

ABNORMAL CONTACT DETECTING METHOD,
ELECTRONIC COMPONENT HOLDING APPARATUS,
AND ELECTRONIC COMPONENT CARRYING APPARATUS

5 TECHNICAL FIELD

[0001] The present disclosure relates to an abnormal
contact detecting method for detecting an abnormal contact
when an electronic component is transferred to a unit, an
electronic component holding apparatus utilizing this method,
10 and an electronic component carrying apparatus including the
same.

BACKGROUND ART

[0002] Electronic components like a semiconductor device
15 are divided into pieces through various assembling processes,
such as dicing, mounting, bonding, and sealing, and are
subjected to various inspection processes. Such processes
are typically carried out by an electronic component carrying
apparatus called a test handler. This electronic component
20 carrying apparatus includes an electronic component holding
apparatus, holds the electronic component by a holder unit
of the electronic component holding apparatus, and carries
the held component to each process unit to carry out the
process. The electronic component having undergone the
25 process is retained in a pocket of a carrier tape through a
taping unit that is one of the process units.

[0003] In the taping unit, when the electronic component
abnormally contacts the pocket, the electrode lead terminal
of the electronic component may be bent or cracked. The term
30 abnormal contact means a continuation of the inserting
process of the electronic component into the pocket while the
electronic component is contacting the edge of the pocket.
This abnormal contact is generally caused by a displacement
of any one of the holder unit of the electronic component,
35 the electronic component, or the pocket of the carrier tape.

[0004] Hence, according to the taping unit, inspections relating to defects, such as whether or not the electronic component is retained in the pocket of the carrier tape with an appropriate position, whether or not the lead electrode of the electronic component is abnormally bent, and whether or not the electronic component has a damage, are carried out. As to the technology of inspecting the defect of the electronic component, conventionally, various technologies are proposed (see, for example, Patent Document 1).

[0005] For example, after the electronic component is inserted in the pocket, the carrier tape is wound by a predetermined pitch to move the electronic component to a visual inspection position. The image of the electronic component is picked up by imaging means, and the defect is inspected through an image analysis. When a defect is detected, the pocket retaining the defective component is returned to the position right below the holder unit, and the electronic component is taken out by the holder unit from the pocket. In addition, a technology of reversely turning a main table by 1/2 pitch, retracting the holder unit from the retaining position, moving rejecting means to the retaining position, and rejecting the electronic component is also proposed.

CITATION LIST

PATENT LITERATURE

[0006] Patent Document 1: WO2010/089275 A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] Most proposed technologies are carried out once the electronic component is inserted in the pocket, and the defect of the electronic component is detected. After the electronic component is put in the pocket, the range of visual inspection for the electronic component is limited. For example, when the image of the electronic component put in

the pocket is picked up by imaging means from above, and a defect is inspected through an image analysis, it is difficult to detect a fine bending of the electrode lead terminal extending from the electronic component. In addition, it is difficult at all to pick up an image of the back of the electronic component, and thus a detection of a crack caused in the back of the electronic component is also difficult.

[0008] Hence, a technology of detecting an abnormal contact causing the defect of the electronic component while the electronic component is being transferred, and of not putting the electronic component possibly defective into the pocket of the carrier tape has been desired. If a detection technology of an abnormal contact while the electronic component is being transferred is once established, in the carrying process of the electronic component, the number of transferring steps possibly causing the abnormal contact of the electronic component is large, and thus it is expected that such a technology can be applied widely.

[0009] The present disclosure has been made to address the above-explained problem of the conventional technologies, and it is an objective of the present disclosure to provide an abnormal contact detecting method that can detect an abnormal contact of an electronic component while the electronic component is being transferred.

SOLUTION TO PROBLEM

[0010] According to the present disclosure, an abnormal contact detecting method of an electronic component is performed by an electronic component holding apparatus including an ascending and descending motor descending, together with a rod supported by a voice coil motor, a holder unit of the electronic component through the rod, and the method includes: applying descending force to the holder unit through the rod by the ascending and descending motor; applying, to the rod by the voice coil motor, opposing thrust force equivalent to counteracting force applied to the rod

relative to the descending force; detecting a relative floating of the rod to the voice coil motor in accordance with abnormal resistive force caused while the holder unit is descending; and detecting an abnormal contact of the electronic component during the descending upon detection of the floating of the rod.

[0011] The abnormal contact detecting method may further include: descending the holder unit holding the electronic component toward a pocket of a carrier tape; detecting a relative floating of the rod to the voice coil motor in accordance with resistive force caused when the electronic component is descending while being in contact with the carrier tape; and detecting a contact to the carrier tape during the descending upon detecting of the floating of the rod.

[0012] The abnormal contact detecting method may further include: terminating the descending, and ascending the holder unit when the floating of the rod occurs.

[0013] The abnormal contact detecting method may further include: alerting a contact of the electronic component during the descending when the floating of the rod occurs.

[0014] An electronic component holding apparatus according to the present disclosure transfers an electronic component, and the apparatus includes: a holder unit capable of ascending and descending to and from a transfer position by external force while holding the electronic component; an ascending and descending motor generating descending force to the holder unit; a rod provided so as to be capable of ascending and descending to and from the holder unit, abutting the holder unit, and transferring the descending force generated by the ascending and descending motor to the holder unit; a voice coil motor applying, to the rod, opposing thrust force equivalent to counteracting force to the rod caused by the descending force applied to the holder unit; and a detector detecting a relative floating of the rod to the voice coil motor in accordance

with abnormal resistive force caused while the holder unit is descending.

[0015] The holder unit may descend toward a pocket of a carrier tape that is the transfer position while holding the electronic component, and the detector may detect a relative floating of the rod to the voice coil motor in accordance with resistive force caused when the electronic component descends while contacting the carrier tape.

[0016] The holder unit may terminate the descending and the holder unit may be ascended when the detector detects the floating of the rod.

