

DESCRIPTION

TITLE OF INVENTION: HANDLER FOR TESTING ELECTRONIC COMPONENT

Technical Field

5 [1] The present invention relates to a handler for electrically connecting electronic components and a tester side to each other to test the electronic components.

Background Art

10 [2] Manufactured electronic components need to undergo testing intended to verify if they are functional.

[3] Among these electronic components, there are semiconductor devices.

15 [4] Semiconductor devices undergo various types of processes in a wafer state, and are finally manufactured in a packaged state.

[5] The packaged semiconductor devices have separate terminals.

[6] The terminals may be formed in the shape of balls or leads.

20 [7] The testing of the packaged semiconductor devices is performed in the state of electrically connecting the terminals, placed on one side thereof, to a tester side.

[8] A handler is the equipment that electrically connects the terminals of semiconductor devices to a tester side.

[9] Handlers may be classified into handlers to which a test tray is applied and handlers to which a test tray is not applied.

[10] Korean Patent Application Publication No. 10-2007-0097247 proposes a handler to which a test tray is applied (hereinafter referred to as 'conventional art 1').

[11] Generally, the handler according to conventional art 1 is used to test semiconductor devices capable of supporting mass production of a small variety, such as memory devices.

[12] The handler according to conventional art 1 loads a large number of semiconductor devices onto a test tray, and then electrically connects the semiconductor devices, loaded onto the test tray, to a tester side all at once.

[13] According to conventional art 1, there is an advantage in that the throughput per unit time is considerably high because a large number of semiconductor devices are processed at once.

[14] However, the semiconductor devices seated onto the test tray are seated in the state of being inserted into the seating depressions of inserts, and the inserts have to have some degree of flexibility to ensure the appropriate electrical connection of the semiconductor devices to a tester.

[15] Korean Patent Application Publication No. 10-2017-0078209 proposes a handler to which a test tray is not applied (hereinafter referred to as 'conventional art 2').

[16] Generally, the handler according to conventional art 2 is used to test semiconductor devices capable of supporting small-amount production of a large variety, such as non-memory logic devices.

5 [17] The handler according to conventional art 2 is implemented such that a small number of semiconductor devices are electrically connected to a tester side in the state of being seated in the inserts of a contact inducer.

10 [18] The inserts of conventional art 2 have to also have some degree of flexibility to ensure the appropriate electrical connection of semiconductor devices to a tester.

[19] However, according to conventional arts 1 and 2, there are the following problems:

15 [20] First, a handler for semiconductor devices capable of supporting mass production of a small variety and a handler for semiconductor devices capable of supporting small-quantity production of a large variety have to be provided separately.

20 [21] Second, in the case where the specifications of semiconductor devices to be tested change, compatibility is ensured only when all components for moving the semiconductor devices, seating the semiconductor devices, and applying pressure to the semiconductor devices are replaced.

25 [22] The above-described factors act as a burden, increasing manufacturing costs, on a consumer.

[23] Meanwhile, the development of integrated circuit technology is making the spacing between terminals finer while increasingly making circuit line widths finer. Accordingly, it requires the more precise electrical contact
5 between semiconductor devices and test sockets.

[24] However, the flexibility of the inserts into which semiconductor devices are inserted, the difference in specifications between a seating space and semiconductor devices, and the seating specifications of various
10 components for the movement of semiconductor devices act as limitations to the precise electrical contact between semiconductor devices and test sockets.

[25] Moreover, the inserts have to have support means for supporting the semiconductor devices loaded into the seating
15 depressions. The thickness of the support means increases the connection distance between the terminals of semiconductor devices and the test sockets of a tester. This acts as a limitation to the direct contact of the contact pads of semiconductor devices with the test sockets.
20 Therefore, the handlers according to conventional arts 1 and 2 cannot be applied to the testing of semiconductor devices in a die state or the testing of HBMs in a state in which multiple dies are stacked.

[26] [Conventional Art Literature]

25 [27] [Patent Literature]

[28] (Patent Document 1) Korean Patent Application Publication 10-2007-0097247

Disclosure

Technical Problem

5 [30] The present invention was conceived from exploration into a handler that allows for the precise positioning of electronic components although the specifications of a seating space where electronic components are seated are not determined.

Technical Solution

[31] A handler for testing electronic components according to the present invention includes: a feeding and recovery device configured to feed electronic components requiring testing or recover tested electronic components; a
15 connection device configured to electrically connect the electronic components requiring testing, fed from the feeding and recovery device, to a tester to enable the testing of the electronic components and transfer the tested electronic components to the feeding and recovery device; a
20 relay device configured to relay electronic components between the feeding and recovery device and the connection device; and a controller configured to control the operations of the feeding and recovery device, the connection device, and the relay device; the connection
25 device includes: a test chuck provided with suction holes

for vacuum-sucking seated electronic components, and configured to move between a unloading area and a test area; a probe board configured to electrically connect electronic components, seated on the test chuck in the test area, to a
5 tester; a horizontal mover configured to move the test chuck in the horizontal direction to selectively position the test chuck in the unloading and test areas; a vertical mover configured to move the test chuck in the vertical direction to bring the electronic components, seated on the test chuck
10 in the test area, into contact with the probe board or release the contact of the electronic components with the probe board; a picker robot configured to move the electronic components requiring testing from a relay plate in the relay device to temporary positions on the test chuck
15 in the unloading area, or move tested electronic components from the test chuck in the unloading area to the relay plate; a re-seating mechanism configured to readjust the electronic components, loaded into the temporary positions on the test chuck, to regular positions; and a rotary mover
20 configured to rotate the test chuck; the re-seating mechanism includes: a re-seating picker configured to grip or release an electronic component; and a camera placed to be spaced apart from the re-seating picker, and configured to photograph a semiconductor device placed at a temporary
25 position of the test chuck by the picker robot; and, when the camera photographs the semiconductor device loaded into the temporary position on the test chuck, the controller

analyzes an image captured by the camera to calculate the horizontal position and degree of misalignment of the semiconductor device, and controls the operations of the re-seating picker, the horizontal mover, the vertical mover,
5 and the rotary mover to load the semiconductor device at a regular position on the test chuck.

[32] The re-seating mechanism may further include an elevator configured to lift or lower the re-seating picker.

