

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).

[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. 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.

[0005]

There also has been a machining apparatus, as disclosed in Patent Literature 2, for machining a workpiece held on a chuck table the position of which is fixed, by moving a cut in the X-axis direction using a machining feeder as well as in the Z-axis direction using a cut-in feeder, so as to machine the workpiece and to cut into the workpiece toward the chuck table, respectively. Such a machining apparatus is configured to eliminate the need for the bellows structure disposed horizontally around the chuck table, as waterproofing against cutting water accompanying the machining of a workpiece in motion.

[0006]

While this machining apparatus eliminates the need for the bellows structure disposed horizontally around the chuck table, the cutting water may spill to nearby components during machining process, and cause a problem.

Citation List

Patent Literatures

[0007]

Patent Literature 1: JP 2007-536727 A

Patent Literature 2: JP 2008-140981 A

Summary of Invention

Technical Problem

[0008]

Therefore, the present invention has been made to solve the problems described above, and a main object of the present invention is to prevent splashing of

machining fluid with a simplified apparatus structure with a smaller footprint.

Solution to Problem

[0009]

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 machines the workpiece held on the machining table; a transfer table onto which the machined workpiece is transferred; a second pickup mechanism that holds the machined workpiece to transport the machined workpiece from the machining table onto the transfer table; a transport moving 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 moving mechanism that moves the machining mechanism in a first direction extending along the transfer shaft and in a second direction orthogonal to the first direction, on a horizontal plane; a machining fluid supplying mechanism that is moved with the machining mechanism by the machining moving mechanism, and that discharges machining fluid onto the machining mechanism from a front side in a machining feed direction; and a machining fluid splash preventing mechanism that is provided on the rear side in the machining feed direction with respect to the machining mechanism, that covers above the machining mechanism in a manner extending to a level lower than a top surface of the machining table to prevent splashing of the machining fluid.

Advantageous Effects of Invention

[0010]

According to the present invention thus configured, it is possible to prevent

splashing of machining fluid with a simplified apparatus structure with a smaller footprint.

Brief Description of Drawings

[0011]

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 moving 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 moving 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 moving mechanism according to the embodiment, as viewed in the Y direction.

FIG. 9 is a cross-sectional view schematically illustrating configurations of a machining moving mechanism and a cover member according to the embodiment, as viewed in the X direction.

FIG. 10 is a cross-sectional view schematically illustrating configurations of the machining moving mechanism, the cover member, and a cutting water splash preventing mechanism according to the embodiment, as viewed in the Y direction.

FIG. 11 is a cross-sectional view schematically illustrating the configurations of the machining moving mechanism, the cover member, and the cutting water splash preventing mechanism according to the embodiment, as viewed in the Y direction.

FIG. 12 is a schematic view illustrating (a) a raised position and (b) a lowered position of a shutter member included in the cutting water splash preventing mechanism according to the embodiment.

FIG. 13 is a schematic view illustrating an operation of the cutting water splash preventing mechanism according to the embodiment.

FIG. 14 is a schematic view illustrating the operation of the cutting water splash preventing mechanism according to the embodiment.

FIG. 15 is a schematic view illustrating an operation of the cutting machine according to the embodiment.

Description of Embodiments

[0012]

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.

[0013]

As mentioned earlier, the 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 machines the workpiece held on the machining table; a transfer table onto which the machined workpiece is transferred; a second pickup mechanism that holds the machined workpiece to transport the machined workpiece from the machining table onto the transfer table; a transport moving 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 moving 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 machining fluid supplying mechanism that is moved with the machining mechanism by the machining moving mechanism, and that discharges machining fluid onto the machining mechanism from the front side in a machining feed direction; and a machining fluid splash preventing mechanism that is provided on the rear side in the machining feed direction with respect to the machining mechanism, that covers above the machining mechanism in a manner extending to a level lower than a top surface of the machining table to prevent splashing of the machining fluid.

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 moving 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 machined without moving the machining table in the first direction nor in the second direction. With this

structure, no ball screw mechanism is used to move the machining table, so that the needs for the bellows member for protecting the 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.

In particular, in the present invention, in the configuration in which the machining fluid is discharged onto the machining mechanism from the front side in the machining feed direction, the machining fluid splash preventing mechanism, covering a range from above the machining mechanism in a manner extending to a level lower than a top surface of the machining table, is provided behind the machining mechanism in the machining feed direction. Therefore, splashing of the machining fluid can be prevented.

[0014]

In order to enable the machining fluid splash preventing mechanism to prevent splashing of the machining fluid while following the movement of the machining mechanism being moved by the machining moving mechanism, the machining fluid splash preventing mechanism preferably includes: a bellows member that expands and contracts following a movement of the machining mechanism, and that covers a top and lateral sides extending orthogonally to the machining feed direction; and a shutter member that is connected to a rear end of the bellows member in the machining feed direction and covers the machining mechanism from the rear side in the machining feed direction.

