

DESCRIPTION
MACHINING APPARATUS AND METHOD FOR MANUFACTURING MACHINED
ARTICLE

Technical Field

[0001]

The present invention relates to a machining apparatus and a method for manufacturing machined articles.

Background Art

[0002]

Conventionally, as disclosed in Patent Literature 1, there has been a cutting machine having a configuration in which a strip picker moves in an X-axis direction to transfer a semiconductor strip from an on-loader unit to a chuck table in a cutting system; the chuck table suctions the semiconductor strip and moves in a Y-axis direction to the rear side of the system; and then the semiconductor strip is diced into semiconductor packages using a spindle. The chuck table is moved in the Y-axis direction using a ball screw (ball-screw mechanism). As an exemplary storage for storing therein diced semiconductor packages, a structure that uses a transparent casing having a rectangular tubular shape, referred to as a stick, for storing the semiconductor packages has been devised, as disclosed in Patent Literature 2.

[0003]

However, because the cutting system described above uses a ball screw to move the chuck table to cut the semiconductor strip, it is necessary to provide a bellows member to protect the ball screw from machining water and swarf, and to provide a plurality of plate members on the bellows member to protect the bellows member,

during the actual dicing operation, e.g., as disclosed in Patent Literature 3. These elements complicate the apparatus structure.

[0004]

In addition, because this cutting system transfers the semiconductor strip in the X-axis direction as well as in the Y-axis direction toward the rear side of the system to cut the semiconductor strip, the cutting machine occupies a large footprint.

Citation List

Patent Literature

[0005]

Patent Literature 1: JP 2007-536727 A

Patent Literature 2: JP S63-131902 U

Patent Literature 3: JP 2004-186361 A

Summary of Invention

Technical Problem

[0006]

The present invention has been made to address the issues described above, and a main object of the present invention is to enable storing of diced workpieces into a tubular container, and eliminating the need for an actuator mechanism for moving a machining table that holds a workpiece at the same time.

Solution to Problem

[0007]

In other words, a machining apparatus according to the present invention includes: a machining table that holds a workpiece; a first pickup mechanism that holds the workpiece to transport the workpiece to the machining table; a machining mechanism that cuts the workpiece held on the machining table to dice it; a transfer

table onto which the workpiece diced by the machining mechanism is transferred; a second pickup mechanism that holds the diced workpiece to transport the diced workpiece from the machining table onto the transfer table; a transport actuator mechanism that includes a shared transfer shaft for moving the first pickup mechanism and the second pickup mechanism, and extending in a direction in which the machining table and the transfer table are arranged; a machining actuator mechanism that moves the machining mechanism across a horizontal plane, in a first direction extending along the transfer shaft and a second direction orthogonal to the first direction; a container setting unit where a tubular container for housing the diced workpiece through an one-end opening is set; and a transport and storage mechanism that transports and stores the diced workpiece from the transfer table to the tubular container set in the container setting unit.

Advantageous Effects of Invention

[0008]

According to the present invention configured as described above, it is possible to store the diced workpiece into a tubular container, and to eliminate the need for an actuator mechanism for moving a machining table that holds a workpiece at the same time.

Brief Description of Drawings

[0009]

FIG. 1 is a diagram schematically illustrating a configuration of a cutting machine according to an embodiment of the present invention.

FIG. 2 is a perspective view schematically illustrating a cutting table and structures around the cutting table according to the embodiment.

FIG. 3 is a view (plan view) schematically illustrating configurations of the

cutting table and the structures around the cutting table according to the embodiment, as viewed in a Z direction.

FIG. 4 is a view (front view) schematically illustrating configurations of the cutting table and the structures around the cutting table according to the embodiment, as viewed in a Y direction.

FIG. 5 is a view (front view) schematically illustrating configurations of a first pickup mechanism and a transport actuator mechanism according to the embodiment, as viewed in the Y direction.

FIG. 6 is a view (side view) schematically illustrating the configuration of the first pickup mechanism and the transport actuator mechanisms according to the embodiment, as viewed in an X direction.

FIG. 7 is a cross-sectional view schematically illustrating a configuration of a rack-and-pinion mechanism according to the embodiment.

FIG. 8 is a view (front view) schematically illustrating configurations of a second pickup mechanism and the transport actuator mechanism according to the embodiment, as viewed in the Y direction.

FIG. 9 is a view (plan view) schematically illustrating a transfer table, a container setting unit, and a transport and storage mechanism according to the embodiment, as viewed in a Z direction.

FIG. 10 is (a) a perspective view, and (b) a cross-sectional view schematically illustrating a configuration of a tubular container according to the embodiment.

FIG. 11 is a view (front view) schematically illustrating the configuration of a first transport mechanism according to the embodiment, as viewed in the Y direction.

FIG. 12 is a schematic diagram illustrating (a) a non-defective product route and (b) a defective product route by a classification mechanism according to the

embodiment.

FIG. 13 is a view schematically illustrating the paths taken by the first pickup mechanism and the second pickup mechanism according to the embodiment.

FIG. 14 is a schematic diagram illustrating the classification mechanism according to a modification.

Description of Embodiments

[0010]

The present invention will now be explained more in detail using some examples. However, the following explanations are not intended to limit the scope of the present invention in any way.

[0011]

A machining apparatus according to the present invention includes: a machining table that holds a workpiece; a first pickup mechanism that holds the workpiece to transport the workpiece to the machining table; a machining mechanism that cuts the workpiece held on the machining table to dice it; a transfer table onto which the workpiece diced by the machining mechanism is transferred; a second pickup mechanism that holds the diced workpiece to transport the diced workpiece from the machining table onto the transfer table; a transport actuator mechanism that includes a shared transfer shaft for moving the first pickup mechanism and the second pickup mechanism, and extending in a direction in which the machining table and the transfer table are arranged; a machining actuator mechanism that moves the machining mechanism across a horizontal plane, in a first direction extending along the transfer shaft and a second direction orthogonal to the first direction; a container setting unit where a tubular container for housing the diced workpiece through an one-end opening is set; and a transport and storage mechanism that transports and stores the diced

workpiece from the transfer table to the tubular container set in the container setting unit.

[0012]

With this machining apparatus, because the first pickup mechanism and the second pickup mechanism move along the shared transfer shaft extending in the direction in which the machining table and the transfer table are arranged, and because the machining actuator mechanism moves the machining mechanism on the horizontal plane, in the first direction that extends along the transfer shaft and the second direction that is orthogonal to the first direction, the workpiece can be diced without moving the machining table in the first direction nor in the second direction. With this structure, no structure such as a ball screw mechanism is used to move the machining table, so that the needs for the bellows member for protecting the structure such as a ball screw mechanism and the cover member for protecting the bellows member can be eliminated. As a result, the apparatus configuration of the machining apparatus can be simplified.

In addition, because the machining table moves on the horizontal plane neither in the first direction nor in the second direction, it is possible to save the space for moving the machining table and the wasted space around the machining table. Therefore, it is possible to reduce the footprint of the machining apparatus.

Furthermore, by causing the transport and storage mechanism to transport the diced workpiece from the transfer table into the tubular container set in the container setting unit, it is possible to store the diced workpiece in the tubular container via the one-end opening.