[0017] An electronic component carrying apparatus according to the present disclosure carries an electronic component to various process units disposed on a carrying route, and transfers the electronic component to the process units, and, the apparatus includes: a holder unit capable of ascending and descending by external force while holding the electronic component; a carrying motor turning the holder unit along the carrying route, and stopping the holder unit above a transfer position to the process unit; an ascending and descending motor generating descending force to the holder unit; a rod provided above the holder unit stopping above the transfer position so as to be capable of ascending and descending, abutting the holder unit, and transferring the descending force generated by the ascending and descending motor to the holder unit; a voice coil motor applying, to the rod, opposing thrust force equivalent to counteracting force to the rod caused by the descending force applied to the holder unit; and a detector detecting a relative floating of the rod to the voice coil motor in accordance with abnormal resistive force caused while the holder unit is descending.

[0018] The holder unit may descend toward a pocket of a carrier tape that is the transfer position while holding the electronic component, and the detector may detect a relative floating of the rod to the voice coil motor in

accordance with resistive force caused when the electronic component descends while contacting the carrier tape.

[0019] The electronic component carrying apparatus may further include a rejecting device of the electronic

5 component, in which the holder unit terminates the descending and the holder unit is ascended and the holder unit transfers the electronic component to the rejecting device when the detector detects the floating of the rod.

[0020] The electronic component carrying apparatus may
10 further include alerting means that alerts a contact of the electronic component during the descending when the floating of the rod occurs.

ADVANTAGEOUS EFFECTS OF INVENTION

15 [0021] According to the present disclosure, an abnormal contact that is a cause of a defective electronic component can be detected while the electronic component is being transferred, and the electronic component possibly defective due to an abnormal contact can be surely taken
20 out.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. 1 is a side view illustrating the whole structure of an electronic component holding apparatus
25 according to an embodiment;

FIG. 2 is a side view illustrating an internal structure of a voice coil motor;

FIG. 3 is an enlarged side view illustrating an external structure of a detector of the electronic
30 component holding apparatus;

FIG. 4 is a diagram illustrating the whole structure of the detector;

FIG. 5 is a block diagram illustrating a controller of the electronic component holding apparatus;

5 FIG. 6 is a flowchart illustrating a control operation of the controller of the electronic component holding apparatus;

FIG. 7 is a side view illustrating force applied to each component of the electronic component holding apparatus
10 in a normal condition;

FIG. 8 is a side view illustrating a condition of the detector in the normal condition;

FIG. 9 is a side view illustrating force applied to each component of the electronic component holding apparatus
15 when an electronic component contacts a carrier tape;

FIG. 10 is a side view illustrating a condition of the detector when the electronic component contacts the carrier tape;

FIG. 11 is a top view illustrating the whole
20 structure of an electronic component carrying apparatus according to the embodiment;

FIG. 12 is a side view illustrating the whole structure of the electronic component carrying apparatus according to the embodiment;

25 FIG. 13 is a block diagram illustrating a structure of a controller of the electronic component carrying apparatus at the time of detecting an abnormal contact;

FIG. 14 is a flowchart illustrating a process of the controller of the electronic component carrying apparatus at
30 the time of detecting an abnormal contact;

FIG. 15 is a partial enlarged view of a part feeder;

FIG. 16 is a partial enlarged view of a position correcting unit; and

35 FIG. 17 is a partial enlarged view of a test contact device.

DESCRIPTION OF EMBODIMENTS

[0023] An abnormal contact detecting method by an electronic component holding apparatus of an electronic component carrying apparatus according to an embodiment of the present disclosure will be explained in detail with reference to the accompanying drawings.

[0024] (Electronic Component Holding Apparatus)

FIG. 1 is a side view illustrating the whole structure of an electronic component holding apparatus 1. As illustrated in FIG. 1, the electronic component holding apparatus 1 is an apparatus that transfers an electronic component D to a process unit 74 (see FIG. 11). The process unit 74 is a device that performs a process on the electronic component D, and includes a taping unit 6. The taping unit 6 intermittently feeds a carrier tape 61 formed with embossed pockets 62 where the electronic component D is to be retained.

[0025] Relative to the taping unit 6, the electronic component holding apparatus 1 inserts the electronic component D in the pocket 62, and releases the electronic component D in the pocket 62. At this time, the electronic component holding apparatus 1 prevents a defective product caused by an inappropriate insertion of the electronic component D into the pocket 62 from being packed in the carrier tape 61 as it is. That is, the electronic component holding apparatus 1 detects an abnormal contact of the electronic component D at the time of insertion into the pocket 62. The abnormal contact detecting method is to sense resistive force when the inserting process is continued with the electronic component D being contacting the carrier tape 61.

[0026] This electronic component holding apparatus 1 mainly includes a holder unit 2, a depressor 3, and an ascending and descending motor 4. The holder unit 2 ascends and descends by external force while holding the electronic component D. The ascending and descending motor 4 generates descending force of the holder unit 2, and controls the descending end point of the holder unit 2 and the descending speed thereof.

The depressor 3 transmits descending force mainly generated by the ascending and descending motor 4 to the holder unit 2.

[0027] The holder unit 2 is, for example, a suction nozzle.
5 The interior of the holder unit 2 is a hollow pipe, and has an opening at the tip thereof. The pipe interior is in connected with a pressured-air circuit through a joint 25 connected to the rear end, the electronic component D is suctioned by the tip upon vacuum generation, and the
10 electronic component D is released upon vacuum break. The electronic component D may be released upon exposure to atmospheric pressure, or may be released by sequential switching between vacuum break and exposure to atmospheric pressure.

15 [0028] This holder unit 2 is held by an arm 21 having a relative height to the pocket 62 fixed, and is located above the pocket 62. The arm 21 extends substantially in parallel with the open plane of the pocket 62, and a bearing 22 vertical to the open plane of the pocket 62 is provided at the tip of
20 the arm so as to pass all the way through it. The holder unit 2 is fitted in the bearing 22 with the opened tip being directed to the pocket 62, and is slidably supported by the arm 21.

