Description

Title of Invention

METHOD FOR PRODUCING CUT PRODUCT, FIXING JIG, AND CUTTING APPARATUS

Technical Field

[0001]

This disclosure relates to a method for producing a cut product, a fixing jig, and a cutting apparatus.

Background Art

[0002]

Substrates with semiconductor chips or the like mounted thereon are typically sealed up in resin and then cut to be singulated for use as electronic parts. Known cutting apparatuses cut substrates sealed up in resin into electronic parts, wash, dry, and inspect the electronic parts, and then suck and convey the electronic parts into a container.

[0003]

Patent Literature 1 discloses a cutting apparatus including a conveying mechanism configured to cut a substrate sealed up in resin ("sealed substrate" in Patent Literature 1) for singulation into two or more cut products ("electronic parts" in Patent Literature 1), place the cut products on a placement mount ("table" in Patent Literature 1) in a staggered pattern, and then suck and convey one row after another of the two or more cut products. When the cutting apparatus of Patent Literature 1 sucks and conveys one row after another of the two or more cut products, the two or more cut products are not fixed to the placement mount. The expression "place two or more cut products in a staggered pattern" means placing two or more cut products at respective positions with the same color in a checkered pattern.

Citation List

Patent Literature

[0004]

Patent Literature 1

JP 2009-135259 A

Summary of Invention

Technical Problem

[0005]

If, for instance, a cutting apparatus cuts a substrate sealed up in resin and provided with a film attached thereto into two or more cut products, a cut product may have a burr resulting from the cut film which burr is in contact with and connected to another cut product adjacent in the front, back, left, or right direction. In such a case, if the cutting apparatus sucks and conveys every other one of the plurality of cut products as disclosed in Patent Literature 1, the cutting apparatus may convey the sucked cut products together with a cut product (not sucked) adjacent in the front, back, left, or right direction to a sucked cut product and connected thereto with a burr. This leaves room for improvement. Further, the cutting apparatus may avoid conveying such a cut product (not sucked), but pull the cut product away from its intended position due to a burr. This leaves room for improvement.

[0006]

There has thus been a demand for a method for producing a cut product, a fixing jig, and a cutting apparatus each of which sucks and conveys intended cut products and moves no other cut products.

Solution to Problem

[0007]

A method as an embodiment of this disclosure for producing a cut product includes: singulating an object to be cut into a plurality of cut products by cutting the object to be cut with a cutting mechanism; fixing, while keeping an arrangement of the plurality of cut products after the singulation, conveying the plurality of cut products together and fixing the plurality of cut products onto a fixing jig; first conveying unfixing only a first cut product group made up of some of the plurality of cut products fixed to the fixing jig and causing a conveying mechanism to suck the first cut product group and convey the first cut product group to a container; and second conveying, after the first conveying, unfixing a second cut product group made up of some of the plurality of cut products fixed to the fixing jig which are other than the first cut product group and causing the conveying mechanism to suck the second cut product group and convey the second cut product group to the container.

[0008]

A fixing jig as an embodiment of this disclosure is a fixing jig for fixing a plurality of cut products, which result from cutting a plurality of mutually intersecting linear cutting portions of an object to be cut, while keeping an arrangement of the plurality of cut products after the cutting, the fixing jig including: a plurality of drawing holes configured to draw air to fix the plurality of cut products individually to the fixing jig;

and a first drawing path and a second drawing path that allow passage of the air independently of each other, wherein the plurality of drawing holes are each connected to the first drawing path or the second drawing path, and those cut products among the plurality of cut products which are not adjacent to each other correspond to respective drawing holes among the plurality of drawing holes which respective drawing holes are each connected to one of the first drawing path and the second drawing path.

[0009]

A cutting apparatus as an embodiment of this disclosure includes: a cutting mechanism configured to cut a plurality of mutually intersecting linear cutting portions of a plate-shaped object to be cut for singulation into a plurality of cut products; and a placement mount including the fixing jig.

Advantageous Effects

[0010]

This disclosure may be embodied to provide a method for producing a cut product, a fixing jig, and a cutting apparatus each of which sucks and conveys intended cut products and moves no other cut products.

Brief Description of Drawings

[0011]

Fig. 1 is a perspective view of a molded substrate and electronic parts.

Fig. 2 is a plan view of a cutting apparatus.

Fig. 3 is a plan view of a first plate.

Fig. 4 is a plan view of a second plate.

Fig. 5 is a plan view of a third plate.

Fig. 6 is a plan view of a fourth plate.

Fig. 7 is a plan view of a base.

Fig. 8 is a cross-sectional view of a placement mount.

Fig. 9 is a diagram illustrating how a first cut product group and a second cut product group are sucked on a placement mount.

Description of Embodiments

[0012]

The description below deals with a method for producing a cut product, a fixing jig, and a cutting apparatus as embodiments of this disclosure with reference to drawings. The embodiments below are mere examples for describing the method for producing a cut product, the fixing jig, and the cutting apparatus. The method for producing a cut

product, the fixing jig, and the cutting apparatus are not limited to the embodiments below. The method for producing a cut product, the fixing jig, and the cutting apparatus according to this disclosure may be embodied variously without departing from the scope of this disclosure.

[0013]

Substrates with elements such as semiconductor chips mounted thereon are sealed up in resin and then cut to be singulated for use as electronic parts. Substrates sealed up in resin are cut with use of a dedicated cutting apparatus.

[0014]

Substrates are sealed up in resin as a result of fixing substrates to a molding die (not illustrated in the drawings) of a resin molding apparatus and supplying liquid, molten resin into the molding die for resin molding of the substrates. The molten resin may be a thermoplastic resin or a thermosetting resin. A thermosetting resin has a viscosity that decreases when heated. Continuing to heat a thermosetting resin polymerizes and cures the thermosetting resin into a cured resin. A thermosetting resin is desirable in resin-sealing substrates with elements such as semiconductor chips mounted thereon. The resin in which the substrates are sealed up protects the elements mounted on the substrates.

[0015]

[Configuration of Molded Substrate]

The present embodiment is a cutting apparatus 1 (see Fig. 2) configured to cut a molded substrate Sb (which is an example object to be cut). As illustrated in Fig. 1, the molded substrate Sb includes a lead frame 63 and two or more elements 61 mounted thereon. The molded substrate Sb includes a resin layer 65 resulting from resin sealing on that face of the lead frame 63 on which the two or more elements 61 are mounted and a protective film 67 (which is an example film) attached to the resin layer 65. The elements 61 are, for example, integrated circuits (that is, semiconductor chips). The protective film 67 includes on its back face an adhesive layer (not illustrated in the drawings) made of an adhesive or the like to be bonded to the resin layer 65. The lead frame 63 is provided with electrodes (not illustrated in the drawings) electrically connected to the elements 61. The electrodes are exposed on that side of the lead frame 63 which is opposite to the resin layer 65.

[0016]

Fig. 1 shows two or more double-dashed chain straight lines intersecting with each other to indicate cutting portions 68 that the cutting apparatus 1 (described later) cuts. Fig. 1 illustrates three electronic parts Sc at the upper right (each of which is an example cut product) that the cutting apparatus 1 as the present embodiment has cut from

the molded substrate Sb. The substrate may be, other than the lead frame 63, a semiconductor substrate such as a silicon wafer, a printed wiring board, a metal substrate, a resin substrate, a glass substrate, or a ceramic substrate. The substrate may be a carrier usable for fan-out wafer level packaging (FOWLP) or fan-out panel level packaging (FOPLP). The substrate may or may not be provided with wiring in advance. Each electronic part Sc includes a single element 61. Examples of the electronic parts Sc include ball grid array (BGA) electronic parts, land grid array (LGA) electronic parts, chip size package (CSP) electronic parts, light emitting diodes (LEDs), and quad flat no-leaded (QFN) electronic parts. The molded substrate Sb for the present embodiment is not limited to a lead frame 63 provided with elements 61 mounted thereon and sealed up in resin. The molded substrate Sb may alternatively be, for example, a resin-sealed circuit board provided with no elements 61 mounted thereon and with single-layer or multilayer wiring. The object to be cut for the present embodiment is not limited to a molded substrate Sb, and may alternatively be a substrate not sealed up in resin.