[0013]

As a specific embodiment of the positioning of the transfer shaft and the machining actuator mechanism, preferably, the transfer shaft is disposed above the

machining actuator mechanism in a manner traversing the machining actuator mechanism.

With this configuration, because the first pickup mechanism that moves along the transfer shaft can move above the machining actuator mechanism, it is possible to prevent the first pickup mechanism from physically interfering with the machining actuator mechanism. Furthermore, because the second pickup mechanism that moves along the transfer shaft can move above the machining actuator mechanism, it is possible to prevent the second pickup mechanism from physically interfering with the machining actuator mechanism.

[0014]

As a specific embodiment of the transport and storage mechanism, preferably, the transport and storage mechanism includes: an intermediate table on which the diced workpiece is temporarily placed; a first transport mechanism that transports the diced workpiece from the transfer table onto the intermediate table; and a second transport mechanism that transports and stores the diced workpiece from the intermediate table into the tubular container set in the container setting unit.

[0015]

In order to enable the condition of the diced workpiece to be checked or inspected, preferably further provided is an image capturing unit that captures an image of the diced workpiece held by the first transport mechanism, or the diced workpiece placed on the transfer table.

[0016]

In order to automatically determine whether the diced workpiece is a non-defective product or a defective product, preferably further provided is a determination unit that determines quality of the diced workpiece using data of the image captured by

the image capturing unit.

[0017]

In order to automatically classify the non-defective product and the defective product based on a determination result of the determination unit, preferably further provided is a classification mechanism that classifies the diced workpiece determined to be a defective product by the determination unit.

[0018]

As a specific embodiment in which the classification mechanism is disposed, preferably, the classification mechanism is provided to the second transport mechanism.

[0019]

As a specific embodiment of the classification mechanism, preferably, the classification mechanism switches a route of the diced workpiece between a non-defective product route for guiding the diced workpiece as a non-defective product by the determination unit to the tubular container, and a defective product route for discarding the diced workpiece determined as a defective product by the determination unit into a disposal container.

[0020]

As a specific embodiment of the actuator mechanism that moves the machining mechanism at least in an X direction that is a first direction and a Y direction that is a second direction, preferably, the machining actuator mechanism includes an X-direction actuator that moves the machining mechanism linearly in the X-direction, and a Y-direction actuator that moves the machining mechanism linearly in the Y-direction, and, also preferably, the X-direction actuator includes a pair of X-direction guide rails that are provided along the X-direction, with the machining table interposed therebetween, and a support that moves along the pair of X-direction guide rails, and

supports the machining mechanism via the Y-direction actuator.

With this configuration, because the pair of X-direction guides are provided along the X direction with the machining tables interposed therebetween, the pitch between the pair of X-direction guide rails can be increased. As a result, machining is less affected by a positional deviation between the X-direction guide rails in the Z direction. In other words, it is possible to reduce a deviation in the orthogonality between the rotary tool (e.g., a blade) and the machining table, so that the machining precision can be improved. Furthermore, it becomes possible to use X-direction guide rails with lower specification requirements, compared with those having been conventionally required.

[0021]

A method for manufacturing a machined article using the machining apparatus also constitutes one aspect of the present invention.

[0022]

<One embodiment of present invention>

A machining apparatus according to one embodiment of the present invention will now be explained with reference to some drawings. Note that, to facilitate understanding, all of the drawings described below are schematic representations, with some omissions and exaggerations made as appropriate. The same elements are denoted by the same reference numerals, and the descriptions thereof will be omitted as appropriate.

[0023]

<Overall configuration of machining apparatus>

A machining apparatus 100 according to this embodiment is a cutting machine for cutting a sealed substrate W, which is a workpiece, to dice the sealed substrate W

into a plurality of products P that are machined articles.

[0024]

The sealed substrate W is a substrate having at least electronic elements connected thereto, such as semiconductor chips, resistor elements, and capacitor elements, sealed with resin. Examples of the substrate of the sealed substrate W include a lead frame and a printed wiring board, as well as a semiconductor substrate (including a semiconductor wafer such as a silicon wafer), a metal substrate, a ceramic substrate, a glass substrate, and a resin substrate. The substrate of the sealed substrate W may include or not include wiring.

[0025]

One surfaces of the sealed substrate W and products P according to this embodiment serve as mounting surfaces to be mounted in a subsequent process. In the description of this embodiment, the one surface to be mounted in the subsequent process will be referred to as a “mounting surface”, and the surface on the opposite side of the mounting surface will be referred to as an “opposite surface”.

[0026]

Specifically, as illustrated in FIG. 1, the cutting machine 100 includes: two cutting tables (machining tables) 2A, 2B each of which holds a sealed substrate W; a first pickup mechanism 3 that picks up a sealed substrate W to be transported onto the cutting table 2A, 2B; a cutting mechanism (machining mechanism) 4 that cuts the sealed substrates W on the cutting table 2A, 2B; a transfer table 5 onto which a plurality of products P are transferred; a second pickup mechanism 6 that picks up a plurality of products P, and transfers the plurality of products P from the cutting tables 2A, 2B onto the transfer table 5; a transport actuator mechanism 7 that includes a shared transfer shaft 71 for moving the first pickup mechanism 3 and the second pickup mechanism 6;

and a cutting actuator mechanism (machining actuator mechanism) 8 that moves the cutting mechanism 4 with respect to the sealed substrate W placed on the cutting table 2A, 2B. Note that the first pickup mechanism 3 and the transport actuator mechanism 7 makes up a transport mechanism (loader) that transfers a sealed substrate W, and the second pickup mechanism 6 and the transport actuator mechanism 7 together make up a transport mechanism (unloader) that transfers the plurality of products P.

[0027]

In the description hereunder, directions orthogonal to each other on a plane extending along the top surfaces of the cutting tables 2A, 2B (horizontal plane) are defined as an X direction that is a first direction and a Y direction that is a second direction, and a vertical direction orthogonal to the X direction and the Y direction is defined as a Z direction. Specifically, the horizontal direction and the vertical direction in FIG. 1 are defined as the X direction and the Y direction, respectively. The X direction also is a direction, as will be described later, along which the support 812 moves, and is a direction orthogonal to a longitudinal direction of a beam (the direction in which the beam extends) bridging a pair of legs of the support 812 having a gate-like shape (see FIGS. 2 and 3).

[0028]

<Cutting tables 2A, 2B>

The two cutting tables 2A, 2B are fixed in the X direction, the Y direction, and the Z direction. The cutting table 2A is enabled to rotate in a θ direction, by a rotating mechanism 9A provided below the cutting table 2A. The cutting table 2B is also enabled to rotate in the θ direction, by a rotating mechanism 9B provided below the cutting table 2B.

[0029]

The two cutting tables 2A, 2B are provided in alignment in the X direction on a horizontal plane. Specifically, the two cutting tables 2A, 2B are disposed in such a manner that the top surfaces thereof extend on the same horizontal plane (are at the same height in the Z direction) (see FIG. 4), and that the centers of the top surfaces (specifically, the centers about which the cutting tables 2A, 2B are rotated by the rotating mechanisms 9A, 9B, respectively) are in alignment with the same straight line extending in the X direction (see FIGS. 2 and 3).

