

DESCRIPTION

CUTTING APPARATUS AND METHOD FOR MANUFACTURING CUT PRODUCT

Technical Field

- 5 [0001] The present invention relates to a cutting apparatus and a method for manufacturing a cut product.

Background Art

- [0002] JP 2017-168575A (Patent Document 1) discloses a cutting apparatus. In this
10 cutting apparatus, a spindle rotation speed for dressing of a cutting blade differs from a spindle rotation speed for processing of a workpiece, for example. A positioning groove is formed in a dressing board at the spindle rotation speed for processing of a workpiece, giving consideration to the influence of warpage of the cutting blade that occurs during processing of a workpiece. The cutting blade (spindle) is positioned with use of the
15 positioning groove. Thus, the influence of displacement due to the cutting blade warping during processing of a workpiece is removed, and therefore, it is possible to precisely perform positioning of a cutting position (see Patent Document 1).

Citation List

- 20 Patent Document
[0003] Patent Document 1: JP 2017-168575A

Summary of Invention

Technical Problem

- 25 [0004] In the cutting apparatus disclosed in Patent Document 1 described above, an image of the positioning groove formed in the dressing board (dress board) is captured by an image capturing means. However, Patent Document 1 does not disclose a

technology for detecting an area of the dressing board that can be used for dressing.

[0005] The present invention was made in order to solve the above-described problem, and it is an object of the present invention to provide a cutting apparatus that can efficiently detect an area of a dressing board that can be used for dressing, and a
5 method for manufacturing a cut product with use of the cutting apparatus.

Solution to Problem

[0006] A cutting apparatus according to an aspect of the present invention is configured to cut an object to be cut with use of a blade. Dressing of the blade is
10 performed with use of a dressing board. The cutting apparatus includes an image capturing unit and a control unit. The image capturing unit is configured to move relative to the dressing board and capture an image of an area of the dressing board. The control unit is configured to control the image capturing unit to sequentially capture images of a plurality of first areas of the dressing board, and judge whether or not there
15 is a cut line in each of the plurality of first areas based on image capturing results obtained from the image capturing unit. Two first areas that are next to each other out of the plurality of first areas are spaced apart from each other sandwiching a second area therebetween. Based on the presence or absence of the cut line in each of the plurality of first areas, the control unit determines necessity for judging whether or not there is a
20 cut line in the second area.

[0007] A method for manufacturing a cut product according to another aspect of the present invention is a method for manufacturing a cut product with use of the cutting apparatus and includes: performing dressing of the blade in an area of the dressing board for which it is judged by the control unit that the cut line is absent; and cutting the object
25 to be cut with use of the blade subjected to dressing.

Advantageous Effects of Invention

[0008] According to the present invention, it is possible to provide a cutting apparatus that can efficiently detect an area of a dressing board that can be used for dressing, and a method for manufacturing a cut product with use of the cutting apparatus.

5 Brief Description of the Drawings

[0009] FIG. 1 is a plan view schematically showing a cutting apparatus.

FIG. 2 is a diagram schematically showing a plane of a holding member.

FIG. 3 is a side view schematically showing a spindle unit.

FIG. 4 is a diagram schematically showing a hardware configuration of a
10 computer.

FIG. 5 is a diagram schematically showing a plane of an example of a dressing board that has been used for dressing several times.

FIG. 6 is a diagram showing detection areas.

FIG. 7 is a diagram schematically showing a software configuration for realizing
15 automatic detection of unused areas.

FIG. 8 is a diagram schematically showing an example of a dressing board that does not include an unused area.

FIG. 9 is a diagram schematically showing an example of a dressing board that includes an unused area in an upper portion thereof.

FIG. 10 is a diagram schematically showing an example of a dressing board that includes an unused area in at least half the area thereof including an upper portion.
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FIG. 11 is a diagram schematically showing an example of a dressing board that includes an unused area in a lower portion thereof.

FIG. 12 is a diagram schematically showing an example of a dressing board that includes unused areas in an upper portion and a lower portion thereof.
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FIG. 13 is a diagram schematically showing an example of an unused dressing board.

FIG. 14 is a flowchart showing a procedure of preparing dressing of a blade.

FIG. 15 is a flowchart showing processing executed in step S130 shown in FIG.

14.

FIG. 16 is a flowchart showing processing executed in step S220 shown in FIG.

5 15.

FIG. 17 is a flowchart showing processing executed in step S355 shown in FIG.

16.

Description of Embodiments

10 [0010] The following describes an embodiment according to an aspect of the present invention (hereinafter also referred to as “the present embodiment”) in detail with reference to the drawings. In the drawings, identical or corresponding elements are denoted by the same reference numerals, and descriptions of those elements are not repeated. Also, the drawings are schematic drawings in which some elements are
15 omitted or exaggerated as appropriate to facilitate understanding.

[0011] [1. Configuration]

<1-1. Overall Configuration of Cutting Apparatus>

FIG. 1 is a plan view schematically showing a cutting apparatus 1 according to the present embodiment. The cutting apparatus 1 is configured to cut a package
20 substrate (object to be cut) to divide the package substrate into a plurality of electronic components (package components). In the package substrate, a substrate or a lead frame on which semiconductor chips are attached is sealed with resin.

[0012] Examples of the package substrate include a BGA (Ball Grid Array) package substrate, an LGA (Land Grid Array) package substrate, a CSP (Chip Size Package)
25 substrate, an LED (Light Emitting Diode) package substrate, and a QFN (Quad Flat No-leaded) package substrate.

[0013] In this example, a package substrate P1 is used as an object to be cut, and the

package substrate P1 is divided into a plurality of electronic components S1 by the cutting apparatus 1. In the following description, a surface of the package substrate P1 sealed with resin will be referred to as a “molded surface”, and a surface of the package substrate P1 that is opposite to the molded surface will be referred to as a “ball/lead surface”.