[0017]

The (upper right) electronic parts Sc as cut in Fig. 1 are illustrated as having burrs 67a on the protective film 67. The burrs 67a are connected to the protective film 67 of other electronic parts Sc adjacent in the front, back, left, and right directions (or of the remaining portion of the molded substrate Sb). The electronic parts Sc are, in other words, connected to other electronic parts Sc adjacent in the front, back, left, and right directions (or to the remaining portion of the molded substrate Sb) with burrs 67a in-between. The expression "connected" for electronic parts Sc as used herein refers not to the state of the protective film 67 not having been cut completely, but to the following state of an electronic part Sc resulting from cutting the protective film 67: The electronic part Sc has a burr 67a with an adhesive layer that is in contact with the protective film 67 or burr 67a of an electronic part Sc adjacent in the front, back, left, or right direction (or of the remaining portion of the molded substrate Sb to be singulated) while the adhesive layer is exhibiting its adhesive force.

[0018]

[Configuration of Cutting Apparatus]

Fig. 2 is a schematic plan view of a cutting apparatus 1 as the present embodiment. The cutting apparatus 1 is configured to cut a molded substrate Sb for singulation into two or more electronic parts Sc (see Fig. 1). The description below uses the term "front face" to refer to that face of a molded substrate Sb which is sealed up in resin and protected by the protective film 67 (that is, that face on which the resin layer 65 and the protective film 67 are disposed in Fig. 1) and the term "back face" to refer to that

face of a molded substrate Sb which is opposite to the front face (that is, that face on which the electrodes are disposed in Fig. 1). Fig. 2 shows a Z axis as a vertical axis, an X axis along which the cutting module A1 and the inspection/storage module B1 are arranged, and a Y axis perpendicular to the X and Z axes (which extends along the depth of each module).

[0019]

The cutting apparatus 1 includes a cutting module A1 and an inspection/storage module B1. The cutting module A1 cuts a molded substrate Sb to produce two or more electronic parts Sc. The inspection/storage module B1 inspects those electronic parts Sc and then stores each electronic part Sc on a non-defective item tray 15a (which is an example container) or a defective item tray 15b (which is an example container). The cutting module A1 and the inspection/storage module B1 are attachable and detachable to each other as well as replaceable.

[0020]

The cutting apparatus 1 includes a control section 50 including a processor such as a central processing unit (CPU) and a storage device such as a random access memory (RAM) or a read only memory (ROM). The control section 50 is configured such that the processor executes control programs stored in the storage device to control the operation of each section of the cutting module A1 and the inspection/storage module B1. The cutting apparatus 1 operates as described below on the basis of operation instructions from the control section 50 unless otherwise specified. The description below basically omits to deal with operation instructions from the control section 50 and deals as necessary with such operation instructions. The cutting apparatus 1 as the present embodiment is configured such that the cutting module A1 includes a control section 50, a monitor 20, and a sound output section 25. The control section 50, the monitor 20, and the sound output section 25 are, however, included in the cutting apparatus 1 and may alternatively be included in the inspection/storage module B1.

[0021]

The cutting module A1 includes as main components a substrate supply section 3, a positioning section 4, cutting tables 5, spindles 6 (which is an example cutting mechanism), and a conveying section 7. The cutting module A1 also includes a portion of a first vacuum pump D1 and second vacuum pumps D2. The cutting apparatus 1 may include a water circulating device configured to circulate water. The water circulating device serves to, for instance, circulate cooling water for cooling a motor 6a or circulate cutting water or washing water for use during a cutting operation.

[0022]

The substrate supply section 3 pushes out molded substrates Sb one by one from a magazine M1 storing two or more molded substrates Sb to supply molded substrates Sb one by one to the positioning section 4 while the molded substrates Sb are each oriented to have a front face (that is, that face on which the protective film 67 is disposed) facing downward.

[0023]

The positioning section 4 places on a rail section 4a a molded substrate Sb as pushed out from the substrate supply section 3 to position the molded substrate Sb. The positioning section 4 then conveys the molded substrate Sb as positioned to a cutting table 5.

[0024]

The cutting tables 5 hold molded substrates Sb to be cut. The cutting module A1 for the present embodiment includes two cutting tables 5. The two cutting tables 5 are each connected to a second vacuum pump D2 through a second flow path VR2.

[0025]

The cutting tables 5 each include a holder 5a, a rotating mechanism 5b, and a moving mechanism 5c. The holder 5a receives a molded substrate Sb conveyed from the positioning section 4 and sucks the molded substrate Sb from below to hold the molded substrate Sb. This fixes the molded substrate Sb to the cutting table 5. The moving mechanism 5c is configured to move the cutting tables 5 along the Y axis.

[0026]

The rotating mechanism 5b is configured to rotate the holder 5a in the direction indicated with θ1 in Fig. 2 (that is, on the XY plane in Fig. 2). The moving mechanism 5c is configured to move the holder 5a along the Y axis in Fig. 2. θ1 indicates the direction of rotation about the Z axis.

[0027]

The spindles 6 each include a motor 6a, a rotary shaft 6b, and a blade 8. The rotary shaft 6b is configured to output rotational driving force from the motor 6a. The blade 8 is at the tip of the rotary shaft 6b. The spindles 6 each rotate its rotary shaft 6b with use of rotational driving force. The rotation of the rotary shaft 6b rotates the blade 8 at a high speed to cut a molded substrate Sb along cutting portions 68 (see Fig. 1) for singulation into two or more electronic parts Sc.

[0028]

The cutting module A1 for the present embodiment includes two spindles 6. The spindles 6 are each movable along the X and Z axes in Fig. 2. The cutting module A1 may alternatively include a single spindle 6.

[0029]

The spindles 6 are each provided with, for example, a cutting water nozzle, a cooling water nozzle, and a washing water nozzle (not illustrated in the drawings). The cutting water nozzle jets out cutting water onto the blade 8 as the blade 8 rotates at a high speed. The cooling water nozzle jets out cooling water onto the blade 8 and a molded substrate Sb as they are heated by the cutting operation. The washing water nozzle jets out washing water for removing cutting debris and the like. The cutting module A1 discharges cutting water, cooling water, and washing water as jetted out.

[0030]

The conveying section 7 sucks all electronic parts Sc (21 electronic parts Sc in the example illustrated in Fig. 1) from above that have been held by the cutting tables 5 and resulted from the cutting operation for singulation, and conveys the electronic parts Sc together to an inspection table 11 of the inspection/storage module B1 while keeping the electronic parts Sc arranged as they were after the cutting operation. The conveying section 7 is connected to the first vacuum pump D1 through a first flow path VR1. The conveying section 7 draws air with use of the first vacuum pump D1 to suck and hold all the electronic parts Sc.

[0031]

The inspection/storage module B1 includes as main components an inspection table 11, a first optical inspection camera 12, a second optical inspection camera 13, a placement section 14, and an extraction section 15 (which is an example conveying mechanism). The first optical inspection camera 12 may alternatively be included in the cutting module A1. The inspection/storage module B1 includes a portion of the first vacuum pump D1. The first vacuum pump D1 thus has a portion included in the cutting module A1 and a portion included in the inspection/storage module B1.

[0032]

The inspection table 11 holds two or more electronic parts Sc for optical inspection. The inspection table 11 is movable along the X axis in Fig. 2. The inspection table 11 is also invertible upside down. The inspection table 11 is provided with a holder (not illustrated in the drawings) configured to suck and hold two or more electronic parts Sc through a drawing operation by the first vacuum pump D1.

[0033]

The first and second optical inspection cameras 12 and 13 capture images of the opposite faces of each electronic part Sc (that is, its front and back faces). The inspection/storage module B1 inspects electronic parts Sc for various aspects on the basis of data on the images captured by the first and second optical inspection cameras 12 and

13. The first and second optical inspection cameras 12 and 13 are proximate to the inspection table 11 and face upward for image capturing.

[0034]

The placement section 14 includes a placement mount 70 configured to receive two or more electronic parts Sc as inspected (see Fig. 1) together while they are arranged as they were after the cutting operation. The placement mount 70 is connected to the first vacuum pump D1 through the first flow path VR1. A later description will deal with how the placement section 14 is configured.

[0035]

The extraction section 15 sucks and holds some of the electronic parts Sc on the placement section 14 and transfers the electronic parts Sc to a tray. The extraction section 15 separates electronic parts Sc (see Fig. 1) into non-defective items and defective items on the basis of the result of the inspection involving use of the first and second optical inspection cameras 12 and 13. The extraction section 15 transfers non-defective electronic parts Sc to the non-defective item tray 15a and defective electronic parts Sc to the defective item tray 15b. The extraction section 15 sucks and transfers not all the electronic parts Sc together but some of the electronic parts Sc repeatedly to eventually transfer all the electronic parts Sc.

