

DESCRIPTION

TITLE OF INVENTION: HANDLER FOR TESTING ELECTRONIC DEVICE

Technical Field

5 [1] The present invention relates to a handler for supporting the testing of electronic components by electrically connecting the electronic components and a tester to each other.

Background Art

10 [2] A handler for testing electronic components is the equipment that handles electronic components in order to electrically connect the electronic components to a tester.

[3] As the degree of integration of electronic components such as semiconductor devices increases, there is a trend
15 toward the line width of circuits becoming increasingly narrow. Accordingly, higher precision is required when electronic components are connected to testers.

[4] For example, although an error range of 20 μm was previously sufficient to ensure the appropriate electrical
20 connection between electronic components and testers, an error range of 10 μm or less, up to a few μm is required now.

[5] Meanwhile, among electronic components, there are dies that are separated into individual units from a wafer state.

[6] Dies may be completed as final products by undergoing
5 a packaging task or by stacking them for High Bandwidth Memory (HBM) production and then undergoing a packaging task.

[7] The testing of dies is required to perform post-die tasks.

10 [8] Electronic components in a die state may be tested by electrically connecting the contact pads thereof to a tester.

[9] Dies have fine intervals between the contact pads thereof and are significantly thin, making them prone to
15 breaking or cracking, so that no suitable test method capable of adequately supporting the testing of electronic components in a die or HBM state has been proposed until now. Accordingly, the applicant proposed Korean Patent Application Publication No. 10-2021-0088373 (hereinafter
20 referred to as the 'conventional art').

[10] The conventional art proposes a technology for aligning the positions of electronic components by rearranging the electronic components before connecting them to a tester.

25 [11] The conventional art allows for the reduction of errors in the positions of electronic components by scanning electronic components on a test table (named the

'chuck' in the conventional art) with a camera to determine the current positions (the arbitrary positions) of the electronic components and then adjusting the positions to move the electronic components to their regular positions.

5 [12] However, according to the conventional art, the following problems arise:

[13] First, when the current positions of electronic components are determined by analyzing images of the electronic components in captured images, image processing
10 and analysis require a large amount of time.

[14] Second, the distance between a camera and electronic components needs to be maintained to the extent that the electronic components are contained within an image captured by the camera, and accordingly it is difficult to
15 obtain a clear image. Furthermore, proportionally, the precision of image analysis decreases, and the range of errors in a rearrangement process increases. In particular, these problems make it difficult to control the positions of electronic components within a range of several μm .

20 [15] When the electrical connection between electronic components and a tester is not appropriately set up, the electronic components may be damaged. Therefore, the accurate control of the positions of electronic components is the most critical issue that has to be addressed first
25 and foremost.

[16] [Conventional Art Literature]

[17] [Patent Literature]

[18] (Patent Document 1) Korean Patent Application
Publication No. 10-2021-0088373

Disclosure

Technical Problem

5 [19] It is necessary to allow image processing and
analysis for electronic components to be performed
precisely while reducing the time required for the image
processing and analysis for the electronic components
photographed by a camera.

10 Technical Solution

[20] A handler for testing electronic components according
to the present invention includes: a transport shuttle
provided with a transport table capable of transporting
electronic components by moving with the electronic
15 components loaded thereonto; a first hand configured to
load the electronic components onto the transport table
that is placed in a first area by the operation of the
transport shuttle; a second hand configured to unload the
electronic components from the transport table that is
20 moved from the first area to a second area by the operation
of the transport shuttle; a test table configured such that
the electronic components unloaded from the transport table
by the second hand are loaded thereonto; a rearrangement
mechanism configured to rearrange the electronic
25 components, loaded into temporary zones of the test table

by the second hand, to regular zones; a movement mechanism configured to move the test table to rearrange the electronic components to regular zones by using the rearrangement mechanism; a connector configured to enable
5 the electronic components, loaded onto the test table on which the electronic components have been rearranged by the rearrangement mechanism, to be tested by electrically connecting the electronic components to a tester; and a controller configured to control the transport shuttle, the
10 first hand, the second hand, the rearrangement mechanism, the movement mechanism, and the connector; the rearrangement mechanism includes: a rearrangement picker capable of gripping an electronic component; and a rearrangement camera disposed to be spaced apart from the
15 rearrangement picker; and the controller calculates a temporary zone of an electronic component loaded onto the test table by analyzing an image acquired by photographing an identification mark of the electronic component with the rearrangement camera, and then controls the movement
20 mechanism and the rearrangement picker to move the electronic component from the temporary zone to a regular zone.

[21] The controller may calculate the temporary zone of the electronic component by analyzing images acquired by
25 controlling the rearrangement camera to sequentially photograph first and second identification marks on the electronic component.

[22] The rearrangement picker and the rearrangement camera may be arranged relative to each other so that, when a first electronic component gripped by the rearrangement picker is located in the regular zone, the rearrangement
5 camera can photograph the first identification mark of a second electronic component adjacent to the first electronic component.

[23] Assuming that the rearrangement camera may photograph the center of the electronic component, the rearrangement
10 camera is installed such that at least a portion of the edge of the electronic component exceeds the field of view thereof.

[24] The identification mark may be formed independently of a circuit pattern in the electronic component.

15 [25] The relative positions of the identification mark to the circuit pattern may be pre-defined.

[26] A method of rearranging an electronic component for a handler for testing electronic components according to the present invention includes: a photographing step of
20 photographing an identification mark of an electronic component on a test table with a rearrangement camera; a first calculation step of calculating the temporary zone of the electronic component by analyzing an image acquired in the photographing step; a second calculation step of
25 calculating the distance required to move the electronic component from the temporary zone, calculated in the first calculation step, to a regular zone; and a movement step of

moving the electronic component, placed in the temporary zone, to the regular zone based on a value calculated in the second calculation step; and the photographing step includes photographing the identification mark of the electronic component on the test table with the rearrangement camera.

[27] The photographing step may include: a first photographing step of photographing a first identification mark on the electronic component; and a second photographing step of photographing a second identification mark of the electronic component on the test table with the rearrangement camera; and the first calculation step may include calculating the temporary zone of the electronic component by analyzing images acquired from the first and second photographing steps.

Advantageous Effects

[28] According to the present invention, it is possible to control the position of an electronic component within a range of several μm by using identification marks whose positions relative to a circuit pattern are clearly defined, so that there is an effect in which the reliability of the handler for testing electronic components is improved.

Description of Drawings

[29] FIG. 1 is a conceptual plan view of a handler for testing electronic components according to a first embodiment of the present invention;

[30] FIG. 2 is a schematic plan view of a transport table
5 applied to the handler for testing electronic components of FIG. 1;

[31] FIG. 3 is a schematic perspective view of a first hand applied to the handler for testing electronic components of FIG. 1;

10 [32] FIG. 4 is a reference view illustrating the first hand of FIG. 3;

[33] FIG. 5 is a schematic perspective view of a test table applied to the handler for testing electronic components of FIG. 1;

15 [34] FIG. 6 is a schematic plan view of a test board coupled to the handler for testing electronic components of FIG. 1;

[35] FIG. 7 is a reference view illustrating the electrical connection relationship between the test board
20 of FIG. 6 and an electronic component;

[36] FIG. 8 is a reference view illustrating temporary zones in the test table of FIG. 5;

[37] FIG. 9 is a reference view illustrating regular zones generated in the test table of FIG. 5;

25 [38] FIG. 10 is a schematic diagram of a rearrangement mechanism applied to the handler for testing electronic components of FIG. 1;

[39] FIG. 11 is a reference view illustrating the areas of an electronic component photographed by a rearrangement camera in the rearrangement mechanism of FIG. 10;

[40] FIG. 12 shows examples of various forms of identification marks;

[41] FIGS. 13 and 14 are reference views comparing the conventional art with the present invention;

[42] FIG. 15 is a reference view illustrating a movement mechanism applied to the handler for testing electronic components of FIG. 1;

[43] FIGS. 16 to 18 are reference views illustrating a set line segment generated on the test board of FIG. 5;

[44] FIGS. 19 and 20 are reference views illustrating an imaginary line segment generated in the test table of FIG. 4;

[45] FIG. 21 is a reference view illustrating regular zones set in the test table of FIGS. 4;

[46] FIG. 22 is a flowchart illustrating a method of rearranging electronic components in the handler for testing electronic components of FIG. 1;

[47] FIGS. 23 to 31 are reference views illustrating the flowchart of FIG. 21;

[48] FIGS. 32 to 35 are reference views illustrating various examples of the identifiers of electronic components; and

[49] FIGS. 36 to 38 are reference views illustrating another example of the method of rearranging electronic components.