[0029] A compression spring 23 is provided on the upper edge of the bearing 22 of the arm 21. The compression spring 23
25 is fitted in the protruding portion of the holder unit 2. The protruding portion of the holder unit 2 is a part protruding from the upper edge of the bearing 22. A flange 24 is provided at the rear-end side of the holder unit 2, and the compression spring 23 pushes the holder unit 2 through this flange 24 in
30 a direction apart from the pocket 62. When external force to the holder unit 2 toward the pocket 62 is canceled, the holder unit 2 ascends so as to move apart from the pocket 62.

[0030] The depressor 3 is supported by a linear guide 31 slidable in a direction in which the holder unit 2 is depressed.
35 The rail of the linear guide 31 extends in a direction vertical to the pocket 62, and has a fixed height. An extending rod

32 is provided at the lower end of the depressor 3. The rod 32 is disposed so as to face the rear end of the holder unit 2, and is coaxial with the holder unit 2. When the depressor 3 slides over the liner guide 31 and descends, and the lower
5 end of the rod 32 abuts the rear end of the holder unit 2, downward external force is applied to the holder unit 2.

[0031] The depressor 3 includes a substantially U-shaped frame 33. The depressor 3 is supported by the linear guide 31 through the back portion of the frame 33, and has the rod
10 32 at a lower arm 33a of the frame 33. The lower arm 33a of the frame 33 extends horizontally to the open plane of the pocket 62, and the rod 32 is attached to a portion where the tip of the lower end and the axial line of the holder unit 2 intersect with each other. The rod 32 is attached so as
15 to be orthogonal to the extending direction of the lower arm 33a, and has the tip and the rear end protruding from the upper and lower ends of the lower arm 33a.

[0032] An upper arm 33b of the frame 33 has a cam follower 34 disposed on the upper face of the upper arm. This cam
20 follower 34 transmits the rotational force of the ascending and descending motor 4 to push down the depressor 3. The ascending and descending motor 4 is, for example, a servo motor. The rotation shaft of the ascending and descending motor 4 is fixed with a cylindrical cam 41. The cylindrical
25 cam 41 abuts the cam follower 34, and the cam follower 34 is driven along the cam surface of the cylindrical cam 41.

[0033] The rotational force by the ascending and descending motor 4 is converted into force in a straight direction along the liner guide 31 by the cylindrical cam 41 and the cam
30 follower 34, and the depressor 3 descends while pushing down the holder unit 2. When the holder unit 2 descends, the ascending and descending motor 4 rotates the rotation shaft with rotation speed and torque that descend the holder unit 2 together with the rod 32 at a predetermined speed. In
35 addition, the rotation shaft is rotated by a predetermined rotation amount set so as to reach the holder unit 2 to a

predetermined descending destination point. The descending destination point of the holder unit 2 is a point where the electronic component D reaches the bottom of the pocket 62 or an upper point distant from the bottom by a predetermined distance. The rotation speed, torque, and rotation amount of the ascending and descending motor 4 are controlled through power supply to the ascending and descending motor 4.

[0034] The depressor 3 further includes a detection mechanism that senses resistive force generated when the inserting process is continued with the electronic component D being contacting the carrier tape 61. This detection mechanism includes the sliding mechanism of the rod 32, a voice coil motor 37 that applies thrust force to the rod 32, and a detector 38 that detects a relative floating of the rod 32 to the voice coil motor 37. The relative floating to the voice coil motor 37 is, in other words, insertion of the rod 32 to the voice coil motor 37.

[0035] In other words, the lower arm 33a of the frame 33 is provided with a bearing 35 vertical to the open plane of the pocket 62 so as to pass all the way through it. The rod 32 is fitted in this bearing 35, and is slidable in the axial direction of the rod 32. A compression spring 36 with pushing force that ejects the rod 32 from the voice coil motor 37 is provided on the lower face of the lower arm 33a of the frame 33, and assists the thrust force of the voice coil motor 37.

[0036] The voice coil motor 37 is fastened to the lower face of the upper arm 33b of the frame 33. This voice coil motor 37 supports the rear end side of the rod 32, and ejects or retracts the rod 32. The voice coil motor 37 is a linear motor having a current and thrust force in a proportional relationship, and as illustrated in FIG. 2, includes a magnet 37a and an annular coil 37b. The annular coil 37b is coupled with the rod 32, and the rod 32 is actuated together with the annular coil 37b. The magnet 37a is disposed near the annular coil 37b, and applies magnetic field thereto. When a current is caused to flow through the annular coil 37b, the annular

coil 37b is disposed in electromagnetic field, and thus Lorentz force is generated on the annular coil 37b. Hence, thrust force directed toward the holder unit 2 is applied to the rod 32 coupled with the annular coil 37b.

5 [0037] The voice coil motor 37 generates opposing thrust force F_{opp} equivalent to counteracting force F_{cr} to the rod 32 generated when the rod 32 transmits descending force F_r to the holder unit 2. That is, the voice coil motor 37 generates static thrust force that maintains the balanced
10 condition of the rod 32, and maintains the position of the rod 32 relative to the voice coil motor 37 with just enough force.

[0038] As illustrated in FIG. 3, the detector 38 includes an air vent 38a, and a lid 38b that opens and closes the air
15 vent 38a. The air vent 38a is an opening orthogonal to the ejecting and retracting direction of the rod 32, and is provided in the upper face of the lower arm 33a of the frame 33. The lid 38b is located right above the air vent 38a, and protrudes from the circumferential surface of the rod 32 so
20 as to move together with the rod 32. The protruding position is a height where the lid 38b covers the air vent 38a with the rod 32 not contacting the holder unit 2. As illustrated in FIG. 4, the air vent 38a is an end of a pipe 38c connected with a pressured-air circuit 38e, and a flow volume meter 38d
25 is provided in the pipe 38c. The flow volume meter 38d includes, for example, an orifice protruding in the pipe, and a pressure difference detector that detects a pressure difference between two areas divided by the orifice.