5 [0014] As shown in FIG. 1, the cutting apparatus 1 includes a cutting module A1 and an inspection-housing module B1 as constituent elements. The cutting module A1 is configured to produce the plurality of electronic components S1 (cut products) by cutting the package substrate P1. The inspection-housing module B1 is configured to inspect each of the produced electronic components S1 and then house the electronic components
10 S1 in a tray. Each constituent element of the cutting apparatus 1 is attachable to another constituent element and detachable therefrom, and is replaceable.

[0015] The cutting module A1 mainly includes a substrate supply unit 3, a positioning unit 4, a cutting table 5, a spindle unit 6, and a conveying unit 7.

15 [0016] The substrate supply unit 3 supplies package substrates P1 one by one to the positioning unit 4 by pushing out the package substrates P1 one by one from a magazine M1 in which a plurality of package substrates P1 are housed. At this time, each package substrate P1 is disposed in such a manner that the ball/lead surface faces upward.

[0017] The positioning unit 4 performs positioning of the package substrate P1 by placing the package substrate P1 pushed out by the substrate supply unit 3 on a rail unit
20 4a. Thereafter, the positioning unit 4 conveys the positioned package substrate P1 to the cutting table 5.

[0018] The cutting table 5 holds the package substrate P that is to be cut. In this example, the cutting apparatus 1 that has a twin cut table structure and includes two cutting tables 5 is shown as an example. Each cutting table 5 includes a holding member
25 5a, a rotating mechanism 5b, and a moving mechanism 5c.

[0019] FIG. 2 is a diagram schematically showing a plane of the holding member 5a. The holding member 5a holds the package substrate P1 by suctioning the package

substrate P1, which has been conveyed by the positioning unit 4, from below.

[0020] As shown in FIG. 2, the holding member 5a includes a holding member body 5a1 and a dressing board holding portion 5a2. The holding member body 5a1 has a rectangular shape in a plan view, and is configured to suction the package substrate P1 from below. The dressing board holding portion 5a2 is provided on a side surface of the holding member body 5a1, and the dressing board holding portion 5a2 and the holding member body 5a1 are formed as a single piece. The dressing board holding portion 5a2 has a rectangular shape in a plan view, and is configured to suction a dressing board 8 from below.

[0021] The dressing board 8 is used for dressing of a blade 6a (described later). Dressing is an operation for removing a bonding material covering abrasive grains constituting the blade 6a to make the abrasive grains protrude. That is, the term “dressing” refers to sharpening the blade 6a and removing clogs from the blade 6a. Dressing of the blade 6a is performed by forming cut lines in the dressing board 8 with use of the blade 6a. The package substrate P1 is cut with use of the blade 6a that has been subjected to dressing, for example. Dressing of the blade 6a will be described later in detail.

[0022] The following description refers to FIG. 1 again. The rotating mechanism 5b can rotate the holding member 5a in the directions indicated by $\theta 1$ shown in FIG. 1. The moving mechanism 5c can move the holding member 5a along the Y axis shown in FIG. 1.

[0023] The spindle unit 6 divides the package substrate P1 into a plurality of electronic components S1 by cutting the package substrate P1. In this example, the cutting apparatus 1 that has a twin spindle structure and includes two spindle units 6 is shown as an example. Each spindle unit 6 is movable along the X axis and the Z axis shown in FIG. 1. Note that the cutting apparatus 1 may also have a single spindle structure and include a single spindle unit 6.

[0024] FIG. 3 is a side view schematically showing the spindle unit 6. As shown in FIG. 3, each spindle unit 6 includes a blade 6a, a rotary shaft 6c, a first flange 6d, a second flange 6e, and a fastening member 6f.

[0025] The blade 6a cuts the package substrate P1 by rotating at high speed and thus divides the package substrate P1 into a plurality of electronic components S1. The blade 6a is attached to the rotary shaft 6c in a state of being sandwiched by one of the flanges (the first flange 6d) and the other of the flanges (the second flange 6e). The first flange 6d and the second flange 6e are fixed to the rotary shaft 6c by the fastening member 6f such as a nut. The first flange 6d is also called an inner flange, and the second flange 6e is also called an outer flange.

[0026] The spindle unit 6 is provided with a cutting water nozzle (not shown) for spraying cutting water toward the blade 6a rotating at high speed, a cooling water nozzle (not shown) for spraying cooling water, and a washing water nozzle (not shown) for spraying washing water for washing chips and the like, for example.

[0027] The following description refers to FIG. 1 again. After the package substrate P1 is suctioned by the cutting table 5, an image of the package substrate P1 is captured by a first position check camera 5d to check the position of the package substrate P1. For example, the position of a mark provided on the package substrate P1 is checked with use of the first position check camera 5d. The mark indicates a cutting position on the package substrate P1, for example.

[0028] Thereafter, the cutting table 5 moves toward the spindle unit 6 along the Y axis shown in FIG. 1. After the cutting table 5 has moved to a position under the spindle unit 6, the package substrate P1 is cut by moving the cutting table 5 and the spindle unit 6 relative to each other. Thereafter, an image of the package substrate P1 is captured by a second position check camera 6b as necessary to check the position of the package substrate P1 and the like. For example, the cutting position on the package substrate P1 and a cutting width are checked with use of the second position check camera 6b. Note

that the second position check camera 6b is also used for dressing of the blade 6a. Details will be described later.

[0029] After cutting of the package substrate P1 is complete, the cutting table 5 moves away from the spindle unit 6 along the Y axis shown in FIG. 1 while suctioning the divided electronic components S1. While the cutting table 5 is moving, upper surfaces (ball/lead surfaces) of the electronic components S1 are washed and dried by a first cleaner 5e.

[0030] The conveying unit 7 suctions the electronic components S1, which are held on the cutting table 5, from above, and conveys the electronic components S1 to an inspection table 11 included in the inspection-housing module B1. While the electronic components S1 are being conveyed, lower surfaces (molded surfaces) of the electronic components S1 are washed and dried by a second cleaner 7a.

[0031] The inspection-housing module B1 mainly includes the inspection table 11, a first optical inspection camera 12, a second optical inspection camera 13, a placement unit 14, and an extraction unit 15. Note that the first optical inspection camera 12 may be provided in the cutting module A1.