[33] The re-seating mechanism may further include a rotator
10 configured to rotate the re-seating picker.

Advantageous Effects

[34] According to the present invention, the following effects are achieved:

[35] First, a new type of handler capable of handling
15 various electronic components may be manufactured.

[36] Second, the seating specifications of electronic components are not limited, so that various specifications and types of electronic components can be tested, thereby considerably improving compatibility.

[37] Third, the present invention may support the testing
20 of electronic components in a die or HBM state, so that a user can reduce setup costs.

[38] Fourth, compatibility is achieved by simply replacing the probe board, so that a user can reduce maintenance
25 costs.

[39] Fifth, there are no restrictions on seating positions during the process of moving or testing electronic components, and fine position adjustment is enabled through the re-seating of electronic components, so that the precise
5 electrical connection between the electronic components and a tester is enabled, thereby improving the reliability of the test.

Description of Drawings

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

[41] FIG. 2 is a conceptual diagram illustrating a manipulator applied to the handler of FIG. 1;

[42] FIG. 3 is a conceptual plan view of a relay device
15 applied to the handler of FIG. 1;

[43] FIGS. 4 to 8 are reference views illustrating the relay device of FIG. 3;

[44] FIG. 9 is a conceptual plan view of a feeding and recovery device applied to the handler of FIG. 1;

20 [45] FIG. 10 is a schematic excerpt of a first picker robot applied to the feeding and recovery device of FIG. 9;

[46] FIG. 11 is a schematic diagram of a picker module applied to the first picker robot of FIG. 10;

[47] FIG. 12 is a schematic diagram illustrating a live-bug
25 picker applied to the picker module of FIG. 10;

[48] FIGS. 13 to 15 are schematic diagrams illustrating a dead-bug picker applied to the picker module of FIG. 10;

[49] FIG. 16 is a schematic diagram according to one example of an inverter applied to the feeding and recovery
5 device of FIG. 9;

[50] FIGS. 17 to 20 are reference views illustrating the operation of the inverter of FIG. 16;

[51] FIG. 21 is a reference view illustrating one example of an air cleaner applied to the feeding and recovery device
10 of FIG. 9;

[52] FIG. 22 is a conceptual plan view of a connection device applied to the handler of FIG. 1;

[53] FIGS. 23 and 24 are reference views illustrating a test chuck applied to the connection device of FIG. 22;

15 [54] FIGS. 25 and 26 are reference views illustrating a probe board applied to the connection device of FIG. 22;

[55] FIG. 27 is a reference view illustrating a re-seating mechanism applied to the connection device of FIG. 22;

[56] FIG. 28 is a reference view illustrating a rotary
20 mover applied to the connection device of FIG. 22;

[57] FIG. 29 is a reference view illustrating a semiconductor device re-seating method using the re-seating mechanism of FIG. 27;

[58] FIG. 30 shows a handler according to a modified
25 example of the handler of FIG. 1;

[59] FIGS. 31 to 33 are reference views illustrating re-seating mechanisms according to modified examples of the re-seating mechanism of FIG. 27;

[60] FIGS. 34 to 36 are reference views additionally
5 illustrating second cooling channels in the test chuck of FIG. 23;

[61] FIG. 37 is a reference view illustrating the shape of a heater;

[62] FIGS. 38 to 41 are reference views illustrating a
10 manipulator that is applicable to the handler of FIG. 30;

[63] FIG. 42 is a reference view illustrating one example of a relay plate that is applicable to the relay device of FIG. 3; and

[64] FIG. 43 is a reference view illustrating one example
15 of a relay plate that is applicable to the relay device of FIG. 3.

Mode for Invention

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

[66] <Overview of Overall Configuration>

[67] FIG. 1 is a conceptual plan view of a handler TH for
25 testing electronic components (hereinafter abbreviated as

the 'handler' TH) according to an embodiment of the present invention.

[68] The handler TH according to the present invention includes a feeding and recovery device 100, a connection
5 device 200, a relay device 300, a manipulator 400, and a controller 500.

[69] The feeding and recovery device 100 feeds semiconductor devices requiring testing or recovers tested semiconductor devices. Semiconductor devices are a type of
10 electronic components, specifically electronic devices that are suitable for performing testing by applying the handler TH according to the present invention thereto.

[70] The semiconductor devices requiring testing fed by the feeding and recovery device 100 are ultimately transferred
15 to the connection device 200, and the tested semiconductor devices recovered by the feeding and recovery device 100 are transferred from the connection device 200.

[71] The connection device 200 electrically connects the semiconductor devices, fed from the feeding and recovery
20 device 100, to a tester TESTER.

[72] The semiconductor devices may be tested in the state of being electrically connected to the tester TESTER.

[73] The connection device 200 ultimately transfers the tested semiconductor devices to the feeding and recovery
25 device 100.

[74] The relay device 300 relays semiconductor devices between the feeding and recovery device 100 and the connection device 200.

5 [75] The semiconductor devices requiring testing are transferred from the feeding and recovery device 100 to the connection device 200 via the relay device 300, and the tested semiconductor devices are transferred from the connection device 200 to the feeding and recovery device 100 via the relay device 300.

10 [76] The manipulator 400 is provided to connect the tester TESTER to the connection device 200.

[77] The manipulator 400 is provided on a side of the connection device 200.

15 [78] The manipulator 400 may be removed or retained when the tester TESTER is coupled to the handler TH, and may be replaced by other means for coupling the tester TESTER to the handler TH. Accordingly, the manipulator 400 may be an optional component.

20 [79] Meanwhile, as shown in FIG. 2, the manipulator 400 may rotate the tester TESTER by 180 degrees. As the tester TESTER is rotated 180 degrees by the manipulator 400, it may be switched to a state in which it can be mounted on the handler TH or detached from the handler TH.

25 [80] In the state of FIG. 2, the tester TESTER may be repaired.

[81] In the state of FIG. 2, a probe board in the connection device 200, which will be described later, may be replaced.

[82] The controller 500 controls all the operations of the feeding and recovery device 100, the connection device 200, and the relay device 300.