[0030]

Each of the two cutting tables 2A, 2B also holds a sealed substrate W by suctioning. As illustrated in FIG. 1, two vacuum pumps 10A, 10B for suctioning to hold the sealed substrate W are disposed correspondingly to the two cutting tables 2A, 2B, respectively. Each of the vacuum pumps 10A, 10B is a water-sealed vacuum pump, for example.

[0031]

Because the cutting tables 2A, 2B are fixed in the XYZ directions, it becomes possible to keep the length of pipes (not illustrated) connecting the vacuum pumps 10A, 10B and the respective cutting tables 2A, 2B short. It is, therefore, possible to inhibit a loss in the pressure inside the pipes, so that reductions in the suctioning forces can be suppressed. As a result, even a very small package such as one having a size of 1 mm square or less can be suctioned reliably to the cutting tables 2A, 2B. Furthermore, because such a configuration can prevent a drop in the suctioning force due to the loss of the pipe pressure, it becomes possible to use vacuum pumps 10A, 10B with smaller capacities, which translate into size and cost reductions.

[0032]

<First pickup mechanism 3>

As illustrated in FIG. 1, the first pickup mechanism 3 picks up a sealed substrate W to transport the sealed substrate W from a substrate feeder mechanism 11 onto the cutting tables 2A, 2B. As illustrated in FIGS. 5 and 6, the first pickup mechanism 3 includes a suction head 31 having a plurality of suction ports 311 for holding the sealed substrate W by suctioning, and a vacuum pump (not illustrated) connected to the suction ports 311 of the suction head 31. By moving the suction head 31 to a desired position using the transport actuator mechanism 7 to be described later, for example, sealed substrates W are transported from the substrate feeder mechanism 11 to the cutting tables 2A, 2B.

[0033]

As illustrated in FIG. 1, the substrate feeder mechanism 11 includes a substrate housing 111 where a plurality of sealed substrates W from outside are stored, and a substrate feeder unit 112 that moves the sealed substrate W from the inside of the substrate housing 111 to a pickup position RP, where the first pickup mechanism 3 suctions to pick up the sealed substrate W. The pickup position RP is in alignment with the two cutting tables 2A, 2B in the X direction. Note that the substrate feeder mechanism 11 may include a heater 113 for heating the sealed substrate W to be suctioned to the first pickup mechanism 3, to make it easier for the first pickup mechanism 3 to pick up the sealed substrate W.

[0034]

<Cutting mechanism 4>

As illustrated in FIGS. 1, 2, and 3, the cutting mechanism 4, which is a machining mechanism, includes two rotary tools 40 including blades 41A, 41B and two spindle units 42A, 42B. The two spindle units 42A, 42B have their rotation axes extending along the Y direction, and are arranged so that the blades 41A, 41B attached

thereto face each other (see FIG. 3). Each of the blade 41A on the spindle unit 42A and the blade 41B on the spindle unit 42B rotates on planes extending across the X direction and the Z direction, to cut the sealed substrate W placed on the cutting table 2A, 2B. As illustrated in FIG. 4, in order to suppress generation of frictional heat by the blades 41A, 41B, the cutting machine 100 according to this embodiment includes a cutting water feeder mechanism 12 having jet nozzles 121 that discharges cutting water (machining fluid). The jet nozzles 121 are supported on a Z-direction actuator 83, which will be described later, for example.

[0035]

<Transfer table 5>

As illustrated in FIG. 1, the transfer table 5 according to this embodiment is a table to which a plurality of products P, having been inspected by an inspection unit 13 to be described later, are transferred. The transfer table 5 is what is called an indexing table, and a plurality of products P are placed thereon temporarily. As illustrated in FIGS. 1 and 9, the transfer table 5 is provided movably along the Y direction, and moves between a transfer position X1 where the plurality of products P are placed by the second pickup mechanism 6, and a pickup position X2 where the plurality of products P are transported by the transport and storage mechanism 22. The transfer position X1 is set on the front side of the transfer shaft 71, and is at a position aligned with the two cutting tables 2A, 2B along a line extending in the X direction on the horizontal plane, and the pickup position X2 is set behind the transfer shaft 71.

[0036]

<Inspection unit 13>

The inspection unit 13 is provided between the cutting tables 2A, 2B and the transfer table 5, as illustrated in FIG. 1, and inspects a plurality of products P held by

the second pickup mechanism 6. The inspection unit 13 according to this embodiment includes a first inspection unit 131 inspecting the opposite surfaces of the products P, and a second inspection unit 132 inspecting the mounting surfaces of the products P. The first inspection unit 131 is an imaging camera including an optical system for inspecting the opposite surfaces, and the second inspection unit 132 is an imaging camera including an optical system for inspecting the mounting surfaces. Note that the first inspection unit 131 and the second inspection unit 132 may be the same unit.

[0037]

To enable the inspection unit 13 to inspect both of the surfaces of the plurality of products P, the inspection unit 13 includes a reversing mechanism 14 for reversing the plurality of products P (see FIG. 1). The reversing mechanism 14 includes a holding table 141 holding a plurality of products P, and a reversing unit 142, such as a motor for flipping the holding table 141 upside down.

[0038]

When the second pickup mechanism 6 picks up the plurality of products P from the machining tables 2A, 2B, the opposite surfaces of the products P are facing downwards. The first inspection unit 131 inspects the opposite surfaces of the plurality of products P while the products P are being transported from the machining tables 2A, 2B to the reversing mechanism 14. The reversing mechanism 14 then reverses the plurality of products P held by the second pickup mechanism 6, and the reversing mechanism 14 then moves to the position of the transfer table 5. During this time of movement, the second inspection unit 132 inspects the mounting surfaces of the products P that are facing downwards. The products P are then passed onto the transfer table 5.

[0039]

<Second pickup mechanism 6>

As illustrated in FIG. 1, the second pickup mechanism 6 picks up a plurality of products P, and transports the plurality of products P from the cutting tables 2A, 2B to the holding table 141 or the transfer table 5. As illustrated in FIG. 8, the second pickup mechanism 6 includes a suction head 61 having a plurality of suction ports 611 for holding a plurality of products P by suctioning, and a vacuum pump (not illustrated) connected to the suction ports 611 of the suction head 61. The suction head 61 is then moved to a desired position with the transport actuator mechanism 7, which will be described later, for example, so as to transport the plurality of products from the cutting tables 2A, 2B onto the holding table 141 or the transfer table 5.

[0040]

<Transport actuator mechanism 7>

As illustrated in FIG. 1, the transport actuator mechanism 7 moves the first pickup mechanism 3 at least between the substrate feeder mechanism 11 and the cutting tables 2A, 2B, and moves the second pickup mechanism 6 at least between the cutting tables 2A, 2B and the holding table 141.

[0041]

As illustrated in FIG. 1, the transport actuator mechanism 7 extends in a straight line along the direction in which the two cutting tables 2A, 2B and the transfer table 5 are aligned (X direction). The transport actuator mechanism 7 includes the shared transfer shaft 71 for moving the first pickup mechanism 3 and the second pickup mechanism 6.