[0032] The inspection table 11 holds the electronic components S1 to perform optical inspection of the electronic components S1. The inspection table 11 is movable along the X axis shown in FIG. 1. Also, the inspection table 11 can be inverted upside down. The inspection table 11 includes a holding member that holds the electronic components S1 by suctioning the electronic components S1.

[0033] The first optical inspection camera 12 and the second optical inspection camera 13 capture images of both surfaces (the ball/lead surface and the molded surface) of the electronic components S1. Various types of inspection are carried out on the electronic components S1 based on image data generated by the first optical inspection camera 12 and the second optical inspection camera 13. The first optical inspection camera 12 and the second optical inspection camera 13 are provided near the inspection

table 11 in such a manner as to capture images of regions on their upper sides.

[0034] The first optical inspection camera 12 captures images of the molded surfaces of the electronic components S1 that are being conveyed to the inspection table 11 by the conveying unit 7. Thereafter, the conveying unit 7 places the electronic components S1 on the holding member of the inspection table 11. After the holding member has suctioned the electronic components S1, the inspection table 11 is inverted upside down. The inspection table 11 moves to a position above the second optical inspection camera 13, and images of the ball/lead surfaces of the electronic components S1 are captured by the second optical inspection camera 13.

[0035] The inspected electronic components S1 are placed on the placement unit 14. The placement unit 14 is movable along the Y axis shown in FIG. 1. The inspection table 11 places the inspected electronic components S1 on the placement unit 14.

[0036] The extraction unit 15 transfers the electronic components S1, which are placed on the placement unit 14, to trays. The electronic components S1 are sorted into “non-defective products” and “defective products” based on the results of inspection carried out using the first optical inspection camera 12 and the second optical inspection camera 13. Based on the result of sorting, the extraction unit 15 transfers each electronic component S1 to a non-defective product tray 15a or a defective product tray 15b. That is, non-defective products are housed in the non-defective product tray 15a, and defective products are housed in the defective product tray 15b. Each of the non-defective product tray 15a and the defective product tray 15b is replaced with a new tray when it is filled with electronic components S1.

[0037] The cutting apparatus 1 further includes a computer 50 and a monitor 20. The monitor 20 is configured to display images. The monitor 20 is constituted by a display device such as a liquid crystal monitor or an organic EL (Electro Luminescence) monitor.

[0038] The computer 50 controls each unit of the cutting module A1 and the

inspection-housing module B1, for example. For example, the computer 50 controls the substrate supply unit 3, the positioning unit 4, the cutting table 5, the spindle unit 6, the conveying unit 7, the inspection table 11, the first optical inspection camera 12, the second optical inspection camera 13, the placement unit 14, the extraction unit 15, and the monitor 20.

[0039] <1-2. Hardware Configuration of Computer>

FIG. 4 is a diagram schematically showing a hardware configuration of the computer 50. As shown in FIG. 4, the computer 50 includes a control unit 70, an input output I/F (interface) 90, a reception unit 95, and a storage unit 80, and the units are electrically connected to each other via a bus.

[0040] The control unit 70 includes a CPU (Central Processing Unit) 72, a RAM (Random Access Memory) 74, a ROM (Read Only Memory) 76, and the like. The control unit 70 is configured to control the constituent elements of the computer 50 and the constituent elements of the cutting apparatus 1 according to information processing.

[0041] The input output I/F 90 is configured to communicate with constituent elements included in the cutting apparatus 1 via signal lines. The input output I/F 90 is used to transmit data from the computer 50 to each constituent element of the cutting apparatus 1 and receive data transmitted from each constituent element of the cutting apparatus 1 to the computer 50. The reception unit 95 is configured to receive instructions from a user. The reception unit 95 is constituted by some or all of a touch panel, a keyboard, a mouse, and a microphone, for example.

[0042] The storage unit 80 is an auxiliary storage device such as a hard disk drive or a solid state drive. The storage unit 80 is configured to store a control program 81 therein, for example. As a result of the control program 81 being executed by the control unit 70, various operations of the cutting apparatus 1 are realized. When the control unit 70 executes the control program 81, the control program 81 is loaded into the RAM 74. Then, the CPU 72 of the control unit 70 interprets and executes the control program 81

loaded into the RAM 74 to control each constituent element.

[0043] <1-3. Software Configuration Relating to Automatic Detection of Area Usable for Dressing>

As described above, dressing of the blade 6a is performed in the cutting apparatus 1. A new dressing board 8 is not always used for the dressing of the blade 6a. For example, a dressing board 8 that has already been used for the dressing several times may be used for the dressing.

[0044] FIG. 5 is a diagram schematically showing a plane of an example of a dressing board 8 that has been used for the dressing several times. As shown in FIG. 5, a plurality of cut lines CL1 have already been formed in the dressing board 8. Each cut line CL1 is a groove formed as a result of the dressing board 8 being cut by the blade 6a during the dressing. The dressing of the blade 6a needs to be performed in an area (hereinafter also referred to as an “unused area”) of the dressing board 8 in which no cut line CL1 has been formed.

[0045] In order to perform the dressing in an unused area, it is conceivable to adopt a method in which a worker confirms positions of cut lines CL1 in the dressing board 8 through visual observation, and manually adjusts the positions of the blade 6a and the dressing board 8 relative to each other. However, this method requires a lot of time and effort.

[0046] In the cutting apparatus 1, unused areas are automatically detected, and a dressing start position on the dressing board 8 is automatically determined based on the result of detection. Accordingly, it is unnecessary for the worker to manually adjust the positions of the blade 6a and the dressing board 8 relative to each other, and it is possible to efficiently perform the dressing of the blade 6a with use of the cutting apparatus 1.

[0047] In the cutting apparatus 1, unused areas are detected with use of the second position check camera 6b provided in the spindle unit 6. The second position check camera 6b is configured to move relative to the dressing board 8 and capture images of

some areas of the dressing board 8. In the cutting apparatus 1, position information regarding areas (detection areas) of the dressing board 8 whose images are captured by the second position check camera 6b before the dressing is started is stored in the storage unit 80 in advance. For example, position information regarding 13 detection areas is stored in the storage unit 80 of the cutting apparatus 1. Note that the number of detection areas is not limited to this example. In the cutting apparatus 1, unused areas are detected based on images captured by the second position check camera 6b.