Mode for Invention

5 [50] Preferred embodiments according to the present invention will be described with reference to the accompanying drawings. For the sake of brevity, descriptions of well-known or redundant components are omitted or abridged as much as possible.

10 [51] **<Overview of Handler for Testing Electronic Components>**

[52] FIG. 1 is a conceptual plan view of a handler TH for testing electronic components (hereinafter abbreviated as the 'handler TH') according to the present invention.

15 [53] The handler TH for testing electronic components according to the present invention may be divided into a movement part MP, an unloading part LU, rearrangement parts RP, and a connection part CP. The handler TH for testing electronic components includes a transport shuttle 100, a
20 first hand 210, second hands 220, test tables 300, vacuum devices 400, rearrangement mechanisms 500, movement mechanisms 600, connectors 700, and a controller 800.

[54] In the movement part MF, electronic components may be moved such that the electronic components are handed over
25 between the unloading part LU and the rearrangement part

RP. To this end, the transport shuttle 100 for transporting electronic components is installed in the movement part MP.

[55] The transport shuttle 100 is provided to transport electronic components between the unloading part LU and the
5 rearrangement part RP.

[56] The transport shuttle 100 has a movable transport table 110.

[57] The transport shuttle 100 may have at least one transport table 110.

10 [58] The transport table 110 is capable of moving in one direction. According to a preferred example, the transport table 110 is capable of reciprocating in the X-axis direction.

[59] In the case where the transport table 100 includes a
15 plurality of transport tables 100, the plurality of transport tables 110 may be provided in parallel with each other in the Y-axis direction.

[60] Furthermore, the plurality of transport tables 110 need to be implemented to reciprocate in the X-axis
20 direction independently of each other.

[61] The transport table 110 may move back and forth between a first area A1 located on an unloading part LU side and a second area A2 located on a rearrangement part RP side.

25 [62] Electronic components may be loaded onto the transport table 110.

[63] The transport table 110 does not have a pocket structure having depressions into which electronic components can be seated, but has rather a vacuum structure which secures electronic components seated on a flat surface by using vacuum pressure.

[64] As shown in the schematic plan view of FIG. 2, vacuum holes VH and vacuum depressions VG for vacuum-sucking electronic components are formed in the transport table 110.

[65] One vacuum hole VH and one vacuum depression VG form a pair.

[66] The vacuum pressure coming via the vacuum hole VH acts on an electronic component while being evenly distributed via the vacuum depression VG.

[67] Since electronic components may be fixed to the transport table 110 by vacuum pressure, the movement of the electronic components does not occur during the process of moving on the transport table 110 in the X-axis direction. Accordingly, as long as the electronic components are placed precisely on the transport table 110, the tolerance for the positional misalignment of the electronic components, which has been a problem in the past, may be minimized.

[68] The vacuum holes VH and the vacuum depressions VG may be arranged in a 2×8 matrix, but the loading capacity of the transport table 110 may be increased or decreased as needed.

[69] In the unloading part LU, electronic components are fed to the handler TH or recovered from the handler TH. That is, electronic components to be tested are fed to the handler TH via the unloading part LU, and tested electronic components are recovered from the handler TH via the unloading part. Electronic components may be loaded onto a carrier such as a JEDEC tray, a ring frame, or some other customer tray and may then be fed to the handler TH or recovered from the handler TH.

[70] Electronic components to be tested in the unloading part LU are loaded onto the transport table 110 in the first area A1, and tested electronic components loaded onto the transport table 110 in the first area A1 are unloaded from the transport table 110. To this end, the first hand 210 is provided in the unloading part LU.

[71] The first hand 210 is provided to load electronic components onto the transport table 110 or unload electronic components from the transport table 110.

[72] For unloading operations by the first hand 210, the transport table 110 has to be moved toward the unloading part LU and be placed in the first area A1.

[73] The first hand 210 loads electronic components to be tested onto the transport table 110 in the first area A1, or unloads tested electronic components from the transport table 110 in the first area A1.

[74] The first hand 210 has one or more pickers capable of gripping or releasing electronic components.

[75] The pickers may grip electronic components by vacuum pressure.

[76] The first hand 210 may be provided with a plurality of pickers to increase the working capacity in a single operation. For example, as shown in the schematic diagram of FIG. 3, the first hand 210 may have four pickers P1 arranged in a 2×2 matrix. The number of pickers P1 provided in the first hand 210 may be increased or decreased depending on the implementation.

[77] The pickers P1 may be provided to be lifted/lowered independently such that they can selectively grip and release electronic components. Accordingly, the electronic components unloaded from the transport table 110 by the first hand 210 may be classified according to their test grade.

[78] The first hand 210 has elevators E1 for independently lifting/lowering the pickers P1. By the elevators E1, the pickers P1 may selectively grip or release electronic components. Accordingly, the electronic components moved to the transport table 110 by the first hand 210 may be individually seated on the transport table 110 while their positions are being individually and precisely adjusted. Furthermore, the electronic components unloaded from the transport table 110 by the first hand 210 may be classified according to the test grade.

[79] The first hand 210 may further include a camera C1.

[80] The first hand 210 may grip an electronic component with the picker P1 after accurately calculating the position of the electronic component by analyzing an image captured by the camera C1 before gripping the electronic component. Accordingly, the picker P1 may grip the electronic component more precisely, and, thus, can place the electronic component at a correspondingly correct position on the transport table 110.

[81] The picker P1 may be implemented to grip electronic components of various heights.

[82] For example, an implementation may be made in such a manner as to determine the lifting height of the picker P1 according to the height of an electronic component preset by an administrator. In this case, when the specifications of an electronic component to be tested change, it entails the inconvenience in which an administrator has to re-enter the height of the electronic component.

[83] For example, an implementation may be made in such a manner as to determine the lifting height of the picker P1 for gripping or releasing an electronic component by calculating the height of the electronic component from an image captured by the camera C1. In this case, operational convenience is improved because the handler TH automatically recognizes the height of the electronic component and then operates the picker P1.

[84] The first hand 210 may further include rotators R1.

[85] The rotators R1 each rotate an electronic component ED in the Θ -axis direction by using a vertical line in the Z-axis direction as the axis of rotation, as shown in FIG. 4.

5 [86] The rotators R1 may rotate the respective pickers P1 individually. Accordingly, the first hand 210 may not only move the electronic component ED in the X-, Y-, and Z-axis directions, but may also rotate the electronic component ED in the Θ -axis direction. That is, the first hand 210 may
10 correct the misalignment of the electronic component ED photographed by the camera C1 before gripping and may then seat it on the transport table 110. The position of the electronic component ED seated at a precise position on the transport table 110 by the first hand 210 is fixed by
15 vacuum pressure. Accordingly, during the process of moving the electronic component ED by the first hand 210, the positions of the electronic component ED in the X-, Y-, Z-, and Θ -axis directions may be precisely adjusted.

[87] However, it may also be possible to provide a
20 rotation means for the electronic component ED separately from the first hand 210.

[88] For example, an implementation may be made such that, when the first hand 210 grips the electronic component ED from a JEDEC tray or ring frame and feeds it to the
25 rotation means, the rotation means may correct the misalignment of the electronic component ED by fixing the electronic component ED with vacuum pressure and then

rotating it. The electronic component ED, the misalignment of which has been corrected by the rotation means, may be gripped again by the first hand 210 and then moved to the transport table 110.

5 [89] In the example of FIG. 3, the first hand 210 is provided with four pickers P1. When a plurality of pickers P1 are provided in this manner, the targets to be gripped may be different for the respective pickers P1.

[90] For example, some pickers P1 may be implemented to
10 grip electronic components ED in a live-bug state (in the state in which terminals face downward), and the remaining pickers P1 may be implemented to grip electronic components ED in a dead-bug state (in the state in which terminals face upward). In this case, all the electronic components
15 ED fed to the handler TH via a JEDEC tray or ring frame may be handled regardless of their loading state, thereby increasing the usability of the handler TH.

[91] In the rearrangement parts RP, electronic components ED to be tested are unloaded from the transport table 110,
20 and the unloaded electronic components ED are rearranged.

[92] According to the present embodiment, two rearrangement parts RP are symmetrically arranged on both sides with the connection part CP disposed therebetween. By having the two rearrangement parts RP in this manner, the
25 handling capacities of the handler TH and a tester are improved.

