the second imaging unit 76, and confirms the blade information associated with the information coinciding with the image obtained by imaging by the second imaging unit 76.

Note that the function of the blade management section 104 is realized by the aforementioned storage apparatus, and the function of the data processing section 105 is realized by execution of the computer program stored in the storage apparatus by the arithmetic processing apparatus.

(Processing Operation of Processing Apparatus)

In the processing apparatus 1, the operator

registers the processing contents information into the control unit 100, accommodates the workpiece 200 before cutting into the cassette 51, places the cassette 51 on an upper surface of the cassette elevator 50, and attaches the cutting blade 21 to the blade holding section 74 of each blade stocker 70 of the blade replacing unit 7. The processing contents information includes blade information concerning the cutting blade 21 to be used when cutting the workpiece 200, and blade information concerning the cutting blade 21 held by each blade holding section 74 of each blade stocker 70.

Thereafter, the processing apparatus 1 starts a processing operation when an instruction to start the processing operation is given from the operator. When the processing apparatus 1 starts the processing operation, the conveying unit 61 conveys the workpiece 200 from inside the cassette 51 to the holding table 10 in the conveying-in/out region 64, the back surface 204 side of the workpiece 200 is held under suction on the holding surface 11 of the holding table 10 with the adhesive tape 206 therebetween, and the annular frame 205 is clamped by the clamp sections 12.

In the processing operation, in the processing apparatus 1, the X-axis moving unit 41 moves the holding

table 10 toward the processing region 63, the imaging unit 30 images the workpiece 200, and alignment is performed based on the image thus imaged by the imaging unit 30. The processing apparatus 1, while relatively moving the workpiece 200 and the cutting unit 20 along the street 202, causes the cutting blade 21 to cut into each street 202, to thereby divide the workpiece 200 into individual devices 203. In the processing apparatus 1, the workpiece 200 divided into the individual devices 203 is conveyed from the holding table 10 to the cleaning unit 60 by the conveying unit 61, and the workpiece 200 is cleaned by the cleaning unit 60.

In the processing apparatus 1, the workpiece 200 after cutting and cleaning is conveyed from the cleaning unit 60 to the cassette 51 by the conveying unit 61 and is accommodated into the cassette 51. In the processing apparatus 1, the workpieces 200 accommodated in the cassette 51 are sequentially cut by the cutting unit 20 or the like, and, when the cutting of all the workpieces 200 in the cassette 51 is completed, and the processing operation is finished.

(Attaching/Detaching Operation of Cutting Blade)

In the first embodiment, the processing apparatus 1, next, performs an attaching/detaching operation of the

cutting blade 21 when it is determined by the control unit 100 that the cutting blade 21 of the cutting unit 20 on at least one side is at a blade replacing timing, during a processing operation of the processing apparatus 1. The blade replacing timing is a timing for replacing the cutting blade 21 of each cutting unit 20. The blade replacing timing may be, for example, each time a preset number of workpieces 200 are cut, or a time when the outside diameter of the cutting blade 21 measured has come below a preset numerical value, and the blade replacing timing is registered in the control unit 100 as part of the processing contents information. In addition, the blade replacing timing in the present invention may be just during processing of a single workpiece 200, or may be a timing for replacing the workpiece 200 in successive processing of a plurality of workpieces 200.

The attaching/detaching operation is an operation of detaching the fixing nut 26 from the spindle 23 of the cutting unit 20, detaching the cutting blade 21 together with the pressing flange 25, attaching the cutting blade 21 held by the blade stocker 70 to the spindle 23 together with the pressing flange 25, and attaching the fixing nut 26 to the spindle 23. In other words, the attaching/detaching operation of the cutting blade 21 is

an operation of replacing the cutting blade held by the blade stocker 70 and the cutting blade mounted to the cutting unit 20 by each other together with the pressing flange 25.

In the attaching/detaching operation, the processing apparatus 1 stops rotation of the spindle 23 of the cutting unit 20 at the blade replacing timing and positions the cutting unit 20 at the blade replacing timing at an attaching/detaching position. In the attaching/detaching operation, the processing apparatus 1 positions the blade holding section 74 holding the cutting blade 21 of the kind to be mounted to the cutting unit 20 at the blade replacing timing at the transfer position 744. In the attaching/detaching operation, the processing apparatus 1 causes the blade chuck 92 on one side of the blade replacing mechanism 90 made to correspond to the cutting unit 20 at the blade replacing timing of the blade attaching/detaching unit 80 to face the blade holding section 74 at the transfer position 744 of the blade stocker 70 in the Y-axis direction.

