

TRANSFER APPARATUS

FIELD OF THE INVENTION

The present invention relates to a transfer apparatus which picks up an electronic device from a retainer, and which loads the picked-up electronic device on another retainer.

BACKGROUND

Conventionally, transfer apparatuses which pick up an electronic device from a retainer, put the picked-up electronic device on a carrying path, perform various processes on the electronic device at respective process point placed on the carrying path, and eventually loads the processed electronic device on another retainer have been proposed, and are applied in actual electronic device manufacturing processes.

Electronic devices are parts utilized in electronic products, and include semiconductor elements. Example such semiconductor elements are a transistor, an LED, an integrated circuit, and other examples are a resistor and a capacitor. The retainer is, for example, a wafer sheet, a lead frame, an organic substrate, an inorganic substrate, a tray with adhesiveness, a substrate, a parts feeder, or a package container like a tape with pockets, a tray, or a sorting bottle. Various processes, such as visual inspection, application of bond, posture check, sorting, forcible ejection of a defective product, mounting on a substrate, electrical property test, temperature adjustment

like heating or cooling, shaping of a terminal that extends from the electronic device, correction of the posture, and marking, etc., are performed on the electronic device at the respective process points.

5 In particular, a transfer apparatus which picks up a semiconductor element from a wafer sheet, a tray, a tape or a parts feeder, turns over the semiconductor element, and bonds the semiconductor element to a lead frame or a mount substrate with a bond is called a die-bonder apparatus.

10 An example known type of this transfer apparatus includes plural rotary tables and rotary pickups, supplies the electronic device through the rotary pickups, and transfers the electronic device at a position where the holders of the rotary tables are arranged in the same straight
15 line, thereby forming a single carrying path (see, for example, Patent Documents 1 to 3).

 An explanation will be given to clarify the difference between the rotary table and the rotary pickup. First, the rotary table is, for example, a turret table, and
20 is utilized as a main carrying path. Second, in order to place the large number of process points for the electronic device, the rotary table is large in size and heavy in weight in comparison with the rotary pickup. Third, a processing unit that processes the electronic device is disposed below the
25 rotary table at the process point, and thus holding means that holds the electronic device is hung down so as to be perpendicular to the table plane. In contrast, the rotary pickup is, first, intended to supply the electronic device

to the main carrying path, and conventionally does not form the main carrying path. Second, in comparison with the rotary table, the rotary pickup is compact and lightweight. Third, holding means that holds the electronic device is disposed
5 in parallel with the rotation plane, and the tip of the holding means is always directed outwardly. That is, the rotary pickup is intended to supply the electronic device to the rotary table, while the rotary table forms the main carrying path of the electronic device, and thus both have different
10 applications, kinds, and sizes.

The transfer apparatus disclosed in Patent Document 1 includes a pickup unit and a rotary head. The pickup unit and the rotary head respectively have plural nozzles which are disposed along the respective circumferences and which
15 extend in the orthogonal direction to the circumferential plane. Those pickup unit and rotary head are disposed in the vertical direction so as to have the respective outer circumferences partially overlapped, and transfer the electronic device through the overlapping portions. The
20 pickup unit can not only rotate the nozzle horizontally but also turns over the nozzle by 180 degrees. Hence, when the pickup unit receives the electronic device at the lower location, and passes the electronic device to the rotary head at the upper location, and thus a turnover process is
25 accomplished.

In addition, according to the transfer apparatus disclosed in Patent Document 2, equal to or greater than three rotary tables with different sizes are disposed horizontally,

and the holders extend in the orthogonal direction to the circumferential plane. This transfer apparatus also has the rotary tables disposed in the vertical direction, and the outer circumferences of those tables are partially overlapped.

According to the transfer apparatus disclosed in Patent Document 3, a holder unit that is a large-size rotary table is disposed horizontally, while an absorption unit that is a small-size rotary pickup is disposed vertically.

According to this transfer apparatus, also, the absorption unit is intended to supply the electronic device to the holder unit, and the holder unit receives the electronic device from the supply unit, and forms the main carrying path of the electronic device. Hence, those have different applications, kinds, and sizes. However, this transfer apparatus also has the holder unit and the absorption unit disposed in the vertical direction, and the respective outer circumferences thereof are partially overlapped.

[Related Technical Documents]

[Patent Documents]

Patent Document 1: JP2000-315856A

Patent Document 2: JP 2667712 B

Patent Document 3: JP2011-66277A

SUMMARY OF THE INVENTION

25 TECHNICAL PROBLEM

Among conventional transfer apparatuses, a type which includes plural rotary tables, and which forms a single carrying path by the holders which are provided on the rotary

tables and which transfer the electronic device at a position where those holders are arranged in the same straight line, the respective rotary tables inevitably have an overlap.

Transfer apparatuses need to perform various
5 processes, and it is sometimes desired to place the large number of process points on the carrying path. However, it is difficult to place the process point at the portion where the rotary tables overlap because the other rotary table, a motor, etc., become physical obstacles. Hence, when it is
10 attempted to place a large number of process points, the rotary table must increase the size. In this case, a large space is necessary to install the transfer apparatus.

When the rotary table becomes large, in order to accomplish a rotation speed of the rotary table that is equal
15 to or faster than a certain speed, a large motor is necessary. Hence, the necessary space for installing the transfer apparatus further increases. Still further, it is unavoidable to reduce the rotary table rotation speed without a large motor.

20 As explained above, according to the transfer apparatuses which have the plural rotary tables disposed in the vertical direction so as to overlap one another, the downsizing and the increase of the process points are in the trade-off relationship. Therefore, the present invention
25 has been made to solve the above-explained conventional technical problems, and it is an objective of the present invention to provide a transfer apparatus that can accomplish both downsizing and increase of process points.

SOLUTION TO PROBLEM

In order to solve the above-explained technical problems, a transfer apparatus picks up an electronic device from a first retainer and which loads the electronic device on a second retainer, and the transfer apparatus includes: a holder holding or releasing, through a tip, one surface of the electronic device; and N number of (where $N \geq 2$) rotary pickups including a plurality of the holders around respective rotation axes, and intermittently rotating predetermined angle by predetermined angle around the respective rotation axes so as to always direct the respective tips of the holders outwardly, in which the N number of rotary pickups in conjunction with each other form a main carrying path for the electronic device from the first retainer to the second retainer; and the adjoining rotary pickups: are disposed on, so as not to overlap with each other, a same plane side by side with the respective rotation axes in parallel with each other; and include a common stop point where the respective tips of the holders of the adjoining rotary pickups face with each other, and transfer the electronic device with the stop point being as a transferring point.

Odd numbers of the rotary pickups may be disposed; the rotary pickup disposed corresponding to the first retainer may hold the one surface of the electronic device picked up from the first retainer and carry the electronic device to the transferring point; and the rotary pickup
5 disposed corresponding to the second retainer may hold an opposite surface of the electronic device and release the electronic device to the second retainer at the transferring point.

10 The N number of rotary pickups may be all installed longitudinally in a vertical direction, and have respective vertical rotation planes.

Either one of the adjoining rotary pickups may further include, at the stop position corresponding to the transferring point, a forward-and-retract drive unit that
15 moves forward the holder stopped at the stop position corresponding to the transferring point outwardly in a radial direction becoming apart from the rotation axis; and either one of the holders facing with each at the transferring point
20 may carry the electronic device to be transferred or approach thereto.

The forward-and-retract drive unit may include a motor that generates thrust force to move forward the holder; and the motor may decelerate a moving speed of the forwarding
25 holder toward the other holder facing the forwarding holder.

The forward-and-retract drive unit may include a voice coil motor that controls load to be applied from the forwarding holder to the electronic device to be transferred.