[83] According to the embodiment of FIG. 1, the feeding and recovery device 100 and the connection device 200 are spaced apart from each other. Furthermore, the feeding and recovery device 100 and the connection device 200 are interconnected by the relay device 300. This means that the feeding and recovery device 100 and the connection device 200 may be manufactured independently and also transported independently. Accordingly, the manufacture, transport, and installation of the handler TH may be performed conveniently.

[84] The final assembly of the handler TH may be completed in a test house of a consumer by interconnecting the feeding and recovery device 100 and the connection device 200 to each other with the relay device 300 interposed therebetween.

[85] Depending on the implementation, it may also be possible to contemplate manufacturing the feed and recovery device 100 and the connection device 200 in the form in which they are directly combined with each other.

[86] **<Description of Relay Device>**

[87] FIG. 3 is a planar conceptual diagram of the relay device 300.

[88] The relay device 300 includes a relay plate 310 and a reciprocation mover 320.

5 [89] The relay plate 310 may reciprocate between the feeding and recovery device 100 and the connection device 200.

[90] The relay plate 310 may be loaded with semiconductor devices.

10 [91] Semiconductor devices requiring testing may be moved to the connection device 200 by being loaded onto the relay plate 310 by the feeding and recovery device 100.

[92] Tested semiconductor devices may be moved to the feeding and recovery device 100 by being loaded onto the
15 relay plate 310 by the connection device 200.

[93] As shown in FIG. 4, the relay plate 100 has a plurality of vacuum holes VH.

[94] The vacuum holes VH are formed to apply vacuum pressure to the semiconductor devices loaded onto the relay
20 plate 310.

[95] The semiconductor devices loaded onto the relay plate 310 may be seated such that the positions thereof can be fixed to remain in place by vacuum pressure.

[96] FIG. 5 shows another example of the relay plate 310 in
25 which the number of vacuum holes VH is reduced and a specific type of vacuum groove VG connected to each vacuum hole VH is formed.

[97] According to the example of FIG. 5, the vacuum pressure provided to semiconductor devices via the vacuum holes VH acts on the semiconductor devices over a wider area via the vacuum grooves VG.

5 [98] In the relay plate 310 according to the example of FIG. 4 or 5, semiconductor devices D are seated in the manner of being placed on the top surface TF of the relay plate 310, as shown in FIG. 6.

[99] Referring to FIG. 6, there are empty spaces between
10 the semiconductor devices D seated on the relay plate 310. That is, there are no protrusions or other barriers on the relay plate 310 that may determine the specifications of the semiconductor devices D to be seated. Accordingly, as can be seen in (a) and (b) of FIG. 6, semiconductor devices D of
15 various different specifications may all be seated on the relay plate 310. However, it is problematic when there are protrusions/depressions on the contact surfaces of the semiconductor devices D that come into contact with the top surface TF of the relay plate 310. Therefore, the
20 semiconductor devices D need to be seated on the relay plate 310 so that the flat surfaces of the semiconductor devices D become the contact surfaces that come into close contact with the top surface TF of the relay plate 310. That is, it is preferable that semiconductor devices D be loaded onto
25 the relay plate 310 in a dead-bug state with the terminals T thereof facing upward.

[100] Referring to FIG. 7, the relay plate 310 has a first heater 311 and a first cooling channel CR1.

[101] The first heater 311 and the first cooling channel CR1 may be embedded below the vacuum holes VH.

5 [102] The first heater 311 is provided to heat the semiconductor devices D loaded onto the relay plate 310.

[103] The first cooling channel CR1 is provided to cool the semiconductor devices D loaded onto the relay plate 310. A temperature-controlled cooling fluid flows through the first
10 cooling channel CR1.

[104] The relay plate 310 is made of a metal material having high thermal conductivity. Accordingly, the heat from the first heater 311 and the chill from the first cooling channel CR1 spread evenly over the top surface of the relay
15 plate 310, and are rapidly transmitted to the semiconductor devices D by conduction. Therefore, compared to the method of controlling the temperature of semiconductor devices D through convection inside a chamber as in conventional art 1 or conventional art 2, the handler TH according to the
20 present invention enables the temperature of the semiconductor devices D to be adjusted much more precisely.

[105] The reciprocation mover 320 moves the relay plate 310 in the left and right directions.

[106] The relay plate 310 may be selectively positioned in
25 first and second areas S1 and S2 by the reciprocation mover 320.

[107] The first area S1 is placed on a feeding and recovery device (100) side, and the second area S2 is placed on a connection device (200) side.

5 [108] In the first area S1, the feeding and recovery device 100 loads semiconductor devices D requiring testing onto the relay plate 310 or unloads tested semiconductor devices D from the relay plate 310.

10 [109] In the second area S2, the connection device 200 loads tested semiconductor devices D onto the relay plate 310 or unloads semiconductor devices D requiring testing from the relay plate 310.

[110] As shown in the example of FIG. 8, the relay device 300 may be implemented to have two relay plates 310 and two reciprocation movers 320.

15 [111] The two relay plates 310 may be moved independently of each other. That is, the two relay plates 310 may be moved in the left and right directions while their positions in the left and right directions overlap or intersect each other.

20 [112] Depending on the implementation, an implementation may be made such that both relay plates 310 may be moved by a single reciprocation mover 320.

[113] It may be contemplated that three or more relay plates 310 are provided.

25 [114] When there are a plurality of relay plates 310, the handling capacity of the handler TH may be increased accordingly.

[115] The operation of the relay device 300 described above will be described.

[116] When the operation of the handler TH for testing begins, the relay device 300 moves the relay plate 310 to
5 the first area S1. The feed and recovery device 100 loads semiconductor devices D onto the relay plate 310 positioned in the first area S.

[117] The relay device 300 moves the relay plate 310 loaded with the semiconductor devices D from the first area S1 to
10 the second area S2. The connection device 200 carries the semiconductor devices D from the relay plate 310 positioned in the second area S2.

[118] Meanwhile, the connection device 200 loads the tested semiconductor devices D onto the empty relay plate 310
15 positioned in the second area S2. When the relay plate 310 is filled with the tested semiconductor devices D in the second area S2, the relay device 300 moves the relay plate 310 from the second area S2 to the first area S1. Then, the feeding and recovery device 100 recovers the tested
20 semiconductor devices D from the relay plate 310 positioned in the first area S1.