[0048] FIG. 6 is a diagram showing detection areas. As shown in FIG. 6, first detection areas D11 to D13 and second detection areas D21 to D25 and D31 to D35 are provided as the detection areas of the dressing board 8. Position information regarding each detection area is stored in the storage unit 80.

[0049] The first detection areas D11 to D13 and the second detection areas D21 to D25 and D31 to D35 are linearly arranged on a diagonal line of the dressing board 8. The first detection area D11 is located at a lower left position in the illustrated dressing board 8. The first detection area D12 is located at the center of the illustrated dressing board 8. The first detection area D13 is located at an upper right position in the illustrated dressing board 8. In the state where the dressing board 8 is held by the dressing board holding portion 5a2, the left-right direction of the dressing board 8 corresponds to the X axis direction shown in FIG. 1, and the up-down direction of the dressing board 8 corresponds to the Y axis direction shown in FIG. 1. The same applies to the up-down direction and the left-right direction of the dressing board 8 referred to in the present specification.

[0050] The first detection area D11 and the first detection area D12, which are next to each other out of the first detection areas D11 to D13, are spaced apart from each other sandwiching the second detection areas D21 to D25 therebetween. The first detection area D12 and the first detection area D13, which are next to each other out of the first detection areas D11 to D13, are spaced apart from each other sandwiching the second

detection areas D31 to D35 therebetween. The detection areas are arranged so as not to overlap each other as far as possible. In this example, the first detection area D12 overlaps the second detection areas D25 and D31, but the other detection areas do not overlap each other.

5 [0051] It is assumed that whether or not there is a cut line CL1 is judged with respect to each detection area (including the first detection areas and the second detection areas) sequentially from the lower left detection area (the first detection area D11) toward the upper right detection area (the first detection area D13) of the dressing board 8. When whether or not there is a cut line CL1 in each detection area is judged following this
10 procedure, it takes a long time to detect an unused area in the case where the dressing board 8 includes an unused area only in an upper portion thereof.

[0052] In the cutting apparatus 1, first, captured images regarding the first detection areas D11 to D13 are obtained, and whether or not there is a cut line CL1 in each of the first detection areas D11 to D13 is judged based on the captured images of the respective
15 first detection areas. Then, the necessity for judging whether or not there is a cut line CL1 in the second detection areas D21 to D25 and D31 to D35 is determined based on the presence or absence of a cut line CL1 in each of the first detection areas D11 to D13. Accordingly, in the cutting apparatus 1, first, locations of unused areas in the dressing board 8 are estimated by judging whether or not there is a cut line CL1 in each of the
20 plurality of first detection areas, and a more detailed search is performed on areas that are highly likely to include unused areas, and therefore, it is possible to efficiently detect unused areas. The following describes a software configuration for realizing this function.

[0053] FIG. 7 is a diagram schematically showing the software configuration for
25 realizing automatic detection of unused areas. As shown in FIG. 7, an obtaining unit 51, a judgment unit 52, a determination unit 53, a camera control unit 54, a spindle unit etc. control unit 55, and a monitor control unit 56 are each realized as a result of the control

program 81 being executed by the computer 50, for example.

[0054] The obtaining unit 51 is configured to obtain captured images of the respective first detection areas D11, D12, and D13 from the second position check camera 6b, for example. The judgment unit 52 judges whether or not there is a cut line CL1 in each of the first detection areas D11, D12, and D13 based on the captured images obtained by the obtaining unit 51.

[0055] In a case where there is a cut line CL1 in any of the first detection areas D11, D12, and D13, the judgment unit 52 further judges whether or not the direction (orientation) of the cut line CL1 is correct. Note that, in the cutting apparatus 1, cut lines CL1 extending in the left-right direction of the dressing board 8 are cut lines CL1 extending in the correct direction. In the cutting apparatus 1, each of the first detection areas D11, D12, and D13 is provided on a diagonal line of the dressing board 8, and therefore, it is possible to judge whether or not the direction of a cut line CL1 is correct.

[0056] It is assumed that the first detection areas D11, D12, and D13 are respectively provided at a lower middle position, the center, and an upper middle position of the dressing board 8. In this case, it is not possible to detect a cut line CL1 extending in the up-down direction in a left portion of the dressing board 8, for example. In the cutting apparatus 1, each of the first detection areas D11, D12, and D13 is provided on a diagonal line of the dressing board 8, and therefore, it is possible to detect such a cut line CL1 extending in the up-down direction.

[0057] The determination unit 53 gives instructions to each of the camera control unit 54, the spindle unit etc. control unit 55, and the monitor control unit 56 based on the result of judgment made by the judgment unit 52. The camera control unit 54, the spindle unit etc. control unit 55, and the monitor control unit 56 control the second position check camera 6b, the spindle unit 6 etc., and the monitor 20, respectively, in accordance with the instructions. The following describes determinations made by the determination unit 53 according to patterns of judgment made by the judgment unit 52.

[0058] FIG. 8 is a diagram schematically showing an example of a dressing board 8 that does not include an unused area. As shown in FIG. 8, cut lines CL1 have been formed in each of the first detection areas D11, D12, and D13 of the dressing board 8. In such a case, the dressing board 8 does not include an unused area, and accordingly, the determination unit 53 determines not to judge whether or not there is a cut line CL1 in each second detection area. Then, the determination unit 53 instructs the monitor control unit 56 to display a message prompting replacement of the dressing board 8 on the monitor 20.

[0059] FIG. 9 is a diagram schematically showing an example of a dressing board 8 that includes an unused area in an upper portion thereof. As shown in FIG. 9, cut lines CL1 have been formed in each of the first detection areas D11 and D12 of the dressing board 8, but no cut line CL1 has been formed in the first detection area D13. In such a case, the dressing board 8 includes an unused area in an upper portion thereof, and accordingly, the determination unit 53 determines to judge whether or not there is a cut line CL1 sequentially from the second detection area D31 toward the second detection area D35 (FIG. 6).