[0039] This detector 38 detects a flow-in or flow-out of
30 air through the air vent 38a, thereby detecting that the rod 32 relatively floats to the voice coil motor 37. This is because when the rod 32 floats, the lid 38b is moved apart from the air vent 38a.

[0040] FIG. 5 is a block diagram illustrating a controller
35 5 of the electronic component holding apparatus 1 employing the above-explained mechanical structure. This controller

5 includes a motor control block 51, a VCM (Voice Coil Motor) control block 52, and an abnormal contact determining block 53.

[0041] The motor control block 51 controls the torque,
5 rotation speed, and rotation amount of the ascending and descending motor 4. When the ascending and descending motor 4 is a servo motor, the motor control block 51 includes an encoder and a torque detector. The VCM control block 52 controls the thrust force of the voice coil motor 37. The
10 abnormal contact determining block 53 determines an abnormal contact of the electronic component D to the pocket 62 based on a signal from the detector 38. The controller 5 may be one of the components of the electronic component holding apparatus 1, or may be one of the parts of a controller 75
15 of an electronic component carrying apparatus 7 to be discussed later.

[0042] FIG. 6 is a flowchart illustrating a control operation by this controller 5, and the status of the electronic component holding apparatus 1 will be explained
20 below together with the control operation by the controller 5.

[0043] First, at a stage of inserting the electronic component D into the carrier tape 61, the holder unit 2 and the pocket 62 are positioned in advance in such a way that
25 the axial line of the holder unit 2 passes through the bottom center of the pocket 62. More specifically, the holder unit 2 stops at the placed position of the taping unit 6, and the taping unit 6 winds off the carrier tape 61, and thus the empty pocket 62 is moved to the stop position of the holder unit
30 2. In addition, negative pressure is generated inside the pipe of the holder unit 2, and the tip of the holder unit 2 suctions the electronic component D.

[0044] In the inserting stage, the motor control block 51 starts driving the ascending and descending motor 4 in step
35 S01. The motor control block 51 causes the ascending and

descending motor 4 to generate force that descends the holder unit 2 together with the rod 32 and through the rod 32.

[0045] Upon driving of the ascending and descending motor 4, the cylindrical cam 41 rotates, and the cam follower 34 abutting the cam surface of the cylindrical cam 41 receives thrust force directed toward the pocket 62. The thrust force directed toward the pocket 62 becomes travel force of the depressor 3 toward the holder unit 2, and the depressor 3 descends along the linear guide 31. When the depressor 3 descends, the rod 32 abuts the rear end of the holder unit 2. When the motor control block 51 further drives the ascending and descending motor 4, the depressor 3 pushes down the holder unit 2. The holder unit 2 starts descending against the push-up force by the compression spring 23.

[0046] At this time, as illustrated in FIG. 7, the holder unit 2 receives descending force F_r from the rod 32, and the rod 32 receives counteracting force F_{cr} thereof. This counteracting force F_{cr} is equivalent to drag against the elastic force of the compression spring 23 pushed in the expanding direction when the compression spring 23 that pushes up the holder unit 2 is provided. In addition, when the compression spring 36 that pushes down the rod 32 is provided, the counteracting force F_{cr} applied to the rod 32 is equivalent to drag against force obtained by subtracting the elastic force of the compression spring 36 from the elastic force of the compression spring 23 of the holder unit 2.

[0047] Moreover, in the inserting stage, the VCM control block 52 starts in step S02 driving the voice coil motor 37 to generate opposing thrust force F_{opp} equivalent to the counteracting force F_{cr} to the rod 32. The start of driving the voice coil motor 37 is simultaneous with the generation of the thrust force by the ascending and descending motor 4, or is right before the rod 32 abuts the holder unit 2. The opposing thrust force F_{opp} equivalent to the counteracting force F_{cr} has the same magnitude as that of the counteracting

force F_{cr} , but is thrust force in the opposite direction. In more detail, the counteracting force F_{cr} increases as the compression spring 23 is compressed, but the VCM control block 52 may control the opposing thrust force F_{opp} so as to increase
5 in proportional with the counteracting force F_{cr} .

[0048] At this time, as illustrated in FIG. 7, the counteracting force F_{cr} is acting on the rod 32, but the opposing thrust force F_{opp} is also applied thereto by the voice coil motor 37. Hence, the forces acting on the rod 32
10 are balanced, the rod 32 maintains the balanced condition, and does not eject and retract relative to the voice coil motor 37. In addition, as illustrated in FIG. 8, when the rod 32 maintains the balanced condition, the lid 38b covers the air vent 38a, and air does not flow in or flow out from the air
15 vent 38a.

[0049] Next, the abnormal contact determining block 53 determines in step S03 whether or not the detector 38 detects a floating of the rod 32.

[0050] When the rod 32 maintains the balanced condition,
20 there is no relative floating of the rod 32 to the voice coil motor 37. Hence, the lid 38b still covers the air vent 38a. Accordingly, the read value by the flow volume meter has no change, and the detector 38 outputs the unchanged value to the abnormal contact detecting block 53. The abnormal
25 contact detecting block 53 compares a threshold stored in advance with the output value by the detector 38, confirms that the output value is the unchanged value, and determines that no floating of the rod 32 is detected upon confirmation.

[0051] Conversely, because of displacement of any one of
30 the position of the holder unit 2, the held position of the electronic component D, and the position of the pocket 62, as illustrated in FIG. 9, the electronic component D may contact the carrier tape 61 while the holder unit 2 is being descended. At this time, resistive force F_d when the
35 electronic component D and the holder unit 2 keep descending

while deflecting the carrier tape 61 is applied to the rod 32.