If the shutter member moves while the machining mechanism is machining the workpiece, the shutter member may fail to prevent splashing of the machining fluid, reliably. In order to solve this problem, the machining apparatus preferably includes a fixing portion that fixes the shutter member while the machining mechanism machines the workpiece.

[0015]

In order to improve the throughput at which the workpieces are machined with one machining apparatus, the machining apparatus according to the present invention preferably includes a plurality of the machining tables.

In this configuration, preferably, the fixing portion is provided correspondingly to each of the plurality of machining tables. With this configuration, it is possible to keep the length of the bellows member to a length corresponding to one machining table. In this manner, it is possible to reduce the size of the contracted bellows member. In addition, because the shutter member can be fixed correspondingly to each of the machining tables, and one of the machining tables can be covered by the bellows member, it is possible to improve the throughput by carrying a sealed substrate W yet to be machined onto the machining table not currently being subjected to machining, or by conveying the processed workpiece using the machining table not currently being subjected to machining, for example.

[0016]

In order to move the shutter member to the plurality of fixing portions that correspond to the plurality of respective machining tables, preferably, the machining moving mechanism is used to move the shutter member to each of the plurality of fixing portions.

With this configuration, because it is not necessary to provide a separate

moving mechanism for moving the shutter member, the configuration for moving the shutter member can be simplified.

[0017]

Because the bottom end of the shutter member extends to a level lower than the top surface of the machining table, the shutter member needs to be moved so as not to interfere with the machining table. Therefore, preferably, the shutter member is configured movable between a raised position where a bottom end of the shutter member is positioned at a level higher than the top surface of the machining table, and a lowered position where the bottom end is positioned at a level lower than the top surface of the machining table, and configured to be fixed by the fixing portion at the lowered position.

[0018]

The machining moving mechanism is what is called a gantry mechanism. Specifically, preferably, the machining moving mechanism includes an X-direction moving part that moves the machining mechanism linearly in an X-direction that is the first direction, and a Y-direction moving part that moves the machining mechanism linearly in a Y-direction that is the second direction, and, also preferably, the X-direction moving part 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 moving part. In this configuration, the shared transfer shaft is disposed above the support in a manner traversing across the support, and the shared transfer shaft and the support are in a positional relationship intersecting each other.

Because the pair of X-direction guides are provided in a manner extending along the X direction with the machining tables interposed therebetween, the pitch

(interval) 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 a vertical direction. In other words, it is possible to reduce a deviation in the orthogonality between the machining mechanism (e.g., a rotary tool such as 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.

[0019]

In the above machining moving mechanism, preferably, the machining feed direction is in a direction extending in one direction parallel to the X direction; and the machining mechanism and the machining fluid supplying mechanism are provided on a one direction parallel to X direction side with respect to the support, and the machining fluid splash preventing mechanism is provided on an opposite direction parallel to the X direction side with respect to the support. With this configuration, it is possible to prevent splashing of the machining fluid passed beneath the support, on the opposite direction parallel to the X direction side with respect to the support.

[0020]

In order to prevent splashing of the machining fluid on the one direction parallel to the X direction side with respect to the support, preferably, a cover member housing the machining mechanism and the machining fluid supplying mechanism is provided on the one direction parallel to the X direction side with respect to the support.

[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.

[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 moving 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 moving mechanism (machining moving 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 moving mechanism 7 makes up a transport mechanism (loader) that transfers a sealed substrate W, and the second pickup mechanism 6 and the transport moving 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 supplying 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 moving mechanism 7 to be described later, for example, sealed substrates W are transported from the substrate supplying mechanism 11 to the cutting tables 2A, 2B.

[0033]

As illustrated in FIG. 1, the substrate supplying mechanism 11 includes a substrate housing 111 where a plurality of sealed substrates W from outside are stored, and a substrate supplying 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 supplying 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 spindles 42A, 42B. The two spindles 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 42A and the blade 41B on the spindle 42B rotates on a plane 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 supplying mechanism (machining fluid supplying mechanism) 12 that discharges cutting water as machining fluid. The cutting water supplying mechanism 12 will be described later.

[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, before the plurality

of products P are sorted onto various trays 21. The transfer table 5 is in alignment with the two cutting tables 2A, 2B in the X direction on the horizontal plane. A sorting mechanism 20 then sorts the plurality of products P placed on the transfer table 5 onto the various trays 21, based on the result of the inspection carried out by the inspection unit 13 (e.g., non-defective products and defective products).

[0036]

The various trays 21 are transferred, by a tray transport mechanism 22 moving along the transfer shaft 71, to desired positions, where products P sorted by the sorting mechanism 20 are placed. The tray transport mechanism 22 then stores the various trays 21 having the products sorted thereon in a tray housing 23.

