DESCRIPTION

TITLE OF INVENTION: ELECTRONIC COMPONENT PROCESSING DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to an electronic component processing device.

BACKGROUND ART

[0002] Patent Literature 1 discloses an electronic component mounting method in which a suction nozzle and a needle are moved such that a center of a chip, a center of the suction nozzle configured to suction the chip, and a center of the needle configured to push the chip toward the suction nozzle coincide with each other.

CITATION LIST

PATENT LITERATURE

[0003] Patent Literature 1: JP-A-2009-044044

SUMMARY OF INVENTION

[0004] The present disclosure relates to a device effective for simplifying a configuration configured to align a position of an electronic component, a position of a suction unit that picks up the electronic component, and a position of a pushing unit that pushes the electronic component toward the suction unit.

[0005] An electronic component processing device according to one aspect of the present disclosure includes: a sheet holding unit configured to hold a sheet including an attachment surface to which an electronic component is attached; a plurality of suction units arranged along a circular track passing through a suction region in which the electronic component is sandwiched between the suction units and the sheet; a turning unit configured to hold the plurality of suction units; a turning driving unit configured to turn the turning unit around a rotation axis fixed along a central axis of the circular track; a pushing unit arranged to sandwich the sheet between the pushing unit and the electronic component and configured to push the sheet toward the suction region; a sheet position adjustment unit configured to change a position of the sheet holding unit in a direction along the attachment surface; and a pushing position adjustment unit configured to change a position of the pushing unit in the

direction along the attachment surface.

BRIEF DESCRIPTION OF DRAWINGS

[0006] Fig. 1 is a plan view schematically showing an electronic component processing device.

Fig. 2 is a side view of a pick-up unit.

Fig. 3 is a cross-sectional view taken along line III-III in Fig. 2.

Fig. 4 is a cross-sectional view taken along line IV-IV in Fig. 3.

Fig. 5 is a block diagram showing an example of a functional configuration of a controller.

Fig. 6 is a block diagram showing an example of a hardware configuration of the controller.

Fig. 7 is a flowchart showing an example of a calibration procedure.

Fig. 8 is a flowchart showing an example of a pick-up procedure.

Fig. 9 is a flowchart showing an example of a transfer procedure.

Fig. 10 is a flowchart showing an example of an imaging procedure of an electronic component.

DESCRIPTION OF EMBODIMENTS

[0007] An embodiment will be described in detail with reference to the drawings. In the description, the same elements or elements having the same function are denoted by the same reference numeral, and redundant description thereof will be omitted.

[0008] [Processing Device] An electronic component processing device 1 according to the present embodiment is a so-called die sorter, which is a device that performs processing such as visual inspection, electrical characteristics test, and marking while conveying an electronic component W formed in a preceding process such as dicing, and then packages the electronic component W in a tape, a container tube, or the like. As shown in Figs. 1 and 2, the processing device 1 includes a conveyance device 10, a plurality of processing units 20, and a controller 200.

[0009] The conveyance device 10 conveys the electronic component W along a circular track CR1. The electronic component W to be conveyed has two main surfaces Wa and Wb parallel to each other. The conveyance device 10 includes a turntable 11, a plurality of holding units 12, a turning driving unit 13, and a plurality of elevation driving units 18. The

turntable 11 is provided to be rotatable around a vertical rotation axis Ax1. The plurality of holding units 12 are arranged at equal intervals along a circumference centered on the rotation axis Ax1, and are fixed to the turntable 11. Each of the plurality of holding units 12 holds the electronic component W. The holding unit 12 may hold the electronic component W by any method. Specific examples of the method of holding the electronic component W include vacuum suction, electrostatic suction, and gripping. For example, the holding unit 12 vacuum-suctions one of the main surfaces Wa and Wb (for example, the main surface Wa) from one side in a direction orthogonal to the turntable 11 (a direction parallel to the rotation axis Ax1).

[0010] As an example, each holding unit 12 includes a suction nozzle 15, a holder 16, and a spring 17. The suction nozzle 15 vacuum-suctions the main surface Wa of the electronic component W from above. For example, the suction nozzle 15 is arranged perpendicular to the turntable 11, and a lower end portion of the suction nozzle 15 is opened vertically downward. The holder 16 is fixed to an outer peripheral portion of the turntable 11, and holds the suction nozzle 15 so as to enable lifting and lowering thereof. The spring 17 resists lowering of the suction nozzle 15 by an elastic force thereof. When a downward external force is applied to an upper end portion of the suction nozzle 15, the spring 17 is elastically deformed in accordance with the lowering of the suction nozzle 15. When the downward external force is no longer applied to the upper end portion of the suction nozzle 15, the spring 17 elastically returns and pushes back the suction nozzle 15 to a height before the lowering.

[0011] The turning driving unit 13 uses, for example, an electric motor as a power source, and turns the turntable 11 around the rotation axis Ax1 by direct drive without gearing. As a result, the plurality of holding units 12 are moved around the horizontal circular track CR1 centered on the rotation axis Ax1. The turning driving unit 13 is controlled to repeat rotation and stop of the turntable 11 at the same pitch as an angular pitch (angular pitch around the rotation axis Ax1) between the adjacent holding units 12. Hereinafter, a plurality of positions at which the plurality of holding units 12 are arranged when the turning driving unit 13 stops the turntable 11 are referred to as “a plurality of stop positions SP1”.