[119] **<Description of Feeding and Recovery Device>**

[120] FIG. 9 is a conceptual plan view of the feeding and recovery device 100.

25 [121] The feeding and recovery device 100 includes a feeding plate 110, a feeding stacker 120, a recovery plate 130, a

recovery stacker 140, a transfer 150, a first picker robot 160, an inverter 170, and an air cleaner 180.

[122] The feeding plate 110 is provided to be vertically movable, and supports a customer tray loaded with semiconductor devices D requiring testing. In this case, the customer tray may be a JEDEC tray or a ring flame.

[123] When the feeding plate 110 is lowered, the customer tray may be placed on the feeding plate 110 or the customer tray placed on the feeding plate 110 is removed by the transfer 150.

[124] The feeding plate 110 may include one or more feeding plates.

[125] The feeding stacker 120 accommodates and stores the customer tray to be moved to the feeding plate 110.

[126] A customer tray loaded with semiconductor devices D requiring testing is brought in from the outside to the feeding stacker 120. That is, the customer tray to be moved to the feeding plate 110 is loaded with semiconductor devices D requiring testing.

[127] The recovery plate 130 is provided to be vertically movable, and supports a customer tray configured to be loaded with tested semiconductor devices D.

[128] When the recovery plate 130 is lowered, the empty customer tray may be placed on the recovery plate 130 or the customer tray placed on the recovery plate 130 may be removed by the transfer 150. The customer tray removed from

the recovery plate 130 is loaded with tested semiconductor devices D.

[129] The recovery stacker 140 accommodates and stores the customer tray recovered from the recovery plate 130 by the transfer 150.

[130] A customer tray loaded with tested semiconductor devices D is carried out from the recovery stacker 140 to the outside.

[131] The transfer 150 transfers a customer tray between the feeding plate 110, the feeding stacker 120, the recovery plate 130, and the recovery stacker 140.

[132] The transfer 150 transfers a customer tray, placed on the feeding stacker 120, to the lowered feeding plate 110, and transfers a customer tray, placed on the recovery plate 130, to the recovery stacker 140.

[133] The transfer 150 may move an empty customer tray, placed on the feeding plate 110, to the recovery plate 130, or may move an empty customer tray, placed on an empty stacker 150, which may be provided separately, to the recovery plate 130.

[134] The above feeding plate 110 and recovery plate 130 are commonly referred to as set plates.

[135] The feeding plate 110, the feeding stacker 120, the recovery plate 130, the recovery stacker 140, and the transfer 150 are well-known technologies that have been widely disclosed via conventional handlers, so that detailed descriptions thereof will be omitted.

[136] The first picker robot 160 moves the semiconductor devices D, loaded onto the customer tray supported by the lifted feeding plate 110, to load them onto the relay plate 310 or move them to the inverter 170.

5 [137] Furthermore, the first picker robot 160 unloads the semiconductor devices D from the relay plate 310, and moves them to an empty customer tray supported by the lifted recovery plate 130 or moves them to the inverter 170.

[138] As shown in FIG. 10, the first picker robot 160
10 includes a first picker module 161 and a first picker mover 162.

[139] The first picker module 161 may grip or release semiconductor devices D.

[140] According to the present embodiment, the first picker
15 module 161 has four pickers 161a and 161b, as shown in the example of FIG. 11.

[141] Two live-bug pickers 161a are arranged in a first row.

[142] The live-bug pickers 161a may grip or release semiconductor devices D in a live-bug state by vacuum
20 pressure.

[143] The semiconductor devices D in the live-bug state have flat top surfaces. Accordingly, as in the example of FIG. 12, the live-bug pickers 161a are each provided with a soft vacuum pad VP in the shape of a truncated cone that is
25 hollow and forms a vacuum space VS.

[144] Two dead-bug pickers 161b are arranged in a second row.

[145] Since the live-bug pickers 161a and the dead-bug pickers 161b form the single picker module 161, the dead-bug pickers 161b move along with the live-bug pickers 161a.

5 [146] The dead-bug pickers 161b may grip or release semiconductor devices D in a dead-bug state by vacuum pressure.

10 [147] The semiconductor devices D in a dead-bug state have top surfaces having protrusions/depressions surface due to terminals T and/or the like. Accordingly, as shown in the example of FIG. 13, the dead-bug pickers 161b are each provided with a shape-adaptive suction pad AP that can be deformed to fit the shape of the protrusions/depressions of a semiconductor device D. That is, the vacuum pads VP of the live-bug pickers 161a and the suction pads AP of the
15 dead-bug pickers 161b have different shapes.

[148] A plurality of vacuum passages PW are formed in each of the suction pads AP to apply vacuum pressure to a semiconductor device D.

20 [149] FIG. 14 shows the state in which the dead-bug picker 161b grips a semiconductor device D. As shown in FIG. 14, the suction pad AP of the dead-bug picker 161b is deformed to adapt to the shape of the contact surface of the semiconductor device D and thus comes into close contact with the contact surface of the semiconductor device D.

25 [150] FIG. 15 shows different examples of the suction pad AP of the dead-bug picker 161b.

[151] (a) of FIG. 15 shows an example in which a single vacuum passage PW is formed in a suction pad AP.

[152] (b) of FIG. 15 is an example in which a suction pad AP is implemented as a plurality of suction columns AC like a
5 brush.

[153] In (b) of FIG. 15, vacuum passages PW are formed in the respective suction columns AC, and the suction columns AC may be freely bent.

[154] (c) of FIG. 15 shows a case where a contact film CM is
10 provided on the bottom surface of a suction pad AP.

[155] The contact film CM has a rectangular shape that is the same as the planar shape of the semiconductor component D.

[156] A number of terminal holes H equal to the number of
15 the terminals T of the semiconductor device D, which have a size suitable for the insertion of the terminals T, are formed in the contact film CM in the same arrangement as the terminals T.

[157] Furthermore, the suction pad AP may be provided with a
20 guider G formed in the shape of a cap and configured to appropriately guide the semiconductor device D.

[158] It is sufficient if one or more live-bug pickers 161a and one or more dead-bug pickers 161b are provided. Meanwhile, when pluralities of pickers 161a and dead-bug
25 pickers 161b are provided, the handling capacity may be increased accordingly.