[93] The second hands 220 are provided in the rearrangement parts RP.

[94] The second hands 220 unload electronic components ED to be tested from the transport table 110 or load tested
5 electronic components ED onto the transport table 110.

[95] For unloading operations by the second hands 220, the transport table 110 has to be moved toward the rearrangement part RP and then placed in the second area A2.

10 [96] The second hands 220 unload electronic components to be tested from the transport table 110 in the second area A2 or load tested electronic components onto the transport table 110 in the second area A2.

[97] In the same manner, the second hands 220 each have
15 one or more pickers capable of gripping or releasing electronic components ED. Preferably, the second hands 220 may each be provided with a plurality of pickers to increase the working capacity in a single operation. For example, the second hands 220 may each have four pickers
20 arranged in a 2×2 matrix. The number of pickers provided in the second hand 220 may be increased or decreased depending on the implementation. Furthermore, the pickers of the second hand 220 may be provided to be independently movable in order to selectively grip or release electronic
25 components ED.

[98] The second hands 220 may be provided in the same operational structure as the first hand 210. However, the

number of pickers P1 provided in the first hand 210 and the number of pickers provided in each of the second hands 220 may differ from each other. Meanwhile, to lower the manufacturing cost of the second hands 220, individual
5 elevation or rotation means for the pickers may not be applied to the second hands 220.

[99] The second hand 220 unloads the electronic components ED to be tested from the transport table 110 in the second area A2 and loads them onto the test table 300 that has
10 been moved to the rearrangement part RP.

[100] Furthermore, the second hand 220 loads the electronic components ED, loaded onto the test table 300 and having been tested, onto the transport table 110 in the second area A2.

15 [101] The test table 300 is provided to be loaded with the electronic components ED that are unloaded from the transport table 110 by the second hand 220.

[102] As shown in the schematic excerpt of FIG. 5, the test table 300 is provided to have a flat top surface.
20 Accordingly, electronic components ED are loaded onto the test table 300 in such a manner that the electronic components ED are placed on the flat top surface of the test table 300.

[103] When viewed in a plan view, the test table 300 may be
25 formed in the shape of a disk as in (a) of FIG. 5 or in the shape of a square plate as in (b) of FIG. 5.

[104] According to the present invention, the test table 300 may be moved in the X- and Y-axis directions, or may be rotated in the Z-axis direction by using a vertical line V1, passing through the center of the test table 300, as the axis of rotation.

[105] Furthermore, the test table 300 may be lifted/lowered by the connector 700 to be described later.

[106] Generally, during the process of moving an electronic component ED to the test table 300, shock or inertia accompanying the movement occurs. Accordingly, the position of the electronic component ED loaded onto the test table 300 may be misarranged due to shock or inertia. To prevent this problem, the vacuum holes h are formed in the areas where electronic components ED are loaded on the test table 300. Furthermore, when vacuum pressure is applied via the vacuum holes h, the electronic components ED may be fixed to the test table 300. That is, when the electronic component ED is placed on the test table 300 by the second hand 220, the electronic component ED may be seated at the position, where it was placed, without change by the vacuum pressure. The vacuum suction structure of the test table 300 may be the same as the vacuum suction structure of the transport table 110 illustrated with reference to FIG. 2.

[107] According to a preferred example, a camera C2 may be installed at the center or on one side of the test table 300. In this case, the camera C2 is used to identify at least one of the angular position (the position in the Θ -

axis direction) of a test board TB to be described later, the test zones TZ of the test board TB to be described later with reference to FIG. 6, and the test pins t of the test board TB. However, any position where the angular
5 position of the test board TB can be identified may be preferred as the installation position of the camera C2.

[108] The camera C2 may be configured to be divided into a high-magnification camera for identifying the positions of each of the test pins t and a low-magnification camera for
10 identifying the test zones TZ within a predetermined area all at once.

[109] The vacuum device 400 provides vacuum pressure to the vacuum holes h in the test table 300 via a vacuum circuit (not shown). The vacuum pressure provided by the vacuum
15 device 400 is transmitted to the electronic components ED via the vacuum holes h. Accordingly, the positions of the electronic components ED loaded onto the test table 300 may be fixed by the vacuum pressure.

[110] The vacuum holes h may be implemented to be
20 selectively opened or closed depending on the control of the vacuum circuit (not shown). Accordingly, the electronic components ED may be fixedly loaded onto the test table 300, or may be removed from the test table 300.

[111] According to the present invention, the electronic
25 components ED loaded onto the test table 300 and to be tested are precisely rearranged in the rearrangement part RP. This will be described in detail later.

[112] In the connection part CP, the electrical connection is set up between the electronic components ED, loaded onto the test table 300 that is moved to the connection part CP, and the tester.

5 [113] For the electrical connection between the electronic components ED and the tester, the tester is provided with the test board TB. Furthermore, the test board TB is coupled to the handler TH. More specifically, the test board TB is coupled to the connection part CP.

10 [114] The electronic components ED loaded onto the test table 300 are electrically connected to the test board TB. Accordingly, the electronic components ED may ultimately be electrically connected to the tester via the test board TB.

[115] In this case, the test board TB will be described in
15 brief.

[116] FIG. 6 is a bottom view showing the bottom surface of the test board TB.

[117] Although the test board TB is formed in the shape of a disk in the example of FIG. 6, the test board TB may also
20 be provided in the shape of a square plate.

[118] As shown in the bottom view of FIG. 6, test zones TZ corresponding to respective electronic components ED are arranged on the test board TB. The test zones TZ correspond to the electronic components ED, loaded onto the test table
25 300, in a one-to-one correspondence.

[119] Each of the test zones TZ is provided with test pins t for electrically connecting to one electronic component ED.

5 [120] The test pins t may be considerably fine contact pins that are the same as or have a different type or shape than the probe pins of a probe card.

[121] The test pins t in each test zone TZ form a single set to form the test zone TZ, and are electrically connected to an electronic component ED. Accordingly, the
10 test zone TZ and the electronic component ED have to be aligned with each other. When the coordinates of the electronic component ED on the test table 300 do not match the coordinates of the test zone TZ on the X-Y plane, a failure occurs in the electrical connection between the
15 electronic component ED and the tester.

[122] In particular, as shown in the conceptual example of FIG. 7, when the electronic component ED on the test table 300 is placed at an angular position rotated by a rotation angle Θ_1 in the Θ -axis direction relative to the test zone
20 TZ, a failure occurs in the electrical connection between the electronic component ED and the tester. Accordingly, all the test zones TZ of the test board TB and all electronic components ED on the test table 300 have to be aligned with each other.

25 [123] The rearrangement mechanism 500 is provided to achieve the alignment between the test zones TZ and the electronic components ED.

[124] According to the present embodiment, the electronic components ED are moved from the transport table 110 to the test table 300 by the second hand 220. During this process, an error in the position of the electronic component ED may occur due to an operational error or shock of the second hand 220. Accordingly, the positions on the X-Y plane or angular positions of the electronic components ED loaded onto the test table 300 by the second hand 220 may differ from each other. That is, the electronic components ED loaded onto the test table 300 may not be aligned with the test zones TZ of the test board TB.

[125] It does not matter when the range of error tolerances between the electronic components ED and the test zones TZ is wide. However, the reality is that a precision within 30 μm is required for the packaged semiconductor device and a precision within 5 μm is required for the die or HBM. To overcome this issue, in the present invention, when the second hand 220 moves electronic components ED from the transport table 110 to the test table 300, it loads them into temporary zones first. Then, the electronic components ED are rearranged from the temporary zones to regular zones. According to a preferred example, the planar shape and area of the temporary and regular zones may be the same as the planar shape and area of the electronic components ED.

[126] The temporary zones are not set positions, but are any positions where electronic components ED are placed on

the test table 300 by the second hand 220. That is, the temporary zones are not set by the controller 800 or are not fixed, but are the positions determined by the second hand 220 as desired. For example, when the second hand 220
5 seats electronic components ED onto the test table 300, the zones where the electronic components ED are seated become the temporary zones BZ. The exaggerated FIG. 8 shows an example of the temporary zones BZ on the test table 300.

[127] The regular zones RZ refer to the positions where the
10 electronic components ED and the test zones TZ are aligned with each other. The exaggerated FIG. 9 shows the relationship between the temporary zones BZ and the regular zones RZ on the test table 300.