The voice coil motor may apply, to the holder, countervail thrust force to drag force applied from the holder with the holder not reaching yet the electronic device to be transferred, and absorbs shock between the electronic device
5 to be transferred and the holder.

The forward-and-retract drive unit: may include a voice coil motor that applies, to the holder, countervail thrust force to drag force applied from the holder with the holder not reaching yet the electronic device to be
10 transferred; and determine a rotation amount of the motor that moves forward the holder based on a behavior change in the voice coil motor caused by a contact of the holder with the electronic device to be transferred.

The N number of rotary pickups may be all a same
15 assembly based on a same design drawing.

The transfer apparatus may further include a single common bracket that regulates positions of the respective rotation axes of the first and second rotary pickups.

In the N number of rotary pickups, an odd-number
20 order rotary unit and an even-number order rotary unit each may include an imaging optical system that obtains an image of an external appearance of the electronic device.

The first imaging optical system may obtain images of five surfaces of the electronic device other than the one
25 surface; and the second imaging optical system may obtain an image of the one surface of the electronic device. In addition, the first imaging optical system may obtain images of five surfaces of the electronic device other than the

opposite surface; and the second imaging optical system may obtain an image of the opposite surface of the electronic device.

5 The rotary pickup disposed corresponding to the second retainer may include an imaging optical system that obtains an image of a posture of the electronic device; and the second retainer may be moved in two-dimensional directions and rotated so as to be positioned and rotated in accordance with the imaged posture.

10 The first retainer and the second retainer may be ones of followings or a combination thereof: a wafer sheet; a lead frame; an organic substrate; an inorganic substrate; a tray with adhesiveness; a substrate; a parts feeder; a tape with pockets; a tray; and a sorting bottle.

15 The rotary pickup disposed corresponding to the second retainer may include a paste applicator unit that applies a bond to the electronic device.

ADVANTAGEOUS EFFECTS OF INVENTION

20 According to the present invention, a rotary pickup does not have an overlap portion where the process point cannot be placed, and thus more process points can be placed, while at the same time, the rotary pickup does not need to increase the diameter, resulting in space saving. In
25 addition, the downsizing of the rotary pickup enables the longitudinal installation of the rotary pickups in the vertical direction, resulting in downsizing of a motor. Consequently, further space saving can be accomplished.

Still further, downsizing of the rotary pickup can increase the rotation speed of the rotary pickup, thereby improving the carrying speed of an electronic device.

5 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view illustrating an overall structure of a transfer apparatus according to an embodiment;

FIG. 2 is a front view of rotary pickups;

FIG. 3 is a side view of the rotary pickups;

10 FIG. 4 is a top view of the rotary pickups;

FIG. 5 is a perspective view of a forward-and-retract drive unit;

FIG. 6 is a perspective view illustrating a bracket;

15 FIG. 7 is an explanatory diagram for an operation of the transfer apparatus;

FIG. 8 is a perspective view illustrating the movement of a retainer in which an electronic device is loaded;

20 FIG. 9 is an exemplary diagram illustrating an operation of the forward-and-retract drive unit;

FIG. 10 is a top view illustrating the movement of the holder in which the electronic device is loaded;

FIG. 11 is an exemplary diagram illustrating another example transfer apparatus; and

25 FIG. 12 is an exemplary diagram illustrating the other example transfer apparatus.

DETAILED DESCRIPTION

(1. Overall Structure)

A transfer apparatus according to an embodiment of the present invention will be explained in detail with references to accompanying figures. FIG. 1 is a front view illustrating an overall structure of a transfer apparatus 1 according to this embodiment. The transfer apparatus 1 picks up an electronic device W from a retainer 5a, and loads the electronic device W on another retainer 5b through various process points.

The electronic device is a part utilized in electronic products, and example electronic devices are a semiconductor element, and, a resistor and a capacitor other than the semiconductor element. Example semiconductor elements are a discrete semiconductor including a transistor, a diode, an LED, a capacitor, and a thyristor, and an integrated circuit including an IC and an LSI. The retainers 5a, 5b are each, for example, a wafer sheet, a lead frame, an organic substrate, an inorganic substrate, a tray with adhesiveness, a substrate, a parts feeder, or a package container like a tape with pockets, a tray, or a sorting bottle. In this embodiment, the electronic device W is picked up from a tray, and mounted on a substrate.

This transfer apparatus 1 includes double rotary pickups 2a and 2b which have a vertical rotation plane relative to the installation plane. The rotary pickups 2a and 2b intermittently rotate, thereby carrying the electronic devices W along the respective outer circumferences. The

double rotary pickups 2a and 2b share the first half of the carrying path for the electronic device W and the second half thereof, respectively, and transfer the electronic device W there between, thereby forming a continuous carrying path.

5 That is, this transfer apparatus 1 includes, to form a main carrying path, the rotary pickups 2a, 2a which are intended to supply the electronic device to the main carrying path.

Each rotary pickup 2a, 2b includes plural holders 21 that hold or release the electronic device W through the
10 respective tips. The holders 21 are disposed on the same circumference at the same pitch thereon, extend along the radial direction from the center of the circumference, and disposed so as to direct the respective tips outwardly in parallel with the circumferential plane. The rotary pickups
15 2a and 2b rotate the holders 21 holding the respective electronic devices W predetermined angle by predetermined angle around respective rotation axes which pass through the respective circumference centers and which are orthogonal to the radial direction.

20 Both rotary pickups 2a and 2b are disposed side by side, and are disposed in such a way that the respective rotation axes to rotate the holders 21 are in parallel with each other, and have the same disposing plane of the holders 21. In other words, both rotary pickups 2a and 2b have no
25 overlap. In addition, a position where the respective tips of the holders 21 face with each other is a transferring point A of the electronic device W, and the electronic device held by the one holder is passed to the other holder. Hence, the

first half of the carrying path and the second half thereof become continuous.

At the transferring point A, the passing holder 21 (21a) holds a surface of the electronic device W through the tip. That is, an opposite surface R of the electronic device W is directed to the receiving holder 21 (21b) facing the passing holder at the transferring point A. The receiving holder 21 (21b) holds the opposite surface R through the tip, and holds the electronic device W in this posture up to the other retainer 5b together with the rotation of the rotary pickup 2b. That is, the double rotary pickups 2a and 2b are a continuous carrying path from the one retainer 5a to another retainer 5, and are also a turnover mechanism for the electronic device W.

In addition, all stop points for the holders 21 other than the transferring point A have no physical obstacle originating from the overlap of the rotary pickups 2a and 2b. Therefore, each stop point can be set as the process point for the electronic device W.

For example, respective one stage devices 4a and 4b are disposed at respective one process points of the rotary pickups 2a and 2b. The one stage unit 4a moves in parallel with the XY directions while mounting thereon the retainer 5a from which the electronic device W is to be picked up, thereby moving each electronic device W in the retainer 5a to a pickup point B one by one. The other stage unit 4b moves in the XY directions while mounting thereon the retainer 5b in which the electronic device W is to be loaded, thereby

positioning each loading location for the electronic device at a release point C for the electronic device W one by one.

The pickup point B is the closest stop point to the retainer 5a for the holder 21 of the rotary pickup 2a that
5 is the first half of the carrying path, and the release point C is the closest stop point to the retainer 5b for the holder 21 of the rotary pickup 2b that is the second half of the carrying path. In this embodiment, both rotary pickups 2a and 2b are installed longitudinally in the vertical direction,
10 the rotation trajectory of the holder 21 is vertical to the installation plane, and the pickup point B and the release point C are located right below both rotary pickups 2a and 2b.

When the retainer 5b in which the electronic device
15 W is to be loaded is a lead frame or a substrate, the transfer apparatus 1 applies beforehand a solder or a bond like a resin paste to the electronic device W. This transfer apparatus 1 includes a paste applicator unit 3 at a process point of the rotary pickup 2b that is the second half of the carrying
20 path.