[159] It is preferable that the live-bug pickers 161a and the dead-bug pickers 161b be equipped with elevators 161c and, thus, be provided to be individually movable vertically.

5 [160] The first picker module 161 may further include rotators 161d.

[161] The rotators 161d rotate the four pickers 161a and 161b, respectively. In this case, the first picker robot 160 may precisely correct the angular misalignment of the
10 semiconductor devices D, gripped by the four pickers 161a and 161b, with the rotators 161d. Accordingly, the first picker robot 160 may load the semiconductor devices D onto the relay plate 310 in a considerably precisely aligned state.

15 [162] The first picker mover 162 moves the first picker module 161 horizontally in the left-right and front-rear directions, thereby ultimately moving the semiconductor devices D, gripped by the first picker module 161, in the left-right and front-rear directions.

20 [163] Furthermore, the first picker mover 162 may lift/lower the first picker module 161, so that the first picker module 161 can be positioned at a height at which it can grip or release the semiconductor devices D and can also be positioned at a height at which it can move in the
25 horizontal direction.

[164] The inverter 170 converts the semiconductor devices D in a live-bug state to a dead-bug state.

[165] Furthermore, the inverter 170 may convert the semiconductor device D in a dead-bug state to a live-bug state.

[166] FIG. 16 shows an example of the inverter 170.

5 [167] The inverter 170 of FIG. 16 includes a first inversion plate 171a, a first rotator 171b, a second inversion plate 172a, and a second rotator 172b.

[168] The first inversion plate 171a may be loaded with semiconductor devices D in a live-bug state.

10 [169] The first rotator 171b may rotate the first inversion plate 171a by 180 degrees by using the horizontal line as the axis of rotation. Accordingly, the semiconductor devices D in the live-bug state loaded onto the first inversion plate 171a may be turned upside down 180 degrees by the first rotator 171b and converted to a dead-bug state.

15 [170] The second inversion plate 172a may be loaded with semiconductor devices in a dead-bug state.

[171] The second inversion plate 172a may cover the first inversion plate 171a, or may be covered by the first inversion plate 171a.

20 [172] The second rotator 172b rotates the second inversion plate 172a by 180 degrees by using the horizontal line as the axis of rotation. Accordingly, the semiconductor devices D in the dead-bug state loaded onto the second inversion plate 172a by the second rotator 172b may be turned upside down 180 degrees and converted to a live-bug state.

[173] For example, when the semiconductor devices D in a live-bug state are loaded onto the first inversion plate 171a by the first picker robot 160 as shown in FIG. 17, the second rotator 172b operates to allow the second inversion plate 171a to cover the first inversion plate 172a as shown in FIG. 18. In this state, the second inversion plate 172a is positioned on the upper side, and the first inversion plate 171a is positioned on the lower side. Furthermore, the first rotator 171b and the second rotator 172a operate simultaneously to rotate the first inversion plate 171a and the second inversion plate 172a by 180 degrees, as shown in FIG. 19. Then, the first inversion plate 171a is positioned on the upper side, and the second inversion plate 172a is positioned on the lower side. Thereafter, as shown in FIG. 20, when the first rotator 171b operates to rotate the first inversion plate 171a and open the second inversion plate 172a, semiconductor devices D are loaded onto the second inversion plate 172a in a dead-bug state. Accordingly, the first picker robot 160 grips the semiconductor devices D in the dead-bug state from the second inversion plate 172a, and moves them to the relay plate 310.

[174] FIG. 16 shows only one of various embodiments of the inverter 170, and the inverter 170 may be implemented in various forms.

[175] For example, the inverter 170 may include a rotation plate and a seating plate.

[176] The rotation plate may rotate 180 degrees by using the horizontal line as the axis of rotation, and may grip the semiconductor devices D by vacuum pressure.

5 [177] The semiconductor devices D seated onto the rotation plate are converted from a live-bug state to a dead-bug state as the seating plate rotates 180 degrees. At the same time, the semiconductor devices D that are vacuum-sucked to the rotation plate are also placed on the seating plate.

10 [178] The seating plate may grip the semiconductor devices D by vacuum pressure.

[179] When the semiconductor devices D seated on the seating plate are vacuum-sucked, the rotation plate releases the vacuum suction of the semiconductor devices and rotates 180 degrees in the opposite direction.

15 [180] The seating plate may be provided to be vertically movable in order to support the operation by the first picker robot 160. To this end, the inverter 170 may further include an elevator for lifting/lowering the seating plate.

20 [181] According to the present invention, the relay plate 310 is configured to be loaded with semiconductor devices D in a dead-bug state.

25 [182] When semiconductor devices D in a dead-bug state are loaded onto a customer tray brought in from the outside to the feeding stacker 120, the operation of the inverter 170 is not required.

[183] Furthermore, when only customer trays loaded with semiconductor devices D in a dead-bug state are brought in to the handler TH, the inverter 170 may be omitted.

[184] The inverter 170 is effective when a customer tray loaded with semiconductor devices D in a live-bug state is brought in to the handler TH. Accordingly, the inverter 170 may operate optionally, or may be an optional component.

[185] Semiconductor devices D requiring testing may be loaded onto a customer tray in a live-bug state and fed via the feeding stacker 120. In this case, the operation of the inverter 170 is required.

[186] The first picker robot 160 uses the live-bug pickers 161a to grip semiconductor devices D in a live-bug state from a customer tray and move them to the inverter 170, and then uses the dead-bug pickers 161b to move the semiconductor devices D, converted to a dead-bug state, from the inverter 170 to the relay plate 310.

[187] Furthermore, the first picker robot 160 uses the dead-bug pickers 161b to grip semiconductor devices D in a dead-bug state from the relay plate 310 and move them to the inverter 170, and then uses the live-bug pickers 161a to move the semiconductor devices D, converted to a live-bug state, from the inverter 170 to an empty customer tray.

[188] Semiconductor devices D requiring testing may be loaded onto a customer tray in a dead-bug state and fed via the feeding stacker 120. In this case, the operation of the inverter 170 is not required.

[189] The first picker robot 160 uses the dead-bug pickers 161b to grip the semiconductor device D in the dead-bug state from the customer tray and immediately move them to the relay plate 310.