[128] Although the regular zones RZ may be preset, they may
15 be set to match the positions and arrangement of the test zones TZ on the test board TB after the electronic components ED to be tested have been loaded onto the test table 300.

[129] The rearrangement mechanism 500 is provided to
20 rearrange the positions of the electronic components ED, loaded onto the test table 300 by the second hand 220, from the temporary zones BZ to the regular zones RZ.

[130] According to the present embodiment, the second hand
220 loads the electronic components ED, unloaded from the
25 transport table 110 and to be tested, into the temporary zones BZ. Then, the rearrangement mechanism 500 operates to move the electronic components ED, placed in the temporary

zones BZ, to the regular zones RZ. In this case, the temporary zones BZ include not only the positions in the X- and Y-axis directions, but also the angular positions in the Θ -axis direction based on the angularly misaligned, rotated states of electronic components ED.

[131] For reference, when only a theoretical design that does not give consideration to machining errors is taken into consideration, the interval between the pickers of the second hand 220 may be the same as the interval between the electronic components seated onto the transport table 110. In this case, the adjustment of the interval between the electronic components ED moved from the transport table 110 to the test table 300 or from the test table 300 to the transport table 110 by the second hand 220 may not be required. Accordingly, the manufacturing cost may be reduced accordingly. In the same manner, the interval between the pickers of the second hand 220 may be the interval between the test zones TZ of the test board TB, and may be the same as the interval between the regular zones RZ on the test table 300.

[132] For reference, although the differences in the interval between temporary zones BZ and regular zones RZ are shown as being large in FIG. 9, the differences in the interval between the temporary zones BZ and the regular zones RZ may be various. In some cases, the temporary zones BZ and the regular zones RZ may have only slight differences in angle.

[133] Meanwhile, as shown in the schematic diagram of FIG. 10, the rearrangement mechanism 500 includes a rearrangement picker 510 and a rearrangement camera 520.

[134] The rearrangement mechanism 500 has a fixed position.
5 For example, the rearrangement mechanism 500 may be fixedly mounted onto a frame that forms the skeleton of the handler TH.

[135] The rearrangement picker 510 may grip or release an electronic component ED. The rearrangement picker 510 may
10 grip the electronic component ED by vacuum pressure.

[136] The rearrangement picker 510 has a fixed position in the horizontal directions, which are the X- and Y-axis directions.

[137] The rearrangement camera 520 is disposed to be spaced
15 apart from the rearrangement picker 510.

[138] The rearrangement camera 520 is disposed to be spaced apart from the rearrangement picker 510.

[139] The rearrangement camera 520 is provided to photograph an electronic component ED. In particular, as
20 shown in the example of FIG. 11, the rearrangement camera 520 is provided to photograph identification marks D1 and D2 of the electronic component ED.

[140] The identification marks D1 and D2 are formed independently of a circuit pattern on the electronic
25 component ED.

[141] The identification marks D1 and D2 may be patterns, characters, symbols, or the like formed at separate

positions independently of the circuit pattern during the manufacturing stage of the electronic component ED.

[142] The identification marks D1 and D2 may be formed in various shapes depending on the manufacturer.

5 [143] FIG. 12 shows various examples of identification marks D1 and D2 in various shapes.

[144] The positions of the identification marks D1 and D2 relative to the circuit pattern are defined. Accordingly, the exact position of the circuit pattern may be determined
10 by identifying the positions of the identification marks D1 and D2.

[145] The identification marks D1 and D2 may include one or more of identification marks, and one or more of them may be selected and photographed.

15 [146] In the present embodiment, the number of identification marks D1 and D2 is two. The two identification marks D1 and D2 may be divided into a first identification mark D1 and a second identification mark D2. The number of identification marks may be three or more.
20 From among them, two identification marks D1 and D2 placed in predetermined areas may be selected. For example, two identification marks D1 and D2 placed close to diagonal corners may be selected.

[147] The first and second identification marks D1 and D2
25 are spaced apart from each other, and may desirably be spaced as far apart as possible.

[148] The two identification marks D1 and D2 may have different shapes.

[149] The first and second identification marks D1 and D2 may be disposed as diagonally as possible.

5 According to one preferred example of the present invention, the distance between the rearrangement camera 520 and the electronic component ED is kept shorter than that in the conventional art. Accordingly, as shown in the example of FIG. 13, assuming that the rearrangement camera
10 520 captures an image by using the center O of the electronic component ED as the center of the image, all or at least a portion of the edge of the electronic component ED exceeds the field of view. That is, according to the present invention, the rearrangement camera 520 is
15 installed such that the overall electronic component ED cannot be placed intact within an image I captured by the rearrangement camera 520. Additionally, assuming that the rearrangement camera 520 performs photographing by using the center O of the electronic component ED as the center
20 of photographing, both identification marks D1 and D2 are not included in a single image. Accordingly, the first identification mark D1 is photographed first, and the second identification mark D2 is photographed later. That is, two acts of photographing are performed sequentially.
25 The focal length of the rearrangement camera 520 is set to

the distance between the lens of the rearrangement camera 520 and the electronic component ED. Therefore, in the images taken by the rearrangement camera 520, the first and second identification marks D1 and D2 of the electronic component ED may be distinguished more clearly.

[150] An implementation may be made such that only one act of photographing is performed by allowing both identification marks D1 and D2 to be included in a single image.

[151] (a) of FIG. 14 shows an image I1 captured by a camera according to the conventional art, and (b) and (c) of FIG. 14 show images I2 and I3 captured by the rearrangement camera 520 according to the present embodiment. (b) of FIG. 14 is the image I2 of the first identification mark D1 of an electronic component ED, and (c) of FIG. 14 is the image I3 of the second identification mark D2 of the electronic component ED.

[152] When the numbers of pixels of the images I1, I2, and I3 in (a), (b) and (c) of FIG. 14 are the same as one another, the identification marks D1 and D2 of the electronic component ED may be distinguished more clearly in the images I2 and I3 of (b) and (c) of FIG. 14 than in the image I1 of (a) of FIG. 14. According to the present invention, the processing and analysis of the images I2 and I3 may be made easier, and thus the time required therefor may be reduced. Furthermore, according to the present invention, the processing and analysis of the images I2 and

I3 may be performed more precisely. Therefore, according to the present invention, the current position (the coordinates on the X-Y plane and angular position) of the electronic component ED placed in the temporary zone BZ may
5 be determined more precisely.

[153] The positions of the identification marks D1 and D2 may be accurately determined by comparison with other specific points on the test table 300 or by comparison with the coordinates of the test table 300. Through this
10 comparison, the angular misalignment of the electronic component ED or the position thereof on the X-Y plane may be identified.

[154] According to a preferred example, the rearrangement picker 510 and the rearrangement camera 520 are grouped and
15 combined into a single module. Accordingly, the relative positions of the rearrangement picker 510 and the rearrangement camera 520 are fixed.

[155] Although the rearrangement picker 510 is fixed in FIG. 10, the rearrangement picker 510 may be provided to be
20 vertically or rotatably movable depending on the implementation.

[156] When the rearrangement picker 510 is implemented to be vertically movable, the vertical movement of the rearrangement picker 510 may be used to grip the electronic
25 component ED on the test table 300 or seat the electronic component onto the test table 300.

[157] When the rearrangement picker 510 is implemented to be rotatably movable, the rotation of the rearrangement picker 510 may be used to perform correction in the Θ -axis direction of the electronic component ED.

5 [158] Furthermore, to prevent damage attributable to the excessive pressure applied to the electronic component ED during a gripping process, the rearrangement picker 510 may be provided to be buffered by a buffer.

[159] The movement mechanism 600 is provided to move the
10 test table 300.

[160] The movement mechanism 600 in the present embodiment may rotate the test table 300 in the Θ -axis direction.

[161] Furthermore, the movement mechanism 600 in the present embodiment may move the test table 300
15 horizontally.

[162] As shown in the schematic excerpt of FIG. 15, the movement mechanism 600 includes a rotary mover 610 and a horizontal mover 620.