[0012] The plurality of elevation driving units 18 individually lift and lower the suction nozzles 15 of the plurality of holding units 12. The plurality of elevation driving units 18 are respectively fixed above the plurality of stop positions SP1 so as not to rotate together with the turntable 11. In a state where each holding unit 12 is located below each elevation

driving unit 18, the elevation driving unit 18 uses an electric motor, an air cylinder or the like as a power source in order to apply a downward force to the upper end portion of the suction nozzle 15. As a result, the suction nozzle 15 is lowered. When the elevation driving unit 18 releases the state where the downward force is applied to the upper end portion of the suction nozzle 15, the suction nozzle 15 is lifted by the elastic force of the spring 17 to a height before the lowering.

[0013] The plurality of processing units 20 are provided so as to correspond to the plurality of stop positions SP1, respectively. It should be noted that the processing unit 20 may not necessarily be provided at all the stop positions SP1. Each processing unit 20 performs predetermined processing on the electronic component W arranged at the stop position SP1 (the stop position SP1 corresponding to the processing unit 20). The “processing” here includes any action of changing a state of the electronic component W. For example, marking or the like on the electronic component W, causing the holding unit 12 to hold the electronic component W, and collecting the electronic component W released by the holding unit 12 correspond to the “processing”. In addition, correction of a position where the electronic component W is held by the holding unit 12 also corresponds to the “processing”. Further, performing certain inspection on the electronic component W also corresponds to the “processing” since a state where inspection data is unknown is changed to a state where the inspection data is known.

[0014] A specific example of the processing unit 20 is a pick-up unit 100. The pick-up unit 100 picks up the electronic component W from a wafer sheet, conveys the electronic component W to the vicinity of one of the stop positions SP1, and transfers the electronic component W to the holding unit 12 at the stop position SP1. Other examples of the processing unit 20 include a position correction unit, a visual inspection unit, an electrical characteristics test unit, a marking unit, a non-defective product collection unit, and a defective product collection unit. The position correction unit corrects the position where the electronic component W is held by the holding unit 12. The visual inspection unit inspects appearance of the electronic component W based on a captured image of the electronic component W. The electrical characteristics test unit inspects electrical characteristics of the electronic component W. Specific examples of the electrical characteristics include electrical resistance between terminals, capacitance, and the like. The marking unit performs marking on the electronic component W by laser marking or the like. The non-defective product collection unit accommodates the electronic component W, which

has no abnormality in all types of inspection, in a tape, a tray, or the like. The defective product collection unit collects the electronic component W, which has abnormality in any one type of the inspection into a box or the like.

[0015] Hereinafter, a configuration of the pick-up unit 100 will be described. As shown in Fig. 2, the pick-up unit 100 includes a sheet holding unit 110, a sheet position adjustment unit 120, a rotary pick-up 130, a pushing unit 150, and a pushing position adjustment unit 160.

[0016] The sheet holding unit 110 holds a sheet including an attachment surface to which the electronic component W is attached. A specific example of the sheet is a wafer sheet 91 to which the electronic component W is attached. The wafer sheet 91 includes an adhesive attachment surface 93 to which a semiconductor wafer is attached. The semiconductor wafer is attached to the attachment surface 93 in a state of being cut into a plurality of the electronic components W (for example, semiconductor chips) by dicing. The main surface Wa of each electronic component W is attached to the attachment surface 93. A ring frame 92 may be attached to a peripheral edge portion of the wafer sheet 91. In this case, the sheet holding unit 110 may also be configured to hold the ring frame 92. The sheet holding unit 110 holds the ring frame 92 around the conveyance device 10 such that the attachment surface 93 stands vertically and faces the rotation axis Ax1.

[0017] The sheet position adjustment unit 120 changes a position of the sheet holding unit 110 in a direction along the attachment surface 93. For example, the sheet position adjustment unit 120 changes the position of the sheet holding unit 110 in two directions in the direction along the attachment surface 93. As an example, the sheet position adjustment unit 120 includes a first driving unit 121 and a second driving unit 122. The first driving unit 121 uses, for example, an electric motor as a power source, and displaces the ring frame 92 in a vertical direction along the attachment surface 93. The second driving unit 122 uses, for example, an electric motor as a power source, and displaces the ring frame 92 in a horizontal direction along the attachment surface 93.

[0018] The rotary pick-up 130 picks up the electronic components W one by one from the wafer sheet 91 held by the sheet holding unit 110, conveys the electronic components W, and transfers the electronic components W to the holding unit 12. The rotary pick-up 130 is arranged below the turntable 11 between the rotation axis Ax1 and the sheet holding unit 110.

[0019] For example, the rotary pick-up 130 includes a plurality of suction units 131, a turning unit 132, and a turning driving unit 133. The plurality of suction units 131 are

arranged along a circular track CR2. The circular track CR2 is arranged such that each electronic component W on the attachment surface 93 is located between the circular track CR2 and the wafer sheet 91. The electronic component W to be picked up by the rotary pick-up 130 is located between a suction region A1 and the wafer sheet 91. In other words, a position between the suction region A1 and the wafer sheet 91 is a position for arranging the electronic component W to be picked up. The circular track CR2 is along a vertical plane including the rotation axis Ax1. The plane is perpendicular to the attachment surface 93 held by the sheet holding unit 110. The plurality of suction units 131 may be arranged at equal intervals (equal angular pitches around the rotation axis Ax1) along the circular track CR2. Although Fig. 2 shows a case where four suction units 131 are arranged each at a pitch of 90°, the number of the suction units 131 is not limited to four.