In addition, the transfer apparatus 1 performs, while transferring the electronic device W from the one retainer 5a to the other retainer 5b, visual inspection on six surfaces of the transferring electronic device W. This
25 transfer apparatus 1 includes, at respective one process points of the rotary pickups 2a and 2b, respective one imaging optical systems 6 that obtain images of the external appearance of the electronic device.

An imaging optical system 61 disposed on the one rotary pickup 2a guides the images of the five surfaces of the electronic device W to a camera. The remaining surface is held by the holder 21 of the rotary pickup 2a, and is
5 directed toward the rotation center. An imaging optical system 62 disposed on the other rotary pickup 2b guides the image of that remaining surface released from the holder 21 through a turnover operation.

Still further, the transfer apparatus 1 checks the
10 posture of the electronic device W right before this electronic device is loaded on the other retainer 5b, and adjusts the posture of the retainer 5b so as to load the electronic device W on the retainer 5b in an appropriate posture. That is, the stage unit 4b that moves, in the XY
15 directions, the retainer 5b in which the electronic device W is to be loaded can also perform θ rotation in the XY plane, and an imaging optical system 63 that obtains the image of the posture of the electronic device W is disposed at a process point of the rotary pickup 2b that loads the electronic device
20 W on the retainer 5b.

(2. Structure Details)

(Rotary Pickup)

FIG. 2 is a front view of the rotary pickups 2a and 2b, and FIG. 3 is a side view of the rotary pickup 2a, 2b.
25 FIG. 4 is a top view of the rotary pickups 2a and 2b. As illustrated in FIGS. 2 to 4, both rotary pickups 2a and 2b are the same assembly assembled with the same parts based on the same design drawing, and have the same shape, structure,

and size. This is because to precisely align the tips of the holders 21 in the same straight line at the transferring point A. Since those rotary pickups 2a and 2b are compact, the rotary pickups can be installed longitudinally in the
5 vertical direction, and the diameter of each rotary pickup is substantially 5 cm to 30 cm.

The rotary pickups 2a and 2b have the holders 21 disposed at equal pitch on the circumference around an axial frame 22 so as to always direct the tip of the holder 21
10 outwardly. When the axial frame 22 is intermittently rotated around the axis by a motor 23, all holders 21 are simultaneously stopped at the respective rotation angles. The holder 21 is installed on the axial frame 22 through a movable mechanism 24, and can move forward-and-retract in the
15 external direction along the radial direction of the rotary pickup 2, in other words, in the direction becoming apart from the center of the rotary pickup 2a, 2b. In addition, forward-and-retract drive units 25 that apply, to the holders 21, driving force for moving forward or retracting the
20 respective holders are disposed at several stop points for the holders 21. The term, several stop points, indicates the pickup point B, the transferring point A, and the release point C.

The holder 21 is, for example, an absorption nozzle
25 that has an axis along the radial direction of the rotary pickup 2a, 2b. The absorption nozzle is a hollow cylinder having the nozzle tip opened, and directs the nozzle tip outwardly in the radial direction, and, the nozzle interior

is in connected with an air-pressure circuit of a vacuum generator unit via a tube. The absorption nozzle absorbs the electronic device W by negative pressure generated by the vacuum generator unit, and releases the electronic device W
5 by vacuum break or generation of positive pressure.

The axial frame 22 is a cylinder spreading in a substantially disk shape toward one end, is a supporting body for the holders 21, and serves as a rotation axis connected with the motor 23. The cylindrical part of the axial frame
10 22 is coaxially connected with the rotation shaft of the motor 23. More specifically, the rotation shaft of the motor 23 is fitted in the cylindrical part of the axial frame 22, and is fastened thereto by, for example, bolts.

The motor is, for example, a servo motor that
15 includes the rotation shaft, and repeats a rotation at a fixed angle and a stop for a fixed time period alternately. This motor 23 locates any one of the holders 21 at the pickup point B and the release point C right below the rotary pickup, and locates any one of the holders 21 at the transferring point
20 A immediately lateral to rotary pickup.

The rotation angle of the motor 23 is equal to the installation angle of the holder 21. For example, the eight holders 21 are disposed on the same circumference at the same pitch, and the installation angle of the holder 21 is set to
25 be integral multiple of 90 degrees. Hence, the holder 21 can stop at the pickup point B and the release point C right below the rotary pickup, and at the transferring point A immediately lateral to the rotary pickup.

The stop time for the rotation of the motor 23 corresponds to the longest time among the pickup time of the electronic device W, the application time of a bond, the image obtainment time of an external appearance, the ejection time
5 of a defective product, and a loading time including the movement of the stage in accordance with a posture.

The movable mechanism 24 includes a sleeve 24a fastened to a stay that extends along the circumference of the disk part of the axial frame 22, a slide shaft 24b that
10 passes completely through the sleeve so as to be slidable in the radial direction of the pickup, and an arm 24c fastened to an external end of the slide shaft 24b in the radial direction of the pickup. The holder 21 is fastened to this arm 24c. The arm 24c is orthogonally fastened to the slide
15 shaft 24b, and extends in parallel with the rotation axis of the rotary pickup 2a, 2b. The one end of the arm protrudes and extends from the disk surface of the axial frame 22, while the other end extends and reaches the rear surface of the disk part of the axial frame 22. The holder 21 is provided at the
20 one end of the arm 24c that protrudes from the disk surface of the axial frame 22 so as to extend along the radial direction of the rotary pickup 2a, 2b.

(Forward-and-Retract Drive Unit 25)

The forward-and-retract drive units 25 are installed
25 at the pickup point B, the release point C, and the transferring point A, and are disposed at the rear side of the disk part of the axial frame 22 so as to apply driving force to the portion of the arm 24c reaching the rear surface

of the disk part. At the transferring point A, the forward-and-retract drive unit 25 is installed on the one rotary pickup 2b only. That is, a structure is employed in which, at the transferring point A, the one holder 21 (21b) 5 unilaterally approaches the other holder 21 (21a) to transfer the electronic device W therebetween. In addition, a control of, at least at the transferring point A, decelerating the moving speed of the holder 21 (21b) toward the electronic device W, and further decreasing the load to be applied to 10 the electronic device W so as to be zero as close as possible is performed.

This forward-and-retract drive unit 25 applies thrust force that moves forward the holder 21 outwardly in the radial direction of the rotary pickup 2a, 2b, and thrust 15 force that retracts the holder 21 toward the rotation center side in the radial direction. More specifically, the arm 24c to which the holder 21 is fastened is pushed outwardly in the radial direction, thereby moving forward the holder 21 fastened to that arm 24c. In addition, the application of 20 the thrust force to the arm 24c is canceled to obtain the push-back force that returns the slide shaft 24b of the movable mechanism 24 toward the rotation center side in the radial direction, thereby retracting the arm 24c fastened to the slide shaft 24b and the holder 21.

25 More specifically, as illustrated in FIG. 5, the forward-and-retract drive unit 25 includes a sliding member 250 that is movable in the radial direction of the pickup. This sliding member 250 is a flat member in an L shape. The

one plane forming the L shape is a side plate 251 that spreads in the radial direction of the pickup, while the other plane is a top plate 252 that spreads in the rotation axis direction of the rotary pickup 2a, 2b. The top plate 252 is located
5 closer to the rotation center side in the radial direction of the pickup than the side plate 251.

The sliding member 250 is movable in the radial direction of the pickup. In addition, a protrusion support plate 253 is connected to the top plate of 252 of the sliding
10 member 250 so as to face with each other via a spring 25b. The protrusion support plate 253 is located outwardly in the radial direction of the pickup relative to the top plate 252, and a protrusion 25c is provided on the surface of the protrusive support plate at the external side in the radial
15 direction of the pickup. This protrusion 25c is located right above the part of the arm 24 reaching the rear surface of the axial frame 22.