[0036]

The cutting apparatus 1 further includes a monitor 20 and a sound output section 25. The monitor 20 is configured to display an image. The monitor 20 includes a display device such as a liquid crystal monitor or an organic electroluminescent (EL) monitor. The sound output section 25 is configured to output sound. The sound output section 25 includes a sound output device such as a loudspeaker, a buzzer, or a bell.

[0037]

[Configuration of Placement Section]

The description below deals with the placement section 14 with reference to Figs. 2 to 8. The placement section 14, as illustrated in Fig. 2, includes a placement mount 70, a first flow path VR1, a first vacuum pump D1, and a switching valve 78. The placement section 14 for the present embodiment is configured such that the first vacuum pump D1 draws air to suck two or more electronic parts Sc and fix the electronic parts Sc to the placement mount 70. The placement mount 70 has two independent drawing paths for passage of air that the first vacuum pump D1 draws. As the present embodiment, the cutting apparatus 1 for electronic parts Sc includes at least cutting tables 5, spindles 6, and a placement mount 70.

[0038]

The placement mount 70, as illustrated in Fig. 8, includes a fixing jig 75 and a base 76 to which the fixing jig 75 is fixed with use of fixing members such as screws. The fixing jig 75 includes a fourth plate 74, a third plate 73, a second plate 72, a first plate 71, and a contact plate 77 that are stacked in this order and that are bonded or joined to one another for integration. The first to fourth plates 71 to 74 and the base 76 are each in the form of a rectangular plate. The first to fourth plates 71 to 74 and the base 76 are each made of a metal; specifically, the first plate 71, the second plate 72, and the third plate 73 are made of stainless steel, whereas the fourth plate 74 and the base 76 are made of aluminum. The first plate 71, the second plate 72, and the third plate 73 have respective thicknesses substantially equal to one another. The fourth plate 74 and the base 76 each have a thickness larger than the combined thickness of the first plate 71, the second plate 72, and the third plate 73. The contact plate 77 is in the shape of a rectangle smaller in area than the first plate 71 as viewed along the Z axis. The present embodiment is configured such that the rectangular placement mount 70 has short sides along the X axis and long sides along the Y axis and that the base 76, the fourth plate 74, the third plate 73, the second plate 72, the first plate 71, and the contact plate 77 are stacked along the Z axis (see Fig. 2 as well).

[0039]

[Configuration of Contact Plate]

As illustrated in Fig. 8, the contact plate 77 of the fixing jig 75 has an upper face 77a (which is an example placement face) and a lower face 77b opposite to the upper face 77a. The contact plate 77 is in the form of a plate with an upper face 77a to which two or more electronic parts Sc as inspected are fixed. The contact plate 77 has two or more suction drawing holes 77c (which is an example drawing hole) each extending from the upper face 77a through to the lower face 77b and having a circular cross section for drawing electronic parts Sc. The suction drawing holes 77c correspond in position and number to two or more electronic parts Sc fixed to the contact plate 77. The suction drawing holes 77c are arranged in parallel lines extending along the X and Y axes. The suction drawing holes 77c have an equal inner diameter. The contact plate 77 may be made of resin to easily suck electronic parts Sc onto the fixing jig 75 (or the contact plate 77) through a drawing operation.

[0040]

[Configuration of First Plate]

As illustrated in Fig. 3, the first plate 71 of the fixing jig 75 has a first upper face 71a bonded to the lower face 77b of the contact plate 77 and a first lower face 71b opposite to the first upper face 71a. Figs. 3 to 5 show double-dashed chain lines surrounding areas

in which two or more electronic parts Sc are fixed. The drawings show two such areas for the present embodiment. This disclosure is, however, not limited to such an arrangement, and may have a single area or three or more areas in which two or more electronic parts Sc are fixed. This disclosure may have such an area(s) as appropriate in correspondence with the number of areas in which two or more electronic parts Sc formed in a single molded substrate Sb are fixed.

[0041]

The first plate 71 has two or more first drawing holes 71c (which is an example drawing hole) each in the form of a through hole with a circular cross section for drawing air. The first drawing holes 71c are similar to the suction drawing holes 77c in the contact plate 77 in that the first drawing holes 71c correspond in position and number to two or more electronic parts Sc fixed to the contact plate 77. The first drawing holes 71c are arranged in parallel lines extending along the X and Y axes. The first drawing holes 71c have an equal inner diameter. This means that with the first plate 71 stacked on the contact plate 77, the suction drawing holes 77c and the first drawing holes 71c together form through holes extending from the upper face 77a to the first plate 71. Drawing air through the suction drawing holes 77c and the first drawing holes 71c fixes two or more electronic parts Sc to the first upper face 71a of the first plate 71 of the placement mount 70.

[0042]

The first plate 71 has in the first lower face 71b two or more first grooves 71d (which is an example first drawing path) extending in two directions inclined relative to the Y axis. First grooves 71d extending in the same direction are apart from one another and connected to one another through intersecting first grooves 71d extending in the other direction. This means that the first grooves 71d are all connected to one another. The first grooves 71d each have a depth approximately half the thickness of the first plate 71, for example. The description below of the components from the first plate 71 to the base 76 uses the expression "connected" about grooves and holes to indicate that they allow air to pass therethrough.

[0043]

While the first drawing holes 71c are arranged in parallel lines extending along the X and Y axes, the first grooves 71d are parallel to the arrangement of first drawing holes 71c that are positioned obliquely relative to each other. As viewed along the Z axis, the first grooves 71d coincide with first drawing holes 71c that are positioned obliquely relative to each other. The first grooves 71d for the present embodiment have a width equal to or slightly larger than the inner diameter of the first drawing holes 71c. While the first grooves 71d have respective first groove bottoms 71d1 (see Fig. 8), the two or

more first drawing holes 71c (which coincide with the first grooves 71d) extend from the first upper face 71a of the first plate 71 through to the first groove bottoms 71d1 for connection to the first grooves 71d. The description below uses the term "first drawing holes 71c1" (which is an example drawing hole) to refer to those among the two or more first drawing holes 71c which coincide with the first grooves 71d.

[0044]

Forming the two or more first grooves 71d forms two or more first protrusions 71e at portions other than and adjacent to the first grooves 71d. The first protrusions 71e protrude relative to the respective first groove bottoms 71d1 of the first grooves 71d and have respective top faces constituting the first lower face 71b. The first protrusions 71e are rhombic as viewed along the Z axis. The first protrusions 71e are on the first lower face 71b of the first plate 71. The first protrusions 71e are apart from one another as they are each defined by four first grooves 71d. The first protrusions 71e are arranged along the first grooves 71d, that is, in two directions inclined relative to the X axis. Stated differently, two mutually obliquely positioned first protrusions 71e are separated from each other by a first groove 71d intersecting the oblique direction.

[0045]

The first protrusions 71e each have a single first drawing hole 71c. The respective first drawing holes 71c in the first protrusions 71e extend from the first upper face 71a through to the first lower face 71b. The description below uses the term "first drawing holes 71c2" (which is an example drawing hole) to refer to those among the two or more first drawing holes 71c which are in the first protrusions 71e.

[0046]

In summary, while the two or more first drawing holes 71c are arranged in parallel lines extending along the X and Y axes, any first drawing hole 71c1 is adjacent to a first drawing hole 71c2 along each of the X and Y axes, whereas any first drawing hole 71c1 is positioned obliquely relative to another first drawing hole 71c1. Further, while the two or more first drawing holes 71c are arranged in parallel lines extending along the X and Y axes, any first drawing hole 71c2 is adjacent to a first drawing hole 71c1 along each of the X and Y axes, whereas any first drawing hole 71c2 is positioned obliquely relative to another first drawing hole 71c2.

[0047]

The first plate 71 has four first drawing ends 71f proximate to the long sides of the rectangular first lower face 71b and connected to the first grooves 71d. The first drawing ends 71f are each in the form of a groove with a depth equal to that of the first grooves 71d: The first drawing ends 71f have respective groove bottoms at a depth equal

to that of the first groove bottoms 71d1.