[163] The rotary mover 610 may rotate the test table 300
20 forward or rearward in the Z-axis direction by using a vertical line V2, passing through the center of the test table 300, as the axis of rotation. The reason why the rotation of the test table 300 is required is to correct the angular position of the electronic component ED in the temporary zone BZ and rearrange it to the regular zone RZ.
25

[164] For example, the angular position of the temporary zone BZ may not be aligned with the angular position of the

regular zone RZ. This means that the angular position of the electronic component ED in the temporary zone BZ is not aligned with the angular position of the regular zone RZ. Furthermore, the angular position of the regular zone RZ is aligned with the angular position of the test zone TZ on the test board TB. Accordingly, when the angular position of the temporary zone BZ is not aligned with and is rotated from the angular position of the regular zone RZ, the angular position of the temporary zone BZ will be aligned with the angular position of the test zone TZ. Then, the alignment between the electronic component ED and the test zone TZ may not be achieved without the correction of the angular position of the electronic component ED in the temporary zone BZ. Accordingly, when the electronic component ED in the temporary zone BZ is rearranged to the regular zone RZ, the angular position of the electronic component ED has to be corrected. However, in the present embodiment, the rearrangement picker 510 is fixed, so that the test table 300 is rotated instead to correct the angular position of the electronic component ED gripped by the rearrangement picker 510. When the rearrangement picker 510 is implemented to be rotatable, the rotation of the test table 300 may not be required during a rearrangement process.

[165] The horizontal mover 620 moves the test table 300 horizontally on the X-Y plane.

[166] The horizontal mover 620 may be divided into and provided as an X-axis mover 621 and a Y-axis mover 622.

[167] The X-axis mover 621 may move the test table 300 horizontally in the X-axis direction.

5 [168] The Y-axis mover 622 may move the test table 300 horizontally in the Y-axis direction.

[169] According to the present invention, the movement mechanism 600 has two functions.

10 [170] A first function of the movement mechanism 600 is to move the test table 300 horizontally in order to selectively position the test table 300 in the rearrangement part RP and the connection part CP. Under the first function, an operation for moving the test table 300 horizontally in the X-axis direction is performed as a main
15 operation. By the first function of the movement mechanism 600, the test table 300 may move back and forth between the rearrangement part RP and the connection part CP.

20 [171] A second function of the movement mechanism 600 is to move the test table 300 to rearrange the electronic component ED using the rearrangement mechanism 500. Under the second function, an operation for rotating the test table 300 by using a vertical line V as the axis of rotation while moving the test table 300 horizontally in the X- and Y-axis directions is performed as a main
25 operation. By the second function of the movement mechanism 600, the electronic component ED placed in the temporary zone BZ may be moved to the regular zone RZ.

[172] Furthermore, the movement mechanism 600 may be utilized even when electronic components ED are seated onto the test table 300 by the second hand 220. In this case, it is sufficient if the second hand is implemented to move the
5 electronic components ED only in the Y-axis direction.

[173] The connector 700 electrically connects the electronic components ED, loaded onto the test table 300 that is moved to the connection part CP, to the tester.

[174] The connector 700 may press the test table 300 toward
10 the test board TB placed above the test table 300. Accordingly, the electronic components ED loaded onto the test table 300 are electrically connected to the test board TB, thereby ultimately electrically connecting the electronic components ED to the tester. The testing of the
15 electronic components ED is performed in the state in which the electronic components ED have been electrically connected to the tester by the connector 700. In this case, the electronic components ED loaded onto the test table 300 has to be in the state in which they have been rearranged
20 from the temporary zones BZ to the regular zones RZ through a rearrangement operation performed in the rearrangement part RP.

[175] In the present embodiment, the test table 300 is positioned below the test board TB. Accordingly, the
25 connector 700 is provided to lift/lower the test table 300.

[176] According to the present embodiment, the connector 700 also has two functions.

[177] A first function of the connector 700 is to electrically connect the electronic components ED, placed on the test table 300, to the test board TB by pressing the test table 300 toward the test board TB placed above the test table 300. In this case, the electronic components ED are electrically connected to the test board TB via respective corresponding test zones TZ.

[178] A second function of the connector 700 is to lift the test table 300 placed in the rearrangement part RP so that the rearrangement picker 310 can grip or release the electronic component ED. Furthermore, the second function of the connector 700 is to lower the test table 300 so that, when the test table 300 is moved by the movement mechanism 600, the test table 300 does not interfere with the electronic component ED gripped by the rearrangement picker 510. That is, the second function of the connector 700 is the function of lifting/lowering the test table 300 during the process of rearranging the electronic component ED. When the rearrangement picker 510 is implemented to be able to be lifted/lowered, the lifting/lowering of the test table 300 by the connector 700 may not be required during the rearrangement process.

[179] When an elevation means for lifting/lowering the rearrangement picker 510 is provided, the lifting/lowering of the test table 300 by the connector 700 may be omitted during the process of rearranging the electronic component ED.

[180] As described above, according to the present embodiment, the rearrangement picker 510 and the rearrangement camera 520 have fixed positions during the process of rearranging the electronic component ED.
5 Instead, the test table 300 moves horizontally or rotationally, or moves vertically. This will be further described using an example.

[181] When the rearrangement picker 510 needs to grip the electronic component ED placed in the temporary zone BZ to
10 rearrange the electronic component ED, the rearrangement picker 510 is fixed and the test table 300 is lifted by the connector 700. Then, the rearrangement picker 510 enters a state where it can grip the electronic component ED loaded onto the test table 300. Subsequently, when the
15 rearrangement picker 510 grips the electronic component ED, the test table 300 is lowered by the connector 700. Thereafter, the test table 300 is rotated and moved horizontally by the operation of the movement mechanism 600 to align the regular zone RZ, where the electronic
20 component ED is to be loaded, with the electronic component ED being gripped by the rearrangement picker 510. Then, the test table 300 is lifted again by the connector 700 so that the test table 300 enters a state where it can support the electronic component ED.

25 [182] When the electronic component ED is fixed to the test table 300 by the vacuum pressure applied via the vacuum hole h in the state where the test table 300 supports the

electronic component ED, the rearrangement picker 510 releases the electronic component ED.

[183] When the rearrangement picker 510 releases the electronic component ED, the connector 700 lowers the test
5 table 300.

[184] As in the present embodiment, when an implementation is made to move the test table 300 instead of the rearrangement picker 510 during the process of moving the electronic component ED from the temporary zone BZ to the
10 regular zone RZ, the manufacturing cost may be reduced.

[185] According to a preferred example of the handler TH according to the present invention, the rotational movement and horizontal movement of the test table 300 are required for the alignment between the test table 300 and the test
15 board TB. Accordingly, when a movement structure for the test table 300 is also utilized for the rearrangement of the electronic components ED, the manufacturing cost will be reduced.

[186] The controller 800 controls the components, such as
20 the transport shuttle 100, the first hand 210, the second hands 220, the vacuum devices 400, the rearrangement mechanisms 500, the movement mechanisms 600, and the connectors 700, required for the appropriate operation of the handler TH.

[187] The controller 800 calculates the degree of
25 misalignment of the electronic component ED through the image analysis intended to identify the positions of the

identification marks D1 and D2 when the camera C1 photographs the electronic component ED loaded onto a JEDEC tray or ring frame, and also controls the rotator R1 to operate to correct the misalignment of the electronic component ED when the picker P1 of the first hand 210 grips the electronic component ED.

[188] The controller 800 analyzes images acquired by sequentially photographing the first and second identification marks D1 and D2 of the electronic component ED, loaded onto the test table 300 by the second hand 220, with the rearrangement camera 520 to calculate the temporary zone BZ of the electronic component ED on the test table 300. Then, the relative positional relationship between the temporary zone BZ and the regular zone RZ may be known, so that the direction and movement distance for the horizontal movement of the test table 300 and the rotational movement of the rearrangement picker 510 required to move the electronic component ED to the regular zone RZ may be determined.

[189] The controller 800 may be implemented to calculate the height of the electronic component ED via an image captured by the camera C1 or the rearrangement camera 520 and determine the lifting height of the picker P1 or the lifting height of the test table 300. However, when an implementation is made to allow an administrator to input the height of the electronic component ED via a separate input means, the controller 800 determines the lifting

height of the picker P1 and the rearrangement picker 510 according to the height of the electronic component ED set by the input.

[190] Next, the operation of the handler TH described above
5 will be described.

[191] First, in the unloading part LU, the first hand 210 loads the electronic components ED to be tested onto the transport table 110 in the first area A1. During this process, the positions of the electronic components in the
10 X-, Y-, and Θ -axis directions may be adjusted.