In such a forward-and-retract drive unit 25, when the sliding member 250 moves outwardly in the radial direction
20 of the pickup, the protrusion 25c abuts the arm 24c, and thus the holder 21 can move forward outwardly in the radial direction of the pickup through the arm 24c. In addition, since the protrusion support plate 253 is movable outwardly in the radial direction of the pickup, the load to the
25 electronic device W from the tip of the holder 21 can be adjusted.

As a driving force generating source to move the sliding member 250, a rotation motor 25a, a cylindrical cam

25e, and a cam follower 25f are provided. In addition, as a driving force generating source to apply load to the protrusion support plate 253, a voice coil motor 25g is provided.

5 The cam follower 25f is a cylindrical member, and is provided on the side plate 251 of the sliding member 250 so as to stand upright, thus extending in the rotation axis direction of the pickup. The cylindrical cam 25e includes an axis that extends in the rotation axis direction of the
10 pickup, and this axis is supported via a bearing by the rotation motor 25b that has the fixed position, and, the outer circumference of the cylindrical cam serves as a cam face. The cam face abuts the circumference of the cam follower 25f from the rotation center side in the radial direction of the
15 pickup. The cam face partially includes a cam robe that increases the diameter of the cylindrical cam 25e.

Hence, when the rotation motor 25d is actuated, the cylindrical cam 25e starts rotating, and when the cam follower 25f passes through the cam robe of the cylindrical cam 25e,
20 the distance between the rotation center of the cylindrical cam 25e and the cam follower 25f increases. Since the cylindrical cam 25e abuts the cam follower 25f from the rotation center side in the radial direction of the pickup, the rotation center of the cylindrical cam 25e and the cam
25 follower 25f increases the distance outwardly in the radial direction of the pickup. Hence, the cam follower 25f is pushed down outwardly in the radial direction of the pickup by the cylindrical cam 25e. The cam follower 25f has a

fastened relationship with the sliding member 250, and thus the sliding member 250 is also pushed down outwardly in the radial direction of the pickup. Subsequently, the protrusion 25c abuts the arm 24c, thereby moving forward the holder 21.

The voice coil motor 25g is a linear motor that has a proportional relationship between a current and thrust force, and includes a magnet, toroidal coils, and a rod connected with the toroidal coils. Lorentz force is generated through the toroidal coils by the electromagnetic interaction between the current-applied toroidal coils and the magnet, and the rod moves forward from a motor housing. The voice coil motor 25g is fastened to the top plate 252, and is disposed between the top plate 252 and the protrusion support plate 253. The rod extends outwardly in the radial direction of the pickup, and has the tip connected with the protrusion support plate 253 from the rotation center side in the radial direction of the pickup.

When the voice coil motor 25g is actuated, and thrust force that countervails the total of the compression force of the spring 25b and the reaction force applied from the arm 24c is applied to the rod, this thrust force is applied to the electrical component W through the protrusion support plate 253, the protrusion 25c, the arm 24c, and the tip of the holder 21. In addition, when thrust force that countervails the drag force applied to the rod with the holder 21 not reaching the electronic device W yet, shock generated when the holder 21 reaches the electronic device W can be

absorbed by the retracted rod, and thus load applied to the electronic device W can be substantially zero.

Next, the forward-and-retract drive unit 25 includes, as the thrust force generating source to retract the holder 21, a spring 25h that pushes, toward the rotation center side in the radial direction of the rotary pickup 2a, 2b, the slide shaft 24b that fastens the holder 21 via the arm 24c. As illustrated in FIG. 2, this spring 25h has one end fixed with a seat that is an end of the sleeve 24a of the movable mechanism 24. The end of the sleeve 24a fastened with the spring 25h is an end at the rotation center side in the radial direction of the rotary pickup 2a, 2b. In addition, the slide shaft 24b protrudes from the sleeve 24a toward the rotation center side in the radial direction, and a flange 24d is formed at this protruding part. The other end of the spring 25h is fastened to the flange 24d.

Hence, when the slide shaft 24 moves outwardly in the radial direction of the rotary pickup 2a, 2b, the spring 25h is compressed by the reduction of the gap between the end of the sleeve 24a and the flange 24d of the slide shaft 24b. When the thrust force in the forward direction is canceled, the spring 25h releases the pushing force accumulated by the compression, thereby retracting the holder 21 toward the rotation center side in the radial direction of the pickup of the rotary pickup 2a, 2b through the arm 24c and the slide shaft 24b.

(3. Assemble Adjustment)

(Bracket)

Both rotary pickups 2a and 2b are positioned and assembled by fitting the rotation shaft of the motor 23 in a common bracket 7 that extends vertically from the installation plane. This is because to precisely align the tips of the respective holders 21 in the same straight line at the transferring point A.

FIG. 6 is a perspective view illustrating the bracket 7. The bracket 7 is a flat plate that sustains the positional relationship between both rotary pickups 2a and 2b. A fastening area to fasten the motors 23 of the rotary pickups 2a and 2b with respective one surfaces of those motors being flat to the bracket 7 is formed in the rear surface of the bracket. In addition, the bracket 7 is formed with two through-holes 71 passing completely through the bracket from the front surface to the rear surface. The through-hole 71 serves as a bearing that has substantially same size as the motor shaft of the rotary pickup 2a, 2b.

Both rotary pickups 2a and 2b have the respective motor shafts fitted in the corresponding through-holes 71, the respective motors 23 are fastened to the fastening area, and the respective axial frames 22 to which the holder 21 is attached are fitted with the motor shaft from the front surface side of the bracket 7, and thus both rotary pickups are positioned and fixed.

Note that the through-holes 71 are drilled at the same depth and with the predetermined pitch. The predetermined pitch is a length that is obtained by adding the twice of the radius of the rotary pickup 2a, 2b to the

expected moving distance of the holder 21 and the thickness of the electronic device W. Hence, both rotary pickups 2a and 2b are positioned and supported in such a way that the holders 21 stopped at the immediately lateral position and facing with each other can precisely butt the respective nozzle openings with each other.

(Holder Forwarding Amount Adjustment)

The forwarding amount of the holder 21 by the rotation motor 25d is managed through encoders, but a point at which the tip of the holder 21 abuts the electronic device W, i.e., the stop point for the holder 21 is set in advance by detecting drag force applied to the rod from the voice coil motor 25g. By adjusting the forwarding amount of the holder 21, the holder 21 can be moved at a fast speed, and an application of excessive load to the electronic device W can be avoided.

That is, after both rotary pickups 2a and 2b are assembled, the holder 21b is moved forward outwardly in the radial direction of the pickup at the transferring point A. When the holder 21b moves forward, thrust force that countervails the total of the compression force by the spring 25b and the drag force applied from the arm 24c to the rod is applied in advance to the rod. When the electronic device W is held between the holders 21a and 21b, the rod receives new drag force from the electronic device W, and moves in the retracting direction. The new drag force is equivalent to the weight of the rod and the frictional force after the rod is retracted. An instant of this movement in the retracting

direction is detected, and the rotation amount of the rotation motor 25d is stored in association with combination information of the facing holders 21a and 21b, or stop point information like the transferring point A. As to the forwarding amount adjustment, it is unnecessary to apply the actual electronic device W, and a mock, etc., may be applied.

(4. Operation)

The transfer apparatus 1 operates as follows. First, in this operation example of the transfer apparatus 1, as illustrated in FIG. 7, the respective rotary pickups 2a and 2b have the respective eight holders 21 disposed on the same circumference at the equal pitch, and the stage unit 4a on which the retainer 5a that retains the electronic device W is mounted is disposed right below the rotary pickup 2a which is the first half of the carrying path. In addition, the stage unit 4b on which the retainer 5b that will load the electronic device W is mounted is disposed right below the rotary pickup 2b which is the second half of the carrying path.