[0052] The voice coil motor 37 applies only the opposing thrust force F_{opp} that satisfies $|F_{cr}| = |F_{opp}|$ to the rod 32. Hence, it becomes $|F_{opp}| < |F_{cr} + F_d|$, floating force F_f is applied to the rod 32, and the balanced condition is canceled. Therefore, the rod 32 floats relative to the voice coil motor 37, and moves in the opposite direction to the pocket 62.

10 [0053] As illustrated in FIG. 10, when the rod 32 floats, the lid 38b covering the air vent 38a is moved apart from the air vent 38a. The air vent 38a released from the lid 38b has air flowing in or flowing out, and thus the read value of the flow volume meter 38d changes. The abnormal contact
15 determining block 53 compares the threshold with the output value by the detector 38, confirms that the output value is a changed value, and determines that a floating of the rod 32 is detected upon such a confirmation.

[0054] When the floating of the rod 32 is detected (step
20 S03: YES), this means that the electronic component D is abnormally contacting the pocket 62. Hence, in step S04, the electronic component carrying apparatus 7 explained next will perform a support operation.

[0055] Conversely, when no floating of the rod 32 is
25 detected (step S03: NO), the motor control block 51 determines in step S05 whether or not the descending level of the holder unit 2 reaches a set value. The set value corresponds to a reaching of the electronic component D to the bottom of the pocket 62. When the descending level of the holder unit 2
30 does not reach the set value (step S05: NO), the abnormal contact determining block 53 determines (step S03) whether or not a floating of the rod 32 is detected by the detector until the holder unit 2 reaches the descending destination point (step S05: YES).

35 [0056] When no floating of the rod 32 is detected (step S03: NO) and the descending level of the holder unit 2 reaches the

set value (step S05: YES), the abnormal contact detecting process is completed, and the electronic component holding apparatus 1 performs the remaining operations of retaining the electronic component D in the pocket 62. That is, the electronic component holding apparatus causes the holder unit 2 to release the electronic component D, and causes the holder unit 2 to ascend. More specifically, the vacuum break in the pipe of the holder unit 2 is caused to release the electronic component D. Next, the cylindrical cam 41 is further rotated to cancel the pushing of the depressor 3 through the cam follower 34, thus releasing the holder unit 2 from the rod 32. The holder unit 2 is ascended by the pushing force by the compression spring 23.

[0057] (Electronic Component Carrying Apparatus 7)

Next, an explanation will be given of the electronic component carrying apparatus 7 that includes the aforementioned electronic component holding apparatus 1, and performs a support operation when an abnormal contact is detected. FIG. 11 is a top view illustrating the whole structure of the electronic component carrying apparatus 7, and FIG. 12 is a side view thereof.

[0058] The electronic component carrying apparatus 7 forms a carrying route 71 for the electronic component D, and carries the electronic component D one by one to each process unit 74 disposed along the carrying route 71. This carrying route 71 is formed by a turn table 72, and the electronic component holding apparatus 1. The turn table 72 has the center supported by the rotation shaft of a carrying motor 73, and intermittently rotates by a predetermined angle in accordance with the drive of the carrying motor 73. The carrying motor 73 is, for example, a direct-drive motor.

[0059] The multiple electronic component holding apparatuses 1 are disposed on the outer circumference of the turn table 72 at an equal interval in the circumference. More specifically, the arm 21 is fastened to the outer circumference of the turn table 72, and the holder unit 2 is

supported by this arm 21. In addition, the linear guide 31 is fixed above the outer circumference of the turn table 72, and the depressor 3 is supported by the linear guide 31 and is located above the turn table 72. The ascending and
5 descending motor 4 is placed on a stationary block that fastens the linear guide 31.

[0060] The respective process units 74 including the taping unit 6 are disposed along the outer circumference of the turn table 72. As the other process units 74, one of or some of
10 a part feeder, a position correcting unit, a test contact device, a marking unit, a visual inspection device, a sorting mechanism, and a rejecting device 74a are selectively disposed.

[0061] According to this embodiment, the rejecting device
15 74a that rejects an unpacked electronic component D from an electronic component inspection apparatus is provided at the following stage of the taping unit 6, i.e., at the immediate downstream side of the taping unit 6 in the rotation direction of the turn table 72.

[0062] The disposing interval of the holder unit 2 is equal
20 to the rotation angle of one pitch of the turn table 72. In other words, the direct-drive motor intermittently rotates the turn table 72 at the same pitch as the disposing interval of the holder unit 2. The depressor 3 is provided at the same
25 location as the stop position of the holder unit 2. In addition, the process unit is also provided at the same location as the stop position of the holder unit 2. As long as the number of stop positions of the holder units 2 is greater than or equal to the number of carrying units, those numbers
30 may be different numbers, and there may be a stop position of the holder unit 2 where no carrying unit is provided.

[0063] According to such an electronic component carrying apparatus 7, the holder unit 2 holding the electronic component D successively moves to the stop position set at
35 the equal interval in the circumference in accordance with an intermittent rotation of the turn table 72. When the

holder unit 2 is positioned at the stop position, the drive unit located above the holder unit 2 descends the holder unit 2. The process unit 74 is located at the descending destination of the holder unit 2, and the process unit 74 located at the descending destination performs a process on the electronic component D. When the process ends, the depressor 3 ascends the holder unit 2, and the turn table 72 moves the holder unit 2 to the next stop position.

[0064] When the electronic component D is transferred to other process units 74 than the carrier tape 61, the voice coil motor 37 pushes the electronic component D against the stage of the process unit 74, and controls the pushing load to a predetermined value.

[0065] FIG. 13 is a block diagram illustrating the structure of a controller 75 of such an electronic component carrying apparatus 7 at the time of abnormal contact detection. The electronic component carrying apparatus 7 includes the turn table 72, electronic component holding means, and the controller 75 that controls the respective process units 74. This controller 75 includes, at the time of detecting an abnormal contact, an alerting device 75a that alerts an abnormal contact, and an rejection control block 75b that rejects a defective product.