[0037]

<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.

[0038]

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.

[0039]

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.

[0040]

<Second pickup mechanism 6>

As illustrated in FIG. 1, the second pickup mechanism 6 picks up a plurality of products P, and transfers the plurality of products P from the cutting tables 2A, 2B to the reversing mechanism 14. 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 moving 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.

[0041]

<Transport moving mechanism 7>

As illustrated in FIG. 1, the transport moving mechanism 7 moves the first pickup mechanism 3 at least between the substrate supplying 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.

[0042]

As illustrated in FIG. 1, the transport moving 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), and includes the shared transfer shaft 71 for moving the first pickup mechanism 3 and the second pickup mechanism 6.

[0043]

The transfer shaft 71 is provided across a range by which the first pickup mechanism 3 can move above the substrate supplying unit 112 of the substrate supplying 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, the various trays 21, the tray transport mechanism 22, the tray housing 23, and a first cleaning mechanism 18, a second cleaning mechanism 19, and a collection container 172, which are to be described later, are also provided on the same side of the transfer shaft 71 (front side).

[0044]

The transport moving mechanism 7 also includes, as illustrated in FIGS. 5, 6, and 8, a main moving 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

moving 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 moving 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.

[0045]

The main moving mechanism 72 includes, as illustrated in FIGS. 5 to 8, a shared guide rail 721 that is provided on the transfer shaft 71, and along which the first pickup mechanism 3 and the second pickup mechanism 6 are guided, 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.

[0046]

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 supplying unit 112 of the substrate supplying 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 moving mechanism 73 and the horizontal moving mechanism 74. While the guide rail 721 is shared by the first pickup mechanism 3 and the second pickup mechanism 6, the vertical moving mechanism 73, the horizontal moving mechanism 74, and the slide member 723 are provided for each of the first pickup mechanism 3 and the second pickup mechanism 6.

[0047]

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.

[0048]

As illustrated in FIGS. 5 and 8, the vertical moving 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 moving mechanism 73 corresponding to the first pickup mechanism 3 is interposed between the transfer shaft 71 (specifically, the main moving mechanism 72) and the first pickup mechanism 3. The vertical moving 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 moving mechanism

73 corresponding to the second pickup mechanism 6 has the same structure as that of the vertical moving mechanism 73 corresponding to the first pickup mechanism 3.

[0049]

As illustrated in FIGS. 5 and 8, the horizontal moving 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 moving mechanism 74 corresponding to the first pickup mechanism 3 is interposed between the transfer shaft 71 (specifically, the vertical moving mechanism 73) and the first pickup mechanism 3. The horizontal moving 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 opposite 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.

[0050]

As illustrated in FIG. 8, the horizontal moving mechanism 74 corresponding to the second pickup mechanism 6 has the same structure as that of the vertical moving mechanism 73 corresponding to the first pickup mechanism 3. The horizontal moving 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 moving mechanism 74. Furthermore, the horizontal moving mechanism 74 may be a moving 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 moving mechanism 73.

[0051]

<Cutting moving mechanism 8 (machining moving mechanism)>

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

[0052]

Specifically, as illustrated in FIGS. 2 to 4 and 9 to 11, the cutting moving mechanism 8 includes an X-direction moving part 81 that moves the spindles 32A, 32B linearly in the X direction, a Y-direction moving part 82 that moves the spindles 32A, 32B linearly in the Y direction, and Z-direction moving parts 83 that move the spindles 32A, 32B linearly in the Z direction. In this embodiment, a machining feed direction SD, to which the cutting moving mechanism 8 moves the cutting mechanism 4, is a direction extending in one direction parallel to the X direction (the direction toward one side from the opposite side in the X direction (see FIG. 3, for example)).

[0053]

The X-direction moving part 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 the support 812 that moves along the pair of X-direction guide rails 811, and that supports the spindles 32A, 32B via the Y-direction moving part 82 and the Z-direction moving parts 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. On the one side of such a support 812 in the X direction (the side facing the machining feed direction SD), the spindles 32A, 32B of the cutting mechanism 4 are provided.

[0054]

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 moving mechanism, such as a linear motor.

[0055]

The Y-direction moving part 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 moving part 82 is provided on a one direction parallel to the X direction side with respect to the support 812 (the side facing the machining feed direction SD). 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 spindles 32A, 32B, respectively. With these sliders, the two spindles 32A, 32B 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 moving mechanism that uses a ball screw mechanism.

[0056]

As illustrated in FIGS. 9 to 11, each of the Z-direction moving parts 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 32A, 32B. In other words, the Z-direction moving part 83 is provided correspondingly to each of the spindles 32A, 32B. 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 moving mechanism such as a ball screw mechanism.