The processing apparatus 1 holds under suction the cutting blade 21 for replacement accommodated in the blade holding section 74 at the transfer position 744 of the blade chuck 92 on one side, together with the

pressing flange 25, moves the blade attaching/detaching unit 80 in the X-axis direction, and causes the nut holder 110 made to correspond to the cutting unit 20 at the blade replacing timing to face the cutting unit 20 at the attaching/detaching position in the Y-axis direction. The processing apparatus 1 grasps the fixing nut 26 by the nut holder 110 and detaches the fixing nut 26 from the male screw 245 of the fixing flange 24.

The processing apparatus 1 moves the blade attaching/detaching unit 80 in the X-axis direction and causes the blade chuck 92 on the other side of the blade replacing mechanism 90 made to correspond to the cutting unit 20 at the blade replacing timing to face the cutting unit 20 at the attaching/detaching position in the Y-axis direction. The processing apparatus 1 holds under suction the cutting blade 21 of the cutting unit 20 with the fixing nut 26 detached by the blade chuck 92 on the other side, together with the pressing flange 25, and detaches the cutting blade 21 from the cutting unit 20 at the blade replacing timing.

The processing apparatus 1 rotates the rotary arm 91 of the blade replacing mechanism 90 by 180 degrees, causes the blade chuck 92 on one side, on which the cutting blade 21 for replacement is held under suction

together with the pressing flange 25, to face the cutting unit 20, from which the cutting blade 21 is detached, at the attaching/detaching position in the Y-axis direction. The processing apparatus 1 moves the blade chuck 92 on one side along the Y-axis direction closer to the spindle 23 of the cutting unit 20 at the attaching/detaching position, attaches the cutting blade 21 for replacement to the fixing flange 24 of the cutting unit 20 together with the pressing flange 25, and, after releasing the holding under suction of the blade chuck 92 on one side, moves the blade chuck 92 on one side away from the cutting unit 20.

The processing apparatus 1 moves the blade attaching/detaching unit 80 in the X-axis direction, causes the nut holder 110 holding the fixing nut 26 to face the cutting unit 20 at the attaching/detaching position in the Y-axis direction, thereafter brings the female screw 261 of the fixing nut 26 into screw engagement with the male screw 245 of the fixing flange 24 by the nut holder 110, to thereby fix the cutting blade 21 to a tip portion of the spindle 23, and moves the nut holder 110 in the Y-axis direction away from the cutting unit 20 at the attaching/detaching position.

The processing apparatus 1 moves the blade

attaching/detaching unit 80 in the X-axis direction, whereby the blade chuck 92 on the other side holding the cutting blade 21 after replacement detached from the cutting unit 20 together with the pressing flange 25 is caused to face the blade holding section 74 at the transfer position 744 of the blade stocker 70 in the Y-axis direction. The processing apparatus 1 moves the blade chuck 92 on the other side in the Y-axis direction closer to the blade holding section 74 at the transfer position 744, holds the cutting blade 21 after replacement on the blade holding section 74 together with the pressing flange 25, and thereafter moves the blade chuck 92 on the other side in the Y-axis direction away from the blade holding section 74 at the transfer position 744, to complete the attaching/detaching operation.

(Cutting Blade Identifying Method)

A cutting blade identifying method according to the first embodiment of the present invention will be described below, based on the drawings. FIG. 11 is a flow chart depicting a flow of the cutting blade identifying method according to the first embodiment. The cutting blade identifying method according to the first embodiment is an identifying method for the cutting blade

21, and, in the first embodiment, is carried out with the aforementioned processing apparatus 1. As depicted in FIG. 11, the cutting blade identifying method includes a blade management step ST1, an imaging step ST2, and a blade information confirming step ST3.

(Blade Management Step)

FIG. 12 is a perspective view depicting a blade management step of the cutting blade identifying method illustrated in FIG. 11. The blade management step ST1 is a step of registering an image obtained by imaging the cutting edge 211 of the cutting blade 21 and blade information in a mutually associated state in the blade management section 104.