[0048]

[Configuration of Second Plate]

As illustrated in Fig. 4, the second plate 72 of the fixing jig 75 has a second upper face 72a and a second lower face 72b opposite to the second upper face 72a. The second upper face 72a is identical in shape to the first lower face 71b of the first plate 71. Specifically, the second plate 72 has two or more second grooves 72d (which is an example first drawing path) that are positioned to face the respective first grooves 71d in the first plate 71 as the second plate 72 is stacked on the first plate 71 and that are identical in shape to the first grooves 71d. The second grooves 72d each have a depth approximately half the thickness of the second plate 72, for example. The second plate 72 includes two or more second protrusions 72e that are positioned to face the respective first protrusions 71e of the first plate 71 and that are identical in shape to the first protrusions 71e. The second plate 72 has four second drawing ends 72f that are positioned to face the respective first drawing ends 71f of the first plate 71 and that are identical in shape to the first drawing ends 71f. The second drawing ends 72f are connected to the second grooves 72d. The second grooves 72d, the second protrusions 72e, and the second drawing ends 72f are not detailed here as they are identical in shape to the first grooves 71d, the first protrusions 71e, and the first drawing ends 71f.

[0049]

The second protrusions 72e each have a second drawing hole 72c (which is an example drawing hole) extending from the second upper face 72a through to the second lower face 72b. The second drawing holes 72c have a diameter equal to those of the suction drawing holes 77c and the first drawing holes 71c2. With the second plate 72, the first plate 71, and the contact plate 77 stacked on top of one another, the second drawing holes 72c coincide entirely with the suction drawing holes 77c and the first drawing holes 71c2 as viewed along the Z axis. This means that with the second plate 72, the first plate 71, and the contact plate 77 stacked on top of one another, the suction drawing holes 77c, the first drawing holes 71c2, and the second drawing holes 72c together form through holes extending from the upper face 77a of the contact plate 77 to the second lower face 72b of the second plate 72.

[0050]

The second plate 72, the second upper face 72a, and the first lower face 71b of the first plate 71 differ from each other on the following point: Specifically, the first grooves 71d have respective first groove bottoms 71d1 with first drawing holes 71c2, whereas the second grooves 72d have respective second groove bottoms 72d1 with no

through holes corresponding to the first drawing holes 71c2. The second plate 72 has on the second upper face 72a four second drawing ends 72f that are unlike the first drawing ends 71f in that they have second drawing end holes 72g (which is an example first drawing path) extending from the second groove bottoms 72d1 through to the second lower face 72b. The second drawing end holes 72g have an inner diameter larger than that of the second drawing hole 72c, for example, approximately by a factor of eight.

[0051]

[Configuration of Third Plate]

As illustrated in Fig. 5, the third plate 73 of the fixing jig 75 has a third upper face 73a and a third lower face 73b opposite to the third upper face 73a. The third plate 73 has in the third upper face 73a third drawing end holes 73g (which is an example first drawing path) that are positioned to face the four respective second drawing end holes 72g in the second plate 72 as the third plate 73 is stacked on the second plate 72 and that extend from the third upper face 73a through to the third lower face 73b. The third plate 73 has a total of four third drawing end holes 73g. The third drawing end holes 73g have an inner diameter equal to that of the second drawing end holes 72g. This means that with the third plate 73 and the second plate 72 stacked on top of each other, the second drawing end holes 72g and the third drawing end holes 73g together form through holes extending from the second groove bottoms 72d1 of the second plate 72 to the third lower face 73b of the third plate 73.

[0052]

The third plate 73 has in the third lower face 73b two or more third grooves 73d (which is an example second drawing path) extending parallel to the Y axis of the third plate 73. The third plate 73 has third drawing holes 73c (which is an example drawing hole) that are positioned to face the respective second drawing holes 72c as the third plate 73 is stacked on the second plate 72 and that have a diameter equal to that of the second drawing holes 72c. The third grooves 73d, which have respective third groove bottoms 73d1 (see Fig. 8), are at respective positions where the third drawing holes 73c extend from the third upper face 73a through to the third groove bottoms 73d1. This means that with the third plate 73, the second plate 72, the first plate 71, and the contact plate 77 stacked on top of one another, the suction drawing holes 77c, the first drawing holes 71c2, the second drawing holes 72c, and the third drawing holes 73c are connected to one another to together form through holes (which is an example drawing hole) extending from the upper face 77a of the contact plate 77 to the respective third groove bottoms 73d1 of the third grooves 73d and connected to the third grooves 73d. The third grooves 73d are not connected to the third drawing end holes 73g.

[0053]

[Configuration of Fourth Plate]

As illustrated in Fig. 6, the fourth plate 74 of the fixing jig 75 has a fourth upper face 74a and a fourth lower face 74b opposite to the fourth upper face 74a. The fourth plate 74 has in the fourth upper face 74a fourth drawing end holes 74g (which is an example first drawing path) that are positioned to face the four respective third drawing end holes 73g in the third plate 73 as the fourth plate 74 is stacked on the third plate 73 and that extend from the fourth upper face 74a through to the fourth lower face 74b. The fourth plate 74 has a total of four fourth drawing end holes 74g. The fourth drawing end holes 74g have an inner diameter equal to that of the third drawing end holes 73g. This means that with the fourth plate 74, the third plate 73, and the second plate 72 stacked on top of one another, the second drawing end holes 72g, the third drawing end holes 73g, and the fourth drawing end holes 74g together form through holes extending from the second groove bottoms 72d1 of the second plate 72 to the fourth lower face 74b of the fourth plate 74.

[0054]

The fourth plate 74 has a drawing area 74h positioned to, with the fourth plate 74 stacked on the third plate 73, face that area of the third plate 73 in which the two or more third grooves 73d are present. The fourth plate 74 has in the drawing area 74h two or more fourth drawing holes 74c (which is an example second drawing path) extending from the fourth upper face 74a through to the fourth lower face 74b. The fourth drawing holes 74c each have a rectangular or triangular cross section as viewed along the Z axis. The fourth drawing holes 74c are present closely throughout the entire drawing area 74h.

[0055]

The fourth plate 74 includes between mutually adjacent fourth drawing holes 74c two or more beams 74i extending in two directions inclined relative to the Y axis. Beams 74i extending in the same direction are apart from one another and connected to one another through intersecting beams 74i extending in the other direction. The rectangular fourth drawing holes 74c are each defined by four beams 74i.

[0056]

As the fourth plate 74 is stacked on the third plate 73, the fourth upper face 74a (that is, the beams 74i) of the fourth plate 74 is in contact with the third lower face 73b (that is, the respective top faces of the walls that define the third grooves 73d) of the third plate 73. The third drawing holes 73c each have an opening toward the third lower face 73b which opening is exposed at the third groove bottom 73d1 of a third groove 73d. While the fourth upper face 74a of the fourth plate 74 is in contact with the third lower

face 73b of the third plate 73 as the fourth plate 74 is stacked on the third plate 73, the beams 74i of the fourth plate 74 do not block the respective openings of the third drawing holes 73c toward the third lower face 73b. The third drawing holes 73c are all connected to the fourth drawing holes 74c. This means that with the fourth plate 74, the third plate 73, the second plate 72, the first plate 71, and the contact plate 77 stacked on top of one another, the suction drawing holes 77c, the first drawing holes 71c2, the second drawing holes 72c, and the third drawing holes 73c are connected to one another to together form through holes connected to the respective fourth drawing holes 74c to extend from the upper face 77a of the contact plate 77 to the fourth lower face 74b of the fourth plate 74.

[0057]

[Configuration of Base]

As illustrated in Fig. 7, the base 76 of the placement mount 70 has an upper face 76a and a lower face 76b opposite to the upper face 76a. The base 76 has in the upper face 76a bottomed drawing end holes 76g (which is an example first drawing path) that are positioned to face the four respective fourth drawing end holes 74g in the fourth plate 74 as the base 76 is stacked on the fourth plate 74 and that extend from the upper face 76a partway along the thickness of the base 76. The base 76 has a total of four drawing end holes 76g. The drawing end holes 76g have an inner diameter equal to that of the fourth drawing end holes 74g. This means that with the base 76, the fourth plate 74, the third plate 73, and the second plate 72 stacked on top of one another, the second drawing end holes 72g, the third drawing end holes 73g, the fourth drawing end holes 74g, and the drawing end holes 76g together form bottomed holes extending from the second groove bottoms 72d1 of the second plate 72 to the base 76.