[0066] The alerting device 75a alerts an abnormal contact. This alerting device 75a can be an arbitrary device as long as such a device can transmit an alert to five senses of a human, such as a display, a speaker, a printer, or a patrol lamp connected through a communication line. In addition, the alerting device 75a includes a memory that stores data, records an occurrence of an abnormal contact, and may alert an abnormal contact when a user requests a browsing of data.

[0067] The rejection control block 75b does not pack the electronic component D that has abnormally contacted the pocket 62 in the carrier tape 61, and causes the rejecting device 74a to reject the defective product. FIG. 14 is a

flowchart illustrating an operation of the rejection control block 75b.

[0068] When the abnormal contact determining block 53 determines that the electronic component D abnormally
5 contacts, the alerting device 75a alerts the abnormal contact in step S11. More specifically, data indicating an abnormal contact is written in the memory, and such data is output to a display or a printer. In addition, a speaker outputs alert sound, and a patrol lamp is turned on.

10 [0069] Still further, when the abnormal contact determining block 53 determines that the electronic component D has abnormally contacted, the rejection control block 75b terminates the operation of electronic component holding
15 apparatus 1 of putting the electronic component D into the pocket 62. That is, the rotation of the ascending and descending motor 4 is terminated in step S12, thereby stopping the descending of the holder unit 2 in the halfway. Next, the depressor 3 is ascended in step S13 to release the pushing force by the compression spring 23, and thus the holder unit
20 2 is ascended while maintaining the holding condition of the electronic component D.

[0070] Yet further, the rejection control block 75b rejects the abnormal contact electronic component D from the electronic component carrying apparatus 7. That is, the turn
25 table 72 is rotated by one pitch in step S14, and the holder unit 2 holding the abnormal contact electronic component D is positioned above the rejecting device 74a. Next, the holder unit 2 is descended and releases the electronic component D in step S15, and thus the abnormal contact
30 electronic component D is transferred to the rejecting device 74a.

[0071] Eventually, the rejection control block 75b controls the rejecting device 74a in step S16 to reject the abnormal contact electronic component D from the electronic component
35 carrying apparatus 7.

[0072] (Advantageous Effects)

As explained above, according to the abnormal contact detecting method of this embodiment, descending force F_r is applied to the holder unit 2 through the rod 32 by the ascending and descending motor 4, and opposing thrust force F_{opp} equivalent to counteracting force F_{cr} of the descending force F_r applied to the rod 32 is applied to the rod 32 by the voice coil motor 37. Next, a relative floating of the rod 32 to the voice coil motor 37 corresponding to resistive force F_d generated when the electronic component D descends while contacting the carrier tape 61 is detected, and upon detection of the floating of the rod 32, a contact to the carrier tape 61 in the halfway of descending is detected.

[0073] This method causes the voice coil motor 37 to function as a part of abnormal contact detection. That is, by applying, to the rod 32, the opposing thrust force F_{opp} equivalent to the counteracting force F_{cr} applied to the rod 32, the total load applied to the rod 32 becomes 0 N, and the resistive force F_d generated when the electronic component D descends while contacting the carrier tape 61 is sensed.

[0074] To set the total load applied to the rod 32 to be 0 N, the voice coil motor 37 is suitable. The voice coil motor 37 is capable of generating thrust force in proportional to a current value, and that thrust force is adjustable in fine pitches in comparison with other motors. Hence, the counteracting force F_{cr} and the opposing thrust force F_{opp} can be easily and precisely balanced, and small resistive force F_d from a soft material that is the carrier tape 61 can be detected.

[0075] Accordingly, an abnormal contact with the carrier tape 61 that is a cause of an occurrence of a defective electronic component D can be quite easily and precisely detected, and thus the electronic component D possibly defective due to an abnormal contact can be surely eliminated. In addition, the voice coil motor 37 utilized to apply an appropriate load to the electronic component D in a process

by other process units 74 can be diverted or commonly used, and thus no special mechanical structure is necessary.

[0076] In addition, according to the conventional technologies, after the electronic component D is put in the pocket 62, this pocket 62 is moved to an inspection position, and when a defective product is found, the pocket 62 is returned to the position of the holder unit 2, and the holder unit 2 is caused to pick up the defective product. In addition, a process of rotating backward the turn table 72 with the holder unit 2 is necessary for those operations.

[0077] Conversely, according to the abnormal contact detecting method of this embodiment, when a floating of the rod 32 occurs, insertion of the electronic component D into the pocket 62 may be terminated, the holder unit 2 may be ascended, and the electronic component D may be rejected from the pocket 62. According to this abnormal contact detecting method, when an abnormal contact of the electronic component D occurs, the rejecting process of the electronic component D of the conventional technologies can be eliminated.

[0078] Hence, as to the rejecting process of the defective product originating from an abnormal contact, the time needed for the rejecting process can be remarkably reduced. In addition, an adverse effect in time to the other electronic components D travelling the carrying route 71 by the process of rejecting the defective product originating from an abnormal contact can be dramatically reduced.

[0079] The electronic component D may become defective due to reasons other than an abnormal contact, and the conventional inspection scheme is still maintained. In addition, when a floating of the rod 32 occurs, a contact of the electronic component D occurred while descending toward the carrier tape 61 may be alerted, and the user may take out the electronic component D.

[0080] (Other Process Units 74)

The abnormal contact detecting method of this embodiment that enables a detection of small resistive force

Fd from the soft material that is the carrier tape 61 is quite suitable for a detection of an abnormal contact of the electronic component D while being packed in the carrier tape 61. However, this method is also applicable to a transfer
5 of the electronic component D to other process units.