In the first embodiment, the blade management step ST1 is carried out when the processing apparatus 1 starts a processing operation, after the cutting blade 21 is accommodated in each blade holding section 74 of each blade stocker 70 and blade information concerning the cutting blade 21 to be accommodated in each blade holding section 74 of each blade stocker 70 is registered as processing contents information by the operator through the input unit 102. In the first embodiment, in the blade management step ST1, as illustrated in FIG. 12, the processing apparatus 1 images, through the through-hole

77 and by the second imaging unit 76, a part of a region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in the blade holding section 74 at the transfer position 744, while the support member 73 of each blade stocker 70 is intermittently rotated by 90 degrees at a time.

In the first embodiment, in the blade management step ST1, in the processing apparatus 1, the control unit 100 associates the images of the cutting edge 211 obtained by imaging by the second imaging unit 76, the holding section numbers given to each blade holding section 74, and the blade information registered as processing contents information with one another, and stores the management data 300 depicted in FIG. 10 including these in a mutually associated state in the blade management section 104.

(Imaging Step)

FIG. 13 is a sectional view depicting the imaging step of the cutting blade identifying method illustrated in FIG. 11. The imaging step ST2 is a step of imaging the cutting edge 211 of the cutting blade 21 of which blade information is to be confirmed.

In the first embodiment, the imaging step ST2 is carried out with respect to the cutting blade 21 conveyed

from the blade stocker 70 by the blade replacing unit 7, for mounting the cutting blade 21 onto the spindle 23 of the cutting unit 20 at the blade replacing timing by the blade replacing unit 7. In the first embodiment, in the imaging step ST2, the control unit 100 reads from the storage apparatus the blade information registered as processing contents information concerning the cutting blade 21 to be mounted to the cutting unit 20 at the replacing timing, at the time of the attaching/detaching operation, and extracts from the management data 300 the holding section number associated with the blade information registered as the processing contents information.

In the first embodiment, in the imaging step ST2, the control unit 100 positions the blade holding section 74 made to correspond to the extracted holding section number at the transfer position 744 and images the region 215 of the surface 213 of the cutting edge 211 through the through-hole 77 by the second imaging unit 76. In this instance, in the imaging step ST2, as depicted in FIG. 13, the control unit 100 images by the second imaging unit 76 while the cutting blade 21 at the transfer position 744 is held under suction by the blade chuck 92 on one side and while the cutting blade 21 is

being intermittently rotated around an axis.

(Blade Information Confirming Step)

The blade information confirming step ST3 is a step of searching the management data 300 stored in the blade management section 104 for an image of the cutting edge 211 coinciding with the image obtained by imaging in the imaging step ST2, by the data processing section 105 of the control unit 100, and confirming the blade information associated with the image.

In the first embodiment, the blade information confirming step ST3 is carried out subsequently to the imaging step ST2 for the cutting blade 21 conveyed from the blade stocker 70 by the blade replacing unit 7, for mounting the cutting blade onto the spindle 23 of the cutting unit 20 at the blade replacing timing by the blade replacing unit 7. In the first embodiment, in the blade information confirming step ST3, the data processing section 105 of the control unit 100 extracts from the management data 300 the image made to correspond to the blade information registered as processing contents information, performs pattern matching such as normalized correlation between the image and a plurality of images obtained by imaging by the second imaging unit 76, and calculates correlating values.

In this way, in the first embodiment, in the blade information confirming step ST3, the data processing section 105 of the control unit 100 performs pattern matching between the image made to correspond to the blade information registered as processing contents information that is extracted from the management data 300 and the plurality of images obtained by imaging by the second imaging unit 76, whereby the image of the cutting edge 211 coinciding with the image obtained by imaging in the imaging step ST2 is searched for from the management data 300 stored in the blade management section 104, and the blade information associated with the image is confirmed.

In the first embodiment, in the blade information confirming step ST3, when at least one image reaching or exceeding a predetermined correlating value, of a plurality of images obtained by imaging by the second imaging unit 76, is present, the data processing section 105 of the control unit 100 finishes the cutting blade identifying method, and the processing apparatus 1 mounts the cutting blade 21 at the transfer position onto the cutting unit 20 described above. Note that the predetermined correlating value is a value indicative of that the image made to correspond to the blade

information registered as processing contents information and the image obtained by imaging by the second imaging unit 76 coincide with each other. Besides, in the first embodiment, in the blade information confirming step ST3, when an image reaching or exceeding the predetermined correlating value, of the plurality of images obtained by imaging by the second imaging unit 76, is absent, the data processing section 105 of the control unit 100 operates the alarm unit 103, to give an alarm to the operator, and stops the attaching/detaching operation.