[0058]

The base 76 has a bottomed first discharge hole 76m (which is an example first drawing path) extending from the lower face 76b partway through the thickness and having a circular cross section. The first discharge hole 76m does not extend to the upper face 76a. The base 76 has between the upper face 76a and the lower face 76b two or more connection holes 76p connecting the four drawing end holes 76g to the first discharge hole 76m. Specifically, the connection holes 76p include two bottomed connection holes 76p1 (which is an example first drawing path) extending along the X axis and connecting two drawing end holes 76g arranged along the X axis. The connection holes 76p also include two bottomed connection holes 76p2 (which is an example first drawing path) extending along the Y axis from the respective short sides of the base 76 (which are parallel to the X axis) and intersecting the respective connection holes 76p1 to be connected thereto. The connection holes 76p also include two connection holes 76p3

(which is an example first drawing path) inclined relative to the Y axis and connecting the respective bottoms of the two connection holes 76p2 to the first discharge hole 76m. The base 76 includes plugs 76q disposed at respective exposed ends of the connection holes 76p1, 76p2, and 76p3 and preventing air flowing through the connection holes 76p from leaking out of the placement mount 70.

[0059]

The base 76 has in the upper face 76a a depression 76d (which is an example second drawing path) positioned to face the drawing area 74h of the fourth plate 74 as the base 76 is stacked on the fourth plate 74. The base 76 includes two or more supports 76e disposed throughout the entire depression 76d and apart from one another. The supports 76e have respective top faces constituting the upper face 76a and support the drawing area 74h on the fourth lower face 74b of the fourth plate 74. While the depression 76d has a depression bottom 76d1 (see Fig. 8) as its bottom face, the base 76 has in the depression bottom 76d1 a second discharge hole 76n (which is an example second drawing path) extending from the depression bottom 76d1 to the lower face 76b of the base 76 and having a circular cross section.

[0060]

As illustrated in Fig. 8, the above configuration allows the base 76, the fourth plate 74, the third plate 73, the second plate 72, the first plate 71, and the contact plate 77 to be stacked on top of one another to connect the upper face 77a of the contact plate 77 to the lower face 76b of the base 76 through the suction drawing holes 77c, the first drawing holes 71c1, the space defined by the first and second grooves 71d and 72d, the second, third, and fourth drawing end holes 72g, 73g, and 74g, the drawing end holes 76g, the connection holes 76p1, 76p2, and 76p3, and the first discharge hole 76m. This allows passage of air. The description below uses the term "first drawing path" to refer to an air passage path formed by the space defined by the first and second grooves 71d and 72d, the second, third, and fourth drawing end holes 72g, 73g, and 74g, the drawing end holes 76g, the connection holes 76p1, 76p2, and 76p3, and the first discharge hole 76m. The first drawing path is connected to the suction drawing holes 77c and the first drawing holes 71c1. As described above, any first drawing hole 71c1 is positioned obliquely relative to another first drawing hole 71c1. The first drawing path extends to connect two or more first drawing holes 71c1 positioned obliquely relative to each other as viewed along the Z axis.

[0061]

The base 76, the fourth plate 74, the third plate 73, the second plate 72, the first plate 71, and the contact plate 77 are stacked on top of one another to connect the upper

face 77a of the contact plate 77 to the lower face 76b of the base 76 through the suction drawing holes 77c, the first drawing holes 71c2, the second and third drawing holes 72c and 73c, the third grooves 73d, the fourth drawing holes 74c, the depression 76d, and the second discharge hole 76n. This allows passage of air. The description below uses the term "second drawing path" to refer to an air passage path formed by the third grooves 73d, the fourth drawing holes 74c, the depression 76d, and the second discharge hole 76n. The second drawing path is connected to the suction drawing holes 77c, the first drawing holes 71c2, the second drawing holes 72c, and the third drawing holes 73c. As described above, any first drawing hole 71c2 is positioned obliquely relative to another first drawing hole 71c2. The second drawing path extends to connect two or more first drawing holes 71c2 positioned obliquely relative to each other as viewed along the Z axis.

[0062]

The first discharge hole 76m has in the lower face 76b an opening connected to a first branch flow path VR11 as a portion of the first flow path VR1. In other words, the first drawing flow path is connected to the first branch flow path VR11. The second discharge hole 76n has in the lower face 76b an opening connected to a second branch flow path VR12 as a portion of the first flow path VR1. In other words, the second drawing flow path is connected to the second branch flow path VR12. The first and second branch flow paths VR11 and VR12 each have an end opposite to the placement mount 70 which end is connected to the switching valve 78, which is connected to the first vacuum pump D1 through a single first flow path VR1 (see Fig. 2). In other words, the first and second branch flow paths VR11 and VR12 merge with each other at the switching valve 78. Stated differently, the first flow path VR1 is divided at the switching valve 78 into first and second branch flow paths VR11 and VR12 to be connected to the base 76. The switching valve 78, under control of the control section 50, selectively causes air to flow through the first branch flow path VR11 or stops air from flowing through the first branch flow path VR11 and selectively causes air to flow through the second branch flow path VR12 or stops air from flowing through the second branch flow path VR12.

[0063]

[Method for Producing Electronic Parts]

With reference to Figs. 1, 2, 8, and 9, the description below deals with a method for cutting a molded substrate Sb with use of the cutting apparatus 1 to produce electronic parts Sc. The method for producing electronic parts Sc includes singulating, fixing, first conveying, and second conveying.

[0064]

As illustrated in Fig. 2, the singulating includes causing a spindle 6 to cut a

molded substrate Sb for singulation into two or more electronic parts Sc. The fixing includes, while keeping the arrangement of the two or more electronic parts Sc after the singulation, conveying the two or more electronic parts Sc together and fixing the electronic parts Sc onto the placement mount 70. The first conveying includes (i) unfixing only a first cut product group Sc1 (see Fig. 9) made up of some electronic parts Sc among the two or more electronic parts Sc fixed to the placement mount 70 and (ii) causing the extraction section 15 to suck the first cut product group Sc1 and convey the first cut product group Sc1 to the non-defective item tray 15a or the defective item tray 15b. The second conveying includes (i) unfixing a second cut product group Sc2 (see Fig. 9) made up of some electronic parts Sc among the two or more electronic parts Sc fixed to the placement mount 70 which electronic parts Sc are other than the first cut product group Sc1 and (ii) causing the extraction section 15 to suck the second cut product group Sc2 and convey the second cut product group Sc2 to the non-defective item tray 15a or the defective item tray 15b. The first and second cut product groups Sc1 and Sc2 will be detailed later.

[0065]

First, the magazine M1 of the cutting apparatus 1 illustrated in Fig. 2 receives molded substrates Sb as illustrated in Fig. 1 while the front face of each molded substrate Sb (that is, that face to which the protective film 67 is attached) faces downward. The substrate supply section 3 pushes out molded substrates Sb one by one from the magazine M1, which stores two or more molded substrates Sb, to supply molded substrates Sb one by one to the positioning section 4.

[0066]

The positioning section 4 places on a rail section 4a a molded substrate Sb as pushed out from the substrate supply section 3 to position the molded substrate Sb. The positioning section 4 then conveys the molded substrate Sb as positioned to a cutting table 5.

[0067]

Before or after the positioning section 4 conveys the molded substrate Sb to a cutting table 5, the cutting apparatus 1 activates the corresponding second vacuum pump D2. Activating the second vacuum pump D2 causes the molded substrate Sb to be sucked by the holder 5a and fixed to the cutting table 5.

[0068]

After the second vacuum pump D2 sucks the molded substrate Sb on the cutting table 5 for fixation, a first position determining camera 5d captures an image of the molded substrate Sb to determine the position of the molded substrate Sb. Then, the

cutting table 5 moves along the Y axis toward a spindle 6. After the cutting table 5 reaches a position under the spindle 6, the cutting apparatus 1 causes the cutting table 5 and the spindle 6 to move relative to each other to cut the molded substrate Sb along the cutting portions 68 (see Fig. 1) for singulation into two or more electronic parts Sc (singulating step). Then, a second position determining camera 6c captures an image of the electronic parts Sc as necessary to determine, for example, which portions the spindle 6 has cut and the widths of the cuts.

[0069]

After the spindle 6 finishes cutting the molded substrate Sb, the cutting table 5 moves away from the spindle 6 along the Y axis while sucking the electronic parts Sc. While the cutting table 5 is moving as such, a first cleaner 5e washes and dries the back face of each electronic part Sc.

[0070]

Next, the conveying section 7 sucks from above the electronic parts Sc that the cutting table 5 is holding. The conveying section 7 sucks the electronic parts Sc and conveys the electronic parts Sc to the inspection table 11 of the inspection/storage module B1. While the conveying section 7 is conveying the electronic parts Sc as such, a second cleaner 7a washes and dries the front face of each electronic part Sc.