5 [190] Furthermore, the first picker robot 160 uses the dead-bug pickers 161b to grip the semiconductor devices D in the dead-bug state from the relay plate 310 and immediately move them to an empty customer tray.

[191] Accordingly, when only customer trays loaded with
10 semiconductor devices D in a dead-bug state are brought in to the handler TH, the handler TH does not need to be provided with the live-bug pickers 161a and the inverter 170.

[192] The air cleaner 180 is provided to clean the relay
15 plate 310 with air.

[193] The air cleaner 180 cleans the relay plate 310 in the first area S1. Once all semiconductor devices D have been loaded onto the relay plate 310 in the first area S and the semiconductor devices D have been fixed by vacuum pressure,
20 the air cleaner 180 operates to clean the relay plate 310 and the semiconductor devices D together.

[194] As shown in FIG. 21, the air cleaner 180 may include a blower 181 and a suction device 182.

[195] The blower 181 blows air toward the top surface TF of
25 the relay plate 310.

[196] The suction device 181 sucks in the air, passing over the top surface TF of the relay plate 310, together with foreign materials.

5 [197] The suction device 191 may be implemented to strongly suck in the air, which scatters in all directions after passing over the top surface TF of the relay plate 310, from below.

10 [198] Since only the semiconductor devices D, from which dust or metal particles have been removed by the air cleaner 180, may be provided to the connection device 200, the electrical connection between the semiconductor devices D and the tester TESTER may be appropriately set up, and the reliability of testing may be improved accordingly.

15 [199] Furthermore, the air cleaner 180 may be implemented to operate even before tested semiconductor devices are recovered. In this case, the tested semiconductor devices may be recovered in a clean state due to the cleaning.

[200] In the present embodiment, the air cleaner 180 is provided in the feeding and recovery device 100.

20 [201] However, depending on the implementation, the air cleaner 180 may be provided in the connection device 200. In this case, the air cleaner 180 may be placed to clean the relay plate 310 in the second area S2.

25 [202] The operation of the feeding and recovery device 100 described above will be described.

[203] **1. When semiconductor devices are brought in in live-bug state**

[204] The transfer 150 transfers a customer tray in the feeding stacker 120 to the feeding plate 110.

[205] The first picker robot 160 grips semiconductor devices D from the customer tray supported on the feeding plate 110, and moves them to the inverter 170. Then, the inverter 170 converts the semiconductor devices D to a dead-bug state.

[206] The first picker robot 160 moves the semiconductor devices D in a dead-bug state from the inverter 170 to the relay plate 310 in the first area S1. Then, the relay plate 310 and the semiconductor devices D seated onto the relay plate 310 are cleaned by the air cleaner 180.

[207] Meanwhile, when the relay plate 310 loaded with tested semiconductor devices D is positioned in the first area S1, the first picker robot 160 moves the tested semiconductor devices D from the relay plate 310 to the inverter 170. Then, the inverter 170 converts the semiconductor devices D to a live-bug state.

[208] The first picker robot 160 moves the semiconductor devices D in the live-bug state from the inverter 170 to an empty customer tray supported on the recovery plate 130.

[209] When the empty customer tray is filled, the transfer 150 transfers the customer tray from the recovery plate 130 to the recovery stacker 140.

[210] **<Description of Connection Device>**

[211] FIG. 22 is a conceptual plan view of the connection device 200.

[212] The connection device 200 of FIG. 22 includes a test chuck 210, a probe board 220, a horizontal mover 230, a vertical mover 240, a second picker robot 250, a re-seating mechanism 260, and a rotary mover 270.

5 [213] As shown in the example of FIG. 23, the test chuck 210 is provided with a rectangle planar surface. Since the test chuck 210 is rectangular, it may allow a larger number of semiconductor devices D to be seated thereon compared to a circular one, thus improving the handling capacity. In
10 other words, since the test chuck 210 is rectangular, it may be implemented using a smaller area compared to a circular one in the case where the same number of semiconductor devices D are seated.

[214] Suction holes AH for vacuum-sucking seated
15 semiconductor devices D are formed in the test chuck 210.

[215] The test chuck 210 may move between an unloading area LU and a test area TD.

[216] In the unloading area LU, semiconductor devices D may be seated onto the test chuck 210, or may be removed from
20 the test chuck 210.

[217] In the test chuck 210 according to the example of FIG. 23, semiconductor devices D in a dead-bug state are placed on the top surface TS of the test chuck 210, as shown in FIG. 24.

25 [218] Referring to FIG. 24, there are empty spaces between the semiconductor devices D seated on the test chuck 210. That is, there are no barriers on the test chuck 210 that

can determine the specifications of semiconductor devices D to be seated. Accordingly, semiconductor devices D of various specifications may all be seated on the test chuck 210. However, it is problematic if there are protrusions/depressions on the contact surfaces of the semiconductor devices D that come into contact with the top surface TS of the test chuck 210. Therefore, the semiconductor devices D need to be seated on the test chuck 210 such that the flat surfaces of the semiconductor devices D become the contact surfaces that come into contact with the top surface TS of the test chuck 210. That is, the semiconductor devices D are seated on the test chuck 210 in a dead-bug state in which the terminals T thereof facing upward.

[219] The test chuck 210 has a second heater 211 and a second cooling channel CR2.

[220] The second heater 211 and the second cooling channel CR2 may be embedded below the suction holes AH.

[221] The second heater 211 is provided to heat the semiconductor devices D loaded onto the test chuck 210.

[222] The second cooling channel CR2 is provided to cool the semiconductor devices D loaded onto the test chuck 210. A temperature-controlled cooling fluid flows through the second cooling channel CR2.

[223] The test chuck 210 is made of a metal material having high thermal conductivity. Accordingly, the heat from the second heater 211 and the chill from the second cooling

channel CR2 spread evenly across the top surface TS of the test chuck 210, and are rapidly transferred to semiconductor devices D by conduction. Therefore, compared to the method of controlling the temperature of semiconductor devices D through convection within a chamber as in conventional art 1 or conventional art 2, the handler TH according to the present invention may control the temperature of semiconductor devices much more precisely.