Note that, in the first embodiment, in the blade information confirming step ST3, when an image reaching or exceeding the predetermined correlating value, of the plurality of images obtained by imaging by the second imaging unit 76, is absent, the data processing section 105 of the control unit 100 gives an alarm to the operator, and stops the attaching/detaching operation. It is to be noted, however, that in the present invention, in the imaging step ST2, the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in the other blade holding section 74 may be imaged by the second imaging unit 76, and the cutting blade 21 having at least one image reaching or exceeding the predetermined correlating value may be mounted to the

cutting unit 20. In this way, in the blade information confirming step ST3, out of the plurality of cutting blades 21 accommodated in the blade stocker 70, the cutting blade 21 coinciding with the image made to correspond to the blade information registered as processing contents information may be mounted to the cutting unit 20.

Note that, in this case, in the case where an image reaching or exceeding the predetermined correlating value, of a plurality of images obtained by imaging the cutting blades 21 accommodated in all the blade holding sections 74 by the second imaging unit 76, is absent, that is, in the case where all the plurality of cutting blades 21 accommodated in the blade stockers 70 disagree with the image made to correspond to the blade information registered as processing contents information, it is desirable that the data processing section 105 of the control unit 100 give an alarm to the operator and stop the attaching/detaching operation. Besides, in the case where there are a plurality of cutting blades 21 coinciding with the image made to correspond to the blade information registered as processing contents information, it is desirable that the processing apparatus 1 mount to the cutting unit 20 the cutting blade 21 having a larger

number of images reaching or exceeding the predetermined correlating value or the cutting blade 21 having the highest correlating value.

As has been described above, according to the cutting blade identifying method and the processing apparatus 1 according to the first embodiment, in the blade management step ST1, the image of the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in each blade holding section 74 and the blade information are registered in a mutually associated state as the management data 300 in the blade management section 104. Therefore, according to the cutting blade identifying method and the processing apparatus 1, in the imaging step ST2, the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 is imaged, and, in the blade information confirming step ST3, the image obtained by imaging is searched for from the management data 300, and the blade information associated with the coinciding image is confirmed, whereby individual information concerning even a cutting blade 21 without blade information printed on the surface 213 thereof can be identified. Therefore, the cutting blade identifying method and the processing apparatus 1 according to the first embodiment produces an

effect such that for even a cutting blade without blade information printed on the surface 213 thereof, the blade information concerning the cutting blade 21 can be confirmed.

According to the cutting blade identifying method and the processing apparatus 1 according to the first embodiment, in the blade management step ST1, the cutting blade 21 is accommodated in each blade holding section 74, after which the blade information and the holding section number are associated with each other; therefore, by confirming the blade information in the blade information confirming step ST3, it can be determined whether or not the cutting blade 21 accommodated in each blade holding section 74 is a regular one.

For this reason, according to the cutting blade identifying method and the processing apparatus 1 according to the first embodiment, even in the case where the cutting blade 21 accommodated in each blade stocker 70 is willfully removed or added, it can properly be determined in the blade information confirming step ST3 the cutting blade 21 of which blade information is accommodated in the blade holding section 74.

[Second Embodiment]

A cutting blade identifying method and a processing

apparatus according to a second embodiment of the present invention will be described based on the drawings. FIG. 14 is a diagram depicting an example of management data stored in a blade management section of a control unit of the processing apparatus according to the second embodiment.

The processing apparatus 1 according to the second embodiment is the same as that in the first embodiment except that, as depicted in FIG. 14, each management data 300 stored in the blade management section 104 of the control unit 100 includes the blade information concerning the cutting blade 21 and the image of the cutting edge 211 of the cutting blade 21 in one-to-one correspondence, that is, in a mutually associated state.

In a blade management step ST1 of the cutting blade identifying method according to the second embodiment, the processing apparatus 1, while intermittently rotating the support member 73 of each blade stocker 70 by 90 degrees at a time, images a region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in the blade holding section 74 at the transfer position through the through-hole 77 by the second imaging unit 76, the control unit 100 puts the image of the cutting edge 211 obtained by imaging by the

second imaging unit 76 and the blade information registered as processing contents information in correspondence with each other, and stores the management data 300-2 depicted in FIG. 14 including them in correspondence in the blade management section 104.