Both rotary pickups 2a and 2b rotate counterclockwise. That is, the carrying path for the electronic device W extends from the pickup point B to the transferring point A in the counterclockwise direction, and further extends from the transferring point to the release point C in the counterclockwise direction.

With the pickup point B being as the first point, the imaging optical system 61 for visual inspection on the five surfaces of the electronic device W is disposed at the fifth point that is counted stop point by stop point through

the carrying path. The seventh point is the transferring point A, and the imaging optical system 62 for visual inspection on the remaining surface of the electronic device W is disposed at the eighth point. The paste applicator unit 3 that applies a bond to the electronic device W is disposed at the ninth point which is the vertex of the rotary pickup 2b that is the second half of the carrying path. The imaging optical system 63 that obtains the image of the posture of the electronic device W is disposed at the 11th point. An ejection container 8 where a defective product is ejected is disposed at the 12th point located right before the release point C. Eventually, the 13th point is the release point C.

At the pickup point B that is the first point, the stage unit 4a carries the electronic device W to the pickup point B, and the holder 21 of the rotary pickup 2a located at the first point holds this electronic device W. As illustrated in FIG. 8, the stage unit 4a moves the stage in the XY directions. The order of carrying the electronic device W to the pickup point B is controlled by a control unit (unillustrated).

When, for example, the electronic device W is two-dimensionally retained in the retainer 5a, and the electronic devices W are left in an X row, an X-direction movement mechanism moves the stage by a pitch in one direction, but a Y-direction movement mechanism does not move this stage. When all electronic devices W in the X row are taken out, in order to sequentially move the electronic devices W in the next Y column, the X-direction movement mechanism moves the

stage in the opposite direction by what corresponds to all rows, and the Y-direction movement mechanism moves the stage in one direction by a pitch.

In addition, the forward-and-retract drive unit 25
5 descends the holder 21 toward the electronic device W located at the pickup point B along the radial direction of the rotary pickup 2a. The holder 21 is guided in the radial direction of the pickup by the movable mechanism 24. When the holder 21 abuts one surface of the electronic device W, the vacuum
10 generator unit generates negative pressure in the nozzle, and thus the holder 21 can hold the one surface of the electronic device. When the holder 21 holds the electronic device W, the forward-and-retract drive unit 25 cancels the driving force that moves forward the holder 21. Next, the spring 25h
15 returns the holder 21 that is holding the electronic device to the upper space.

At a visual inspection point D that is the fifth point, the images of external appearance are obtained for the five surfaces of the electronic device W except the one surface
20 held by the holder 21, and the electronic devices are sorted as a good product or a defective product. The imaging optical system 61 has respective prisms which guide the images of the five surfaces to a camera and which are disposed around the electronic device W stopped at the fifth point, and also has
25 the camera including imaging elements like CMOS disposed on the optical extended line for light emitted from the prisms. In addition, the imaging optical system 61 includes a light source to the electronic device W. The light source includes,

for example, LEDs disposed annularly, and light beam passes through the opening. The image of the electronic device W obtained by the camera is subjected to image analysis by an image processor (unillustrated), and is determined whether or not there is a scratch, etc., and information indicating whether the electronic device is a good product or a defective product is associated in accordance with the determination result.

At the transferring point A that is the seventh point, the holder 21b of the rotary pickup 2b that is the second half of the carrying path approaches the electronic device W. The holder 21a that is holding the electronic device W releases the electronic device W by vacuum break or blow, and the approaching holder 21b has negative pressure generated in the nozzle by the vacuum generator, and holds an opposite surface R of the electronic device W directed outwardly in the radial direction of the pickup.

At this time, the forward-and-retract drive unit 25 that is moving forward the holder 21b controls the forwarding speed of the holder 21b and the load applied to the electronic device W by the holder 21b. That is, the rotation motor 25d of the forward-and-retract drive unit 25 decreases the rotation speed as the forwarded holder 21b becomes close to the holder 21a that is holding the electronic device W, decelerates the moving speed of the holder 21b, and when the tip of the holder 21b abuts the electronic device W, sets the moving speed to be zero. The deceleration may be linear or may be performed step by step. Still further, when the holder

21b abuts the electronic device W, the rotation motor 25d of the forward-and-retract drive unit 25 adjusts the thrust force of the voice coil motor 25g to set the load applied to the electronic device to be substantially zero.

5 More specifically, as illustrated in FIG. 9, the forward-and-retract drive unit 25 rotates the cylindrical cam 25e by actuation of the rotation motor 25d. The cam follower 25f passes through the cam robe of the cam face, and thus the sliding member 250 attached to the cam follower 25f is pushed
10 outwardly in the radial direction. The protrusion 25c of the protrusion support plate 253 coupled with the sliding member 250 abuts the arm 24c at a certain time point, and the holder 21b is pushed out together with the arm 24c. The holder 21b is guided by the movable mechanism 24, and is moved forward
15 toward the electronic device W held by the waiting holder 21a.

At this time, the rotation motor 25d of the forward-and-retract drive unit 25 rotates at a fast rotation speed so as to move the holder 21b at a fast speed until the tip of the holder 21b reaches a position right ahead of the
20 electronic device W, rotates at a slow rotation speed so as to move the holder 21b at a slow speed when the tip of the holder reaches the right ahead position, and sets the speed to be zero when the tip of the holder is about to reach the abutting position with the electronic device W. In addition,
25 a difference in torque limitation is set before and after the reaching to the electronic device W. After the tip of the holder 21b reaches the right ahead position of the electronic device W, a strict limitation is set so as to decrease the

maximum torque. According to this speed and torque control, the rotation amount of the rotation motor 25d associated with the combination information of the facing holders 21a and 21b or the stop point information like the transferring point A is referred. Hence, application of excessive load to the electronic device W can be prevented beforehand.

In addition, the voice coil motor 25g applies, to a rod 25i, thrust force F that countervails the total of drag force F1 applied to the rod 25i when the holder 21b not reaching the electronic device W yet is moved forward and compression force F2 of the spring 25b that supports the protrusion support plate 253. Hence, the rod 25i does not move forward, and does not retract in the housing of the voice coil motor 25g.

When, however, the tip of the holder 21b abuts the electronic device W, and new drag force F3 is applied from the electronic device W, the rod 25i is retracted in the voice coil motor 25g. That is, upon retraction of the rod 25i in the housing, the voice coil motor 25g absorbs shock originating from the contact of the holder 21b with the electronic device W. Hence, load applied to the electronic device W by the holder 21b can be remarkably reduced.

Accordingly, depending on positioning error, the position of the holder 21a and that of the holder 21b are misaligned at the transferring point A, and rotational moment may be applied to the electronic device W with the one holder being as a pivot point and the other holder being as an effort point. According to this forward-and-retract drive unit 25,

however, since the load applied to the electronic device W is set to be substantially zero, it becomes possible to avoid a displacement of the posture of the electronic device W and a lateral turning thereof in the worst case.

5 In addition, both rotary pickups 2a and 2b are the same assembly, and are assembled with the common bracket 7. Hence, by simply assembling both rotary pickups 2a and 2b with the bracket 7, the positioning of both rotary pickups 2a and 2b can be finished, and thus the facing holders 21a, 21b at
10 the transferring point A can be precisely aligned in the same straight line. Therefore, the positional displacement itself of the facing holders 21a, 21b can be maximally suppressed.