[0057]

The cutting moving mechanism 8 and the transfer shaft 71 are in a positional relationship in which the transfer shaft 71 traverses across the cutting moving mechanism 8 above the cutting moving 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.

[0058]

<Cover member 15>

As illustrated in FIGS. 3, 4, and 9 to 11, the support 812 of the cutting moving mechanism 8 is provided with a cover member 15 for housing the two spindles 32A, 32B. In FIG. 2, the cover member 15 is not illustrated. The cover member 15 is provided on the one direction parallel to the X direction side with respect to the support 812 (the side facing the machining feed direction SD), and houses not only the two spindles 32A, 32B of the cutting mechanism 4 but also jet nozzles 121 of the cutting water supplying mechanism 12, to prevent splashing of the cutting water discharged

from the jet nozzle 121.

[0059]

Specifically, as illustrated in FIGS. 9 to 11, the cover member 15 has an opening 15a on the bottom surface, through which the blades 41A, 41B are exposed. The cover member 15 also has an opening 15b on the top surface so as not to interfere with the movement of the spindles 42A, 42B and the cutting moving mechanism 8. The opening 15b on the top surface is closed by a bellows member 16, and the bellows member 16 is configured to expand and to contract as the spindles 42A, 42B move. The cover member 15 and the bellows member 16 are structured to cover both sides of the spindles 42A, 42B in the X direction, both sides in the Y direction, and above, on the one direction parallel to the X direction side with respect to the support 812 (the side facing the machining feed direction SD), to confine the splashing of the cutting water discharged from the jet nozzles 121. The cover member 15 also has a window 151 through which inside of the cover member 15 can be visually recognized, on a front wall thereof (the side on the opposite side of the support 812) (see FIGS. 10 and 11). Furthermore, an exhaust mechanism (not illustrated) exhausts the air inside of the cover member 15, so that droplets (mist) can be discharged effectively to the outside.

[0060]

<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.

[0061]

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.

[0062]

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.

[0063]

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.

[0064]

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 three or more collection containers 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.

[0065]

As illustrated in drawings such as FIG. 4, the swarf container 17 includes a separator 173 that separates cutting water from the swarf. 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.

[0066]

<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.

[0067]

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 moving mechanism 181 for moving the first cleaning mechanism 18 up and down in the Z direction is provided. Examples of this vertical moving 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.

[0068]

<Second cleaning mechanism 19>

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.

[0069]

<Machining fluid supplying mechanism 12 (cutting water supplying mechanism) and machining fluid splash preventing mechanism 24 (cutting water splash preventing mechanism)>

In this embodiment, as described above, the machining feed direction SD in which the cutting mechanism 4 is moved is a direction extending in one direction parallel to the X direction (the direction moving from the top to the bottom of the paper in FIG. 3, and the direction moving from the right to the left of the paper in FIG. 4).

[0070]

As illustrated in FIGS. 3, 4, 10, and 11, the cutting machine 100 according to this embodiment includes the cutting water supplying mechanism 12 moved with the cutting mechanism 4, by the cutting moving mechanism 8, and a cutting water splash

preventing mechanism 24 for preventing splashing of the cutting water.

[0071]

The cutting mechanism 4 and the cutting water supplying mechanism 12 are provided on the one direction parallel to the X direction side with respect to the support 812 (the side facing the machining feed direction SD), and the cutting water splash preventing mechanism 24 is provided on an opposite direction parallel to the X direction side with respect to the support 812 (the side facing the opposite side of the machining feed direction SD).

[0072]

As illustrated in FIGS. 10 and 11, the cutting water supplying mechanism 12 includes the jet nozzles 121 via which the cutting water is discharged onto the blades 41A, 41B of the cutting mechanism 4, from the front side thereof in the machining feed direction SD. The jet nozzles 121 are supported on the Z-direction moving part 83, for example. Specifically, the jet nozzle 121 discharges the cutting water onto the blades 41A, 41B of the cutting mechanism 4 from the opposite side of the support 812 with respect to the blades 41A, 41B of the cutting mechanism 4.

[0073]

The cutting water splash preventing mechanism 24 is provided behind the cutting mechanism 4 in the machining feed direction SD, and is configured to cover a range from above the cutting tables 2A, 2B to a level lower than a top surface of the machining table.

[0074]

Specifically, as illustrated in FIGS. 3, 4, 10, and 11, the cutting water splash preventing mechanism 24 includes a bellows member 241 that expands and contracts as the cutting mechanism 4 is moved, and a shutter member 242 connected to the rear end

of the bellows member 241 in the machining feed direction SD.