In an imaging step ST2 of the cutting blade identifying method according to the second embodiment, the control unit 100, at the time of an attaching/detaching operation, reads from the storage apparatus the blade information registered as processing contents information concerning the cutting blade 21 to be mounted to the cutting unit 20 at the replacing timing and extracts from the management data 300 the image made to correspond to the blade information registered as processing contents information.

In the second embodiment, in the imaging step ST2, while intermittently rotating the support member 73 of each blade stocker 70 by 90 degrees at a time, the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in the blade holding section 74 at the transfer position is image through the through-hole 77 by the second imaging unit 76. In addition, in the second embodiment, in the imaging step ST2, at the time of imaging the region 215 of the surface

213 of the cutting edge 211 of the cutting blade 21 accommodated in each blade holding section 74, the control unit 100 images by the second imaging unit 76 while the cutting blade 21 at the transfer position 744 is held under suction by the blade chuck 92 on one side and while the cutting blade 21 is being intermittently rotated around an axis, as in the first embodiment, as depicted in FIG. 13.

In a blade information confirming step ST3 of the cutting blade identifying method according to the second embodiment, the data processing section 105 of the control unit 100 performs pattern matching such as normalized correlation between the image made to correspond to the blade information registered as processing contents information that is extracted from the management data 300 and a plurality of images obtained by imaging by the second imaging unit 76 and calculates correlating values.

In the second embodiment, in a blade information confirming step ST3, when there is at least one image reaching or exceeding a predetermined correlating value, of the plurality of images obtained by imaging by the second imaging unit 76, the data processing section 105 of the control unit 100 finishes the cutting blade

identifying method, and the processing apparatus 1 mounts at least one cutting blade 21 having the image reaching or exceeding the predetermined correlating value to the cutting unit 20, as in the first embodiment. In addition, in the second embodiment, in the blade information confirming step ST3, when an image reaching or exceeding the predetermined correlating value, of the plurality of images obtained by imaging by the second imaging unit 76, is absent, the data processing section 105 of the control unit 100 operates the alarm unit 103, to give an alarm to the operator, and stops the attaching/detaching operation.

As has been described above, in the cutting blade identifying method and the processing apparatus 1 according to the second embodiment, in the blade management step ST1, the image of the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 accommodated in each blade holding section 74 and the blade information are registered in a mutually associated state as management data 300-2 in the blade management section 104. Therefore, in the cutting blade identifying method and the processing apparatus 1, in the imaging step ST2, the region 215 of the surface 213 of the cutting edge 211 of the cutting blade 21 is imaged, and, in the blade information confirming step ST3, the image

obtained by imaging is searched for from the management data 300, and the blade information associated with the coinciding image is confirmed, whereby for even a cutting blade without the blade information printed on the surface 213 thereof, the individual information can be identified. Consequently, the cutting blade identifying method and the processing apparatus 1 according to the second embodiment produce an effect such that for even a cutting blade 21 without the blade information printed on the surface 213 thereof, the blade information concerning the cutting blade 21 can be confirmed.

[Third Embodiment]

A cutting blade identifying method according to a third embodiment of the present invention will be described based on the drawings. FIG. 15 is a diagram depicting a configuration of a blade identifying apparatus for carrying out the cutting blade identifying method according to the third embodiment. FIG. 16 is a plan view depicting a region of a surface of a cutting blade that is imaged by the imaging unit of the blade identifying apparatus illustrated in FIG. 15. FIG. 17 is a diagram depicting management data stored in a blade management section of the blade identifying apparatus illustrated in FIG. 15. Note that, in FIGS. 15, 16, and

17, the same parts as those in the first embodiment above are denoted by the same reference symbols as used above, and descriptions thereof will be omitted.

The cutting blade identifying method according to the third embodiment is carried out by a blade identifying apparatus 400 depicted in FIG. 15. As illustrated in FIG. 15, the blade identifying apparatus 400 includes an imaging unit 506 as an imaging section, and a data management apparatus 500.