[192] Once all the electronic components ED have been loaded onto the transport table 110, the transport shuttle 100 operates to move the transport table 110 to the second area A2. Then, the second hand 220 unloads the electronic components ED from the transport table 110 and moves them
15 to the test table 300 placed in the rearrangement part RP. In this case, the positions of the electronic components ED loaded onto the test table 300 by the second hand 220 are temporary zones BZ. In this case, the number of electronic components ED that can be loaded onto the test table 300
20 may be larger than the number of electronic components ED that can be loaded onto the transport table 110. In this case, the transport table 110 may move back and forth between the first area A1 and the second area A2 two or
25 more times to transport electronic components ED to be tested. When the loading capacity of the transport table 110 is 16 and the loading capacity of the test table 300 is

256, the transport table 110 has to make 16 round trips to fill the test table 300.

[193] Once all the electronic components ED to be tested have been loaded onto the test table 300, the controller
5 800 operates the rearrangement mechanism 500, the movement mechanism 600, and the connector 700 to rearrange the electronic components ED from the temporary zones BZ to the regular zones RZ.

[194] When the rearrangement of electronic components ED on
10 the test table 300 is completed, the movement mechanism 600 operates to move the test table 300 to the connection part CP. Thereafter, the connector 700 operates to lift the test table 300 toward the test board TB so that the electronic components ED are electrically connected to the tester.

[195] When the testing of the electronic components ED is
15 completed, the connector 700 operates to lower the test table 300 and then the test table 300 is moved to the rearrangement part RP by the movement mechanism 600. Then, the second hand 220 moves the tested electronic components
20 ED to the transport tray 110 in the second area A2, and the transport tray 110 filled with the tested electronic components ED moves to the first area A1. Then, the first hand 210 unloads the tested electronic components ED from the transport table 110.

[196] According to the present invention, two rearrangement
25 parts RP are disposed, and are provided with two second hands 220, two test tables 300, two rearrangement

mechanisms 500, two movement mechanisms 600, and two connectors 700. This is intended to improve the operation rate by reducing the idle time of the tester.

[197] For example, it is assumed that the testing of electronic components ED is performed in the state in which the test table 300 on one side has been aligned with the test board TB. Then, on the test table 300 on the other side, the task of emptying the tested electronic components ED, the task of filling the test table 300 with electronic components ED to be tested after the tested electronic components ED have been emptied, and the task of rearranging the electronic components ED are performed. Accordingly, the operation rate of the handler TH may be increased, and the idle time of the tester may be minimized.

[198] **<Description of Regular Zones>**

[199] The test board TB is coupled to the handler TH in a rotatably coupled structure. Accordingly, the angular position of the test board TB may vary slightly depending on the degree of installation.

[200] For example, as shown in the exaggerated example of FIG. 15, the test board TB may be coupled to the handler TH with the row direction D of the test zones TZ rotated at a predetermined angle α with respect to the X-axis direction.

[201] Accordingly, it is necessary to accurately determine the angular position of the test board TB relative to the X- or Y-axis direction. To this end, as previously

mentioned, there may be required the tasks of installing the camera C on the test table 300, photographing the test board TB with the camera C, and accurately identifying the arrangement and angular position of test zones TZ and the positions of test pins t. However, when the test board TB can be coupled to the handler TH to always have a predetermined angular position, the task of identifying the angular position of the camera C or test board TB may not be required.

10 [202] In the example of FIG. 16, the test zones TZ may have an arrangement angularly misaligned by a predetermined angle α with respect to the X-axis. Accordingly, as in the example of FIG. 17, the controller 800 generates a set line segment SL, containing any two reference points L1 and L2, on an image captured by the camera C2. According to a preferred example, the set line segment SL is generated in parallel with the rows of the test zones TZ.

[203] The two reference points L1 and L2 may be selected in various manners.

20 [204] The two reference points L1 and L2 may be the centers of two test zones TZ that belong to the same row and are spaced apart from each other.

[205] As in the example of FIG. 18, the two reference points L1 and L2 may be two marks that are located at positions spaced apart from each other and are marked separately.

25

[206] Meanwhile, the electronic components ED have to be rearranged on the test table 300 to have a row direction parallel to the set line segment SL. To achieve this, it is necessary to generate an imaginary line segment on the test
5 table 300. The controller 800 has to also calculate and determine the positional relationship between the imaginary line segment and the set line segment SL. According to a preferred example, to simplify the calculation of the controller 800, the imaginary line segment may be generated
10 to coincide with, or be at least parallel to or perpendicular to, the set line segment SL when the test table 300 and the test board TB are aligned with each other. However, it may be most preferable for the imaginary line segment to be generated to coincide with the set line
15 segment SL at the time when the test board TB and the test table 300 are aligned with each other.

[207] When an imaginary line segment is generated, the regular zones RZ that match the test zones TZ may be calculated and determined based on the relationship between
20 the set line segment SL and the imaginary line segment.

[208] According to a first example, the imaginary line segment may be generated immediately following the generation of the set line segment SL. The regular zones RZ are also determined following the generation of the
25 imaginary line segment.

[209] According to a second example, the imaginary line segment may be generated when the electronic components EDs

are loaded into the temporary zones BZ. This second example will be further described in more detail.

[210] First, the second hand 220 loads the electronic components ED onto the test table 300. Accordingly, the
5 electronic components ED are placed in the temporary zones BZ. As previously mentioned, the temporary zones BZ on the test table 300 are variable positions that are determined only when the electronic components ED to be tested are placed thereon. The planar shape of the temporary zones BZ
10 and the planar shape of the electronic components ED are the same as each other.

[211] When the test table 300 is filled with the electronic components ED, the controller 800 identifies two identification points to form an imaginary line segment.
15 The identification task performed in this case may be performed by the controller 800 using the movement mechanism 600 and the rearrangement camera 520 of the rearrangement mechanism 500. That is, the two identification points may be identified using images
20 acquired by performing photographing with the rearrangement camera 520 while moving the test table 300 with the movement mechanism 600.

[212] The two identification points may be selected in various manners.

25 [213] For example, the two identification points may be the centers O of two different electronic components ED belonging to the same row among the electronic components

ED placed in the temporary zones BZ. In this case, to minimize errors between the imaginary line segment and the set line segment SL, an implementation may be made to select the centers O of the two electronic components ED, which are furthest apart among the electronic components ED belonging to the same row, as the two identification points. For example, as shown in FIG. 19, an implementation may be made to select the center points O1 and O2 of the two electronic components ED, which are furthest apart among the electronic components ED belonging to any one of the plurality of rows of electronic components ED placed in the temporary zones BZ, as the two identification points L3 and L4. When the rows of electronic components ED have different lengths, the two identification points L3 and L4 may be the centers O of the two electronic components ED, which are farthest apart in the longest row, in order to minimize errors.

[214] When two identification points L3 and L4 are identified as in the example of FIG. 19, the controller 800 generates an imaginary line segment GL containing the two identification points L3 and L4, as shown in the exaggerated FIG. 20. Then, the regular zones RZ are determined by calculation based on the relationship (coincidence or parallelism) between the set line segment SL and the imaginary line segment GL, as shown in FIG. 21. In this case, the regular zones RZ indicated by thick lines are set to be spaced apart from the temporary zones BZ

indicated by thin lines by approximately one unit space (the interval between adjacent electronic components).

[215] The regular zones RZ generated on the test table 300 may be aligned with the test zones TZ on the test board TB
5 in terms of their arrangement and positions when the rotational position of the test table 300 is adjusted.

[216] The electronic components ED placed in the temporary zones BZ are moved to the set regular zones RZ in a predetermined order. The rearrangement mechanism 500 is
10 utilized in this process.

[217] **<Description of Rearrangement Method>**

[218] The electronic components ED placed in the temporary zones BZ of the test table 300 may be precisely rearranged to the regular zones RZ so that they are aligned with the
15 test zones TZ of the test board TB within an error range of several μm . To this end, the controller 800 rearranges the electronic components ED according to the flowchart of FIG. 22 while appropriately controlling the rearrangement mechanism 500, the movement mechanism 600, and the
20 connector 700. The method of rearranging electronic components ED on the test table 300 will be described below with reference to the flowchart of FIG. 22.

[219] **1. Identification of Identification Points <S11>**

[220] When all the temporary zones BZ of the test table 300 are filled with the electronic components ED by the second
25 hand 200, the controller 800 identifies two preset identification points L3 and L4. In this case, the "preset"

means that objects (such as the center points of electronic components or separate marks) for the two identification points L3 and L4 to be identified have been set.

[221] To identify the two identification points L3 and L4,
5 the controller 800 operates the movement mechanism 600 to successively photograph the plane of the test table 300 with the rearrangement camera 520 while moving the test table 300. Accordingly, the controller 800 may identify the two identification points L3 and L4 by analyzing captured
10 images.