[0075]

The bellows member 241 covers the top and lateral sides extending orthogonally to the machining feed direction SD. Specifically, the bellows member 241 includes a pair of side walls covering the sides, and a top wall provided continuously to the upper ends of the pair of side walls and covering the top. A front end of the bellows member 241 in the machining feed direction SD is connected to the surface of the support 812 (the surface facing the opposite side of the machining feed direction SD). The shutter member 242 covers the rear side in the machining feed direction SD. With the bellows member 241 and the shutter member 242, the cutting water passed beneath the support 812 (specifically, below the beam of the support 812) and spilled toward the opposite side of the support 812 in the machining feed direction SD is confined within the space surrounded by the bellows member 241 and the shutter member 242. At this time, by exhausting the air inside of the guide chute 171 of the swarf container 17 with the exhaust mechanism (not illustrated), the droplets (mist) can be discharged effectively to the outside.

[0076]

As illustrated in FIGS. 3, 4, 10, and 11, the cutting water splash preventing mechanism 24 includes fixing portions 243A, 243B that fix the shutter member 242 to the cutting tables 2A, 2B, while the cutting mechanism 4 cuts the sealed substrate W. In this embodiment, because the two cutting tables 2A, 2B are provided, the fixing portions 243A, 243B are provided correspondingly to the two cutting tables 2A, 2B. Specifically, the fixing portions 243A, 243B are provided on the rear side of the cutting tables 2A, 2B in the machining feed direction SD. The two fixing portions 243A, 243B are arranged in the Y direction, to fix the respective ends of the shutter member

242 in the Y direction (see FIG. 3).

[0077]

The shutter member 242 is then moved, by the X-direction moving part 81 of the cutting moving mechanism 8, to each of the fixing portions 243A, 243B provided correspondingly to the two respective cutting tables 2A, 2B.

[0078]

While the cutting mechanism 4 cuts the sealed substrate W, the bottom end of the shutter member 242 is kept at a level lower than the top surfaces of the cutting tables 2A, 2B. Therefore, as illustrated in FIGS. 10, 11, and 12, the shutter member 242 according to this embodiment is configured to be movable between a raised position U (see FIGS. 10 and 12(a)) where the bottom end of the shutter member 242 is at a level higher than the top surfaces of the cutting tables 2A, 2B and a lowered position D (see FIGS. 11 and 12(b)) where the bottom end is at a level lower than the top surfaces of the cutting tables 2A, 2B. The bellows member 241 may also be configured in such a manner that the bottom ends of the pair of side walls thereof are disposed at a level lower than the top surfaces of the cutting tables 2A, 2B.

[0079]

At the lowered position D illustrated in FIGS. 11 and 12(b), the shutter member 242 is fixed by the fixing portion 243A, 243B. Specifically, a first protrusion 242a provided on each side surface of the shutter member 242 becomes engaged with the recess of the corresponding fixing portion 243A, 243B, to fix the shutter member 242 at the lowered position D.

[0080]

The shutter member 242 is also connected to the rear end of the bellows member 241 in a manner enabled to move up and down. A vertical moving

mechanism 244 provided to the support 812, as illustrated in FIGS. 3, 4, and 10 to 12, moves the shutter member 242 up and down.

[0081]

As illustrated in FIGS. 10 to 12, the vertical moving mechanism 244 includes shutter holders 244a for holding the shutter member 242, guide rails 244b for guiding the shutter holder 244a in the vertical directions (Z directions) with respect to the support 812, and a drive unit 244c such as an air cylinder for moving the shutter holder 244a along the guide rail 244b. In this embodiment, each of the shutter holders 244a has a recess that becomes engaged with a second protrusion 242b provided on the side surface of the shutter member 242.

[0082]

By causing the drive unit 244c to lift the shutter holder 244a, the recess of the shutter holder 244a becomes engaged with the second protrusion 242b, and the shutter holder 244a lifts the shutter member 242 to the raised position U (see FIGS. 10 and 12(a)). Note that the raised position U is a position where the shutter holder 244a holds the shutter member 242, and the shutter member 242 is released from the fixing portion 243A, 243B.

[0083]

<Operation of cutting water splash preventing mechanism 24 accompanying cutting>

An operation of the cutting water splash preventing mechanism 24 will now be explained with reference to FIGS. 10 to 14, using an example for cutting the sealed substrate W on the cutting table 2A on the left side in FIG. 4.

[0084]

To begin with, the shutter holder 244a of the vertical moving mechanism 244 is lifted to become engaged with the second protrusion 242b of the shutter member 242,

and to lift the shutter member 242 to the raised position U (see FIGS. 10, 12(a), and 13(a)). The transport moving mechanism 7 then moves the first pickup mechanism 3 holding the sealed substrate W to the cutting table 2A, and causes the first pickup mechanism 3 to place the sealed substrate W on the cutting table 2A (see FIG. 13(a)). With the sealed substrate placed, the support 812 of the cutting moving mechanism 8 is moved toward the one side in the X direction, to move the shutter member 242 to a position above the fixing portion 243A corresponding to the cutting table 2A on the left side. At this position, the vertical moving mechanism 244 lowers the shutter holder 244a, thereby causing the shutter member 242 to lower to the lowered position D, and to become engaged with the fixing portion 243A (see FIGS. 12(b) and 13(b)). Once the shutter member 242 reaches the lowered position D, the shutter member 242 is released from the shutter holder 244a.