[0060] That is, it has been judged that there are cut lines CL1 in each of the first detection areas D11 and D12 next to each other, and therefore, the determination unit 53 determines not to judge whether or not there is a cut line CL1 in the second detection areas D21 to D25. Also, it has been judged that there are cut lines CL1 in the first detection area D12 and there is no cut line CL1 in the first detection area D13, and therefore, the determination unit 53 determines to judge whether or not there is a cut line CL1 in the second detection areas D31 to D35 sandwiched between the first detection areas D12 and D13 next to each other.

[0061] Then, the determination unit 53 instructs the spindle unit etc. control unit 55 to move the second position check camera 6b relative to the dressing board in the direction from the second detection area D31 toward the second detection area D35. For example,

the spindle unit etc. control unit 55 controls positions of the cutting table 5 and the spindle unit 6 in accordance with the instruction. Furthermore, the determination unit 53 instructs the camera control unit 54 to cause the second position check camera 6b to capture images of the second detection areas D31 to D35 in this order.

5 [0062] If an unused area with a sufficient size is detected in the middle of the detection of unused areas sequentially performed from the second detection area D31 toward the second detection area D35, for example, the detection performed in the second detection areas ends in the middle of the detection. This makes it possible to start dressing of the blade 6a earlier. Note that an unused area with a sufficient size is an
10 unused area that has a size required to perform dressing of the blade 6a, for example. For example, in a case where the user can set the number of cut lines CL1 to be formed in the dressing, the size of an unused area necessary to form the set number of cut lines CL1 may be set as the size required to perform dressing.

[0063] FIG. 10 is a diagram schematically showing an example of a dressing board
15 8 that includes an unused area in at least half the area thereof including an upper portion. As shown in FIG. 10, cut lines CL1 have been formed in the first detection area D11 of the dressing board 8, but no cut line CL1 has been formed in each of the first detection areas D12 and D13. In such a case, the dressing board 8 includes an unused area in at least half the area thereof including an upper portion, and accordingly, the determination
20 unit 53 determines to judge whether or not there is a cut line CL1 sequentially from the second detection area D21 toward the second detection area D25.

[0064] That is, it has been judged that there is no cut line CL1 in each of the first detection areas D12 and D13 next to each other, and therefore, the determination unit 53 determines not to judge whether or not there is a cut line CL1 in the second detection
25 areas D31 to D35. Also, it has been judged that there are cut lines CL1 in the first detection area D11 and there is no cut line CL1 in the first detection area D12, and therefore, the determination unit 53 determines to judge whether or not there is a cut line

CL1 in the second detection areas D21 to D25 sandwiched between the first detection areas D11 and D12 next to each other.

[0065] Then, the determination unit 53 instructs the spindle unit etc. control unit 55 to move the second position check camera 6b relative to the dressing board in the direction from the second detection area D21 toward the second detection area D25. For example, the spindle unit etc. control unit 55 controls positions of the cutting table 5 and the spindle unit 6 in accordance with the instruction. Furthermore, the determination unit 53 instructs the camera control unit 54 to cause the second position check camera 6b to capture images of the second detection areas D21 to D25 in this order. If an unused area with a sufficient size is detected in the middle of the detection of unused areas sequentially performed from the second detection area D21 toward the second detection area D25, for example, the detection performed in the second detection areas ends in the middle of the detection.

[0066] FIG. 11 is a diagram schematically showing an example of a dressing board 8 that includes an unused area in a lower portion thereof. As shown in FIG. 11, no cut line CL1 has been formed in the first detection area D11 of the dressing board 8, but cut lines CL1 have been formed in each of the first detection areas D12 and D13. In such a case, the dressing board 8 includes an unused area in a lower portion thereof, and accordingly, the determination unit 53 determines to judge whether or not there is a cut line CL1 sequentially from the second detection area D21 toward the second detection area D25.

[0067] That is, it has been judged that there are cut lines CL1 in each of the first detection areas D12 and D13 next to each other, and therefore, the determination unit 53 determines not to judge whether or not there is a cut line CL1 in the second detection areas D31 to D35. Also, it has been judged that there is no cut line CL1 in the first detection area D11 and there are cut lines CL1 in the first detection area D12, and therefore, the determination unit 53 determines to judge whether or not there is a cut line

CL1 in the second detection areas D21 to D25 sandwiched between the first detection areas D11 and D12 next to each other.

[0068] Then, the determination unit 53 instructs the spindle unit etc. control unit 55 to move the second position check camera 6b relative to the dressing board in the direction from the second detection area D21 toward the second detection area D25. For example, the spindle unit etc. control unit 55 controls positions of the cutting table 5 and the spindle unit 6 in accordance with the instruction. Furthermore, the determination unit 53 instructs the camera control unit 54 to cause the second position check camera 6b to capture images of the second detection areas D21 to D25 in this order. If an unused area with a sufficient size is detected in the middle of the detection of unused areas sequentially performed from the second detection area D21 toward the second detection area D25, for example, the detection performed in the second detection areas ends in the middle of the detection.

[0069] FIG. 12 is a diagram schematically showing an example of a dressing board 8 that includes unused areas in an upper portion and a lower portion thereof. As shown in FIG. 12, no cut line CL1 has been formed in each of the first detection areas D11 and D13 of the dressing board 8, but cut lines CL1 have been formed in the first detection area D12. In such a case, the dressing board 8 includes unused areas in an upper portion and a lower portion thereof, and accordingly, the determination unit 53 determines to initially judge whether or not there is a cut line CL1 sequentially from the second detection area D21 toward the second detection area D25.

[0070] Then, the determination unit 53 instructs the spindle unit etc. control unit 55 to move the second position check camera 6b relative to the dressing board in the direction from the second detection area D21 toward the second detection area D25. For example, the spindle unit etc. control unit 55 controls positions of the cutting table 5 and the spindle unit 6 in accordance with the instruction. Furthermore, the determination unit 53 instructs the camera control unit 54 to cause the second position check camera 6b to

capture images of the second detection areas D21 to D25 in this order.