The imaging unit 506 is for imaging a surface 213 of a cutting edge 211 of a cutting blade 21. In the third embodiment, the imaging unit 506 includes an imaging element that images the surface 213 of the cutting edge 211 of the cutting blade 21. The imaging element is, for example, a CCD imaging element or a CMOS imaging element. The imaging unit 30 images the surface 213 of the cutting edge 211 of the cutting blade 21 and outputs the thus obtained image to the data management apparatus 500.

The data management apparatus 500 is a computer that has an arithmetic processing apparatus having a microprocessor such as a CPU, a storage apparatus having a memory such as a ROM and a RAM, and an input/output interface apparatus. The arithmetic processing apparatus of the data management apparatus 500 carries out

arithmetic processing according to a computer program stored in the storage apparatus. The data management apparatus 500 is connected to the imaging unit 506 and the like through the input/output interface apparatus.

The data management apparatus 500 is connected to a display unit 501 including a liquid crystal display for displaying the state of a processing operation and an image and the like, an input unit 502 used by the operator to register processing contents information and the like, and an alarm unit 503. The input unit 502 includes at least one of a touch panel provided at the display unit 501, and an external input apparatus such as a keyboard. The alarm unit 503 gives an alarm to the operator by issuing at least one of sound and light.

In addition, as illustrated in FIG. 15, the data management apparatus 500 includes a blade management section 504 and a data processing section 505. The blade management section 504 is for storing management data 300-3 depicted in FIG. 17, in which the image obtained by imaging a predetermined region 216 indicated by alternate long and short dash line in FIG. 16 of the surface 213 of the cutting edge 211 of the cutting blade 21 by the imaging unit 506 and the blade information are associated with each other.

In the third embodiment, as depicted in FIG. 17, the management data 300-3 includes the blade information concerning the cutting blade 21 and the image of the region 216 of the surface 213 of the cutting edge 211 of the cutting blade 21 in one-to-one correspondence, that is, in a mutually associated state. Note that the blade information includes information indicative of the kind of the cutting blade 21 as in the first embodiment, but, in the present invention, the blade information may include information indicative of use history of the cutting blade 21. In short, in the present invention, it is sufficient that the blade information includes either one of the information indicative of the kind of the cutting blade 21 and the information indicative of the use history of the cutting blade 21. The blade information is registered in the blade management section 104, by accepting of an operator's operation of an input unit 102 by the data management apparatus 500, or by accepting the reading results from a reading apparatus having read the blade information given to the outer surface of the blade case accommodating the cutting blade 21.

The image is obtained by imaging the region 216 of the surface 213 of the cutting edge 211 of the cutting

blade 21 by the imaging unit 506 at a predetermined timing of registering the blade information or the like, and is registered into the blade management section 104 by accepting of the image obtained by the imaging unit 506 by the data management apparatus 500.

The data processing section 105 is for extracting and searching the management data 300 in the blade management section 104 for the image coinciding with the image obtained by imaging by the imaging unit 506 and for confirming the blade information associated with the image coinciding with the image obtained by imaging by the imaging unit 506.

Note that the function of the blade management section 104 is realized by the aforementioned storage apparatus, and the function of the data processing section 105 is realized by executing a computer program stored in the storage apparatus by the arithmetic processing apparatus.

The cutting blade identifying method according to the third embodiment is an identifying method for the cutting blade 21, as in the first embodiment, and, in the third embodiment, the cutting blade identifying method is realized by the aforementioned blade identifying apparatus 400. The cutting blade identifying method

includes a blade management step ST1, an imaging step ST2, and a blade information confirming step ST3, as in the first embodiment.

In the third embodiment, the blade management step ST1 is carried out, for example, at a predetermined timing of registering the blade information. In the third embodiment, in the blade management step ST1, the imaging unit 506 images the region 216 of the surface 213 of the cutting edge 211 of the cutting blade 21, and the blade information inputted by the operator is accepted by the data management apparatus 500 through the input unit 102. In the blade management step ST1, in the data management apparatus 500, the control unit 100 puts the image of the region 216 of the surface 213 of the cutting edge 211 obtained by the imaging unit 506 and the blade information into correspondence with each other, and the management data 300-3 depicted in FIG. 17 including them in correspondence with each other is stored in the blade management section 104.