 Returning to the explanation for the operation, when
15 the holder 21b holds the electronic device W, the forward-and-retract drive unit 25 inversely rotates the cylindrical cam 25e by the actuation of the rotation motor 25d. When the cam follower 25f is disengaged with the cam robe, the driving force to the arm 24c is canceled. The spring
20 25h is compressed by the forwarded slide shaft 24b of the movable mechanism 24, and when the driving force to the arm 24c is canceled, pushing force to return the spring in the original condition is accomplished. Hence, the slide shaft 24b is returned toward the rotation center side in the radial
25 direction. When the slide shaft 24b returns toward the rotation center side in the radial direction, the holder 21b fastened to the slide shaft 24b through the arm 24c returns

toward the axial center side of the rotary pickup 2b while holding the electronic device W.

At the visual inspection point D that is the eighth point, the image of the external appearance of the opposite surface R of the electronic device W that cannot be imaged at the first half of the carrying path is obtained, and the electronic devices W are sorted as a good product or a defective product. In the rotary pickup 2a that is the first half of the carrying path, the one surface is held by the holder 21, and is directed toward the rotational center side of the rotary pickup 2a. Hence, imaging of the external appearance is difficult. Conversely, in the rotary pickup 2b that is the second half of the carrying path, the electronic device W is automatically turned over through an transferring operation, and thus the opposite surface R that was difficult to obtain the image is directed outwardly, enabling the image obtainment of the opposite surface.

At an apply point E that is the ninth point, a bond is applied to the surface of the electronic device directed outwardly. The paste applicator unit 3 is in a stand-by condition with the tip of a stamping pin being directed right above the apply point E that is the ninth point. The stamping pin 31 is a bar-shape member with a tapered tip.

This paste applicator unit 3 includes a tray 32 that reserves a bond, and the stamping pin 31 is moved in the tray in advance to dip the tip of the stamping pin 31 in the bond. Subsequently, the paste applicator unit becomes a standby condition at the apply point E that is the ninth point. When

the electronic device W is delivered to the apply point E, the stamping pin 31 is moved down, and the bond is applied to the electronic device W stopped at the apply point E.

At a posture check point F that is the 11th point,
5 the posture of the electronic device W is checked, and the displacement of the electronic device W in the X, Y, and θ directions is detected. At this posture check point F, also, the same imaging optical system 63 as that of the visual inspection point D which is the eighth point is disposed, and
10 the displacement is calculated based on the image of the electronic device W. The displacement can be calculated by measuring a distance to each point on the electronic device with reference to a given point in the image. Information on the displacement amount in the X, Y, and θ directions is
15 stored in association with the electronic device W.

At an ejection point G that is the 12th point, the electronic device determined as a defective product is forcibly ejected. The ejection container 8 having the opening directed in the falling direction is disposed at this
20 ejection point G that is the 12th point. In the visual inspection, when the electronic device associated with information indicating that this electronic device is a defective product is delivered to the ejection point G, the vacuum generator unit generates positive pressure in the
25 nozzle of the holder 21 to blow out the held electronic device, and thus the electronic device falls in the ejection container 8.

At the release point C that is the 13th point, the stage unit 4b carries the loading location to the release point C, and the holder 21 of the rotary pickup 2b located at the 13th point releases the electronic device W. As
5 illustrated in FIG. 10, the stage unit 4b moves the stage in the X and Y directions, or rotates in the θ direction. When there is an empty loading location left in the X column, the movement in the X direction is by what corresponds to a value that is obtained by adding a pitch in one direction with the
10 stored displacement amount in the X direction. When there is no empty loading location in the X column, the movement in the Y direction is by what corresponds to a value obtained by adding a pitch in one direction with the stored displacement amount in the Y direction. Still further, the
15 θ rotation corresponds to the stored displacement amount in the θ direction.

The stage is moved in the X, Y, and θ directions in advance, and when this movement completes, the holder 21 located at the release point C that is the 13th point is
20 descended by the forward-and-retract drive unit 25, and the electronic device W is released to the loading location. When the retainer 5b mounted on the stage unit 4b is a substrate P, the surface to which the bond is applied, is directed toward the substrate P, and the electronic device W and the substrate
25 P are bonded via the bond. At this time, the forward-and-retract drive unit 25 controls the rotation motor 25d and the voice coil motor 25g to apply certain load to the

electronic device W, thereby prompting the bonding of the electronic device W with the substrate P.

(5. Action and Effect)

As explained above, the transfer apparatus 1 of this
5 embodiment includes the double rotary pickups 2a and 2b as
the carrying path. Both rotary pickups 2a and 2b
intermittently rotate predetermined angle by predetermined
angle around the respective rotation axes while always
directing the tips of the holders 21 outwardly in the radial
10 direction of the pickup. The rotary pickups 2a and 2b are
disposed on, so as not to overlap with each other, the same
plane side by side with the respective rotation axes in
parallel with each other. In addition, both rotary pickups
2a and 2b have the common stop point where the respective tips
15 of the holders 21a of both rotary pickups face with each other,
and transfer the electronic device W at the stop point that
is the transferring point A.

Hence, since the rotary pickups 2a and 2b are
disposed on, so as not to overlap with each other, the same
20 plane with the respective rotation axes in parallel with each
other, a large number of process points can be provided at
the respective circumferences of the rotary pickups 2a and
2b. The process points are locations where various processes,
such as visual inspection, application of bond, and posture
25 check, are performed on the electronic device W.

That is, when the rotary pickups 2a and 2b partially
overlap, no process point can be placed at the overlapping
portion of both rotary pickups 2a and 2b and the peripheral

location therearound. This is because one of the rotary pickups 2a and 2b, the motor 23, etc., become the physical obstacle. However, the transfer apparatus 1 of this embodiment has no such overlap, and thus process points can
5 be placed at all locations on the rotary pickups 2a and 2b except the transferring point A.

In addition, according to this transfer apparatus 1, a large number of process points can be placed. Hence, it is unnecessary to increase the diameter of the pickup,
10 thereby accomplishing a space saving. Still further, the downsizing of the rotary pickup 2 enables a longitudinal installation thereof in the vertical direction, and also a downsizing of the motor 23. This results in a further space saving.

15 When downsizing of the rotary pickups 2a and 2b is accomplished, the fast rotation speed of the rotary pickup 2a, 2b can be realized. Hence, the improved carrying speed of the electronic device W can be accomplished. According to the double rotary pickups 2a and 2b, the transferring
20 process of the electronic device W is also the turnover process. Hence, the electronic device W can be turned over without performing a turnover process in addition to the transferring process. Accordingly, the carrying speed of the electronic device W can be further improved.

25 According to such double rotary pickups 2a and 2b require a highly precise positioning. In this point, according to the transfer apparatus 1 of this embodiment, the rotary pickups 2a and 2b are the same assembly based on the

same design drawing, and a single common bracket 7 that regulates the positions of the respective rotation axes of the rotary pickups 2a and 2b is applied.

Accordingly, both rotary pickups 2a and 2b can be
5 highly precisely positioned by simply fitting the rotary pickups 2a and 2b in the bracket 7, and the holders 21 having respective tips facing with each other at the transferring point A can be highly precisely aligned in the same straight line through a simple positioning work. Hence, although a
10 structure in which such rotary pickups 2a and 2b transferring the electronic device W therebetween is employed, the yield of the electronic device W is excellent, and the apparatus effectiveness is also excellent.

Still further, according to this transfer apparatus
15 1, either one of the holders 21 facing with each other at the transferring point A carries the electronic device W to be transferred or approaches thereto, and the forward-and-retract drive unit 25 controls the moving speed of the forwarding holder 21 so as to be decelerated toward
20 the other facing holder 21, and also controls the load to be applied from the forwarding holder 21 to the electronic device W to be transferred.