[0085]

After the shutter member 242 is fixed to the fixing portion 243A, the cutting moving mechanism 8 moves the cutting mechanism 4 in the machining feed direction SD, to cut the sealed substrate W, with the cutting water being discharged from the jet nozzles 121 of the cutting water supplying mechanism 12 (see FIGS. 11 and 13 (c)). During this cutting operation, the bellows member 241 having the rear end thereof fixed to the shutter member 242 expands and contracts, following the movement of the cutting mechanism 4 and the support 812. In this manner, the bellows member 241 and the shutter member 242 block the splashing of the cutting water passed beneath the support 812, so that the splashing of the cutting water on the cutting table 2B and the like on the right side is prevented.

[0086]

Once cutting of the sealed substrate W is finished, the support 812 of the

cutting moving mechanism 8 is moved near the fixing portion 243A, to a position allowing the shutter holder 244a to become engaged with the second protrusion 242b of the shutter member 242. At this position, the shutter holder 244a of the vertical moving mechanism 244 is raised, thereby causing the shutter holder 244a to become engaged with the second protrusion 242b, and to lift the shutter member 242 to the raised position U (see FIGS. 12(a) and 14(d)). As a result, the shutter member 242 is released from the fixing portion 243A. The support 812 of the cutting moving mechanism 8 is then moved to a position not interfering with the transportation of the plurality of products P. At this positioning, the transport moving mechanism 7 moves the second pickup mechanism 6 to the cutting table 2A for which the cutting has been finished, and the second pickup mechanism 6 suctions to pick up the plurality of products P, and transports the plurality of products P from the cutting table 2A (see FIG. 14(e)).

[0087]

When another sealed substrate W is then to be cut on the right cutting table 2B subsequently, the sealed substrate W is placed on the cutting table 2B (see FIG. 14(f)), and the support 812 of the cutting moving mechanism 8 is moved to the opposite side in the X direction. The shutter member 242 is then moved above the fixing portion 243B corresponding to the right cutting table 2B. The operation then follows the same sequence described above.

[0088]

<One example of operation of cutting machine>

An example of the operation of the cutting machine 100 will now be explained. FIG. 15 illustrates the paths followed by the first pickup mechanism 3 and the second pickup mechanism 6 during the operation of the cutting machine 10. In this

embodiment, a 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, operation of the cutting water splash preventing mechanism 24, and inspections of the products P

[0089]

The substrate supplying unit 112 in the substrate supplying mechanism 11 supplies the sealed substrate W housed inside the substrate housing 111 to a pickup position RP, where the first pickup mechanism 3 picks up the sealed substrate W.

[0090]

The transport moving 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. The transport moving 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 moving mechanism 72 adjusts the position of the sealed substrate W in the X direction, and the horizontal moving 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.

[0091]

To move the first pickup mechanism 3 holding the sealed substrate W toward the cutting table 2B, the vertical moving mechanism 73 lifts the first pickup mechanism 3 to a position not physically interfering with the cutting moving 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.

[0092]

In this setting, by causing the cutting moving mechanism 8 to move the two spindles 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. While the sealed substrate W is being cut in a lattice shape, the cutting water splash preventing mechanism 24 performs the operation described in <Operation of cutting water splash preventing mechanism 24 accompanying cutting> described above.

[0093]

After the sealed substrate W is cut, the transport moving 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 moving mechanism 7 causes the first pickup mechanism 3 and the first cleaning mechanism 18 to retract to predetermined respective positions.

[0094]

The transport moving 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 moving 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.

[0095]

After the cleaning, both sides of the plurality of products P held by the second

pickup mechanism 6 are subjected to the inspections by the inspection unit 13 and the reversing mechanism 14. The transport moving mechanism 7 then moves the second pickup mechanism 6 to the transfer table 5, and the second pickup mechanism 6 releases to place the plurality of products P being suctioned and held onto the transfer table 5. A sorting mechanism 20 then sorts the plurality of products P placed on the transfer table 5 onto the various trays 21, based on the result of the inspection carried out by the inspection unit 13 (e.g., non-defective products and defective products).

[0096]

To inspect both sides of the products P, for example, one surfaces are at first inspected while the products P is being suctioned and held by the second pickup mechanism 6. The products P are transferred from the second pickup mechanism 6 to the holding table 141 of the reversing mechanism 14, are reversed, and the other surfaces are inspected while the products P are being sucked and held by the holding table 141. In the manner described above, both sides can be inspected. Subsequently, the products P can be transported from the holding table 141 to the transfer table 5 by transferring the products P from the holding table 141 to the second pickup mechanism 6. The products P may also be transported and transferred to the transfer table 5 by making the holding table 141 movable in the X direction and at least one of the holding table 141 and the transfer table 5 movable in the Z direction, and by moving the holding table 141 above the transfer table 5.