[224] The lower side of the probe board 220 is electrically connected to the semiconductor devices D seated on the test chuck 210, and the upper side thereof is electrically connected to the tester TESTER. That is, the tester TESTER is placed above the probe board 220, and the test chuck 210 is placed below the probe board 220.

[225] The probe board 220 electrically connects the semiconductor devices D, seated on the test chuck 210 in the test area TD, to the tester TESTER.

[226] The probe board 220 is provided with a rectangular planar surface to correspond to the shape of the test chuck 210. However, the probe board 220 may be provided with a circular planar surface.

[227] When the test chuck 210 is lifted, the probe board 220 and the semiconductor devices D seated on the test chuck 210 come into electrical contact, thereby allowing the semiconductor devices D and the tester TESTER to be electrically connected to each other.

[228] Referring to the example according to the perspective view of FIG. 25 and the exploded perspective view of FIG. 26, the probe board 220 includes an arrangement frame 221, micro-sockets 222, and fixators 223.

5 [229] The arrangement frame 221 forms the skeleton of the probe board 220, and is made of a solid metal material.

[230] The arrangement frame 221 has a rectangular planar surface, and arrangement holes PH formed in the vertical direction are formed through the arrangement frame 221.

10 [231] The micro-sockets 222 have a square cube shape, and are installed in the arrangement frame 221.

[232] There are provided a number of micro-sockets 222 equal to the number of arrangement holes PH.

15 [233] The micro-sockets 222 are arranged in the manner of being inserted into the arrangement holes PH, as shown in FIG. 25.

[234] The bottom sides of the micro-sockets 222 come into electrical contact with the semiconductor devices D, and the top sides of the micro-sockets 222 come into electric
20 contact with the tester TESTER. Accordingly, the micro-sockets 222 electrically connect the semiconductor devices D and the tester TESTER to each other.

[235] The fixators 223 are provided to fix the micro-sockets 222 to the arrangement frame 221.

25 [236] The fixators 223 are implemented to release the micro-sockets 222.

[237] When the fixators 223 release the micro-sockets 222, the micro-sockets 222 may be separated from the arrangement frame 221.

5 [238] That is, the micro-sockets 222 may be detachably mounted onto the arrangement frame 221. Accordingly, when some of the micro-sockets 222 break down, an operator may easily repair the probe board 220 by replacing the defective micro-sockets 222.

10 [239] Furthermore, when the specifications of semiconductor devices D requiring testing change, the operator changes the handling specifications of the handler TH by replacing the micro-sockets 222.

15 [240] The probe board 220 may be implemented to be detachably mounted. Accordingly, when the specifications of semiconductor devices D requiring testing change, the operator may rapidly change the handling specifications of the handler TH simply by replacing the probe board 220 itself and mounting a new one.

20 [241] The horizontal mover 230 moves the test chuck 210 in the front-rear and left-right directions, which are the horizontal directions.

[242] The test chuck 210 may be selectively positioned in the unloading and test areas LU and TD by the horizontal mover 230.

25 [243] The vertical mover 240 moves the test chuck 210 in the vertical direction.

[244] In the case where the test chuck 210 is placed in the test area TD, when the test chuck 210 is lifted by operating the vertical mover 240, the semiconductor devices D seated on the test chuck 210 come into electrical contact with the probe board 220. When the test chuck 210 is lowered, the contact between the semiconductor devices D seated on the test chuck 210 and the probe board 220 is released.

[245] Furthermore, the horizontal mover 230 and the vertical mover 240 are also operated when the positions of the semiconductor devices D are rearranged on the test chuck 210.

[246] The second picker robot 250 moves semiconductor devices D requiring testing from the relay plate 310 in the second area S2 to the test chuck 210 in the unloading area LU.

[247] Furthermore, the second picker robot 250 moves tested semiconductor devices D from the test chuck 210 in the unloading area LU to the empty relay plate 310 in the second area S2.

[248] The second picker robot 250 has an unloading picker capable of gripping or releasing a semiconductor device D by vacuum pressure.

[249] The second picker robot 250 may move the unloading picker horizontally in the front-rear and left-right directions, and may also lift/lower the unloading picker in the vertical direction.

[250] The second picker robot 250 may be provided with at least one unloading picker.

[251] Since the unloading picker has to be able to grip or release a semiconductor device in a dead-bug state, it has the same structure as the dead-bug picker 161b described previously.

[252] The re-seating mechanism 260 is provided to readjust the positions of the semiconductor devices D placed on the test chuck 210 by the second picker robot 250.

[253] The re-seating mechanism 260 readjusts the positions of the semiconductor devices D that are misaligned.

[254] The re-seating mechanism 260 has a fixed position. For example, the re-seating mechanism 260 may be fixedly mounted on a frame that forms the skeleton of the handler TH.

[255] As shown in FIG. 27, the re-seating mechanism 260 may include a re-seating picker 261 and a camera 262.

[256] The re-seating picker 261 may grip or release a semiconductor device D. The re-seating picker 261 may grip a semiconductor device D by vacuum pressure.

[257] The re-seating picker 261 has a position fixed in the horizontal and vertical directions.

[258] The re-seating picker 261 has to be able to re-seat a semiconductor device D on the test chuck 210 while gripping or releasing the semiconductor device D in a dead-bug state, so that it has the same structure as the dead-bug picker 161b described previously.

[259] The camera 261 is placed to be spaced apart from the re-seating picker 261.

[260] The camera 261 is provided to photograph a semiconductor device D.

5 [261] The camera 261 photographs a semiconductor device D placed on the test chuck 210 on the relay plate 310 by the second picker robot 250.

[262] The rotary mover 270 is provided to correct the misalignment of a semiconductor device D.

10 [263] The rotary mover 270 rotates the test chuck 210.

[264] As shown in FIG. 28, the rotary mover 270 rotates the test chuck 210 by using the vertical line PL as the axis of rotation. Accordingly, a semiconductor device D loaded on the test chuck 210 is also rotated by the operation of the
15 rotary mover 270.

[265] The re-seating mechanism 260 is utilized to move a semiconductor device D, loaded into a temporary position on the test chuck 210, to a regular position, along with the horizontal mover 230, the vertical mover 240, and the rotary
20 mover 270.