[0042]

The transfer shaft 71 is provided across a range by which the first pickup mechanism 3 can move above the substrate feeder unit 112 of the substrate feeder

mechanism 11, and the second pickup mechanism 6 can move above the transfer table 5 (see FIG. 1). The first pickup mechanism 3, the second pickup mechanism 6, the cutting tables 2A, 2B, and the transfer table 5 are provided on the same side of the transfer shaft 71 (front side), in a plan view. The inspection unit 13, the reversing mechanism 14, a first cleaning mechanism 18, a second cleaning mechanism 19, and a container setting unit 21, which are to be described later, are also provided on the same side of the transfer shaft 71 (front side).

[0043]

The transport actuator mechanism 7 also includes, as illustrated in FIGS. 5, 6, and 8, a main actuator mechanism 72 that moves the first pickup mechanism 3 and the second pickup mechanism 6 in the X direction along the transfer shaft 71, a vertical actuator mechanism 73 that moves the first pickup mechanism 3 and the second pickup mechanism 6 up and down with respect to the transfer shaft 71 in the Z direction, and a horizontal actuator mechanism 74 that moves the first pickup mechanism 3 and the second pickup mechanism 6 horizontally with respect to the transfer shaft 71 in the Y direction.

[0044]

The main actuator mechanism 72 is provided on the transfer shaft 71, as illustrated in FIGS. 5 to 8. The main actuator mechanism 72 includes a shared guide rail 721 guides the first pickup mechanism 3 and the second pickup mechanism 6; and a rack-and-pinion mechanism 722 that moves the first pickup mechanism 3 and the second pickup mechanism 6 along the guide rail 721.

[0045]

The guide rail 721 extends linearly in the X direction along the transfer shaft 71, and is provided across a range in which the first pickup mechanism 3 can move

above the substrate feeder unit 112 of the substrate feeder mechanism 11, and the second pickup mechanism 6 can move above the transfer table 5, in the same manner as the transfer shaft 71. On the guide rail 721, slide members 723 are provided slidably. On each of the slide members 723, the first pickup mechanism 3 and the second pickup mechanism 6 are provided via the vertical actuator mechanism 73 and the horizontal actuator mechanism 74. While the guide rail 721 is shared by the first pickup mechanism 3 and the second pickup mechanism 6, the vertical actuator mechanism 73, the horizontal actuator mechanism 74, and the slide member 723 are provided for each of the first pickup mechanism 3 and the second pickup mechanism 6.

[0046]

The rack-and-pinion mechanism 722 includes a cam rack 722a shared between the first pickup mechanism 3 and the second pickup mechanism 6, and a pinion gear 722b provided to each of the first pickup mechanism 3 and the second pickup mechanism 6, and caused to rotate by an actuator (not illustrated). The cam rack 722a is provided on the shared transfer shaft 71. The length of the cam rack 722a can be changed variously, by connecting a plurality of cam rack elements. The pinion gears 722b are what is called roller pinions, and are provided on the slide member 723. Each of the pinion gears includes, as illustrated in FIG. 7, a pair of roller main bodies 722b1 rotating with the rotation shaft of a motor, and a plurality of roller pins 722b2 provided between the pair of roller main bodies 722b1, at equal intervals along the circumferential direction, and rollable with respect to the roller main bodies 722b1. Because the rack-and-pinion mechanism 722 according to this embodiment uses the roller pinion described above, two or more roller pins 722b2 come into contact with the cam rack 722a, so that the pinion gear 722b does not receive backlash in the forward and reverse directions. In this manner, the positioning precision when the first pickup

mechanism 3 and the second pickup mechanism 6 move in the X direction is improved.

[0047]

As illustrated in FIGS. 5 and 8, the vertical actuator mechanism 73 is provided for each of the first pickup mechanism 3 and the second pickup mechanism 6. As illustrated in FIGS. 5 and 6, the vertical actuator mechanism 73 corresponding to the first pickup mechanism 3 is interposed between the transfer shaft 71 (specifically, the main actuator mechanism 72) and the first pickup mechanism 3. The vertical actuator mechanism 73 includes Z-direction guide rails 73a provided along the Z direction, and an actuator 73b that moves the first pickup mechanism 3 along the Z-direction guide rail 73a. Note that the actuator 73b may be an actuator using a ball screw mechanism, an air cylinder, or a linear motor. As illustrated in FIG. 8, the vertical actuator mechanism 73 corresponding to the second pickup mechanism 6 has the same structure as that of the vertical actuator mechanism 73 corresponding to the first pickup mechanism 3.

[0048]

As illustrated in FIGS. 5, 6 and 8, the horizontal actuator mechanism 74 is provided correspondingly to each of the first pickup mechanism 3 and the second pickup mechanism 6. As illustrated in FIGS. 5 and 6, the horizontal actuator mechanism 74 corresponding to the first pickup mechanism 3 is interposed between the transfer shaft 71 (specifically, the vertical actuator mechanism 73) and the first pickup mechanism 3. The horizontal actuator mechanism 74 includes Y-direction guide rails 74a that are provided along the Y direction, elastic bodies 74b that apply a force to the Y-direction guide rails 74a toward one side with respect to the first pickup mechanism 3, and a cam mechanism 74c that moves the first pickup mechanism 3 to the other side of the Y-direction guide rail 74a. The cam mechanism 74c is a cam mechanism using an eccentric cam. By rotating the eccentric cam with an actuator such as a motor, the

amount by which the first pickup mechanism 3 moves in the Y direction can be adjusted.

[0049]

As illustrated in FIG. 8, the horizontal actuator mechanism 74 corresponding to the second pickup mechanism 6 has the same structure as that of the vertical actuator mechanism 73 corresponding to the first pickup mechanism 3. The horizontal actuator mechanism 74 for the second pickup mechanism 6 may also be omitted. It is also possible for neither one of the first pickup mechanism 3 nor the second pickup mechanism 6 to be provided with the horizontal actuator mechanism 74. Furthermore, the horizontal actuator mechanism 74 may be an actuator mechanism using a ball screw mechanism, an air cylinder, or a linear motor, for example, instead of the one using the cam mechanism 74c, in the same manner as the vertical actuator mechanism 73.

[0050]

<Cutting actuator mechanism 8 (machining actuator mechanism)>

A cutting actuator mechanism 8 moves each of the two spindle units 42A, 42B linearly, in each of the X direction, the Y direction, and the Z direction.

[0051]

Specifically, as illustrated in FIGS. 2, 3, and 4, the cutting actuator mechanism 8 includes an X-direction actuator 81 that moves the spindle units 42A, 42B linearly in the X direction, a Y-direction actuator 82 that moves the spindle units 42A, 42B linearly in the Y direction, and Z-direction actuators 83 that move the spindle units 42A, 42B linearly in the Z direction.

[0052]

The X-direction actuator 81 is shared between the two cutting tables 2A, 2B, and in particular, as illustrated in FIGS. 2 and 3, includes a pair of X-direction guide

rails 811 provided along the X-direction, with the two cutting tables 2A, 2B interposed therebetween, and a support 812 that moves along the pair of X-direction guide rails 811, and that supports the spindle units 42A, 42B via the Y-direction actuator 82 and the Z-direction actuators 83. The pair of X-direction guide rails 811 is provided on respective sides of the two cutting tables 2A, 2B that are arranged along the X direction. The support 812 is a support having a gate-like shape, for example, and has a shape extending in the Y direction. Specifically, the support 812 has a pair of legs extending upwards from the pair of X-direction guide rails 811, and a beam bridging the pair of legs. The beam extends in the Y direction.