[0071]

The inspection table 11 holds the electronic parts Sc for the first and second optical inspection cameras 12 and 13 to optically inspect the electronic parts Sc. The inspection table 11 is movable along the X axis. The inspection table 11 is also invertible upside down.

[0072]

The first optical inspection camera 12 captures an image of the front face of each electronic part Sc as the conveying section 7 conveys the electronic parts Sc to the inspection table 11. Then, the conveying section 7 places the electronic parts Sc onto a holder (not illustrated in the drawings) of the inspection table 11. After the holder sucks the electronic parts Sc, the cutting apparatus 1 inverts the inspection table 11 upside down. After the inverted inspection table 11 moves to a position above the second optical inspection camera 13, the second optical inspection camera 13 captures an image of the back face of each electronic part Sc.

[0073]

The cutting apparatus 1 fixes the two or more inspected electronic parts Sc together to the contact plate 77 of the fixing jig 75 of the placement mount 70 of the placement section 14 while they are arranged as they were after the spindle 6 cut the

molded substrate Sb. The present embodiment fixes the two or more electronic parts Sc to the contact plate 77 of the fixing jig 75 of the placement mount 70 while the back face of each electronic part Sc (that is, that face on which the electrodes are disposed in Fig. 1) faces the contact plate 77, so that the electronic parts Sc are placed on the contact plate 77 (see Fig. 8 as well). Fig. 9 illustrates two or more electronic parts Sc on the placement mount 70. The first cut product group Sc1 mentioned above refers to a set of those two or more electronic parts Sc among the two or more electronic parts Sc on the placement mount 70 which are positioned obliquely relative to each other (that is, whose cutting portions 68 do not face each other) and which are each marked with "X" in Fig. 9. The second cut product group Sc2 refers to a set of those two or more electronic parts Sc which are positioned obliquely relative to each other (that is, whose cutting portions 68 do not face each other) and which are each not marked with "X" in Fig. 9. The two or more electronic parts Sc on the placement mount 70 each belong to either the first cut product group Sc1 or the second cut product group Sc2.

[0074]

The two or more electronic parts Sc include two or more electronic parts Sc that are not adjacent to each other and that each correspond to a drawing hole connected to either the first drawing path or the second drawing path. Specifically, the first cut product group Sc1 includes electronic parts Sc that are not adjacent to each other and that are each disposed over a hole among those suction drawing holes 77c in the contact plate 77 which are connected to the first drawing path, the hole being connected to a first drawing hole 71c1. Those electronic parts Sc of the first cut product group Sc1 which are not adjacent to each other are positioned obliquely relative to each other. Specifically, the second cut product group Sc2 includes electronic parts Sc that are not adjacent to each other and that are each disposed over a hole among those suction drawing holes 77c in the contact plate 77 which are connected to the second drawing path, the hole being connected to a first drawing hole 71c2. Those electronic parts Sc of the second cut product group Sc2 which are not adjacent to each other are positioned obliquely relative to each other. In other words, any electronic part Sc of the first cut product group Sc1 is adjacent to electronic parts Sc of the second cut product group Sc2 along the X and Y axes, whereas any electronic part Sc of the first cut product group Sc1 is positioned obliquely relative to other electronic parts Sc of the first cut product group Sc1. Stated differently, those electronic parts Sc of the first and second cut product groups Sc1 and Sc2 are adjacent to each other along the X or Y axis across cutting portions 68 (see Fig. 1) having been cut by a spindle 6 and facing each other, whereas those electronic parts Sc of the first cut product group Sc1 or the second cut product group Sc2 are positioned obliquely relative

to each other across no cutting portions 68 facing one another.

[0075]

The control section 50, in the above state on the placement mount 70, activates the first vacuum pump D1 and switches the switching valve 78 to draw air through both the first branch flow path VR11 (which is connected to the first drawing path) and the second branch flow path VR12 (which is connected to the second drawing path). As illustrated in the left portion of Fig. 9, this causes the electronic parts Sc of both the first and second cut product groups Sc1 and Sc2 to be sucked and fixed to the placement mount 70 (see "Sucked").

[0076]

Next, the control section 50 switches the switching valve 78 to stop drawing air through the first branch flow path VR11 and continue drawing air through the second branch flow path VR12 alone. As illustrated in the right portion of Fig. 9, this unfixes the first cut product group Sc1 from the placement mount 70 (see "Not sucked") and allows the second cut product group Sc2 to remain fixed to the placement mount 70 (see "Sucked").

[0077]

As illustrated in Fig. 8, with the first cut product group Sc1 unfixed from the placement mount 70, the extraction section 15 conveys two or more electronic parts Sc of the first cut product group Sc1 on the placement mount 70 to a tray (first conveying step). The extraction section 15 repeats sucking and conveying some of the two or more electronic parts Sc until the extraction section 15 conveys all the first cut product group Sc1. During this operation, the two or more electronic parts Sc of the second cut product group Sc2 remain fixed to the placement mount 70. Even if the first cut product group Sc1 includes an electronic part Sc connected to an electronic part Sc of the second cut product group Sc2 with a burr 67a of the protective film 67, the extraction section 15 will not move the electronic part Sc of the second cut product group Sc2 when conveying the electronic part Sc of the first cut product group Sc1. Rather, the conveyance will remove the burr 67a from the electronic part Sc of the second cut product group Sc2 for the burr 67a to be conveyed together with the electronic part Sc of the first cut product group Sc1.

[0078]

The extraction section 15 conveys electronic parts Sc of the first cut product group Sc1 onto the non-defective item tray 15a or the defective item tray 15b on the basis of the result of the inspection by the first and second optical inspection cameras 12 and 13 to store non-defective electronic parts Sc on the non-defective item tray 15a and defective electronic parts Sc on the defective item tray 15b.

[0079]

In response to the extraction section 15 finishing conveying all the electronic parts Sc of the first cut product group Sc1 onto a tray, the control section 50 switches the switching valve 78 to stop drawing air not only through the first branch flow path VR11 but also through the second branch flow path VR12. This unfixes the second cut product group Sc2 from the placement mount 70 (see "Not sucked"). The extraction section 15 then separates the two or more electronic parts Sc of the second cut product group Sc2 on the placement mount 70 into non-defective items and defective items and conveys the two or more electronic parts Sc onto the non-defective item tray 15a or the defective item tray 15b in a manner similar to that for the first cut product group Sc1 (second conveying step). The extraction section 15 again repeats sucking and conveying some of the two or more electronic parts Sc until the extraction section 15 conveys all the second cut product group Sc2. This allows all the two or more electronic parts Sc resulting from singulation of a molded substrate Sb to be conveyed and stored on the non-defective item tray 15a or the defective item tray 15b.

[0080]

As described above, in conveying two or more electronic parts Sc, the extraction section 15 conveys the two or more electronic parts Sc of the first cut product group Sc1 while the second cut product group Sc2 is sucked and fixed to the placement mount 70. Even if an electronic part Sc of the first cut product group Sc1 has a burr 67a of the protective film 67 connected to the protective film 67 or burr 67a of an electronic part Sc of the second cut product group Sc2 which electronic part Sc is adjacent to the electronic part Sc of the first cut product group Sc1 along the X or Y axis, the above configuration prevents the electronic part Sc of the second cut product group Sc2 from being moved from the portion at which the electronic part Sc of the second cut product group Sc2 is fixed to the placement mount 70, when the extraction section 15 conveys the electronic part Sc of the first cut product group Sc1. The above configuration separates the burr 67a on the electronic part Sc of the first cut product group Sc1 from the electronic part Sc of the second cut product group Sc2 for the burr 67a to be conveyed together with the electronic part Sc of the first cut product group Sc1. The above configuration thereby allows the electronic parts Sc of the first cut product group Sc1 to be sucked and conveyed without moving the electronic parts Sc of the second cut product group Sc2.

[0081]

[Alternative Embodiments]

The description below deals with embodiments alternative to the embodiments described above. For ease of understanding, the description below uses the same terms

and reference signs as in the description of the above embodiments for similar elements.

[0082]

(1) The embodiment described above is configured such that the two or more electronic parts Sc are each so arranged on the placement mount 70 that that face on which the electrodes are disposed faces the first plate 71 and is in contact with the first plate 71 and that the protective film 67 faces upward. The two or more electronic parts Sc may alternatively be each so arranged that the protective film 67 faces the first plate 71 and is in contact with the first plate 71.