[0020] The circular track CR2 further passes through a transfer region A2. In other words, the transfer region A2 is beside the suction region A1 along the circular track CR2. The transfer region A2 is located at an uppermost portion of the circular track CR2. A position of the transfer region A2 coincides with the stop position SP1 corresponding to the pick-up unit 100. Hereinafter, this stop position SP1 is referred to as a “transfer stop position SP1”. The rotary pick-up 130 transfers the electronic component W from the suction unit 131 located in the transfer region A2 to the holding unit 12. In other words, the conveyance device 10 acquires the electronic component W from any one of the suction units 131 in the transfer region A2 and conveys the electronic component W. For example, the conveyance device 10 suctions the electronic component W in the transfer region A2 by the holding unit 12 arranged at the transfer stop position SP1.

[0021] The plurality of suction units 131 may be arranged in such a manner that when any one of the suction units 131 is located in the suction region A1, another one of the suction units 131 is located in the transfer region A2. For example, around a center of the circular track CR2, an interval (angular pitch) between the adjacent suction units 131 coincides with an interval (angular pitch) between the suction region A1 and the transfer region A2.

[0022] Each suction unit 131 suctions the electronic component W to be picked up. The suction unit 131 may suction the electronic component W by any method. Specific examples of the method of suctioning the electronic component W include vacuum suction, electrostatic suction, and the like. For example, the suction unit 131 includes a suction nozzle 134. The suction nozzle 134 is opened outward in a radial direction of the circular track CR2 and vacuum-suctions the main surface Wb of the electronic component W.

[0023] The turning unit 132 holds the plurality of suction units 131. The turning driving unit 133 turns the turning unit 132 around a rotation axis Ax2 fixed along a central axis of the circular track CR2. The turning driving unit 133 uses, for example, an electric motor as a power source, and turns the turning unit 132 around the rotation axis Ax2 by direct drive without gearing. The turning driving unit 133 is fixed around the rotation axis Ax1 such that the rotation axis Ax2 is not displaced relative to the rotation axis Ax1.

[0024] The rotary pick-up 130 may further include a plurality of buffering portions 135. The plurality of buffering portions 135 are respectively interposed between the turning driving unit 133 and the plurality of suction units 131. Each buffering portion 135 retracts each suction unit 131 in response to an inward external force (an external force toward the rotation axis Ax2) acting on the suction unit 131 (the suction unit 131 corresponding to the buffering portion 135). Here, “retract” means to displace toward the rotation axis Ax2. Each buffering portion 135 includes a spring 136. The spring 136 resists retraction of the suction nozzle 134 by an elastic force thereof. When an inward external force is applied to the suction nozzle 134, the spring 136 is elastically deformed in response to the retraction of the suction nozzle 134, and, when the inward external force is no longer applied, the spring 136 elastically returns and pushes back the suction nozzle 134 to a position before the retraction.

[0025] The pushing unit 150 is arranged such that the wafer sheet 91 is located between the pushing unit 150 and the electronic component W to be picked up. The pushing unit 150 pushes the wafer sheet 91 and the electronic component W to be picked up toward the suction region A1. The pushing unit 150 includes a pushing pin 151 that protrudes toward a back surface 94 of the wafer sheet 91 (a back surface of the attachment surface 93). The pushing pin 151 extends along a line (hereinafter referred to as a “pushing line”) 152 perpendicular to the attachment surface 93 and the back surface 94. The pushing unit 150 uses, for example, an electric motor or the like as a power source, and causes the pushing pin 151 to advance or retreat along the pushing line 152.

[0026] The pushing position adjustment unit 160 changes a position of the pushing unit 150 in the direction along the attachment surface 93 (a direction along a plane parallel to the attachment surface 93). For example, the pushing position adjustment unit 160 changes the position of the pushing unit 150 in two directions in the direction along the attachment surface 93. As an example, the pushing position adjustment unit 160 includes a first driving unit 161 and a second driving unit 162. The first driving unit 161 uses, for example, an electric

motor as a power source, and displaces the pushing unit 150 in the vertical direction along the plane parallel to the attachment surface 93. The second driving unit 162 uses, for example, an electric motor as a power source, and displaces the pushing unit 150 in the horizontal direction along the plane parallel to the attachment surface 93.

[0027] The pick-up unit 100 may further include a first imaging unit 170. The circular track CR2 further passes through a first imaging region A3 whose image is to be captured by the first imaging unit 170. In other words, the first imaging region A3 is beside the suction region A1 along the circular track CR2. The first imaging unit 170 is arranged so as to capture an image of the first imaging region A3 from a radially outer side of the circular track CR2, and captures an image of the electronic component W or the suction unit 131 located in the first imaging region A3. For example, the first imaging unit 170 includes a camera 171. The camera 171 includes an imaging element such as a charge coupled device (CCD) image sensor or a complementary metal oxide semiconductor (CMOS) image sensor, and a lens that forms an image on the imaging element. The camera 171 is arranged such that the first imaging region A3 is located between the camera 171 and the rotation axis Ax2. The lens of the camera 171 faces the first imaging region A3. In Fig. 2, the first imaging region A3 is located at a lowermost portion of the circular track CR2.

[0028] The pick-up unit 100 may further include a second imaging unit 180. The second imaging unit 180 captures an image of the suction region A1 from a radially inner side of the circular track CR2. To capture an image from the radially inner side means that an optical path from the suction region A1 to a position where the image captured by the second imaging unit 180 is formed passes through a viewpoint located on an inner periphery of the circular track CR2. The position where the image captured by the second imaging unit 180 is formed may not necessarily be located on the inner periphery of the circular track CR2.