[0097]

<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 moving 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 machined without moving the cutting tables 2A, 2B in the X direction and the Y direction. Therefore, no ball screw mechanism is used to move the cutting tables 2A, 2B, so that the needs for the bellows member for protecting 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. In addition, because the cutting tables 2A, 2B are not moved in the X direction or the Y direction, the footprint of the cutting machine 100 can be reduced.

[0098]

Furthermore, according to this embodiment, in the configuration in which cutting water is discharged onto the cutting mechanism 4 from the front side in the machining feed direction SD, the cutting water splash preventing mechanism 24 is provided behind the cutting mechanism 4 in the machining feed direction SD, in a manner covering a range from above the cutting mechanism 4 to a level lower than the top surfaces of the cutting tables 2A, 2B. Therefore, it is possible to prevent the splashing of the cutting water. In particular, according to this embodiment, in the configuration in which the cutting mechanism 4 and the cutting water supplying mechanism 12 are provided on one direction parallel to the X direction side with respect to the support 812, the cutting water splash preventing mechanism 24 is provided on the opposite direction parallel to the X direction side with respect to the support 812, so that it is possible to prevent splashing of the cutting water passed beneath the support 812, on the opposite direction parallel to the X direction side with respect to the support 812.

[0099]

Furthermore, according to this embodiment, the cutting water splash preventing mechanism 24 is configured using the bellows member 241. Therefore, it is possible to prevent splashing of the cutting water, in a manner following the movement of the cutting mechanism 4, being moved by the cutting moving mechanism 8. In this configuration, the shutter member 242 is connected to the rear end of the bellows member 241, the rear end being the rear end in the machining feed direction SD, and the shutter member 242 is fixed by the fixing portions 243A, 243B. Therefore, a space surrounded by the bellows member 241 and the shutter member 242 can be ensured while the sealed substrate W is being machined, so that splashing of the cutting water can be prevented reliably.

[0100]

Furthermore, two or more cutting tables 2A, 2B are arranged along the X direction, and the support 812 supporting the spindles 42A, 42B moves in the X direction. Therefore, while the sealed substrate W is being machined on one cutting table 2A, the other cutting table 2B can perform another process such as transporting. In this embodiment, because the fixing portions 243A, 243B for fixing the shutter member are provided for each of the cutting tables 2A, 2B, it is possible to keep the length of the bellows member 241 to the length of the corresponding one of the cutting table 2A, 2B. Hence, it is possible to reduce the size of the contracted bellows member 241. Furthermore, because the shutter member 242 is fixed correspondingly to each of the cutting tables 2A, 2B, and one of the cutting tables 2A, 2B is covered by the bellows member 241, the throughput can be improved by carrying a sealed substrate W yet to be machined onto the cutting table 2A, 2B not currently being subjected to machining, or by transporting a plurality of products P on the cutting table 2A, 2B not

currently being subjected to machining, for example.

[0101]

In this embodiment, because the cutting tables 2A, 2B are interposed between the pair of X-direction guide rails 811 provided along the X direction, the pitch between the pair of X-direction guide rails 811 can be increased. As a result, machining is less affected by a positional deviation between the X-direction guide rails 811 in the Z direction. Furthermore, by increasing the pitch of the pair of guide rails 811, the straightness of the X-direction moving part 81 is improved. Therefore, it is possible to reduce positional deviations of the cutting edges of the blades 41A, 41B, as well as the cutting resistance or like at the time of cutting. Hence, it becomes possible to improve the machining precision. Furthermore, it becomes possible to use the X-direction guide rails 811 with lower specification requirements, compared with those having been conventionally required.

[0102]

In this embodiment, because the two or more cutting tables 2A, 2B do not move in the Y direction during the cutting operation, the parallelity of the moving mechanism 8 (X-direction moving part 81) with respect to the two or more cutting tables 2A, 2B in the X direction can be adjusted at once. In other words, assuming that two cutting tables are provided to a conventional apparatus in which the cutting tables move during the cutting operation, it is necessary to adjust the parallelity between the two cutting tables in the X direction, and to also adjust this adjusted parallelity of the two cutting tables in the X direction to the parallelity of the blades in the X direction (specifically, two sets of adjustments have been required). However, in this embodiment, because the two cutting tables 2A, 2B do not move in the X direction during the cutting operation, it is only necessary to adjust the parallelity of the blades

41A, 41B in the X direction (specifically, a single run of adjustment is sufficient).

[0103]

<Other modifications>

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

[0104]

For example, 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. Three or more cutting tables may also be provided. In such a configuration, too, three or more fixing portions are provided correspondingly to each of the three or more cutting tables.