Hence, even if the holders 21 are misaligned at the transferring point A depending on, for example, assembling
25 precision, rotational moment to the electronic device W generated by the displacement of the points on the front and rear surfaces of the electronic device W where loads are applied from both sides becomes quite small. Accordingly,

the transferring of the electronic device W does not cause a posture change, and does not cause a failure of receiving the electronic device W due to a lateral turning thereof. Hence in this point, also, the yield of the electronic device
5 W is excellent, and the apparatus effectiveness is also excellent.

(6. Modified Example)

When, for example, the transfer apparatus 1 has the rotary pickups 2a and 2b disposed on, so as not to overlap
10 with each other, the same plane side by side with the respective rotation axes in parallel with each other, a large number of process points can be placed. Accordingly, the rotary pickups 2a and 2b may be laterally installed in the horizontal direction.

15 Example process points are, in addition to visual inspection, bond application, posture check, forcible ejection of defective product, and mounting on substrate all explained in the above embodiment, electrical characteristic inspection, temperature adjustment, such as heating or
20 cooling, shaping of terminal extending from the electronic device W, posture correction, marking and other various kinds of processes.

As to the holder 21, in addition to an absorption nozzle that absorbs or releases the electronic device W by
25 vacuum generation or break, or, generation of positive pressure, an electrostatic absorption type, a Bernoulli chuck type, or a chuck mechanism that mechanically holds the electronic device W are also applicable.

In addition, the kinds of the holders 21 installed on the rotary pickups 2a and 2b are not limited to one kind, and two kinds of holders may be disposed. For example, different kinds of holders 21 in the odd-number order and the even-number order may be installed so that the same kind of holders 21 are disposed alternately. When the first kind electronic device W is supplied, the odd-number order holder 21 may hold this electronic device, and when the second kind electronic device W is supplied, the even-number order holder 21 may hold this electronic device. When the same kind of electronic devices are sequentially supplied, the rotary pickups 2a and 2b are rotated two pitch by two pitch, and when different kinds of electronic devices are sequentially supplied, the rotary pickups 2a and 2b are rotated by one pitch to hold the different electronic devices. When the kind change frequently occurs in multi-kind but small-quantity production, a work of replacing the holder 21 depending on the kind can be eliminated, and the production efficiency can be improved.

Still further, in the above-explained embodiment, a type of causing the holder 21b of the rotary pickup 2b that is the second half of the carrying path to approach the electronic device W at the transferring point A, but a type of causing the holder 21a of the rotary pickup 2a that is the first half of the carrying path to move in order to pass the electronic device W to the other holder may be employed. Yet still further, a type of causing both holders to move to the middle location may be also employed. In this case, the

forward-and-retract drive unit 25 may be disposed at the transferring point A relative to the rotary pickup 2a that is the first half of the carrying path, and the forward-and-retract drive devices 25 may be disposed for both
5 rotary pickups 2a and 2b.

A positioning work can be manually carried out without the single common bracket 7. In addition, for example, the paste applicator unit 3 that is a pin print type with a stamping pin is applied, but a dispenser type that discharges
10 a liquid filled in a syringe from the tip of the nozzle by air pressure or mechanical pressure is also applicable.

In addition, in the above-explained embodiment, the one retainer 5a is a tray, while the other retainer 5b is a mount substrate, but the present invention is not limited to
15 this case, and either one of a tray, a substrate, a wafer sheet, a tape with pockets or a combination of the above-explained two kinds is applicable. Still further, one of the adopted imaging optical systems 61 for visual inspection obtains images of five surfaces simultaneously, but the imaging
20 target may be divided into several planes, and the imaging optical system may be further disposed at other stop point.

For example, FIG. 11 is an exemplary diagram illustrating another example transfer apparatus 1. In this transfer apparatus 1, the one retainer 5 is a wafer sheet.
25 The immediately lateral stop point opposite to the transferring point of the rotary pickup 2a that is the first half of the carrying path is set as the first pint, and both

rotary pickups 2a and 2b rotate counterclockwise from the first point.

A ring holder 50 is disposed instead of the stage at the stop point that is the first point the immediately lateral position. Disposed at the third point is an imaging optical system 6 that obtains an image of a surface of the electronic device W directed outwardly in the radial direction in the rotary pickup 2a that is the first half of the carrying path. The fifth point is the transferring point A. An ejection piping 80 is disposed at the stop point two points apart from the first point in the clockwise direction. The electronic device W not successfully transferred at the fifth transferring point is ejected to this ejection piping 80. When the holder 21 keeps holding the electronic device W, the redundant electronic device W is to be superimposed at the first pickup point.

Disposed at the sixth pint is the imaging optical system 6 that obtains an image of a bond applying surface of the electronic device W for the paste applicator unit 3 which is installed at the seventh point and which applies the bond. This imaging optical system 6 detects a displacement amount in the X, Y, and θ directions of the electronic device W, and the position of the stamping pin 31 is corrected in accordance with the detected displacement amount.

The imaging optical system 6 for visual inspection on the bond applied surface is disposed at the stop point that is the eighth point. This imaging optical system 6 inspects the bond applied surface and the condition of the applied bond.

The imaging optical system 6 for visual inspection on four side faces of the electronic device W is disposed at the stop point that is the ninth point.

A sorting piping 82 is provided instead of the
5 ejection piping at the stop point that is the 10th point. This sorting piping 82 retains the electronic device W which is not a defective product but is not high grade. Through each visual inspection, ranking in accordance with the goodness of the electronic device W is carried out, and the electronic
10 device W associated with the predetermined rank is ejected to the sorting piping 82 by the holder 21 serving as a blower.

A stage on which a mount substrate like a lead frame is mounted is disposed at the stop point that is the 11th point. The defective product not released to the sorting piping 82
15 at the 10th point and the stage at the 11th point is discarded to an ejection piping 81 provided at the 12th point. Since the next point is the transferring point A and when the holder 21 keeps holding such an electronic device W, the redundant electronic device W is to be superimposed at the transferring
20 point A.

In addition, in the above-explained embodiment, it is presumed that the transfer apparatus 1 includes the two rotary pickups 2 that form the carrying path, but the number of the rotary pickups 2 that form the carrying path is not
25 limited to two, and three, four, ... and N (where $N \geq 2$) number of rotary pickups may be disposed in sequence.

FIG. 12 illustrates a transfer apparatus 1 that disposes three rotary pickups 2a, 2b, and 2c in sequence to

form the carrying path. The rotary pickups 2a, 2b, and 2c are each installed longitudinally in the vertical direction, and are sequentially disposed along the same vertical plane. The rotary pickups 2a and 2b at both ends have the same height, while the middle rotary pickup 2c is disposed at the oblique upper space relative to the rotary pickups 2a and 2b at both ends. This is because to reduce the sequential length of the three rotary pickups 2a, 2b, and 2c.

The rotary pickup 2a picks up the electronic device W one by one from the wafer ring held by one wafer holder 50a. The middle rotary pickup 2c receives the electronic device W from the rotary pickup 2a, and passes it to the rotary pickup 2b. The rotary pickup 2b attaches the electronic device W to a wafer ring 50b held by the other wafer holder.

This transfer apparatus 1 is also applicable as an inspection apparatus for visual inspection on the electronic device W, and imaging optical systems 64 to 67 for the electronic device W are disposed at plural points on the carrying path formed by the rotary pickups 2a, 2b, and 2c.

The first imaging optical system 64 is disposed at the stop point which is the first point near the rotary pickup 2a and at which the electronic device W picked up from the one ring holder 50a stops at first. This imaging optical system 64 includes a mirror and a camera, and determines whether the electronic device W is a good product or a defective product. The electronic device W determined as the defective product is immediately removed from the carrying path.

The second imaging optical system 65 is disposed at the stop point which the second point is near the rotary pickup 2c and at which the electronic device W received from the rotary pickup 2a stops at first. This second imaging optical
5 system 65 includes a prism and a camera, and measures in advance the positional displacement of the electronic device W to correct the position of the electronic device W. The position of the electronic device W is corrected at the stop point immediately after the second stop point based on the
10 measured positional displacement.