[0029] In order to provide the viewpoint for imaging the suction region A1 on the inner periphery of the circular track CR2, the turning unit 132 may include a cavity formed in the center of the circular track CR2 and a window that is provided between the adjacent suction units 131 and guides light from the outside of the turning unit 132 into the cavity. For example, as shown in Figs. 3 and 4, the turning unit 132 includes a tubular portion 137, a turning plate 138, and a plurality of windows 139. The tubular portion 137 surrounds the rotation axis Ax2 so as to form a cavity 141, and holds the plurality of suction units 131. The tubular portion 137 has a cylindrical shape, and a central axis thereof coincides with the rotation axis Ax2. Hereinafter, among both ends of the tubular portion 137, an end closer to

the turning driving unit 133 is referred to as a “driving end”, and an end on a side opposite to the turning driving unit 133 is referred to as an “opening end”. The turning plate 138 closes the driving end of the tubular portion 137 and is connected to the turning driving unit 133. The plurality of windows 139 are formed in the tubular portion 137, and are alternately arranged with the plurality of suction units 131. In other words, each window 139 is formed between the adjacent suction units 131. The window 139 is, for example, a through hole, which introduces light into the cavity 141 from the outside of the tubular portion 137.

[0030] The second imaging unit 180 captures an image of the suction region A1 from the cavity 141 through the window 139. For example, the second imaging unit 180 includes a mirror 181 and a camera 182. The mirror 181 is provided in the cavity 141. The mirror 181 reflects the light introduced into the cavity 141 from the suction region A1 by the window 139 toward the opening end of the tubular portion 137. The mirror 181 may be any mirror as long as the mirror includes a reflective surface that reflects the light toward the opening end of the tubular portion 137. The mirror 181 may be a plate-like mirror, or may be a prism configured and arranged such that one surface thereof serves as the reflective surface. The camera 182 captures an image of the suction region A1 via the mirror 181. For example, the camera 182 includes an imaging element such as a CCD image sensor or a CMOS image sensor, and a lens that forms an image on the imaging element. The camera 182 is arranged outside the cavity 141 such that the lens faces the opening end of the tubular portion 137. Therefore, the light reflected toward the opening end by the mirror 181 is incident on the lens of the camera 182. In this way, by providing the mirror 181 in the cavity 141, the optical path passing through the viewpoint located on the inner periphery of the circular track CR2 is formed. The camera 182 can be arranged in any manner as long as the camera 182 can capture an image passing through the viewpoint located on the inner periphery of the circular track CR2. For example, the camera 182 may be arranged inside the cavity 141, or may be arranged outside the circular track CR2.

[0031] The controller 200 is configured to intermittently turn the turning unit 132 by the turning driving unit 133 so as to sequentially arrange the plurality of suction units 131 in the suction region A1. In addition, the controller 200 is configured to control the sheet position adjustment unit 120 such that a position of the electronic component W is aligned with a position of the suction unit 131 and control the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the suction unit 131 each time when any one of the suction units 131 is arranged in the suction region A1.

[0032] For example, as shown in Fig. 5, as functional configurations (hereinafter, referred to as "functional blocks"), the controller 200 includes a turning control unit 211, a first imaging control unit 212, a reference position calculation unit 213, a second imaging control unit 214, a component position calculation unit 215, a third imaging control unit 216, a pushing position calculation unit 217, a position information storage unit 218, a fourth imaging control unit 219, an alignment control unit 221, a suction control unit 222, a transfer control unit 223, and a conveyance control unit 224. Hereinafter, each functional block will be described. Processing executed by each functional block corresponds to processing executed by the controller 200.

[0033] The turning control unit 211 causes the turning driving unit 133 to intermittently turn the turning unit 132 so as to sequentially arrange the plurality of suction units 131 in the suction region A1. Intermittent turning means to repeat turning and stop. For example, the turning control unit 211 starts from a state where any one of the suction units 131 is arranged in the suction region A1 and causes the turning driving unit 133 to intermittently turn the turning unit 132 at the same pitch as the angular pitch between the adjacent suction units 131. In addition, the turning control unit 211 turns the turning unit 132 in a direction (clockwise direction in Fig. 2) in which each suction unit 131 sequentially passes through the suction region A1, the first imaging region A3, and the transfer region A2.

[0034] The first imaging control unit 212 causes the first imaging unit 170 to acquire an image of the suction unit 131 in the first imaging region A3 in a state where any one of the plurality of suction units 131 is located in the first imaging region A3 without holding the electronic component W.

[0035] The reference position calculation unit 213 calculates a position when the suction unit 131 is arranged in the suction area A1 based on the image of the suction unit 131 acquired in the first imaging unit 170 by the first imaging control unit 212 (hereinafter, simply referred to as the "image of the suction unit 131"). The reference position calculation unit 213 calculates the position of the suction unit 131 in the first imaging region A3 (hereinafter, referred to as an "actual position of the suction unit 131") based on the image of the suction unit 131. Thereafter, the reference position calculation unit 213 calculates an error of the actual position of the suction unit 131 with reference to a design position of the suction unit 131 in the first imaging region A3 (hereinafter, referred to as an "ideal position of the suction unit 131"). Thereafter, the reference position calculation unit 213 adds the error to the design position of the suction unit 131 in the suction region A1 to calculate the position of the

suction unit 131 in the suction region A1. For example, the reference position calculation unit 213 calculates the position of the suction unit 131 in two directions along the attachment surface 93 (along the plane parallel to the attachment surface 93). As an example, the reference position calculation unit 213 calculates the position of the suction unit 131 in the vertical direction and the horizontal direction on the plane parallel to the attachment surface 93. The position of the suction unit 131 may be a position of any portion of the suction unit 131. For example, the position of the suction unit 131 is a center position of the suction nozzle 134.