[0071] If an unused area with a sufficient size is detected in the middle of the detection of unused areas sequentially performed from the second detection area D21 toward the second detection area D25, for example, the detection performed in the second
5 detection areas ends in the middle of the detection. On the other hand, if an unused area with a sufficient size is not detected in the first detection area D11 and the second detection areas D21 to D25, the determination unit 53 determines to judge whether or not there is a cut line CL1 sequentially from the second detection area D31 toward the second detection area D35.

10 [0072] Then, the determination unit 53 instructs the spindle unit etc. control unit 55 to move the second position check camera 6b relative to the dressing board in the direction from the second detection area D31 toward the second detection area D35. For example, the spindle unit etc. control unit 55 controls positions of the cutting table 5 and the spindle unit 6 in accordance with the instruction. Furthermore, the determination unit 53
15 instructs the camera control unit 54 to cause the second position check camera 6b to capture images of the second detection areas D31 to D35 in this order. If an unused area with a sufficient size is detected in the middle of the detection of unused areas sequentially performed from the second detection area D31 toward the second detection area D35, for example, the detection performed in the second detection areas ends in the middle of the
20 detection.

[0073] FIG. 13 is a diagram schematically showing an example of an unused dressing board 8. As shown in FIG. 13, no cut line CL1 has been formed in each of the first detection areas D11 to D13 of the dressing board 8. In such a case, the dressing board 8 has not been used, and accordingly, the determination unit 53 determines not to judge
25 whether or not there is a cut line CL1 in each of the second detection areas. Then, the determination unit 53 determines the first detection area D11 of the dressing board 8 as the start position of dressing of the blade 6a.

[0074] [2. Operations]

FIG. 14 is a flowchart showing a procedure of preparing dressing of the blade 6a. The processing shown in this flowchart is executed by the control unit 70 after the number of cut lines CL1 to be formed in the dressing is set by the user and a dressing start instruction is given by the user, for example.

[0075] As shown in FIG. 14, the control unit 70 controls a relative position of the second position check camera 6b so that the second position check camera 6b can capture an image of the first detection area D11 (FIG. 6) of the dressing board 8 attached to the dressing board holding portion 5a2. For example, the control unit 70 controls the relative position of the second position check camera 6b by controlling positions of the cutting table 5 and the spindle unit 6. Then, the control unit 70 controls the second position check camera 6b to capture an image of the first detection area D11 (step S100).

[0076] The control unit 70 controls the relative position of the second position check camera 6b so that the second position check camera 6b can capture an image of the first detection area D12. The control unit 70 controls the second position check camera 6b to capture an image of the first detection area D12 (step S110). The control unit 70 controls the relative position of the second position check camera 6b so that the second position check camera 6b can capture an image of the first detection area D13. The control unit 70 controls the second position check camera 6b to capture an image of the first detection area D13 (step S120).

[0077] The control unit 70 executes processing based on image capturing results of the first detection areas D11, D12, and D13 (step S130). Processing executed in step S130 will be described later in detail. The control unit 70 judges whether or not the start position of dress cutting (dressing) has been determined as a result of the processing executed in step S130 (step S140).

[0078] When it is judged that the start position of dress cutting has been determined (YES in step S140), the control unit 70 controls the spindle unit 6 to start dress cutting

from the determined start position (step S150). On the other hand, when it is judged that the start position of dress cutting has not been determined (NO in step S140), the control unit 70 controls the monitor 20 to output a message prompting the user to replace the dressing board 8 (including a message prompting the user to adjust the direction of the dressing board 8) (step S160).

[0079] FIG. 15 is a flowchart showing the processing executed in step S130 shown in FIG. 14. As shown in FIG. 15, the control unit 70 judges whether or not a cut line CL1 has been detected in any of the first detection areas D11, D12, and D13 (step S200).

[0080] When it is judged that a cut line CL1 has not been detected in any of the first detection areas D11, D12, and D13 (NO in step S200), the processing transitions to step S220. On the other hand, when it is judged that a cut line CL1 has been detected in any of the first detection areas D11, D12, and D13 (YES in step S200), the control unit 70 judges whether or not the direction of the detected cut line CL1 is correct based on the images captured by the second position check camera 6b (step S210).

[0081] When it is judged that the direction of the cut line CL1 is correct (YES in step S210), the control unit 70 executes dress cutting position determination processing (step S220). Processing executed in step S220 will be described later in detail. On the other hand, when it is judged that the direction of the cut line CL1 is not correct (NO in step S210), the control unit 70 determines to cause the monitor 20 to display a message prompting the user to adjust the direction of the dressing board 8, and the processing shown in this flowchart ends.

[0082] FIG. 16 is a flowchart showing the processing executed in step S220 shown in FIG. 15. As shown in FIG. 16, the control unit 70 judges whether or not a cut line CL1 has been formed in the first detection area D11 based on the captured image of the first detection area D11 (step S300).

[0083] When it is judged that a cut line CL1 has been formed in the first detection area D11 (YES in step S300), the control unit 70 judges whether or not a cut line CL1 has

been formed in the first detection area D12 based on the captured image of the first detection area D12 (step S305). When it is judged that a cut line CL1 has been formed in the first detection area D12 (YES in step S305), the control unit 70 judges whether or not a cut line CL1 has been formed in the first detection area D13 based on the captured
5 image of the first detection area D13 (step S310). When it is judged that a cut line CL1 has been formed in the first detection area D13 (YES in step S310), the control unit 70 determines to cause the monitor 20 to display a message prompting the user to replace the dressing board 8 (step S315).

[0084] When it is judged in step S310 that no cut line CL1 has been formed in the
10 first detection area D13 (NO in step S310), the control unit 70 executes processing for detecting cut lines CL1 from the second detection area D31 toward the second detection area D35 (FIG. 6) (step S320). That is, the control unit 70 executes processing for detecting unused areas from the second detection area D31 toward the second detection area D35. The detection of unused areas ends when an unused area with a required size
15 is detected, for example. When an unused area with a required size is detected, the control unit 70 determines the start position of dress cutting in the unused area (step S325).