[0053]

The support 812 then moves back and forth linearly along the pair of X-direction guide rails 811 in the X direction, for example, via a ball screw mechanism 813 extending in the X direction. The ball screw mechanism 813 is driven by a drive source (not illustrated), such as a servo motor. The support 812 may also be configured to move back and forth via another type of linear actuator mechanism, such as a linear motor.

[0054]

The Y-direction actuator 82 includes, as particularly illustrated in FIG. 3, a Y-direction guide rail 821 provided to the support 812 in a manner extending along the Y-direction, and Y-direction sliders 822 that move along the Y-direction guide rail 821. The Y-direction sliders 822 are driven by a linear motor 823, for example, and moves back and forth linearly along the Y-direction guide rail 821. In this embodiment, two Y-direction sliders 822 are provided correspondingly to the two spindle units 42A, 42B, respectively. With these sliders, the two spindle units 42A, 42B are movable independently with respect to each other in the Y direction. The Y-direction sliders

822 may also be configured to move back and forth via another linear actuator mechanism that uses a ball screw mechanism.

[0055]

As illustrated in FIGS. 2 to 4, each of the Z-direction actuators 83 includes Z-direction guide rails 831 provided to the corresponding Y-direction slider 822, in a manner extending along the Z-direction, and a Z-direction slider 832 that moves along the Z-direction guide rails 831 and supports the corresponding spindle unit 42A, 42B. In other words, the Z-direction actuator 83 is provided correspondingly to each of the spindle units 42A, 42B. Each of the Z-direction sliders 832 is driven by, for example, an eccentric cam mechanism (not illustrated), and moves back and forth linearly along the Z-direction guide rail 831. The Z-direction slider 832 may also be configured to move back and forth via another linear actuator mechanism such as a ball screw mechanism.

[0056]

The cutting actuator mechanism 8 and the transfer shaft 71 are in a positional relationship in which the transfer shaft 71 traverses across the cutting actuator mechanism 8 above the cutting actuator mechanism 8, as illustrated in FIGS. 1 and 4. Specifically, the transfer shaft 71 is disposed above the support 812 in a manner traversing across the support 812, and the transfer shaft 71 and the support 812 are in a positional relationship intersecting with each other.

[0057]

<Swarf container 17>

As illustrated in FIG. 1, the cutting machine 100 according to this embodiment further includes a swarf container 17 that stores therein swarf S, such as waste material discharged by cutting the sealed substrate W.

[0058]

As illustrated in FIGS. 2 to 4, the swarf container 17 is provided below the cutting tables 2A, 2B, and includes a guide chute 171 having a top opening 171X surrounding the cutting tables 2A, 2B in a plan view, and collection containers 172 that collect the swarf S guided along the guide chute 171. By providing the swarf container 17 below the cutting tables 2A, 2B, the recovery rate of the swarf S can be improved.

[0059]

The guide chute 171 guides the swarf S scattered or fallen out of the cutting tables 2A, 2B into the collection container 172. In this embodiment, because the top opening 171X of the guide chute 171 is configured to surround the cutting tables 2A, 2B (see FIG. 3), the wasted amount of the swarf S can be reduced, and the recovery rate of the swarf S can be further improved. The guide chute 171 is also provided in a manner surrounding the rotating mechanisms 9A, 9B provided under the cutting tables 2A, 2B (see FIG. 4), and is configured to protect the rotating mechanisms 9A, 9B from the swarf S and cutting water.

[0060]

In this embodiment, the swarf container 17 is shared by the two cutting tables 2A, 2B, but may also be provided correspondingly to each of the cutting tables 2A, 2B.

[0061]

The collection containers 172 collect the swarf S passed through the guide chute 171 by its own weight, and in this embodiment, are provided correspondingly to the two cutting tables 2A, 2B, as illustrated in drawings such as FIG. 4. The two collection containers 172 are disposed on the front side of the transfer shaft, and are independently removable from the front side of the cutting machine 100. With this

configuration, maintainability such as disposal of the swarf S can be improved. It is also possible to provide one collection container 172, or to partition the collection container 172 into three or more units, under the entire cutting tables, considering factors such as the size of the sealed substrate W, the size and amount of the swarf S, and workability.

[0062]

As illustrated in drawings such as FIG. 4, the swarf container 17 includes a separator 173 that separates cutting water from the swarf S. As a configuration of the separator 173, for example, a filter such as a porous plate that passes the cutting water may be provided to the bottom surface of the collection container 172. With such a separator 173, the swarf S can be collected without accumulating the cutting water in the collection container 172.

[0063]

<First cleaning mechanism 18>

As illustrated in FIGS. 1 and 5, the cutting machine 100 according to the present invention also includes the first cleaning mechanism 18 for cleaning the top surfaces (mounting surfaces) of the plurality of products P placed on the cutting table 2A, 2B. The first cleaning mechanism 18 cleans the top surfaces of the plurality of products P placed on the cutting tables 2A, 2B, via jet nozzles 18a (see FIG. 5) by discharging cleaning liquid and/or compressed air onto the top surfaces of the products P.

[0064]

As illustrated in FIG. 5, the first cleaning mechanism 18 is configured to be movable with the first pickup mechanism 3, along the transfer shaft 71. The first cleaning mechanism 18 is provided on the slide member 723 that slides along the guide

rail 721 provided on the transfer shaft 71. Between the first cleaning mechanism 18 and the slide member 723, a vertical actuator mechanism 181 for moving the first cleaning mechanism 18 up and down in the Z direction is provided. Examples of this vertical actuator mechanism 181 include a configuration using a rack-and-pinion mechanism, a configuration using a ball screw mechanism, and a configuration using an air cylinder.

[0065]

<Second cleaning mechanism>

As illustrated in FIG. 1, the cutting machine 100 according to the present invention further includes a second cleaning mechanism 19 that cleans the bottom surfaces (opposite surfaces) of the plurality of products P held by the second pickup mechanism 6. The second cleaning mechanism 19 is provided between the cutting table 2B and the inspection unit 13, and cleans the bottom surfaces of the products P by discharging the cleaning liquid and/or the compressed air onto the bottom surfaces of the plurality of products P being held by the second pickup mechanism 6. In other words, the second cleaning mechanism 19 cleans the bottom surfaces of the products P while the second pickup mechanism 6 moves along the transfer shaft 71.

[0066]

<Configuration of tube storage>

The cutting machine 100 according to this embodiment is configured to be capable of storing the plurality of products P in a tubular container 20 (also referred to as "tube storage"). The tubular container 20 is also sometimes referred to as a tube, a magazine stick, a stick magazine, or a stick, for example.

[0067]

Specifically, as illustrated in FIGS. 1, 9, and 10, the cutting machine 100

includes a container setting unit 21 where a tubular container 20 for storing a plurality of products P via a one-end opening 20x is set, and a transport and storage mechanism 22 for transporting and storing the plurality of products P from the transfer table 5 into the tubular container 20 set in the container setting unit 21.

[0068]

In the container setting unit 21, an empty tubular container 20 storing therein no product P is set, and the transport and storage mechanism 22 inserts the products P into the tubular container 20 via the one-end opening 20x.