[0036] The second imaging control unit 214 causes the second imaging unit 180 to acquire an image of the electronic component W in a state where the electronic component W to be picked up is located between the suction region A1 and the wafer sheet 91. For example, the second imaging control unit 214 causes the second imaging unit 180 to acquire an image of the suction region A1 through the window 139 when the window 139 is located between the cavity 141 and the suction region A1. As a result, the image of the electronic component W to be picked up is acquired by the second imaging unit 180 through the suction region A1.

[0037] The component position calculation unit 215 calculates the position of the electronic component W based on the image of the electronic component W acquired in the second imaging unit 180 by the second imaging control unit 214. For example, the component position calculation unit 215 calculates the position of the electronic component W in two directions along the attachment surface 93. As an example, the component position calculation unit 215 calculates the position of the electronic component W in the vertical direction and the horizontal direction on the attachment surface 93. The position of the electronic component W may be a position of any portion of the electronic component W. For example, the position of the electronic component W is a center position of the electronic component W.

[0038] The third imaging control unit 216 causes the second imaging unit 180 to acquire an image of the pushing unit 150 through the suction region A1 in a state where the wafer sheet 91 is not located between the second imaging unit 180 and the pushing unit 150.

[0039] The pushing position calculation unit 217 calculates the position of the pushing unit 150 based on the image of the pushing unit 150 acquired in the second imaging unit 180 by the third imaging control unit 216. For example, the pushing position calculation unit 217 calculates the position of the pushing unit 150 in two directions along the attachment surface 93 (along the plane parallel to the attachment surface 93). As an example, the pushing

position calculation unit 217 calculates the position of the pushing unit 150 in the vertical direction and the horizontal direction on the plane parallel to the attachment surface 93. The position of the pushing unit 150 may be a position of any portion of the pushing unit 150. For example, the position of the pushing unit 150 is a center position of the pushing pin 151.

[0040] The position information storage unit 218 stores the position calculated by the reference position calculation unit 213 for each suction unit 131, and stores the position calculated by the pushing position calculation unit 217.

[0041] The fourth imaging control unit 219 causes the first imaging unit 170 to acquire the image of the electronic component W in the first imaging region A3 in a state where any one of the plurality of suction units 131 holds the electronic component W and is located in the first imaging region A3. The image captured by the fourth imaging control unit 219 is used for, for example, visual inspection of the main surface Wa of the electronic component W.

[0042] The alignment control unit 221 controls the sheet position adjustment unit 120 such that the position of the electronic component W to be picked up is aligned with the position of the suction unit 131, and controls the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the suction unit 131 each time when any one of the suction units 131 is arranged in the suction region A1. For example, the alignment control unit 221 controls the sheet position adjustment unit 120 such that the center position of the electronic component W to be picked up is aligned with the center position of the suction nozzle 134 in the direction along the attachment surface 93 based on the position calculated by the reference position calculation unit 213 and the position calculated by the component position calculation unit 215. In addition, the alignment control unit 221 controls the pushing position adjustment unit 160 such that the center position of the pushing pin 151 is aligned with the center position of the suction nozzle 134 in the direction along the attachment surface 93 based on the position calculated by the reference position calculation unit 213 and the position calculated by the pushing position calculation unit 217.

[0043] In a state where the position of the electronic component W to be picked up and the position of the pushing unit 150 are aligned with the position of the suction unit 131 in the suction region A1, the suction control unit 222 controls the pushing unit 150 such that the electronic component W is pushed out into the suction region A1 by the pushing pin 151, and controls the rotary pick-up 130 such that the electronic component W is suctioned by the suction unit 131 in the suction region A1. Further, the suction control unit 222 controls the pushing unit 150 such that the pushing pin 151 is retracted in the state where the electronic

component W to be picked up is suctioned by the suction unit 131. As a result, the wafer sheet 91 returns to an original position while the electronic component W is left in the suction region A1.

[0044] The transfer control unit 223 controls the rotary pick-up 130 such that the electronic component W is released in the transfer region A2 in a state where any one of the plurality of suction units 131 holds the electronic component W and is located in the transfer region A2, and controls the conveyance device 10 to acquire the electronic component W in the transfer region A2.

[0045] For example, at the transfer stop position SP1, the transfer control unit 223 causes the elevation driving unit 18 to lower the holding unit 12 until the holding unit 12 comes into contact with the electronic component W in the transfer region A2, causes the holding unit 12 to suction the electronic component W, and causes the elevation driving unit 18 to lift the holding unit 12 to a height before the lowering. In addition, by the time when the holding unit 12 which has suctioned the electronic component W in the transfer region A2 starts to be lifted, the transfer control unit 223 releases the suction of the electronic component W suctioned by the suction unit 131 in the transfer region A2.