[0081] For example, FIG. 15 is a partial enlarged view of a part feeder. The part feeder in FIG. 15 is a unit that supplies the electronic component D to the electronic component carrying apparatus 7. This part feeder includes
10 a carrying route 81 and a junction table 82.

[0082] The carrying route 81 swings in an oblique direction to the direction in which the carrying route runs, and moves the electronic component D to a termination through the swinging operation. The junction table 82 is an escape
15 mechanism that relays the electronic component D on the carrying route 81 to the holder unit 2, receives the electronic component D from the carrying route 81, and positions the electronic component D at the stop position of the holder unit 2 by a parallel movement. The junction stage
20 82 is disposed so as to face the termination of the carrying route 81. A mount face 82a for the electronic component D is formed at the front end of the junction table 82. The junction table 82 is also formed with a wall 82b one step taller than the mount face 82a so as to face the mount face 82a.

[0083] In this part feeder, the wall 82b has a function of correcting a position of the electronic component D mounted on the mount face 82a, but when the electronic component D is transferred between the carrying route 81 and the junction table 82, and when the junction table 82 moves in parallel,
25 the electronic component D might run on the wall 82b, or might be propped against that wall.
30

[0084] At this time, the highest portion of the electronic component D is higher than when the electronic component D is not propped against the wall 82b and is mounted on the mount face 82a properly. Hence, the holder unit 2 descending, based
35 on the presumption that the electronic component is mounted

on the mount face 82a properly, abnormally contacts the electronic component D during the descending.

[0085] Therefore, according to the electronic component holding apparatus 1, in response to resistive force R due to an abnormal contact caused while the holder unit 2 is descending, the rod 32 floats relative to the voice coil motor 37, and such a floating is detected by the detector 38. Hence, a collision between the electronic component D and the holder unit 2 is detected, and thus the electronic component D possibly becoming defective due to the collision can be picked up.

[0086] Moreover, FIG. 16 is a partial enlarged view of a position correcting unit. This position correcting unit includes a guide member 83 that corrects the position of the electronic component D. The guide member 83 is formed with a pyramid-shaped hole 83a becoming narrower toward the bottom. When the holder unit 2 fits the electronic component D in the hole 83a of the guide member 83, the position of the electronic component D changes in accordance with the internal wall shape of the hole 83a. By changing the position, the position correcting unit corrects the electronic component D to a desired position.

[0087] When the electronic component D is fitted in this guide member 83, a depth of fitting of the electronic component D is adjusted beforehand. In other words, in accordance with the dimension of the electronic component D, the descending level of the holder unit 2 is set in advance. However, depending on the variance in the dimension and thickness of the electronic component D, and the variance in the position of the electronic component D held by the holder unit 2, the electronic component D might abnormally contact the guide member 83.

[0088] At this time, since the electronic component D is to be fitted in a smaller diameter hole than the dimension of the electronic component, larger abnormal resistive force R than normal resistive force generated when the position of

the electronic component changes through the internal wall of the guide member 83 is generated.

[0089] Hence, according to the electronic component holding apparatus 1, the ascending and descending motor 4 keeps
5 applying descending force to the holder unit 2 through the rod 32. Normal resistive force generated when the position of the electronic component is changed through the internal wall of the guide member 83 is added to the descending force. In addition, the voice coil motor 37 keeps applying, to the
10 rod 32, opposing thrust force equivalent to the counteracting force to the descending force applied to the rod 32.

[0090] Next, in response to the resistive force R due to an abnormal contact caused while the holder unit 2 is descending, the rod 32 floats relative to the voice coil motor
15 37, and such a floating is detected by the detector 38. At this time, a collision between the electronic component D and the guide member 83 is detected, and thus the electronic component D possibly defective due to the collision can be picked up.

20 [0091] In addition, FIG. 17 is a partial enlarged view of a test contact device. The test contact device is a device that tests the electrical characteristic of the electronic component D upon electrical conduction, and includes therein a socket 84 having a conducting electrode exposed.

25 [0092] In this test contact device, when the electronic component D is fitted in the socket 84, the electronic component D might run on the internal side wall of the socket 84, or might be propped against the internal side wall.

[0093] At this time, the highest portion of the electronic
30 component D is higher than the corresponding portion when the electronic component is appropriately fitted in the socket 84. Hence, the holder unit 2 descending, based on the presumption that the electronic component is appropriately fitted in the socket 84, abnormally contacts the electronic
35 component D during the descending.

[0094] Hence, according to the electronic component holding apparatus 1, in response to resistive force R due to an abnormal contact caused while the holder unit 2 is descending, the rod 32 floats relative to the voice coil motor 37, and
5 such a floating is detected by the detector 38. Therefore, a collision between the electronic component D and the holder unit 2 is detected, and the electronic component D possibly defective due to the collision can be picked up.

[0095] (Other Embodiments)

10 The embodiment of the present disclosure was explained above, but various omissions, replacements, and modifications are applicable without departing from the scope of the present disclosure. Such embodiments and
15 modifications thereof are within the scope of the present disclosure, and are also within the equivalent range to the appended claims.

[0096] For example, in the aforementioned embodiment, the explanation was given of an example case in which the ascending and descending motor 4 is a servo motor, but as the
20 motor, all conventionally well-known ones like a stepping motor are also applicable. In addition, the explanation was given of an example case in which the holder unit 2 is a suction nozzle, but an electrostatic absorption type, a Bernoulli chuck type, or a chuck mechanism that mechanically holds the
25 electronic component D is applicable.

[0097] In addition, as to the compression springs 23, 36 both provided in the embodiment, only either one of the compression springs may be provided, or both may be omitted, and the opposing thrust force F_{opp} equivalent to the
30 counteracting force F_{cr} applied to the rod 32 can be generated in accordance with the way of the application of the compression spring. That is, the term descending force F_r contains force descending only the holder unit 2 without the compression springs 23, 36, force descending only the holder
35 unit 2 against the compression spring 23, or force descending only the holder unit 2 against the difference between

respective elastic forces of the compression springs 23, 36, and the term counteracting force F_{cr} is corresponding force to the descending force F_r .