The third imaging optical system 66 is disposed at the stop point which the third point is near the rotary pickup 2b and at which the electronic device W received from the rotary pickup 2c stops at first. This third imaging optical
15 system 66 also includes a prism and a camera, and determines whether or not a scratch, etc., was formed in the electronic device W during the carriage through the carrying path. When the electronic device W determined as a defective product with a scratch, etc., this electronic device W is removed from the
20 carrying path without being attached on the wafer ring in the other ring holder 50b.

In addition, the fourth imaging optical system 67 is disposed at the stop point that is the fourth stop point where the electronic device W on the rotary pickup 2b finally
25 stops right before being attached on the other ring holder 50b. This fourth imaging optical system 67 includes a mirror and a camera, and measures in advance the positional displacement of the electronic device W in order to correct

the attaching position of the electronic device W to the wafer ring. The ring holder 50b is subjected to parallel movement based on the measured positional displacement, and the attaching position of the electronic device W is adjusted.

5 (Other Embodiment)

The embodiment of the present invention and the modified examples thereof were explained above, but various omissions, replacements, modifications, and combinations can be made without departing from the scope of the present invention. Such embodiments and modified embodiments thereof are within the scope and spirit of the present invention, and also within the scope of the subject matter as recited in the appended claims and the equivalent range thereto.

15

REFERENCE SIGNS LIST

- 1 Transfer apparatus
- 2 Rotary pickup
- 2a Rotary pickup
- 20 2b Rotary pickup
- 2c Rotary pickup
- 21 Holder
- 22 Axial frame
- 23 Motor
- 25 24 Movable mechanism
- 24a Sleeve
- 24b Slide shaft
- 24c Arm

	25	Forward-and-retract drive unit
	250	Sliding member
	251	Side plate
	252	Top plate
5	253	Protrusion support plate
	25b	Spring
	25c	Protrusion
	25d	Rotation motor
	25e	Cylindrical cam
10	25f	Cam follower
	25g	Voice coil motor
	25h	Spring
	25i	Rod
	3	Paste applicator unit
15	31	Stamping pin
	32	Tray
	4	Stage unit
	5	Retainer
	50	Ring holder
20	50a	Ring holder
	50b	Ring holder
	6	Imaging optical system
	61	Imaging optical system
	62	Imaging optical system
25	63	Imaging optical system
	64	Imaging optical system
	65	Imaging optical system
	66	Imaging optical system

	67	Imaging optical system
	7	Bracket
	71	Through-hole
	8, 80, 81	Ejection piping
5	82	Sorting piping
	A	Transferring point
	B	Pickup point
	C	Release point
	D	Visual inspection point
10	E	Apply point
	F	Posture check point
	G	Ejection point
	W	Electronic device
	P	Substrate
15	F	Thrust force by voice coil motor
	F1	Drag force applied to rod
	F2	Compression force
	F3	New drag force

CLAIMS

1. A transfer apparatus which picks up an electronic device from a first retainer and which loads the electronic
5 device on a second retainer, the transfer apparatus comprising:

a holder holding and releasing, through a tip, one surface of the electronic device; and

N number of (where $N \geq 2$) rotary pickups having a
10 plurality of the holders around respective rotation axes, and intermittently rotating by each predetermined angle around the respective rotation axes with always directing the respective tips of the holders outwardly,

wherein:

15 the N number of rotary pickups in conjunction with each other form a main carrying path for the electronic device from the first retainer to the second retainer; and

the adjoining rotary pickups:

are disposed on, without overlapping with each
20 other, a same plane side by side with the respective rotation axes in parallel with each other; and

include a common stop point where the respective tips of the holders of the adjoining rotary pickups face with each other, and transfer the electronic
25 device at the stop point being as a transferring point.

2. The transfer apparatus according to claim 1, wherein:

30 odd numbers of the rotary pickups are disposed;

the rotary pickup disposed corresponding to the first retainer holds the one surface of the electronic device

picked up from the first retainer and carries the electronic device to the transferring point; and

the rotary pickup disposed corresponding to the second retainer holds an opposite surface of the electronic device and releases the electronic device to the second retainer at the transferring point.

3. The transfer apparatus according to claim 1 or 2, wherein the N number of rotary pickups are all installed longitudinally in a vertical direction, and have respective vertical rotation planes.

4. The transfer apparatus according to any one of claims 1 to 3, wherein:
either one of the adjoining rotary pickups further comprises, at the stop position corresponding to the transferring point, a forward-and-retract drive unit that moves forward the holder stopped at the stop position corresponding to the transferring point outwardly in a radial direction becoming apart from the rotation axis; and either one of the holders facing with each other at the transferring point carries the electronic device to be transferred or approaches thereto.

5. The transfer apparatus according to claim 4, wherein:

the forward-and-retract drive unit has a motor that generates thrust force to move forward the holder; and

the motor decelerates a moving speed of the forwarding holder as the forwarding holder approaches the other holder facing the forwarding holder.

6. The transfer apparatus according to claim 4 or 5, wherein the forward-and-retract drive unit has a voice coil motor that controls load to be applied from the forwarding holder to the electronic device to be transferred.

5

7. The transfer apparatus according to claim 6, wherein the voice coil motor applies, to the holder, countervail thrust force to drag force applied from the holder with the holder not reaching yet the electronic device to be transferred, and absorbs shock between the electronic device to be transferred and the holder.

8. The transfer apparatus according to claim 4 or 5, wherein the forward-and-retract drive unit:
15 has a voice coil motor that applies, to the holder, countervail thrust force to drag force applied from the holder with the holder not reaching yet the electronic device to be transferred; and

determines a rotation amount of the motor that moves
20 forward the holder based on a behavior change in the voice coil motor caused by a contact of the holder with the electronic device to be transferred.

9. The transfer apparatus according to any one of
25 claims 1 to 8, wherein the N number of rotary pickups are all a same assembly based on a same design drawing.

10. The transfer apparatus according to any one of
claims 1 to 9, further comprising a single common bracket
30 that regulates positions of the respective rotation axes of the first and second rotary pickups.

11. The transfer apparatus according to any one of claims 1 to 10, further comprising an imaging optical system wherein:

5 the imaging optical system that obtains an image of an external appearance of the electronic device is located with one of the odd-number order rotary pickups and one of the even-number order rotary pickups in the N number of rotary pickups.

10 12. The transfer apparatus according to claim 11, wherein:

the first imaging optical system obtains images of five surfaces of the electronic device other than the one surface; and

15 the second imaging optical system obtains an image of the one surface of the electronic device.

13. The transfer apparatus according to claim 11, wherein:

20 the first imaging optical system obtains images of five surfaces of the electronic device other than the opposite surface; and

the second imaging optical system obtains an image of the opposite surface of the electronic device.

25

14. The transfer apparatus according to any one of claims 1 to 13, further comprising an imaging optical system wherein:

30 the imaging optical system that obtains an image of a posture of the electronic device is located with the rotary pickup disposed corresponding to the second retainer; and

the second retainer is moved in two-dimensional directions and rotated so as to be positioned and rotated in accordance with the imaged posture.

5 15. The transfer apparatus according to any one of
claims 1 to 14, wherein the first retainer and the second
retainer are ones of followings or a combination thereof: a
wafer sheet; a lead frame; an organic substrate; an
inorganic substrate; a tray with adhesiveness; a substrate;
10 a part feeder; a tape with pockets; a tray; and a sorting
bottle.

16. The transfer apparatus according to any one of
claims 1 to 15, further comprising a paste applicator unit
15 wherein:

the paste applicator unit that applies a bond to the
electronic device is located with the rotary pickup
disposed corresponding to the second retainer.