[0069]

As illustrated in FIGS. 1 and 9, the container setting unit 21 according to this embodiment includes an empty container storage unit 211 for storing therein an empty tubular container 20, an insertion position setting unit 212 to which the empty tubular container 20 in the empty container storage unit 211 is transported, and where the empty tubular container 20 is set at an insertion position at which the products P are inserted into the empty tubular container 20 via the one-end opening 20x, and a filled container storage unit 213 for storing the tubular containers 20 filled with products P or storing therein a desired number of products P.

[0070]

In the example explained herein, the tubular container 20 stores therein a plurality of products P in a manner aligned in a row, as illustrated in FIG. 10. Specifically, the tubular container 20 has a shape extending linearly, and has a space in which the products P are stored. The tubular container has a cross-sectional shape corresponding to the cross-sectional shape of the product P, in the direction orthogonal to the longitudinal direction. Although the tubular container 20 illustrated in FIG. 10 has an opening on a part of a side wall extending along the longitudinal direction, but

this side wall may also be closed. In addition to the configuration in which the plurality of products P are stored in a manner aligned in one row, the tubular container 20 may also be configured to store the plurality of products P in a manner aligned in a plurality of rows. The tubular container 20 may be made of resin or metal. In addition, although FIG. 10 illustrates an example in the products P are leaded packages, but the products P may be leadless packages such as QFN packages.

[0071]

As illustrated in FIGS. 1 and 9, the transport and storage mechanism 22 includes an intermediate table 23 on which a plurality of products P are temporarily placed, a first transport mechanism 24 that transports the plurality of products P from the transfer table 5 at the pickup position onto the intermediate table 23, and a second transport mechanism 25 that transports and stores the plurality of products P from the intermediate table 23 into the tubular container 20 set in the insertion position setting unit 212 in the container setting unit 21.

[0072]

The first transport mechanism 24 transports the products P from the transfer table 5 that is at the pickup position X2 to the intermediate table 23, and the products P are temporarily placed thereon. The second transport mechanism 25 then transports the products P temporarily placed on the intermediate table 23 into the tubular container 20 set in the container setting unit 21. The intermediate table 23 according to this embodiment is fixed in the X direction and the Y direction, but may also be configured to be movable.

[0073]

The first transport mechanism 24 transports a predetermined number (e.g., one) of a plurality of products P at a time, from the transfer table 5, having been moved

to the pickup position X2, onto the intermediate table 23.

[0074]

Specifically, as illustrated in FIGS. 9 and 11, the first transport mechanism 24 includes a product suction mechanism 241 that suctions a predetermined number (e.g., one) of a plurality of products P placed on the transfer table 5, and a suctioning actuator mechanism 242 that moves the product suction mechanism 241 in the X direction.

[0075]

As illustrated in FIG. 11, the product suction mechanism 241 includes a suction head 241A having a plurality of suction ports 241a for holding a plurality of products P by suctioning, and a vacuum pump or vacuum ejector (not illustrated) connected to the suction ports 241a of the suction head 241A. The product suction mechanism 241 is configured to cause each of the suction ports 241a to suction one product P. The plurality of suction ports 241a are configured to be movable up and down independently from one another, and each of the suction ports 241a can be lowered to suction the product P individually.

[0076]

As illustrated in FIG. 11, the suctioning actuator mechanism 242 includes an X-direction actuator 242a that moves the product suction mechanism 241 in the X direction, and a Z-direction actuator 242 b that moves the product suction mechanism 241 in the Z direction. The suctioning actuator mechanism 242 may also include a Y-direction actuator that moves the product suction mechanism 241 in the Y direction.

[0077]

The X-direction actuator 242a includes an X-direction guide rail 242a1 provided in a manner extending along the X-direction on the rear side of the transfer shaft 71, and a support 242a2 that moves along the X-direction guide rail 242a1 and

supports the product suction mechanism 241 with the Z-direction actuator 242b therebetween. The support 242a2 then moves back and forth linearly along the X-direction guide rails 242a1 in the X direction, for example, via a ball screw mechanism (not illustrated) extending in the X direction. The ball screw mechanism is driven by a drive source (not illustrated), such as a servo motor. The support 242a2 may also be configured to move back and forth via another type of linear actuator mechanism, such as a linear motor.

[0078]

As illustrated in FIG. 11, the Z-direction actuator 242b includes a Z-direction guide rail 242b1 provided on the support 242a2 in a manner extending in the Z direction, and a Z-direction slider 242b2 that moves along the Z-direction guide rails 242b1 and supports the product suction mechanism 241. The Z-direction slider 242b2 moves back and forth linearly along the Z-direction guide rail 242b1 in the Z direction, for example, via a ball screw mechanism (not illustrated) extending in the Z direction. The Z-direction slider 242b2 may also be configured to move back and forth via another type of linear actuator mechanism, such as a linear motor.

[0079]

As illustrated in FIGS. 9 and 12, the second transport mechanism 25 transports the product P placed on the intermediate table 23 into the tubular container 20 set in the insertion position setting unit 212 of the container setting unit 21, and inserts and stores the product P from the one-end opening 20x of the tubular container 20.

[0080]

Specifically, the second transport mechanism 25 includes a product guide 251 that guides the product P to the one-end opening 20x of the tubular container 20, and a product actuator 252 that moves the product P along the product guide 251 toward the

one-end opening 20x of the tubular container 20.

[0081]

The product guide 251 aligns and guides the products P into the tubular container 20. Because the tubular container 20 according to this embodiment is set in a manner extending along the Y direction, the product guide 251 is also provided in a manner extending along the Y direction. In this embodiment, because the container setting unit 21 is provided in front of the transfer shaft 71 and the intermediate table 23 is provided behind the transfer shaft 71, the product guide 251 extends below the transfer shaft 71, orthogonally to the transfer shaft 71.

[0082]

The product actuator 252 includes a pressing member 252a for pressing the product P, and a drive unit 252b that moves the pressing member 252a in the Y direction. Note that the drive unit 252b may be an actuator using a ball screw mechanism, an air cylinder, or a linear motor.

[0083]

<Function for classifying defective products>

The cutting machine 100 according to this embodiment has a function of inspecting the quality of a plurality of products P, and classifying the defective products.

[0084]

Specifically, as illustrated in FIGS. 1, 9, and 12, the cutting machine 100 also includes an image capturing unit 26 that captures an image of a plurality of products P, a determination unit 27 that determines the quality of the plurality of products P using the data of the image captured by the image capturing unit 26, and a classification mechanism 28 that sorts the products P determined to be a defective product by the determination unit 27.

[0085]

The image capturing unit 26 is an image-capturing camera that captures an image of the product P held by the product suction mechanism 241 of the first transport mechanism 24 from below, and captures an image of the bottom surface (opposite surface) of the product P. Another image capturing unit may also be provided to capture an image of the top surface (mounting surface) of the product P placed on the transfer table 5, for example.

[0086]

The determination unit 27 detects a defect (e.g., a bent lead, unfilled resin, or an air bubble) in the product P using the data of the image captured by the image capturing unit 26, and determines the quality of the product P. The determination unit 27 is implemented by a control unit CTL.