In the third embodiment, the imaging step ST2 is carried out, for example, at a time when there is the cutting blade 21 of which the blade information is to be confirmed, at a timing after the blade information is registered. In the third embodiment, in the imaging step

ST2, the region 216 of the surface 213 of the cutting edge 211 of the cutting blade 21 of which the blade information is to be confirmed is imaged by the imaging unit 506.

In the third embodiment, the blade information confirming step ST3 is carried out subsequently to the imaging step ST2. In the third embodiment, in the blade information confirming step ST3, the data processing section 105 of the data management apparatus 500 performs pattern matching such as normalized correlation between the image obtained by imaging by the imaging unit 506 in the imaging step ST2 and the image registered in the management data 300 and calculates correlating values.

In this way, in the third embodiment, in the blade information confirming step ST3, the data processing section 105 of the control unit 100 performs pattern matching between the image registered in the management data 300 and a plurality of images obtained by imaging by the imaging unit 506, whereby the management data 300 stored in the blade management section 104 is searched for the image of the cutting edge 211 coinciding with the image obtained by imaging in the imaging step ST2, and the associated blade information is confirmed.

In the third embodiment, in the blade information

confirming step ST3, the data processing section 105 of the control unit 100 extracts from the management data 300-3 the image whose correlating value with the image obtained by imaging by the imaging unit 506 is equal to or more than a predetermined correlating value and which has the highest correlating value, displays on the display unit 101 the blade information corresponding to the extracted image having the highest correlating value, and finishes the cutting blade identifying method. In addition, in the third embodiment, in the blade information confirming step ST3, when an image whose correlating value with the image obtained by imaging by the imaging unit 506 is equal to or more than the predetermined correlating value is absent, the data processing section 105 of the control unit 100 displays on the display unit 101 that the blade information is unclear or the like, operates the alarm unit 503 to give an alarm to the operator, and finishes the cutting blade identifying method.

Note that the present invention is not limited to the above-described embodiments. In other words, the present invention can be carried out by various modifications in such ranges as not to depart from the gist of the invention. Note that the cutting blade 21 is

what is generally called a washer blade including only the cutting edge 211 in the above embodiments, but, in the present invention, the cutting blade 21 may be what is generally called a hub blade including a ring-shaped base and a cutting edge 211 disposed at an outer edge portion of the base.

The present invention is not limited to the details of the above described preferred embodiments. 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. A cutting blade identifying method comprising:
a blade management step of registering an image obtained by imaging a cutting edge of a cutting blade and blade information including either one of a kind and use history of the cutting blade in a mutually associated state in a blade management section, wherein

at least one piece of management data is stored in the blade management section;

an imaging step of imaging the cutting edge of the cutting blade of which the blade information is to be confirmed; and

a blade information confirming step of searching the blade management section for the image of the cutting edge coinciding with the image obtained by imaging in the imaging step and confirming the associated blade information, wherein

the blade information includes the information indicative of the kind of the cutting blade and information indicative of the use history of the cutting blade.

2. The cutting blade identifying method according to claim 1 to be carried out in a processing apparatus, the processing apparatus including:

a spindle for fixing a cutting blade to a tip thereof;

a holding table that holds a workpiece;

a blade stocker in which a plurality of cutting blades are accommodated;

a blade replacing section that conveys the cutting blade between the spindle and the blade stocker and attaches or detaches the cutting blade; and

an imaging section that images a cutting edge of the cutting blade,

wherein the blade management step is performed for the cutting blade which is accommodated in the blade stocker, and

the imaging step and the blade information confirming step are performed for the cutting blade conveyed from the blade stocker by the blade replacing section for mounting to the spindle.

3. A processing apparatus comprising:

a spindle for fixing, to a tip thereof, a cutting blade for processing a workpiece held by a holding table;

a blade stocker in which a plurality of cutting blades are accommodated;

a blade replacing section that conveys the cutting blade between the spindle and the blade stocker and

attaches or detaches the cutting blade;

an imaging section that images a cutting edge of the cutting blade;

a blade management section that stores an image of the cutting edge of the cutting blade to be accommodated in the blade stocker and blade information including either one of a kind and use history of the cutting blade in a mutually associated state; and

a data processing section,

wherein the imaging section

images the cutting edge of the cutting blade conveyed from the blade stocker by the blade replacing section for mounting to the spindle, and

the data processing section

searches the blade management section for an image coinciding with the image obtained by imaging and confirms the associated blade information.