[0046] The conveyance control unit 224 controls the conveyance device 10 such that the electronic component W acquired in the transfer region A2 is conveyed along the circular track CR1. For example, the conveyance control unit 224 causes the turning driving unit 13 to turn the turntable 11 after the lifting of the holding unit 12 that has suctioned the electronic component W in the transfer region A2 is completed.

[0047] Fig. 6 is a block diagram showing an example of a hardware configuration of the controller 200. As shown in Fig. 6, the controller 200 includes a circuit 290. The circuit 290 includes one or more processors 291, a memory 292, a storage 293, and an input and output port 294. The storage 293 includes a computer-readable storage medium such as a hard disk or a nonvolatile semiconductor memory. The storage 293 stores a program for causing the controller 200 to execute the following processes: intermittently turning the turning unit 132 by the turning driving unit 133 so as to sequentially arrange the plurality of suction units 131 in the suction region A1; and controlling the sheet position adjustment unit 120 such that the position of the electronic component W is aligned with the position of the suction unit 131 and controlling the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the suction unit 131 each time when any one of the plurality of suction units 131 is arranged in the suction region A1. For

example, the storage 293 stores a program for causing the controller 200 to implement each of the above-described functional blocks.

[0048] The memory 292 temporarily stores a program loaded from the storage 293 and a calculation result calculated by the processor 291. The processor 291 executes the program in cooperation with the memory 292 so as to cause the controller 200 to implement each functional block. The input and output port 294 performs input and output of electric signals between the turning driving unit 133, the sheet position adjustment unit 120, the pushing position adjustment unit 160, the pushing unit 150, the suction unit 131, the holding unit 12, the elevation driving unit 18, the turning driving unit 13, and the like in accordance with a command from the processor 291. It should be noted that the circuit 290 is not necessarily limited to have a configuration in which each function is implemented by a program. For example, at least a part of functions of the circuit 290 may be implemented by a dedicated logic circuit or an application specific integrated circuit (ASIC) in which the dedicated logic circuit is integrated.

[0049] [Control Procedure of Processing Device]

Next, as an example of an electronic component processing method, a control procedure executed by the controller 200 will be described by being divided into a calibration procedure, a pick-up procedure, a transfer procedure, and an electronic component imaging procedure.

[0050] (Calibration Procedure)

The calibration procedure is a control procedure of acquiring and storing position information of each suction unit 131 and position information of the pushing unit 150 in the suction region A1 before the pick-up unit 100 picks up the electronic component W. For example, as shown in Fig. 7, the controller 200 first executes steps S01, S02, S03, S04, and S05. In step S01, the turning control unit 211 causes the turning driving unit 133 to start turning of the turning unit 132. In step S02, the first imaging control unit 212 waits for the suction unit 131 that does not hold the electronic component W to be arranged in the first imaging region A3. In step S03, the first imaging control unit 212 causes the first imaging unit 170 to acquire the image of the suction unit 131 in the first imaging region A3. In step S04, the reference position calculation unit 213 calculates the position when the suction unit 131 is arranged in the suction region A1 based on the image of the suction unit 131 acquired in the first imaging unit 170 by the first imaging control unit 212, and records the position in the position information storage unit 218. In step S05, the first imaging control unit 212

checks whether the position when the suction unit 131 is arranged in the suction region A1 has been calculated and recorded for all the suction units 131.

[0051] When it is determined in step S05 that there is any suction unit 131 for which the calculation of the position has not been completed, the controller 200 returns the process to step S02, and performs the imaging of the next suction unit 131 and the calculation and recording of the position.

[0052] When it is determined in step S05 that the calculation and recording of the position have been completed for all the suction units 131, the controller 200 executes steps S06, S07, S08, and S09. In step S06, the third imaging control unit 216 waits for the second imaging unit 180 to become capable of capturing the image of the pushing unit 150. For example, the third imaging control unit 216 waits for the window 139 to be arranged between the cavity 141 and the suction region A1. In step S07, the third imaging control unit 216 causes the second imaging unit 180 to acquire the image of the pushing unit 150. In step S08, the pushing position calculation unit 217 calculates the position of the pushing unit 150 based on the image of the pushing unit 150 acquired in the second imaging unit 180 by the third imaging control unit 216, and records the position in the position information storage unit 218. In step S09, the turning control unit 211 causes the turning driving unit 133 to stop turning of the turning unit 132. As described above, the calibration procedure is completed.

[0053] (Pick-up Procedure)

The pick-up procedure is a control procedure of causing the pick-up unit 100 to sequentially pick up the electronic component W from the wafer sheet 91. For example, as shown in Fig. 8, the controller 200 first executes steps S11, S12, S13, S14, and S15. In step S11, the turning control unit 211 causes the turning driving unit 133 to start turning of the turning unit 132. In step S12, the alignment control unit 221 causes the sheet position adjustment unit 120 to move the sheet holding unit 110 such that the electronic component W to be picked up is arranged between the suction region A1 and the wafer sheet 91. In step S13, the second imaging control unit 214 waits for the second imaging unit 180 to become capable of capturing the image of the electronic component W to be picked up. For example, the second imaging control unit 214 waits for the window 139 to be arranged between the cavity 141 and the suction region A1. In step S14, the second imaging control unit 214 causes the second imaging unit 180 to acquire the image of the electronic component W to be picked up. In step S15, the component position calculation unit 215 calculates the position of the electronic component W based on the image of the electronic component W acquired in

the second imaging unit 180 by the second imaging control unit 214.