[0087]

The classification mechanism 28 is provided to the second transport mechanism 25, and switches the route of the products between a non-defective product route R1 for guiding the product P determined to be a non-defective product by the determination unit 27 to the tubular container 20, and a defective product route R2 for discarding the product P determined to be a defective product by the determination unit 27 into a disposal container 29, as illustrated in FIG. 12.

[0088]

Specifically, the classification mechanism 28 is provided to a part of the product guide unit 251, and switches the route of the products between the non-defective product route R1 and the defective product route R2. The classification mechanism 28 according to this embodiment includes a rotary table 281 on which the product P is placed, and an actuator mechanism 282 that moves the product P from the

rotary table 281 to each of the routes R1, R2. To switch between the non-defective product route R1 and the defective product route R2, the rotary table 281 is rotated. In the explained herein, the non-defective product route R1 is a route in the Y direction, and the defective product route R2 is a route in the X direction. The actuator mechanism 282 may have the same configuration as the product actuator 252 in the second transport mechanism 25 described above.

[0089]

<One example of operation of cutting machine>

An example of an operation of the cutting machine 100 will now be explained with reference to FIGS. 9, 11, 12, and 13. FIG. 13 illustrates the paths followed by the first pickup mechanism 3 and the second pickup mechanism 6 during the operation of the cutting machine 100. In this embodiment, the control unit CTL (see Fig. 1) is responsible for all operations and controls of the operations of the cutting machine 100, such as transportation of the sealed substrate W, cutting of the sealed substrate W, inspections of the products P, and housing the products P in the tubes.

[0090]

The substrate feeder unit 112 in the substrate feeder mechanism 11 feeds the sealed substrate W stored inside the substrate housing 111 to a pickup position RP, where the first pickup mechanism 3 picks up the sealed substrate W (see FIG. 1).

[0091]

The transport actuator mechanism 7 moves the first pickup mechanism 3 to the pickup position RP, and the first pickup mechanism 3 picks up the sealed substrate W by suctioning, as illustrated in FIG. 13. The transport actuator mechanism 7 then moves the first pickup mechanism 3 holding the sealed substrate W to the cutting table 2A, 2B, and the first pickup mechanism 3 releases the sealed substrate W being held by

suctioning, to place the sealed substrate W on the cutting tables 2A, 2B. At this time, the main actuator mechanism 72 adjusts the position of the sealed substrate W in the X direction, and the horizontal actuator mechanism 74 adjusts the position of the sealed substrate W in the Y direction. The cutting table 2A, 2B then suctions to hold the sealed substrate W.

[0092]

To move the first pickup mechanism 3 holding the sealed substrate W toward the cutting table 2B, the vertical actuator mechanism 73 lifts the first pickup mechanism 3 to a position not physically interfering with the cutting actuator mechanism 8 (support 812). If the support 812 is configured to move away from the cutting table 2B toward the transfer table 5, it is not necessary to raise and to lower the first pickup mechanism 3 in the manner described above when the first pickup mechanism 3 holding the sealed substrate W is to be moved to the cutting table 2B.

[0093]

In this setting, by causing the cutting actuator mechanism 8 to move the two spindle units 42A, 42B in the X direction and then in the Y direction sequentially, and rotating the cutting tables 2A, 2B, the sealed substrate W is cut in a lattice-like shape, and diced.

[0094]

After the sealed substrate W is cut, the transport actuator mechanism 7 moves the first cleaning mechanism 18, so as to clean the top surfaces (mounting surfaces) of the plurality of products P held on the cutting table 2A, 2B. After the cleaning, the transport actuator mechanism 7 causes the first pickup mechanism 3 and the first cleaning mechanism 18 to retract to predetermined respective positions.

[0095]

The transport actuator mechanism 7 then moves the second pickup mechanism 6 to the cutting table 2A, 2B for which the cutting has finished. The second pickup mechanism 6 then suctions the plurality of products P. The transport actuator mechanism 7 then moves the second pickup mechanism 6 holding the plurality of products P to the second cleaning mechanism 19. As a result, the second cleaning mechanism 19 cleans the bottom surfaces (opposite surfaces) of the plurality of products P held by the second pickup mechanism 6.

[0096]

After the cleaning, the inspection unit 131 inspects the bottom surfaces (opposite surfaces) of the plurality of products P held by the second pickup mechanism 6. The plurality of products P are then passed to the reversing mechanism 14, and have their opposite surfaces suctioned and held, and then reversed by the reversing mechanism 14. After the reversal, the reversing mechanism 14 moves and the inspection unit 132 inspects the mounting surfaces of the products P. After the both surfaces are inspected in the manner described above, the reversing mechanism 14 passes the products P onto the transfer table 5.

[0097]

The transfer table 5 having the plurality of products P placed thereon moves to the pickup position X2 (see FIGS. 1, 9, and 11). Meantime, an empty tubular container 20 is set to the insertion position setting unit 212 of the container setting unit 21. (see FIGS. 9 and 12).

[0098]

In this setting, as illustrated in FIG. 11, the first transport mechanism 24 suctions and holds the product P from the transfer table 5 at the pickup position X2. The image capturing unit 26 then moves upwards. The image capturing unit 26 then

captures an image of the products P suctioned and held by the first transport mechanism 24. The determination unit 27 then determines the quality of the product P using the data of the image captured by the image capturing unit 26. The first transport mechanism 24 then moves the product P to the intermediate table 23, releases the product P being held by suctioning, and places the product P on the intermediate table 23. The product P placed on the intermediate table 23 is transported to the rotary table 281 by the actuator mechanism 282 of the classification mechanism 28, for example.

[0099]

The classification mechanism 28 switches the route between the non-defective product route R1 and the defective product route R2 for each product P, based on the result of the quality determined by the determination unit 27. If the product P is a non-defective product, the route is switched to the non-defective product route R1 (see FIG. 12 (a)), and the actuator mechanism 282 transports the product P to the product guide 251. The product actuator 252 of the second transport mechanism 25 then inserts and stores the product P, being transported along the product guide 251, into the tubular container 20. If the product P is a defective product, the route is switched to the defective product route R2 (see FIG. 12 (b)), and the actuator mechanism 282 transports and disposes the product P into the disposal container 29.

[0100]

If the tubular container 20 is full, or if a desired number of products P have been stored in the tubular container 20, the stored tubular container 20 in the insertion position setting unit 212 is moved to the filled container storage unit 213, and an empty tubular container 20 is sent from the empty container storage unit 211 and set to the insertion position setting unit 212.

[0101]

<Advantageous effects achieved by embodiment>

With the cutting machine 100 according to this embodiment, the first pickup mechanism 3 and the second pickup mechanism 6 are moved by the shared transfer shaft 71 extending along the direction in which the cutting tables 2A, 2B and the transfer table 5 are arranged, and the cutting actuator mechanism 8 moves the cutting mechanism 4 on the horizontal plane, in each of the X direction extending along the transfer shaft 71 and the Y direction orthogonal to the X direction, so that the sealed substrate W can be diced without moving the cutting tables 2A, 2B in the X direction and the Y direction. Therefore, no structures such as a ball screw mechanism is used to move the cutting tables 2A, 2B, so that the needs for the bellows member for protecting the structures such as the ball screw mechanism and the cover member for protecting the bellows member can be eliminated. As a result, the apparatus configuration of the cutting machine 100 can be simplified.