[0083]

(2) The embodiment described above is configured such that the two or more electronic parts Sc are separated into first and second cut product groups Sc1 and Sc2. The two or more electronic parts Sc may alternatively be separated into three or more cut product groups as long as no electronic part Sc of a cut product group is adjacent to another electronic part Sc of the same cut product group along the X or Y axis. This alternative embodiment will need drawing paths in a number corresponding to the number of the cut product groups.

[0084]

(3) The embodiment described above is configured such that the electronic parts Sc are disposed on and fixed to the contact plate 77 of the placement mount 70. The placement mount 70 may alternatively exclude the contact plate 77 so that the electronic parts Sc are disposed directly on the first plate 71.

[0085]

(4) The embodiment described above is configured such that the first and second plates 71 and 72 have first and second grooves 71d and 72d to form a first drawing path. The first drawing path may alternatively be present in only either the first grooves 71d or the second grooves 72d as long as the first drawing path causes a sufficiently small pressure loss in air drawn.

[0086]

(5) The embodiment described above is configured such that the first plate 71 has a single first drawing hole 71c for each electronic part Sc. The first plate 71 may alternatively have two or more first drawing holes 71c for each electronic part Sc. The first plate 71 may also have for each electronic part Sc first drawing holes 71c1 and first drawing holes 71c2 in respective numbers different from each other.

[0087]

(6) The embodiment described above is configured such that the electronic parts Sc of the first cut product group Sc1 are disposed over suction drawing holes 77c

connected to first drawing holes 71c1 and that the electronic parts Sc of the second cut product group Sc2 are disposed over suction drawing holes 77c connected to first drawing holes 71c2. This disclosure is, however, not limited to such a configuration, and may be configured such that the electronic parts Sc of the first cut product group Sc1 are disposed over suction drawing holes 77c connected to first drawing holes 71c2 and that the electronic parts Sc of the second cut product group Sc2 are disposed over suction drawing holes 77c connected to first drawing holes 71c1.

[0088]

(7) The embodiment described above is configured such that a molded substrate Sb (that is, an object to be cut) is provided with a protective film 67 attached to only one face. A molded substrate Sb may alternatively be provided with a protective film 67 attached to each face.

[0089]

(8) The embodiment described above is configured such that a molded substrate Sb (that is, an object to be cut) is provided with a protective film 67 attached thereto. The cutting apparatus 1 as the embodiment described above is effective also for an object to be cut to which a protective film 67 is not attached. The cutting apparatus 1 is particularly useful in such a case as where the object to be cut is made of a material that tends to cause the object to be cut to have burrs when singulated or where electronic parts have burrs so large that the burrs of mutually adjacent electronic parts are easily joined to each other.

[0090]

[Summary of Above Embodiments]

The description below summarizes the method for producing a cut product (Sc), the fixing jig (75), and the cutting apparatus (1) each described above as an embodiment.

[0091]

<1> A method as an aspect for producing a cut product (Sc) includes: singulating an object to be cut (Sb) into a plurality of cut products (Sc) by cutting the object to be cut with a cutting mechanism (5, 6); fixing, while keeping an arrangement of the plurality of cut products (Sc) after the singulation, conveying the plurality of cut products (Sc) together and fixing the plurality of cut products (Sc) onto a fixing jig (75); first conveying unfixing only a first cut product group (Sc1) made up of some of the plurality of cut products (Sc) fixed to the fixing jig (75) and causing a conveying mechanism (15) to suck the first cut product group (Sc1) and convey the first cut product group (Sc1) to a container (15a, 15b); and second conveying, after the first conveying, unfixing a second cut product group (Sc2) made up of some of the plurality of cut products (Sc) fixed to the fixing jig (75) which are other than the first cut product group (Sc1) and causing the

conveying mechanism (15) to suck the second cut product group (Sc2) and convey the second cut product group (Sc2) to the container (15a, 15b).

[0092]

The method as this aspect for producing a cut product (Sc) includes: first conveying unfixing only a first cut product group (Sc1) made up of some of the plurality of cut products (Sc) fixed to the fixing jig (75) and causing a conveying mechanism (15) to suck the first cut product group (Sc1) and convey the first cut product group (Sc1) to a container (15a, 15b); and second conveying, after the first conveying, unfixing a second cut product group (Sc2) made up of some of the plurality of cut products (Sc) fixed to the fixing jig (75) which are other than the first cut product group (Sc1) and causing the conveying mechanism (15) to suck the second cut product group (Sc2) and convey the second cut product group (Sc2) to the container (15a, 15b). The method causes the cut products (Sc) of the second cut product group (Sc2) to be sucked and remain fixed to the fixing jig (75) while conveying the cut products (Sc) of the first cut product group (Sc1). Even if the first cut product group (Sc1) includes a cut product (Sc) connected to a cut product (Sc) of the second cut product group (Sc2) for a reason after the cutting mechanism (5, 6) cuts the object to be cut (Sb), the above configuration prevents the cut product (Sc) of the second cut product group (Sc2) from being accidentally conveyed together with the cut product (Sc) of the first cut product group (Sc1) or moved from the position at which the cut product (Sc) of the second cut product group (Sc2) is fixed, when the conveying mechanism (15) conveys the cut products (Sc) of the first cut product group (Sc1).

[0093]

<2> The method for producing a cut product (Sc) according to <1> above may preferably be further configured such that the object to be cut (Sb) is a plate provided with a film (67) attached to at least one face of the plate for protecting the object to be cut (Sb).

[0094]

If the object to be cut (Sb) is provided with a film (67) attached thereto, the film (67) on a cut product (Sc) of the first cut product group (Sc1) may have a burr (67a) connected to a cut product (Sc) of the second cut product group (Sc2) due to adhesive force after the cutting mechanism (5, 6) cuts the object to be cut (Sb). In such a case, the cut product (Sc) of the second cut product group (Sc2) may be accidentally conveyed together with the cut product (Sc) of the first cut product group (Sc1) or moved from the position at which the cut product (Sc) of the second cut product group (Sc2) is fixed, when the conveying mechanism (15) conveys the cut products (Sc) of the first cut product

group (Sc1). However, even if the first cut product group (Sc1) includes a cut product (Sc) connected to a cut product (Sc) of the second cut product group (Sc2) after the cutting, the method as this aspect for producing a cut product (Sc) causes the cut product (Sc) of the second cut product group (Sc2) to remain fixed to the fixing jig (75) and thereby prevents the cut product (Sc) of the second cut product group (Sc2) from being accidentally conveyed together with the cut product (Sc) of the first cut product group (Sc1) or moved from the position at which the cut product (Sc) of the second cut product group (Sc2) is fixed, when the conveying mechanism (15) conveys the cut products (Sc) of the first cut product group (Sc1).

[0095]

<3> The method for producing a cut product (Sc) according to <1> or <2> above may preferably be further configured such that the fixing jig (75) has a plurality of drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c) configured to draw air to fix the plurality of cut products (Sc) individually to the fixing jig (75), the plurality of drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c) being each connected to one of a first drawing path and a second drawing path that allow passage of the air independently of each other, the first conveying involves blocking the air from passing through the first drawing path, and the second conveying involves blocking the air from passing through the second drawing path.

[0096]

The method involves a first drawing path and a second drawing path and simply controls passage of air through the first and second drawing paths independently of each other to fix and unfix the cut products (Sc) of the first cut product group (Sc1) and those of the second cut product group (Sc2) to and from the fixing jig (75).

[0097]

<4> A fixing jig (75) as an aspect is a fixing jig (75) for fixing a plurality of cut products (Sc), which result from cutting a plurality of mutually intersecting linear cutting portions (68) of a plate-shaped object to be cut (Sb), while keeping an arrangement of the plurality of cut products (Sc) after the cutting, the fixing jig (75) including: a plurality of drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c) configured to draw air to fix the plurality of cut products (Sc) individually to the fixing jig (75); and a first drawing path and a second drawing path that allow passage of the air independently of each other, wherein the plurality of drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c) are each connected to the first drawing path or the second drawing path, and those cut products (Sc) among the plurality of cut products (Sc) which are not adjacent to each other correspond to respective drawing holes among the plurality of drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c)

which respective drawing holes are each connected to one of the first drawing path and the second drawing path.