[0098] The controller 5 of the electronic component holding apparatus 1 may be possessed by the electronic component holding apparatus 1, or the controller 75 of the electronic component carrying apparatus 7 may execute the same processes.

[0099] Still further, the explanation was given of an example case in which the one turn table 72 is provided with various process units 74, but as to a carrying mechanism, a linear carrying type may be applicable or multiple turn tables 72 may form a carrying route 71. The kinds of the process units 74 are not limited to the aforementioned examples. The process units can be replaced with other various kinds of process units 74, and the disposing order can be changed as needed.

REFERENCE SIGNS LIST

20	[0100]	1	Electronic component holding apparatus
		2	Holder unit
		21	Arm
		22	Bearing
		23	Compression spring
25		24	Flange
		25	Joint
		3	Depressor
		31	Linear guide
		32	Rod
30		33	Frame
		33a	Lower arm
		33b	Upper arm
		34	Cam follower
		35	Bearing
35		36	Compression spring
		37	Voice coil motor

	37a Magnet
	37b Annular coil
	38 Detector
	38a Air vent
5	38b Lid
	38c Pipe
	38d Flow volume meter
	38e Pressured-air circuit
	4 Ascending and descending motor
10	41 Cylindrical cam
	5 Controller
	51 Motor control block
	52 VCM control block
	53 Abnormal contact determining block
15	6 Taping unit
	61 Carrier tape
	62 Embossed pockets
	7 Electronic component carrying apparatus
	71 Carrying route
20	72 Turn table
	73 Carrying motor
	74 Process unit
	74a Rejecting device
	75 Controller
25	75a Alerting device
	75b Rejection control block
	81 Carrying route
	82 Junction table
	82a Mount face
30	82b Wall
	83 Guide member
	83a Hole
	84 Socket
	D Electronic component

CLAIMS

1. An abnormal contact detecting method of an electronic component by an electronic component holding apparatus including an ascending and descending motor descending, together with a rod supported by a voice coil motor, a holder unit of the electronic component through the rod, the method comprising:

applying descending force to the holder unit through the rod by the ascending and descending motor;

applying, to the rod by the voice coil motor, opposing thrust force equivalent to counteracting force applied to the rod relative to the descending force;

detecting a relative floating of the rod to the voice coil motor in accordance with abnormal resistive force caused while the holder unit is descending; and

detecting an abnormal contact of the electronic component during the descending upon detection of the floating of the rod.

20

2. The abnormal contact detecting method according to claim 1, further comprising:

descending the holder unit holding the electronic component toward a pocket of a carrier tape;

detecting a relative floating of the rod to the voice coil motor in accordance with resistive force caused when the electronic component is descending while being in contact with the carrier tape; and

detecting a contact to the carrier tape during the descending upon detecting of the floating of the rod.

3. The abnormal contact detecting method according to claim 1 or 2, further comprising:

terminating the descending, and ascending the holder unit when the floating of the rod occurs.

4. The abnormal contact detecting method according to any one of claims 1 to 3, further comprising:

alerting a contact of the electronic component during the descending when the floating of the rod occurs.

5. An electronic component holding apparatus transferring an electronic component, the apparatus comprising:

a holder unit capable of ascending and descending to and from a transfer position by external force while holding the electronic component;

an ascending and descending motor generating descending force to the holder unit;

a rod provided so as to be capable of ascending and descending to and from the holder unit, abutting the holder unit, and transferring the descending force generated by the ascending and descending motor to the holder unit;

a voice coil motor applying, to the rod, opposing thrust force equivalent to counteracting force to the rod caused by the descending force applied to the holder unit; and

a detector detecting a relative floating of the rod to the voice coil motor in accordance with abnormal resistive force caused while the holder unit is descending.

6. The electronic component holding apparatus according to claim 5, wherein:

the holder unit descends toward a pocket of a carrier tape that is the transfer position while holding the electronic component; and

the detector detects a relative floating of the rod to the voice coil motor in accordance with resistive force caused when the electronic component descends while contacting the carrier tape.

5

7. The electronic component holding apparatus according to claim 5 or 6, wherein the holder unit terminates the descending and the holder unit is ascended when the detector detects the floating of the rod.

10

8. An electronic component carrying apparatus carrying an electronic component to various process units disposed on a carrying route, and transferring the electronic component to the process units, the apparatus comprising:

15

a holder unit capable of ascending and descending by external force while holding the electronic component;

a carrying motor turning the holder unit along the carrying route, and stopping the holder unit above a transfer position to the process unit;

20

an ascending and descending motor generating descending force to the holder unit;

a rod provided above the holder unit stopping above the transfer position so as to be capable of ascending and descending, abutting the holder unit, and transferring the descending force generated by the ascending and descending motor to the holder unit;

25

a voice coil motor applying, to the rod, opposing thrust force equivalent to counteracting force to the rod caused by the descending force applied to the holder unit; and

30

a detector detecting a relative floating of the rod to the voice coil motor in accordance with abnormal resistive force caused while the holder unit is descending.

5 9. The electronic component carrying apparatus according to claim 8, wherein:

the holder unit descends toward a pocket of a carrier tape that is the transfer position while holding the electronic component; and

10 the detector detects a relative floating of the rod to the voice coil motor in accordance with resistive force caused when the electronic component descends while contacting the carrier tape.

15 10. The electronic component carrying apparatus according to claim 8 or 9, further comprising a rejecting device of the electronic component,

wherein the holder unit terminates the descending and the holder unit is ascended, and the holder unit transfers
20 the electronic component to the rejecting device when the detector detects the floating of the rod.

11. The electronic component carrying apparatus according to any one of claims 8 to 10, further comprising
25 alerting means that alerts a contact of the electronic component during the descending when the floating of the rod occurs.