[0102]

In addition, because the cutting tables 2A, 2B do not move on the horizontal plane, neither in the X-axis direction nor in the Y-axis direction, it is possible to save the space for moving the cutting tables 2A, 2B and the wasted space around the cutting tables 2A, 2B. Therefore, it is possible to reduce the footprint of the cutting machine 100.

[0103]

Furthermore, it is possible to store a plurality of products P into the tubular container 20 via the one-end opening 20x by causing the transport and storage mechanism 22 to transport the plurality of products P from the transfer table 5 into the tubular container 20 set in the container setting unit 21.

[0104]

<Other modifications>

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

[0105]

For example, in the embodiment described above, the container setting unit 21 is provided in front of the transfer shaft 71, but may also be provided behind the transfer shaft 71.

[0106]

Furthermore, the tubular container 20 set in the container setting unit 21 may be provided in a manner extending along the X direction, in addition to the configuration provided along the Y direction, or may be provided in a manner extending along any other direction.

[0107]

Furthermore, the classification mechanism 28 may have any configuration as long as the products P can be classified into the product P determined to be a non-defective product and the product P determined to be a defective product, and as long as the defective product is removed from the non-defective product route. For example, as illustrated in FIG. 14(a), the classification mechanism 28 may be configured in such a manner that an opening/closing mechanism 283 is provided on the bottom surface of the product guide 251 along which the product P slides, and the opening/closing mechanism 283 is opened to drop and to remove a defective product. As illustrated in FIG. 14(b), the classification mechanism 28 may also include a removal mechanism 284 that pushes the product P determined to be a defective product and moving along the product guide 251 toward a side, and be configured to cause the removal mechanism 284 to push and to remove the defective product.

[0108]

The image capturing unit 26 according to the embodiment described above captures an image of the product P held by the first transport mechanism 24, but may capture an image of the products P placed on the transfer table 5. The image capturing unit 26 may be mounted on the product suction mechanism 241 in the first transport mechanism 24, and captures an image of the products P placed on the transfer table 5 or on the intermediate table 23. In addition to the image capturing unit 26 according to the embodiment described above, an image capturing unit mounted on the product suction mechanism 241 of the first transport mechanism 24 may be used in combination.

[0109]

In the above embodiment, an example of a twin-cut table cutting machine having a twin-spindle configuration has been explained, but the present invention is not limited thereto, and it is also possible to use a single-cut table cutting machine having a single-spindle configuration, or a single-cut table cutting machine having a twin-spindle configuration, for example.

[0110]

Furthermore, because the cam rack element included in the transfer shaft 71 may be configured as a plurality of connected cam rack elements, for example, it is possible to configure the cutting machine (machining apparatus) 100 as a module that can be separated and connected (detachable) between the second cleaning mechanism 19 and the inspection unit 13. In such a configuration, for example, a module for performing another type of inspection different from the inspection performed by the inspection unit 13 may be added between the modules on the side of the second cleaning mechanism 19 and the side of the inspection unit 13. In addition to the

configurations explained herein, it is also possible to use a modular configuration in which the cutting machine (machining apparatus) 100 can be separated and coupled (detachable) anywhere, and a module with various types of function other than the inspection function may be added thereto.

[0111]

In addition, the present invention is not limited to the embodiment described above, and it should be needless to say that various modifications may be made within the scope not departing from the gist of the present invention.

Industrial Applicability

[0112]

According to the present invention, it is possible to store the diced workpieces in the tubular container, while eliminating the need for the movement mechanism for moving the machining table.

Reference Signs List

[0113]

100	cutting machine (machining apparatus)
W	sealed substrate (workpiece)
P	product (machined article)
2A, 2B	cutting table (machining table)
3	first pickup mechanism
4	cutting mechanism (machining mechanism)
5	transfer table
6	second pickup mechanism
7	transport actuator mechanism
71	transfer shaft

8	machining actuator mechanism
81	X-direction actuator
82	Y-direction actuator
811	pair of X-direction guide rails
812	support
20	tubular container
20x	one-end opening
21	container setting unit
22	transport and storage mechanism
23	intermediate table
24	first transport mechanism
25	second transport mechanism
26	image capturing unit
27	determination unit
28	classification mechanism
29	disposal container
R1	non-defective product route
R2	defective product route

CLAIMS

1. A machining apparatus comprising:
 - a machining table that holds a workpiece;
 - a first pickup mechanism that holds the workpiece to transport the workpiece to the machining table;
 - a machining mechanism that cuts the workpiece held on the machining table to dice it;
 - a transfer table onto which the workpiece diced by the machining mechanism is transferred;
 - a second pickup mechanism that holds the diced workpiece to transport the diced workpiece from the machining table onto the transfer table;
 - a transport actuator mechanism that includes a shared transfer shaft for moving the first pickup mechanism and the second pickup mechanism, and extending in a direction in which the machining table and the transfer table are arranged;
 - a machining actuator mechanism that moves the machining mechanism on a horizontal plane, in a first direction extending along the transfer shaft and a second direction orthogonal to the first direction;
 - a container setting unit where a tubular container for housing the diced workpiece through a one-end opening is set; and
 - a transport and storage mechanism that transports and stores the diced workpiece from the transfer table to the tubular container set in the container setting unit.
2. The machining apparatus according to claim 1, wherein the transfer shaft is disposed above the machining actuator mechanism, in a manner traversing the machining actuator mechanism.

3. The machining apparatus according to claim 1 or 2, wherein the transport and storage mechanism includes:
 - an intermediate table on which the diced workpiece is temporarily placed;
 - a first transport mechanism that transports the diced workpiece from the transfer table onto the intermediate table; and
 - a second transport mechanism that transports and stores the diced workpiece from the intermediate table into the tubular container set in the container setting unit.
4. The machining apparatus according to claim 3, further comprising an image capturing unit that captures an image of the diced workpiece held by the first transport mechanism, or the diced workpiece placed on the transfer table.
5. The machining apparatus according to claim 4, further comprising a determination unit that determines quality of the diced workpiece using data of the image captured by the image capturing unit.
6. The machining apparatus according to claim 5, further comprising a classification mechanism that classifies the diced workpiece determined as a defective product by the determination unit.
7. The machining apparatus according to claim 6, wherein the classification mechanism is provided to the second transport mechanism.
8. The machining apparatus according to claim 6 or 7, wherein the classification mechanism switches a route of the diced workpiece between a non-defective product route for guiding the diced workpiece determined as a non-defective product by the determination unit into the tubular container, and a defective product route for discarding the diced workpiece determined as a defective product by the determination

unit into a disposal container.

9. The machining apparatus according to any one of claims 1 to 8, wherein the machining actuator mechanism includes an X-direction actuator that moves the machining mechanism linearly in an X-direction that is a first direction and a Y-direction actuator that moves the machining mechanism linearly in a Y-direction that is a second direction, and

the X-direction actuator includes a pair of X-direction guide rails that are provided along the X-direction, with the machining table interposed therebetween, and a support that moves along the pair of X-direction guide rails, and that supports the machining mechanism via the Y-direction actuator.

10. A method for manufacturing a machined article, the method comprising manufacturing a machined article using the machining apparatus according to any one of claims 1 to 9.