[0054] Next, the controller 200 executes steps S16, S17, and S18. In step S16, the alignment control unit 221 starts to control the sheet position adjustment unit 120 such that the position of the electronic component W to be picked up is aligned with the position when the next suction unit 131 is arranged in the suction region A1 (hereinafter, referred to as a "position of the next suction unit 131"), and to control the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the next suction unit 131. For example, the alignment control unit 221 reads the position of the next suction unit 131 and the position of the pushing unit 150 from the position information storage unit 218. The alignment control unit 221 controls the sheet position adjustment unit 120 such that the position of the electronic component W is aligned with the position of the next suction unit 131 based on the position of the next suction unit 131 read from the position information storage unit 218 and the position of the electronic component W calculated by the component position calculation unit 215. In addition, the alignment control unit 221 controls the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the next suction unit 131 based on the position of the next suction unit 131 read from the position information storage unit 218 and the position of the pushing unit 150 read from the position information storage unit 218.

[0055] In step S17, the suction control unit 222 waits for the next suction unit 131 to be arranged in the suction region A1. In step S18, the suction control unit 222 waits for the position of the electronic component W to be picked up and the position of the pushing unit 150 to be aligned with the position of the next suction unit 131.

[0056] Next, the controller 200 executes steps S21, S22, and S23. In step S21, the suction control unit 222 controls the pushing unit 150 such that the electronic component W is pushed out into the suction region A1 by the pushing pin 151. In step S22, the suction control unit 222 causes the suction unit 131 in the suction region A1 to suction the electronic component W pushed out into the suction region A1. In step S23, the suction control unit 222 retracts the pushing pin 151. As a result, the wafer sheet 91 returns to the original position while the electronic component W is left in the suction region A1. Thereafter, the controller 200 returns the process to step S12. Thereafter, by repeating steps S12 to S23, the plurality of electronic components W on the wafer sheet 91 are sequentially picked up by the pick-up unit 100.

[0057] (Transfer Procedure)

The transfer procedure is a control procedure of causing the conveyance device 10 and the pick-up unit 100 to transfer the electronic component W in the transfer region A2. For example, as shown in Fig. 9, the controller 200 executes steps S31, S32, S33, S34, and S35. In step S31, the transfer control unit 223 waits for the suction unit 131 that suctions the electronic component W to be arranged in the transfer region A2. In step S32, the transfer control unit 223 causes the elevation driving unit 18 to lower the holding unit 12 at the transfer stop position SP1 until the holding unit 12 comes into contact with the electronic component W in the transfer region A2. In step S33, the transfer control unit 223 causes the holding unit 12 to suction the electronic component W in the transfer region A2, and releases the suction of the electronic component W suctioned by the suction unit 131 in the transfer region A2. In step S34, the transfer control unit 223 causes the elevation driving unit 18 to lift the holding unit 12 that has suctioned the electronic component W in the transfer region A2 up to the height before the lowering. In step S35, the conveyance control unit 224 causes the turn driving unit 13 to turn the turntable 11 by one pitch. As a result, the electronic component W suctioned by the holding unit 12 in the transfer region A2 is conveyed, and the next holding unit 12 is arranged at the transfer stop position SP1. Thereafter, the controller 200 returns the process to step S31. Thereafter, the transfer of the electronic component W in the transfer region A2 is repeated.

[0058] (Electronic Component Imaging Procedure)

The electronic component imaging procedure is a control procedure of causing the first imaging unit 170 to sequentially capture images of the electronic component W in the first imaging region A3. For example, as shown in Fig. 10, the controller 200 executes steps S41 and S42. In step S41, the fourth imaging control unit 219 waits for the suction unit 131 that has suctioned the electronic component W to be arranged in the first imaging region A3. In step S42, the fourth imaging control unit 219 causes the first imaging unit 170 to acquire the image of the electronic component W in the first imaging region A3. Thereafter, the controller 200 returns the process to step S41. Thereafter, the imaging of the electronic component W in the first imaging region A3 is repeated. As described above, the image of the electronic component W is used for, for example, the visual inspection of the main surface Wa of the electronic component W and the like.

[0059] As described above, the processing device 1 includes: the sheet holding unit 110 configured to hold the wafer sheet 91 including the attachment surface 93 to which the electronic component W is attached; the plurality of suction units 131 arranged along the

circular track CR2 passing through the suction region A1 in which the electronic component W is sandwiched between the suction units 131 and the wafer sheet 91; the turning unit 132 configured to hold the plurality of suction units 131; the turning driving unit 133 configured to turn the turning unit 132 around the rotation axis Ax2 fixed along the central axis of the circular track CR2; the pushing unit 150 arranged to sandwich the wafer sheet 91 between the pushing unit 150 and the electronic component W and configured to push the wafer sheet 91 toward the suction region A1; the sheet position adjustment unit 120 configured to change the position of the sheet holding unit 110 in the direction along the attachment surface 93; and the pushing position adjustment unit 160 configured to change the position of the pushing unit 150 in the direction along the attachment surface 93.

[0060] According to the processing device 1, the positions of the electronic component W and the pushing unit 150 can be changed according to individual differences between the positions of the suction units 131, and the positions of each suction unit 131, the electronic component W, and the pushing unit 150 can be aligned. As a result, pick-up failure caused by positional deviation between the suction unit 131, the electronic component W, and the pushing unit 150 can be prevented. Here, in a case where the position of the suction unit 131 is changed in order to align the positions of the three components, a configuration of changing the position of the suction unit 131 in the suction region A1 is required in addition to a configuration of replacing the suction unit 131 in the suction region A1 (the turning unit 132 and the turning driving unit 133), and thus a configuration of the device becomes complicated. In contrast, the processing device 1 that changes the positions of the electronic component W and the pushing unit 150 is effective for simplifying the configuration configured to align the positions of the three components.