[0098]

With the above configuration, those two or more cut products (Sc) among the two or more cut products (Sc) whose cutting portions (68) do not face each other correspond to respective drawing holes (77c, 71c, 71c1, 71c2, 72c, 73c) in the fixing jig (75) which are each connected to one of the first drawing path and the second drawing path. Unfixing cut products (Sc) from the fixing jig (75) through one of the first drawing path and the second drawing path allows conveyance of those two or more cut products (Sc) whose cutting portions (68) do not face each other. In other words, the fixing jig (75) keeps fixing one of the two or more cut products (Sc) whose cutting portions (68) face each other to prevent the two or more cut products (Sc) from being conveyed together. Even if two or more cut products (Sc) whose cutting portions (68) face each other adjacently are connected to each other for a reason after a cutting mechanism (6) cuts the object to be cut (Sb), the above configuration prevents cut products (Sc) adjacent to each other from being accidentally conveyed together or moved from the respective positions at which the cut products (Sc) are fixed.

[0099]

<5> The fixing jig (75) according to <4> above may preferably further include: a contact plate (77); a first plate (71); a second plate (72); a third plate (73); and a fourth plate (74), wherein the fourth plate (74), the third plate (73), the second plate (72), the first plate (71), and the contact plate (77) are stacked upward in this order, a plate surface of the contact plate (77) opposite to a side on which the first plate (71) is stacked serves as a placement face (77a) on which to place the plurality of cut products (Sc), the first drawing path is formed in at least one of the first plate (71) and the second plate (72), the second drawing path is formed in at least one of the third plate (73) and the fourth plate (74), a drawing hole (77c, 71c, 71c1) among the plurality of drawing holes to which drawing hole (77c, 71c, 71c1) the first drawing path is connected is formed in the contact plate (77) and the first plate (71), and a drawing hole (77c, 71c, 71c2, 72c, 73c) among the plurality of drawing holes to which drawing hole (77c, 71c, 71c2, 72c, 73c) the second drawing path is connected extends from the contact plate (77) to the third plate (73).

[0100]

The fixing jig (75) simply includes a stack of two or more plates to have a first drawing path and a second drawing path independent of each other.

[0101]

<6> The fixing jig (75) according to <5> above may preferably be further

configured such that the first drawing path extends from the first plate (71) to the second plate (72).

[0102]

The above configuration allows the fixing jig (75) for cut products (Sc) to have a first drawing path with a large cross-sectional area and have a small pressure loss in air passing.

[0103]

<7> The fixing jig (75) according to <5> or <6> above may preferably be further configured such that the third plate (73) has a face facing the fourth plate (74) and having a plurality of grooves (73d) as the second drawing path, and the drawing hole (77c, 71c, 71c2, 72c, 73c) to which the second drawing path is connected is connected to the plurality of grooves (73d).

[0104]

The fixing jig (75) configured as above is such that with the third plate (73) and the fourth plate (74) stacked on top of each other, those drawing holes (77c, 71c, 71c2, 72c, 73c) which are connected to the second drawing path are connected to the two or more grooves (73d) and not blocked by the fourth plate (74) even if the third plate (73) and the fourth plate (74) are in contact with each other.

[0105]

<8> A cutting apparatus (1) as an aspect includes: a cutting mechanism (6) configured to cut a plurality of mutually intersecting linear cutting portions (68) of a plate-shaped object to be cut (Sb) for singulation into a plurality of cut products (Sc); and a placement mount (70) including a fixing jig (75) according to any one of <4> to <7> above.

[0106]

The cutting apparatus (1), as described above, includes: a cutting mechanism (6) configured to cut cutting portions (68) of a plate-shaped object to be cut (Sb) for singulation into a plurality of cut products (Sc); and a placement mount (70) including a fixing jig (75) for fixing the cut products (Sc) resulting from the cutting. This configuration allows the cutting apparatus (1) to move the two or more cut products (Sc) resulting from the cutting to the fixing jig (75) of the placement mount (70) and fix the two or more cut products (Sc) to the fixing jig (75) while keeping the arrangement of the two or more cut products (Sc) after the cutting, and then unfix the cut products (Sc) from the fixing jig (75) through one of the first drawing path and the second drawing path to convey those two or more cut products (Sc) whose cutting portions (68) do not face each other.

Industrial Applicability

[0107]

This disclosure is applicable to a method for producing a cut product, a fixing jig, and a cutting apparatus.

Reference Signs List

[0108]

1	Cutting apparatus
6	Spindle (cutting mechanism)
15	Extraction section (conveying mechanism)
15a	Non-defective item tray (container)
15b	Defective item tray (container)
61	Element
67	Protective film (film)
68	Cutting portion
70	Placement mount
71	First plate
71c, 71c1, 71c2	First drawing hole (drawing hole)
71d	First groove (first drawing path)
72	Second plate
72c	Second drawing hole (drawing hole)
72d	Second groove (first drawing path)
72g	Second drawing end hole (first drawing path)
73	Third plate
73c	Third drawing hole (drawing hole)
73d	Third groove (second drawing path)
73g	Third drawing end hole (first drawing path)
74	Fourth plate
74c	Fourth drawing hole (second drawing path)
74g	Fourth drawing end hole (first drawing path)
75	Fixing jig
76d	Depression (second drawing path)
76g	Drawing end hole (first drawing path)
76m	First discharge hole (first drawing path)
76n	Second discharge hole (second drawing path)
76p1	Connection hole (first drawing path)

76p2	Connection hole (first drawing path)
76p3	Connection hole (first drawing path)
77	Contact plate
77a	Upper face (placement face)
77c	Suction drawing hole (drawing hole)
Sb	Molded substrate (object to be cut)
Sc	Electronic part (cut product)
Sc1	First cut product group
Sc2	Second cut product group

Claims

1. A method for producing a cut product,
the method comprising:
singulating an object to be cut into a plurality of cut products by cutting the object to be cut with a cutting mechanism;
fixing the plurality of cut products onto a fixing jig by conveying the plurality of cut products together while keeping an arrangement of the plurality of cut products after the singulation;
first conveying unfixing only a first cut product group made up of some of the plurality of cut products fixed to the fixing jig and causing a conveying mechanism to suck the first cut product group and convey the first cut product group to a container; and
second conveying, after the first conveying, unfixing a second cut product group made up of some of the plurality of cut products fixed to the fixing jig which are other than the first cut product group and causing the conveying mechanism to suck the second cut product group and convey the second cut product group to the container.

2. The method according to claim 1, wherein
the object to be cut is a plate provided with a film attached to at least one face of the plate for protecting the object to be cut.

3. The method according to claim 1 or 2, wherein
the fixing jig has a plurality of drawing holes configured to draw air to fix the plurality of cut products individually to the fixing jig, the plurality of drawing holes being each connected to one of a first drawing path and a second drawing path that allow passage of the air independently of each other,
the first conveying involves blocking the air from passing through the first drawing path, and
the second conveying involves blocking the air from passing through the second drawing path.

4. A fixing jig for fixing a plurality of cut products, which result from cutting a plurality of mutually intersecting linear cutting portions of an object to be cut, while

keeping an arrangement of the plurality of cut products after the cutting,

the fixing jig comprising:

a plurality of drawing holes configured to draw air to fix the plurality of cut products individually to the fixing jig; and

a first drawing path and a second drawing path that allow passage of the air independently of each other,

wherein the plurality of drawing holes are each connected to the first drawing path or the second drawing path, and

those cut products among the plurality of cut products which are not adjacent to each other correspond to respective drawing holes among the plurality of drawing holes which respective drawing holes are each connected to one of the first drawing path and the second drawing path.

5. The fixing jig according to claim 4, further comprising:

a contact plate;

a first plate;

a second plate;

a third plate; and

a fourth plate,

wherein the fourth plate, the third plate, the second plate, the first plate, and the contact plate are stacked upward in this order,

a plate surface of the contact plate opposite to a side on which the first plate is stacked serves as a placement face on which to place the plurality of cut products,

the first drawing path is formed in at least one of the first plate and the second plate,

the second drawing path is formed in at least one of the third plate and the fourth plate,

a drawing hole among the plurality of drawing holes to which drawing hole the first drawing path is connected is formed in the contact plate and the first plate, and

a drawing hole among the plurality of drawing holes to which drawing hole the second drawing path is connected extends from the contact plate to the third plate.

6. The fixing jig according to claim 5, wherein

the first drawing path extends from the first plate to the second plate.

7. The fixing jig according to claim 5 or 6, wherein

the third plate has a face facing the fourth plate and having a plurality of grooves as the second drawing path, and

the drawing hole to which the second drawing path is connected is connected to the plurality of grooves.

8. A cutting apparatus, comprising:

a cutting mechanism configured to cut a plurality of mutually intersecting linear cutting portions of a plate-shaped object to be cut for singulation into a plurality of cut products; and

a placement mount including a fixing jig according to any one of claims 4 to 7.