[222] As shown in the example of FIG. 19, the two identification points L3 and L4 may be the center points of the two electronic components ED (hereinafter referred to as 'reference materials') that are furthest apart from each
15 other in the longest row among the rows of the electronic components ED loaded into the temporary zones BZ of the test table 300.

[223] **2. Generation of Imaginary Line Segment <S12>**

[224] The controller 800 generates an imaginary line
20 segment GL connecting two identification points L3 and L4, as in the example of FIG. 20.

[225] Meanwhile, in the present embodiment, when the imaginary line segment GL is generated, the test table 300 is rotated such that the angular positions of the imaginary
25 line segment GL and the set line segment SL coincide with each other on the X-Y plane when the test table 300 and the test board TB are aligned with each other. For example,

when the angular positions of the imaginary line segment GL and the set line segment SL do not coincide with each other on the X-Y plane as shown in the exaggerated FIG. 23, the controller 800 rotates the test table 300 with the rotary
5 mover 610 to allow the angular positions of the imaginary line segment GL and the set line segment SL to coincide with each other on the X-Y plane, as shown in FIG. 24. Then, in a state such as the state of FIG. 23, step S13 and its subsequent steps are performed. However, when the
10 controller 800 is capable of high-performance computing operations, an implementation may be made to perform step S13 and its subsequent steps even without aligning the imaginary line segment GL and the set line segment SL with each other.

15 [226] **3. Setup of Regular Zones <S13>**

[227] The controller 800 sets up regular zones RZ, where electronic components ED are to be rearranged, based on the imaginary line segment GL, as in the example of FIG. 21. In this case, information regarding the regular zones RZ may
20 include positions on the X axis, positions on the Y axis, and angular positions in the Θ -axis direction for the individual regular zones RZ, and coordinates for the centers of the regular zones RZ.

25 [228] **4. First Photographing for First Identification Mark <S14>**

[229] The controller 800 first photographs the first identification mark D1 of a first electronic component ED1

to be rearranged first with the rearrangement camera 520 in order to rearrange electronic components ED in a predetermined order. Then, an image I2, such as the image of (a) of FIG. 25, is acquired.

5 **[230] 5. Second Photographing for Second Identification Mark <S15>**

10 [231] After the first photographing has been performed by step S14, the controller 800 photographs the second identification mark D2 of the first electronic component ED1 with the rearrangement camera 520. Then, an image I3, such as the image of (b) of FIG. 25, is acquired. To sequentially photograph the first and second identification marks D1 and D2 of the first electronic component ED1, the controller 800 controls the movement mechanism 600 to move
15 the test table 300.

[232] 6. First Calculation <S16>

 [233] The controller 800 analyzes the images I2 and I3, acquired by the first photographing according to step S14 and the second photographing according to step S15 to
20 calculate the regular zone BZ of the first electronic component ED1. Information regarding the regular zone BZ calculated in this manner may include a position on the X axis, a position on the Y axis, and an angular position in the θ -axis direction for the first electronic component
25 ED1, and coordinates for the center of the first electronic component ED1.

[234] For reference, the method according to steps S14 to S16 may be used in the same manner to identify the two identification points L3 and L4 in step S11.

[235] **7. Second Calculation <S17>**

5 [236] Once step S16 has been completed, the controller 800 calculates the distances required to move the first electronic component ED1 from the temporary zone BZ to the regular zone RZ. In this case, the distances include the horizontal movement distance in the X-axis direction, the
10 horizontal movement distance in the Y-axis direction, and the rotational movement distance based on the difference in angular position in the Θ -axis direction.

[237] **8. Movement of Electronic Component <S18>**

[238] Once the second calculation according to step S17 has
15 been completed, the controller 800 operates the rearrangement mechanism 500, the movement mechanism 600, and the connector 700 to move the first electronic component ED1 from the temporary zone BZ to the regular zone RZ. This movement of the first electronic component
20 ED1 may be divided into more specific steps as shown in FIG. 26.

[239] 8-1. Gripping of Electronic Component <S18a>

[240] The controller 800 calculates coordinates for the center O of the first electronic component ED1 using the
25 position of the first identification mark D1 and the position of the second identification mark D2. However, this calculation may be performed in advance at step S16.

Then, the controller 800 operates the movement mechanism 600 to move the test table 300 so that the center of the rearrangement picker 510 and the center O of the first electronic component ED1 coincide with each other on a vertical line, as in the example of FIG. 27.

[241] In the state in which the center of the rearrangement picker 510 and the center O of the first electronic component ED1 have coincided with each other, the controller 800 operates the connector 700 to lift the test table 300 to the height at which the rearrangement picker 510 can grip the first electronic component ED1, as in the example of FIG. 28. In this state, the controller 800 controls the rearrangement picker 510 to grip the first electronic component ED1. Therefore, the rearrangement picker 510 grips the first electronic component ED1 by vacuum pressure. Thereafter, the controller 800 lowers the test table 300.

[242] 8-2. Correction of Angular Position <S18b>

[243] The regular zone RZ is generated based on the imaginary line segment GL. Meanwhile, as shown in the exaggerated (a) of FIG. 29, the angular position of the first electronic component E1 gripped by the rearrangement picker 510 may not coincide with the angular position of the imaginary line segment GL, and may have a difference of a specific angle β . Then, the controller 800 operates the rotary mover 610 to rotate the test table 300 so that the angular position of the first electronic component ED1

gripped by the rearrangement picker 510 coincides with the angular position of the imaginary line segment GL, as shown in (b) of FIG. 29.

[244] An implementation may also be made to directly
5 compare the angular position of the first electronic component ED1 with the angular position of the regular zone RZ.

[245] 8-3. Checking of Angular Position <S18c>

[246] The controller 800 checks reference materials with
10 the rearrangement camera 520 to measure the center points of the reference materials, and checks whether the angular position of the first electronic component ED1 coincides with the angular position of the imaginary line segment SL. For this purpose, the controller 800 moves the test table
15 300 with the movement mechanism 600.

[247] However, step S18c may be omitted as desired because it is merely checking.

[248] 8-4. Rearrangement <S18d>

[249] Once the checking has been completed, the controller
20 800 operates the movement mechanism 600 and the connector 700 to rearrange the first electronic component ED1, gripped by the rearrangement picker 510, to the regular zone RZ.

[250] According to a preferred example of the present
25 invention, an implementation is made such that, when step S18d is performed on the first electronic component ED1, a

rearrangement task for the second electronic component begins.

[251] For example, as shown in FIG. 30, the controller 800 operates the rearrangement camera 520 while rearranging the first electronic component ED1 gripped by the rearrangement picker 510 to the regular zone RZ to perform first photographing according to step S14 on the first identification mark D1 of a second electronic component ED2 to be rearranged next. To this end, one example is implemented such that the second electronic component ED2 is disposed adjacent to the first electronic component ED1 in a diagonal direction relative to the first electronic component ED1. Accordingly, the rearrangement picker 510 and the rearrangement camera 520 need to be disposed relative to each other so that the rearrangement camera 520 can photograph the first identification mark D1 of the posterior second electronic component ED2, to be rearranged after the anterior first electronic component ED1, at the time when the rearrangement picker 510 rearranges the anterior first electronic component ED1.

[252] That is, at the time when the first electronic component ED1 is rearranged according to step S18d, the first photographing according to step S14 for the rearrangement of the second electronic component ED2 is also performed. Thereafter, steps S15 to S18 for the rearrangement of the second electronic component ED2 are performed. The rearrangement camera 520 photographs the

first identification mark D1 of a third electronic component ED3 at the time when the second electronic component ED2 is rearranged to the regular zone RZ,, as shown in FIG. 31. Furthermore, in this manner, the rearrangement task for all electronic components ED is performed.

[253] Furthermore, once the rearrangement of all the electronic components ED has been completed as described above, the controller 800 controls the movement mechanism 600 to move the test table 300 below the test board TB and then performs the procedures required for testing.

[254] However, according to the example mentioned above, the alignment between the test table 300 and the test board TB may be achieved in the state in which the angular positions of the set line segment SL and the imaginary line segment GL have coincided with each other. Accordingly, at least before the electronic components ED are electrically connected to the test board TB, the controller 800 needs to rotate the test table 300 to allow the angular positions of the imaginary line segment GL and the set line segment SL to coincide with each other.