[0061] The processing device 1 may further include the first imaging unit 170 arranged to image the first imaging region A3 beside the suction region A1 along the circular track CR2 from the radially outer side of the circular track CR2. In this case, the first imaging unit 170 can be shared for grasping appearance of the electronic component W held by the suction unit 131 and grasping the position of the suction unit 131. Therefore, the configuration of the device is more effectively simplified.

[0062] The processing device 1 may further include the second imaging unit 180 that captures the image of the suction region A1 from the radially inner side of the circular track CR2. In this case, the alignment can be performed based on the position of the electronic component W viewed (captured) from the side of the suction unit 131 that serves as a

reference for aligning the positions of the three components. Therefore, accuracy of the alignment can be more effectively improved.

[0063] The processing device 1 may further include the turning control unit 211 that intermittently turns the turning unit 132 by the turning driving unit 133 so as to sequentially arrange the plurality of suction units 131 in the suction region A1, and the alignment control unit 221 that controls the sheet position adjustment unit 120 such that the position of the electronic component W is aligned with the position of the suction unit 131 and controls the pushing position adjustment unit 160 such that the position of the pushing unit 150 is aligned with the position of the suction unit 131 each time when any one of the plurality of suction units 131 is arranged in the suction region A1. In this case, the positions of the three components can be automatically aligned in accordance with individual differences in the positions of the suction units 131.

[0064] The processing device 1 may further include the conveyance device 10 that acquires the electronic component W from any one of the plurality of suction units 131 in the transfer region A2 beside the suction region A1 along the circular track CR2 and conveys the electronic component W, and the plurality of suction units 131 may be arranged such that, when any one of the suction units 131 is located in the suction region A1, another one of the suction units 131 is located in the transfer region A2. In this case, the suction of the electronic component W in the suction region A1 and the transfer of the electronic component W in the transfer region A2 can be simultaneously performed at least partially by using a configuration in which the positions of the three components can be aligned without displacing the suction unit 131, and thus processing time can be shortened.

[0065] Although the embodiment has been described above, the present invention is not necessarily limited to the above-described embodiment, and various modifications can be made without departing from the spirit of the present invention.

[0066] According to the present disclosure, there is provided a device effective for simplifying a configuration configured to align a position of an electronic component, a position of a suction unit that picks up the electronic component, and a position of a pushing unit that pushes the electronic component toward the suction unit.

[0067] The present application is based on Japanese Patent Application No. 2019-187451 filed on October 11, 2019, and the contents thereof are incorporated by reference in the present application.

REFERENCE SIGNS LIST

[0068] 1... processing device, W... electronic component, 10... conveyance device, 110... sheet holding unit, 120... sheet position adjustment unit, 150... pushing unit, 160... pushing position adjustment unit, 91... wafer sheet, 93... attachment surface, 131... suction unit, 132... turning unit, 133... turning driving unit, A1... suction region, CR2... circular track, A2... transfer region, Ax2... rotation axis, 170... first imaging unit, A3... first imaging region, 180... second imaging unit, 139... window, 141... cavity, 211... turning control unit, 221... alignment control unit.

CLAIMS

[Claim 1]

An electronic component processing device comprising:

a sheet holding unit configured to hold a sheet including an attachment surface to which an electronic component is attached;

a plurality of suction units arranged along a circular track passing through a suction region;

a turning unit configured to hold the plurality of suction units;

a turning driving unit configured to turn the turning unit around a rotation axis fixed along a central axis of the circular track;

a pushing unit configured to push the sheet toward the suction region;

a sheet position adjustment unit configured to change a position of the sheet holding unit in directions along the attachment surface; and

a pushing position adjustment unit configured to change a position of the pushing unit in the directions along the attachment surface,

wherein the suction region is arranged such that the electronic component is located between the suction region and the sheet, and

wherein the pushing unit is arranged such that the sheet is located between the pushing unit and the electronic component.

[Claim 2]

The electronic component processing device according to claim 1, further comprising:

a first imaging unit,

wherein the first imaging unit is configured to capture an image of a first imaging region from a radially outer side of the circular track, and

wherein the first imaging region is provided beside the suction region along the circular track.

[Claim 3]

The electronic component processing device according to claim 1 or 2, further comprising:

a second imaging unit,

wherein the second imaging unit is configured to capture an image of the suction region from a radially inner side of the circular track.

[Claim 4]

The electronic component processing device according to any one of claims 1 to 3, further comprising:

a turning control unit configured to intermittently turn the turning unit by the turning driving unit so as to sequentially arrange the plurality of suction units in the suction region; and

an alignment control unit configured to control the sheet position adjustment unit such that a position of the electronic component is aligned with a position of the suction unit and control the pushing position adjustment unit such that the position of the pushing unit is aligned with the position of the suction unit, each time when one of the plurality of suction units is arranged in the suction region.

[Claim 5]

The electronic component processing device according to any one of claims 1 to 3, further comprising:

a conveyance device configured to acquire the electronic component from any one of the plurality of suction units in a transfer region arranged beside the suction region along the circular track, and to convey the electronic component,

wherein the plurality of suction units are arranged such that when any one of the suction units is located in the suction region, another one of the suction units is located in the transfer region.