[0085] When it is judged in step S305 that no cut line CL1 has been formed in the first detection area D12 (NO in step S305), the control unit 70 executes processing for detecting unused areas from the second detection area D21 toward the second detection
20 area D25 (step S330). The detection of unused areas ends when an unused area with a required size is detected, for example. When an unused area with a required size is detected, the control unit 70 determines the start position of dress cutting in the unused area (step S325).

[0086] When it is judged in step S300 that no cut line CL1 has been formed in the
25 first detection area D11 (NO in step S300), the control unit 70 judges whether or not a cut line CL1 has been formed in the first detection area D12 (step S335). When it is judged that no cut line CL1 has been formed in the first detection area D12 (NO in step S335),

the control unit 70 determines the first detection area D11 as the start position of dress cutting (step S340).

[0087] When it is judged in step S335 that a cut line CL1 has been formed in the first detection area D12 (YES in step S335), the control unit 70 judges whether or not a cut

5 line CL1 has been formed in the first detection area D13 (step S345). When it is judged that a cut line CL1 has been formed in the first detection area D13 (YES in step S345), the control unit 70 executes processing for detecting unused areas from the second detection area D21 toward the second detection area D25 (step S350). The detection of unused areas ends when an unused area with a required size is detected, for example.

10 When an unused area with a required size is detected, the control unit 70 determines the start position of dress cutting in the unused area (step S325).

[0088] When it is judged in step S345 that no cut line CL1 has been formed in the first detection area D13 (NO in step S345), the control unit 70 executes processing for detecting cut lines CL1 (step S355). That is, the control unit 70 executes processing for

15 detecting unused areas.

[0089] FIG. 17 is a flowchart showing the processing executed in step S355 shown in FIG. 16. As shown in FIG. 17, the control unit 70 executes processing for detecting unused areas from the second detection area D21 toward the second detection area D25 (step S400). The control unit 70 judges whether or not an unused area with a required

20 size has been detected (step S410). When it is judged that an unused area with a required size has been detected (YES in step S410), the control unit 70 determines the start position of dress cutting in the unused area (step S420).

[0090] On the other hand, when it is judged in step S410 that an unused area with a required size has not been detected (NO in step S410), the control unit 70 executes

25 processing for detecting unused areas from the second detection area D31 toward the second detection area D35 (step S430). The control unit 70 judges whether or not an unused area with a required size has been detected (step S440). When it is judged that

an unused area with a required size has been detected (YES in step S440), the control unit 70 determines the start position of dress cutting in the unused area (step S420). On the other hand, when it is judged that an unused area with a required size has not been detected (NO in step S440), the control unit 70 determines to cause the monitor 20 to display a message prompting the user to replace the dressing board 8, and the processing shown in this flowchart ends.

[0091] [3. Features]

As described above, in the cutting apparatus 1 according to the present embodiment, the control unit 70 controls the second position check camera 6b to sequentially capture images of the first detection areas D11, D12, and D13, and judges whether or not there is a cut line CL1 in each of the first detection areas D11, D12, and D13 based on image capturing results obtained from the second position check camera 6b. Then, based on the presence or absence of a cut line CL1 in each of the first detection areas D11, D12, and D13, the control unit 70 determines the necessity for judging whether or not there is a cut line CL1 in the second detection areas D21 to D25 and D31 to D35. In the cutting apparatus 1, first, locations of unused areas in the dressing board 8 are estimated by judging whether or not there is a cut line CL1 in each of the plurality of first detection areas, and a more detailed search is performed on areas that are highly likely to include unused areas, and therefore, it is possible to efficiently detect unused areas.

[0092] Note that the cutting apparatus 1 is an example of a “cutting apparatus” in the present invention. The blade 6a is an example of a “blade” in the present invention, and the package substrate P1 is an example of an “object to be cut” in the present invention. The dressing board 8 is an example of a “dressing board” in the present invention. The second position check camera 6b is an example of an “image capturing unit” in the present invention. The control unit 70 is an example of a “control unit” in the present invention. Each of the first detection areas D11, D12, and D13 is an example of a “first area” in the

present invention, and each of the second detection areas D21 to D25 and D31 to D35 is an example of a “second area” in the present invention. The monitor 20 is an example of a “display unit” in the present invention. The electronic components S1 are examples of a “cut product” in the present invention.

5 [0093] [4. Other Embodiments]

The idea of the above embodiment is not limited to the embodiment described above. The following describes examples of other embodiments to which the idea of the above embodiment can be applied.

[0094] <4-1>

10 In the above embodiment, positions of the cutting table 5 and the spindle unit 6 are controlled to control positions of the second position check camera 6b and the dressing board 8 relative to each other. However, a configuration is also possible in which the position of either one of the cutting table 5 and the spindle unit 6 is controlled to control the positions of the second position check camera 6b and the dressing board 8 relative to
15 each other.

[0095] <4-2>

In the above embodiment, the dressing board 8 is attached to the dedicated dressing board holding portion 5a2. However, the position to which the dressing board 8 is attached is not limited to this example. For example, the dressing board 8 may also
20 be attached to the holding member body 5a1 when dressing of the blade 6a is performed. In this case, a dedicated attachment jig may be used to improve the accuracy of the position of the dressing board 8 on the holding member body 5a1.

[0096] <4-3>

In the above embodiment, detection of unused areas performed in the second
25 detection areas D21 to D25 and D31 to D35 ends in response to an unused area with a required size being detected. However, the detection of unused areas in the second detection areas D21 to D25 and D31 to D35 need not necessarily end in response to an

unused area with a required size being detected. For example, detection of unused areas may be performed in all of the second detection areas D21 to D25 irrespective of whether or not an unused area with a required size has been detected in the detection of unused areas performed in the second detection areas D21 to D25. Also, detection of unused areas may be performed in all of the second detection areas D21 to D25 irrespective of whether or not an unused area with a required size has been detected in the detection of unused areas performed in the second detection areas D31 to D35.