[255] Meanwhile, depending on the implementation, the test zones TZ, the temporary zones BZ, and the regular zones RZ may each be generated as a single point (a single point coordinate) rather than as an object having an area. In this case, the point may be the center of each of the test zones TZ, the temporary zones BZ (or the electronic

components), and the regular zones RZ. In this case as well, steps S16 to S18 may be appropriately performed based on the relationship between the coordinates of the first identification mark D1 of the electronic component ED in
5 the temporary zone BZ, the coordinates of the second identification mark D2 of the electronic component ED, and the angular position of the imaginary line segment GL.

[256] **<Additional Notes>**

[257] **1. Regarding Identification Marks D1 and D2**

10 [258] The above embodiment utilizes the positions of identification marks D1 and D2 to identify the position of the electronic component ED. However, various forms of identifiers, such as the following examples, other than the identification marks D1 and D2 may be adopted.

15 [259] (1) Utilization of Corners

[260] As shown in FIG. 32, the corners D3 and D4 of the electronic component ED may be utilized as identifiers. An implementation may be made to ultimately identify the position of the electronic component ED by photographing
20 the corners D3 and D4 with the second camera C2 and identifying the positions of the corners D3 and D4.

[261] (2) Utilization of Identification Patterns

[262] As shown in FIG. 33, the identification patterns D5 and D6 of an electronic component ED may be utilized as
25 identifiers. An implementation may be made to ultimately identify the position of the electronic component ED by photographing the identification patterns D5 and D6 with

the second camera C2 and identifying the positions of the identification patterns D5 and D6.

[263] (3) Utilization of Identification Pads

[264] As shown in FIG. 34, the identification pads D7 and
5 D8 of an electronic component ED may be utilized as
identifiers. An implementation may be made to ultimately
identify the position of the electronic component ED by
photographing the identification pads D7 and D8 with the
second camera C2 and identifying the positions of the
10 identification pads D7 and D8.

[265] (4) Utilization of Identification Terminals

[266] As shown in FIG. 35, the identification terminals T1
and T2 of an electronic component ED may be utilized as
identifiers. An implementation may be made to ultimately
15 identify the position of the electronic component ED by
photographing the identification terminals T1 and T2 with
the second camera C2 and identifying the positions of the
identification pads T1 and T2. In this case, the
identification terminals T1 and T2 may be collections of
20 multiple terminals.

[267] **2. Other Examples of Rearrangement Method**

[268] As previously described, in order to fill the test
table 300 with the electronic components ED, the transport
table 110 needs to transport the electronic components ED
25 while reciprocating a dozen or so times.

[269] Accordingly, when rearrangement is performed after the test table 300 has been filled with all the electronic components ED, the total handling time may increase.

5 [270] Accordingly, when rearrangement is performed with the electronic components ED divided into groups of 16 electronic components, which can be transported by the transport table 110 at each time, the handling time may decrease accordingly.

10 [271] For example, an implementation may be made such that, while electronic components are loaded onto the transport table 110 that has been emptied from the second area S2 and moved to the first area S1, the rearrangement of 16 electronic components ED may be performed in the test table 300.

15 [272] Furthermore, there may be adopted a method of photographing a plurality of electronic components at once and then rearranging them instead of photographing and rearranging each electronic component ED and then moving on to a subsequent electronic component ED. A preferred
20 example of this will be described with reference to FIG. 36 and its subsequent drawings.

[273] As shown in FIG. 36, 16 electronic components ED are loaded onto a test table 300.

25 [274] The controller 800 first controls the rearrangement camera 520 and the movement mechanism 600 to sequentially photograph the first identification marks D1 of the

respective electronic components ED in the direction of the arrow (a), as shown in FIG. 37.

[275] When the photographing of the first identification marks D1 have been terminated, the controller 800 controls
5 the rearrangement camera 520 and the movement mechanism 600 to sequentially photograph the second identification marks D2 of the respective electronic components ED in the direction of the arrow (b), as shown in FIG. 38. In this case, to reduce the time slightly further, the order of
10 photographing the second identification marks D2 may be reversed from the order of photographing the first identification marks D1.

[276] However, an implementation may be made such that, depending on the implementation, first identification marks
15 D1 for eight electronic components ED in a first row may be photographed sequentially, then second identification marks D2 for the eight electronic components ED in the first row may be photographed, and then eight electronic components ED in a second row may be photographed in the same manner.

[277] The controller 800 also calculates the positions of the electronic components ED for which the second
20 identification marks D2 have been photographed in the photographing of FIG. 38.

[278] Once the photographing of FIG. 38 has been completed,
25 the controller 800 operates the rearrangement picker 510, the movement mechanism 600, and the like to rearrange the

electronic components ED, whose positions have been calculated, to the regular zones RZ.

[279] Thereafter, a rearrangement operation is performed again on the 16 electronic components ED that are newly
5 transported by the transport table 110.

[280] The above-described embodiments have been described using preferred examples of the present invention, and may have various forms of application. Therefore, the present invention should not be understood as being limited only to
10 the content described above. Instead, the scope of the present invention should be understood as the separately described claims and their equivalents.

CLAIMS

[Claim 1] A handler for testing electronic components, the handler comprising:

5 a transport shuttle provided with a transport table capable of transporting electronic components by moving with the electronic components loaded thereonto;

a first hand configured to load the electronic components onto the transport table that is placed in a first area by an operation of the transport shuttle;

10 a second hand configured to unload the electronic components from the transport table that is moved from the first area to a second area by an operation of the transport shuttle;

15 a test table configured such that the electronic components unloaded from the transport table by the second hand are loaded thereonto;

a rearrangement mechanism configured to rearrange the electronic components, loaded into temporary zones of the test table by the second hand, to regular zones;

20 a movement mechanism configured to move the test table to rearrange the electronic components to regular zones by using the rearrangement mechanism;

25 a connector configured to enable the electronic components, loaded onto the test table on which the electronic components have been rearranged by the rearrangement mechanism, to be tested by electrically

connecting the electronic components to a tester; and

a controller configured to control the transport shuttle, the first hand, the second hand, the rearrangement mechanism, the movement mechanism, and the connector;

5 wherein the rearrangement mechanism comprises:

a rearrangement picker capable of gripping an electronic component; and

a rearrangement camera disposed to be spaced apart from the rearrangement picker; and

10 wherein the controller calculates a temporary zone of an electronic component loaded onto the test table by analyzing an image acquired by photographing an identification mark of the electronic component with the rearrangement camera, and then controls the movement
15 mechanism and the rearrangement picker to move the electronic component from the temporary zone to a regular zone.

[Claim 2] The handler of claim 1, wherein the controller calculates the temporary zone of the electronic
20 component by analyzing images acquired by controlling the rearrangement camera to sequentially photograph first and second identification marks on the electronic component.

[Claim 3] The handler of claim 2, wherein the rearrangement picker and the rearrangement camera are
25 arranged relative to each other so that, when a first

electronic component gripped by the rearrangement picker is located in the regular zone, the rearrangement camera can photograph a first identification mark of a second electronic component adjacent to the first electronic component.

[Claim 4] The handler of claim 1, wherein, assuming that the rearrangement camera photographs a center of the electronic component, the rearrangement camera is installed such that at least a portion of an edge of the electronic component exceeds a field of view thereof.

[Claim 5] The handler of claim 1, wherein the identification mark is formed independently of a circuit pattern in the electronic component.

[Claim 6] The handler of claim 5, wherein a relative position of the identification mark to the circuit pattern is pre-defined.

[Claim 7] A method of rearranging an electronic component for a handler for testing electronic components, the method comprising:

- a photographing step of photographing an identification mark of an electronic component on a test table with a rearrangement camera;
- a first calculation step of calculating a temporary

zone of the electronic component by analyzing an image acquired in the photographing step;

a second calculation step of calculating a distance required to move the electronic component from the temporary zone, calculated in the first calculation step,
5 to a regular zone; and

a movement step of moving the electronic component, placed in the temporary zone, to the regular zone based on a value calculated in the second calculation step;

10 wherein the photographing step comprises photographing the identification mark of the electronic component on the test table with the rearrangement camera.

[Claim 8] The method of claim 7, wherein the photographing step comprises:

15 a first photographing step of photographing a first identification mark on the electronic component; and

a second photographing step of photographing a second identification mark of the electronic component on the test table with the rearrangement camera;

20 wherein the first calculation step comprises calculating the temporary zone of the electronic component by analyzing images acquired from the first and second photographing steps.