[0105]

The transfer table 5 according to the embodiment has been explained as an indexing table where the products P are temporarily placed before being sorted into the various trays 21, but the transfer table 5 may also be used as the holding table 141 of the reversing mechanism 14.

[0106]

Furthermore, explained above in the embodiment is a configuration in which the plurality of products P on the transfer table 5 are sorted onto the trays 21 (also referred to as "tray storage"). Other possible configurations include: a configuration in which the plurality of products P are stored by bonding the plurality of products P on a bonding member having an adhesive surface (also referred to as "ring storage"); a configuration in which the plurality of products P are loosely dropped and stored in a

storage box (also referred to as "bulk storage"); or a configuration in which the plurality of products P are inserted into and stored in a tubular container via an opening on one end (also referred to as "tube storage").

[0107]

Furthermore, in the configuration according to the embodiment, a groove may be formed on the sealed substrate, without cutting through, on the cutting tables 2A, 2B. In such a configuration, for example, the first pickup mechanism 3 and the transport moving mechanism 7 may carry the sealed substrate W having grooves formed thereon on the cutting tables 2A, 2B, back to the substrate supplying unit 112. The sealed substrate W brought back to the substrate supplying unit 112 may then be housed in the substrate housing 111.

[0108]

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.

[0109]

Furthermore, the machining apparatus according to the present invention may perform machining other than cutting, and for example, may perform other types of machining such as milling and grinding.

[0110]

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

[0111]

According to the present invention, it is possible to prevent splashing of machining fluid with a simplified apparatus structure with a smaller footprint.

Reference Signs List

[0112]

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

81	X-direction moving part
811	pair of X-direction guide rails
812	support
82	Y-direction moving part
12	cutting water supplying mechanism (machining fluid supplying mechanism)
15	cover member
24	cutting water splash preventing mechanism (machining fluid splash preventing mechanism)
241	bellows member
242	shutter member
243A, 243B	fixing portion
U	raised position
D	lowered position

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 machines the workpiece held on the machining table;
 - a transfer table onto which the machined workpiece is transferred;
 - a second pickup mechanism that holds the machined workpiece to transport the machined workpiece from the machining table onto the transfer table;
 - a transport moving 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 moving mechanism that moves the machining mechanism on a horizontal plane, in a first direction extending along the transfer shaft and in a second direction orthogonal to the first direction;
 - a machining fluid supplying mechanism that is moved with the machining mechanism by the machining moving mechanism, and that discharges machining fluid onto the machining mechanism from one side in a machining feed direction; and
 - a machining fluid splash preventing mechanism that is provided on another side in the machining feed direction with respect to the machining mechanism, that covers above the machining mechanism in a manner extending to a level lower than a top surface of the machining table to prevent splashing of the machining fluid.
2. The machining apparatus according to claim 1, wherein

the machining fluid splash preventing mechanism includes:

a bellows member that expands and contracts following a movement of the machining mechanism, and covers a top and lateral sides extending orthogonally to the machining feed direction; and

a shutter member that is connected to a rear end of the bellows member in the machining feed direction and covers the machining mechanism from the rear side in the machining feed direction.

3. The machining apparatus according to claim 2, further comprising a fixing portion that fixes the shutter member to the machining table, while the machining mechanism is machining the workpiece.

4. The machining apparatus according to claim 3, further comprising a plurality of the machining tables, wherein

the fixing portion is provided correspondingly to each of the plurality of machining tables.

5. The machining apparatus according to claim 4, wherein the machining moving mechanism moves the shutter member to each of the plurality of fixing portions.

6. The machining apparatus according to any one of claims 3 to 5, wherein the shutter member is configured movable between a raised position where a bottom end of the shutter member is positioned at a level higher than a top surface of the machining table, and a lowered position where the bottom end is positioned at a level lower than the top surface of the machining table, and configured to be fixed by the fixing portion at the lowered position.

7. The machining apparatus according to any one of claims 1 to 6, wherein the machining moving mechanism includes an X-direction moving part that

moves the machining mechanism linearly in an X-direction that is the first direction and a Y-direction moving part that moves the machining mechanism linearly in a Y-direction that is the second direction, and

the X-direction moving part 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 moving part.

8. The machining apparatus according to claim 7, wherein

the machining feed direction is a direction extending in one direction parallel to the X direction, and

the machining mechanism and the machining fluid supplying mechanism are provided on a one direction parallel to the X direction side with respect to the support, and

the machining fluid splash preventing mechanism is provided on an opposite direction parallel to the X direction side with respect to the support.

9. The machining apparatus according to claim 8, wherein a cover member housing the machining mechanism and the machining fluid supplying mechanism is provided on the one direction parallel to the X direction side with respect to the support.

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.