[0097] <4-4>

A configuration is also possible in which, when cut lines CL1 are not detected in the first detection areas D11 and D13 and are detected only in the first detection area D12 (FIG. 12), it is judged that an abnormality has occurred in the dressing board 8. In such a case, a message prompting the user to replace the dressing board 8 may be displayed on the monitor 20, for example.

[0098] <4-5>

In the above embodiment, the number of cut lines CL1 formed in the dressing board 8 during dress cutting is set by the user. However, the number of cut lines CL1 formed in the dressing board 8 during dress cutting need not necessarily be set by the user. The number of cut lines CL1 formed in the dressing board 8 during dress cutting may also be automatically determined by the computer 50, for example.

[0099] In the above embodiment, the cutting apparatus 1 may further include a replacement mechanism for automatically replacing the dressing board 8 held by the dressing board holding portion 5a2. In this case, the control unit 70 may transmit a control signal for replacing the dressing board 8 held by the dressing board holding portion 5a2 to the replacement mechanism in step S160 shown in FIG. 14, for example. As a result, the dressing board 8 held by the dressing board holding portion 5a2 is automatically replaced by the replacement mechanism.

[0100] An embodiment of the present invention has been described as an example.

That is, the detailed description and the attached drawings are disclosed for the purpose of illustration. Accordingly, the constituent elements described in the detailed description and shown in the attached drawings may include constituent elements that are not essential for solving the problem. Accordingly, simply because those nonessential constituent elements are described in the detailed description and shown in the attached drawings, those nonessential constituent elements are not intended to be immediately identified as essential.

[0101] Also, the above embodiment is merely an example of the present invention in all aspects. Various modifications and changes can be made to the above embodiment within the scope of the present invention. That is, when implementing the present invention, specific configurations can be adopted as appropriate depending on the embodiment.

List of Reference Numerals

15	[0102]	1	Cutting apparatus
		3	Substrate supply unit
		4	Positioning unit
		4a	Rail unit
		5	Cutting table
20		5a	Holding member
		5a1	Holding member body
		5a2	Dressing board holding portion
		5b	Rotating mechanism
		5c	Moving mechanism
25		5d	First position check camera
		5e	First cleaner
		6	Spindle unit

	6a	Blade
	6b	Second position check camera
	6c	Rotary shaft
	6d	First flange
5	6e	Second flange
	6f	Fastening member
	7	Conveying unit
	7a	Second cleaner
	8	Dressing board
10	11	Inspection table
	12	First optical inspection camera
	13	Second optical inspection camera
	14	Placement unit
	15	Extraction unit
15	15a	Non-defective product tray
	15b	Detective product tray
	20	Monitor
	50	Computer
	51	Obtaining unit
20	52	Judgment unit
	53	Determination unit
	54	Camera control unit
	55	Spindle unit etc. control unit
	56	Monitor control unit
25	70	Control unit
	72	CPU
	74	RAM

	76	ROM	
	80	Storage unit	
	81	Control program	
	90	Input output I/F	
5	95	Reception unit	
	A1	Cutting module	
	B1	Inspection-housing module	
	CL1	Cut line	
	D11, D12, D13	First detection area	
10	D21, D22, D23, D24, D25, D31, D32, D33, D34, D35	Second detection	
		area	
	M1	Magazine	
	P1	Package substrate	
	S1	Electronic component	
15			

CLAIMS

1. A cutting apparatus configured to cut an object to be cut with use of a blade,
dressing of the blade being performed with use of a dressing board, the cutting apparatus
5 comprising:

an image capturing unit configured to move relative to the dressing board and
capture an image of an area of the dressing board; and

a control unit configured to control the image capturing unit to sequentially
capture images of a plurality of first areas of the dressing board, and judge whether or not
10 there is a cut line in each of the plurality of first areas based on image capturing results
obtained from the image capturing unit,

wherein two first areas that are next to each other out of the plurality of first areas
are spaced apart from each other sandwiching a second area therebetween, and

based on the presence or absence of the cut line in each of the plurality of first
15 areas, the control unit determines necessity for judging whether or not there is a cut line
in the second area.

2. The cutting apparatus according to claim 1,

wherein, when it is judged that the cut line is present in each of the plurality of
20 first areas, the control unit does not judge whether or not there is a cut line in the second
area.

3. The cutting apparatus according to claim 1 or 2,

wherein, when it is judged that the cut line is absent from each of the plurality
25 of first areas, the control unit does not judge whether or not there is a cut line in the second
area.

4. The cutting apparatus according to any one of claims 1 to 3,
wherein, when it is judged that the cut line is present in each of the two first areas
next to each other, the control unit does not judge whether or not there is a cut line in the
second area sandwiched between the two first areas next to each other.

5

5. The cutting apparatus according to any one of claims 1 to 4,
wherein, when it is judged that the cut line is absent from each of the two first
areas next to each other, the control unit does not judge whether or not there is a cut line
in the second area sandwiched between the two first areas next to each other.

10

6. The cutting apparatus according to any one of claims 1 to 5,
wherein, when it is judged that the cut line is present in one first area of the two
first areas next to each other and is absent from the other first area of the two first areas
next to each other, the control unit judges whether or not there is a cut line in the second
15 area sandwiched between the two first areas next to each other.

7. The cutting apparatus according to claim 6,
wherein judgment as to whether or not there is a cut line in the second area ends
in response to an area with a predetermined size not including the cut line being detected,
20 and

the predetermined size is a size required for dressing of the blade.

8. The cutting apparatus according to any one of claims 1 to 7,
wherein the dressing board has a rectangular shape in a plan view, and
25 each of the plurality of first areas is located on a diagonal line of the dressing
board.

9. The cutting apparatus according to claim 8, further comprising:
a display unit configured to display an image,
wherein the control unit judges whether or not the direction of the cut line in
each of the plurality of first areas is correct, and when it is judged that the direction is not
5 correct, the control unit controls the display unit to display a message.
10. A method for manufacturing a cut product with use of the cutting apparatus
according to any one of claims 1 to 9, the method comprising:
performing dressing of the blade in an area of the dressing board for which it is
10 judged by the control unit that the cut line is absent; and
cutting the object to be cut with use of the blade subjected to dressing.