[266] For example, as shown in the exaggerated FIG. 29, the second picker robot 250 loads a semiconductor device D to be tested at a temporary position Pt on the test chuck 210. Then, the controller 500 controls the camera 261 to
25 photograph the semiconductor device D loaded into the temporary position Pt on the test chuck 210.

[267] When the semiconductor device D is photographed by the camera 261, the controller 500 analyzes a captured image to calculate the horizontal position (the position in the front-rear and left-right directions) and degree of misalignment of the semiconductor device D. Thereafter, the controller 500 moves the test chuck 210 horizontally to a position where the re-seating picker 261 can grip a semiconductor device D, and then lifts the test chuck 210 to control the re-seating picker 261 to grip the semiconductor device D.

[268] When the semiconductor device D is gripped by the re-seating picker 261, the controller 500 lowers the test chuck 210. Then, the controller 500 operates the horizontal mover 230, the vertical mover 240, and the rotary mover 270 so that the semiconductor device D can be loaded into a regular position Pr to move the test chuck 210 horizontally and rotate it so that the semiconductor device D is accurately aligned with the regular position Pr.

[269] When the semiconductor device D is accurately aligned with the regular position Pr, the controller 500 lifts the test chuck 210 so that the semiconductor device D gripped by the re-seating picker 261 is loaded into the regular position Pr. Then, instead of the test chuck 210 gripping the semiconductor device D, the re-seating picker 261 releases the semiconductor device D, and then the test chuck 210 is lowered. In this manner, all semiconductor devices D loaded into temporary positions Pt on the test chuck 210 may

be sequentially moved and loaded into regular positions Pr.
The operation of the connection device 200 described above
will be described.

5 [270] When the relay plate 310 loaded with semiconductor
devices D requiring testing is positioned in the second area
S2, the second picker robot 250 moves the semiconductor
devices D from the relay plate 310 to the test chuck 210 in
the unloading area LU.

10 [271] When all the semiconductor devices D to be tested are
loaded into the temporary positions Pt of the test chuck
210, the positions of the semiconductor devices D are
readjusted using the re-seating mechanism 260.

15 [272] For example, when there is a specific semiconductor
device D whose position needs to be readjusted to a regular
position Pr, the horizontal mover 230 moves the test chuck
210 horizontally so that the specific semiconductor device D
is positioned directly below the re-seating picker 261.
Then, the vertical mover 240 operates to lift the test chuck
210 to a predetermined height so that the re-seating picker
20 261 can grip the specific semiconductor device D.

[273] When the re-seating picker 261 grips the specific
semiconductor device D by vacuum pressure, the vacuum
pressure of the suction hole AH that sucks the specific
semiconductor device D is released. Thereafter, the
25 vertical mover 240 operates to lower the test chuck 210, and
then the horizontal mover 230 and the rotary mover 270
operate to move the test chuck 210 horizontally and rotate

it so that the regular position is placed directly below the re-seating picker 261.

[274] When the regular position is placed directly below the re-positioning picker 261, the vertical mover 240 operates
5 to lift the test chuck 210. When the specific semiconductor device D is placed in the regular position of the lifted test chuck 210, the position of the specific semiconductor device D is fixed by the vacuum pressure of the suction hole AH. Furthermore, when the re-seating picker 261 releases
10 the specific semiconductor device D, the vertical mover 240 operates to lower the test chuck 210.

[275] In this manner, when the positions of semiconductor devices D requiring the readjustment of positions are readjusted to regular positions, the horizontal mover 230
15 operates to move the test chuck 210 from the unloading area LU to the test area TS.

[276] When the test chuck 210 is positioned in the test area TS, the vertical mover 240 operates to lift the test chuck 210 and electrically connect the semiconductor devices D,
20 seated onto the test chuck 210, to the probe board 220.

[277] Meanwhile, once the testing of the semiconductor devices D has been completed, the vertical mover 240 operates to lower the test chuck 210, and then the horizontal mover 230 operates to move the test chuck 210
25 from the test area TS to the unloading area LU. Thereafter, the second picker robot 250 operates to move the tested

semiconductor devices D from the test chuck 210 to the relay plate 310.

[278] The semiconductor devices D moved to the relay plate 310 are recovered by the feeding and recovery device 100.

5 [279] **<Modified Example of Handler>**

[280] The preceding embodiments have been described using the cases where there is one test chuck 210 as examples. However, as in a handler TH according to the example of FIG. 30, two test chucks 210A and 210B may be provided.

10 [281] According to the handler TH of FIG. 30, two unloading areas LU are placed on both the left and right sides of a test area TD. That is, the two unloading areas LU are placed with a test area TS interposed therebetween.

[282] Furthermore, the relay plate 310 of the relay device
15 300 may be positioned in both the two unloading areas LU. That is, in the handler TH of FIG. 30, there are two second areas S2.

[283] Furthermore, in the handler TH of FIG. 30, a manipulator 400 is placed behind a relay device 300.

20 [284] According to the present modified example, when one test chuck 210A or 210B is positioned in the test area TD, the other test chuck 210B or 210A may be positioned in the unloading area LU. At the test chuck 210A or 210B in the unloading area LU, a task in which tested semiconductor
25 devices D may be removed or semiconductor devices D requiring testing may be seated may be carried out.

[285] **<Modified Example of Re-seating Mechanism>**

[286] **1. Application of Buffer**

[287] FIG. 31 is a first modified example of the re-seating mechanism 260.

[288] The re-seating mechanism 260 of FIG. 31 may include a
5 re-seating picker 261, a camera 262, and a buffer 263.

[289] The buffer 263 buffers the pressure applied to a semiconductor device D gripped by the re-seating picker 261.

[290] The buffer 263 may be provided as a spring, a pneumatic cylinder, or the like.

10 [291] According to the present embodiment, the position of the re-positioning picker 261 is fixed in the horizontal direction. Furthermore, as the test chuck 210 is lifted, the re-seating picker 261 may grip a semiconductor device D on the test chuck 210, or may seat a semiconductor device D
15 on the test chuck 210.

[292] According to the present invention, the precise positioning of a semiconductor device D is significantly important. The position of a semiconductor device D has to be prevented from changing when the test chuck 210 is lifted
20 and the re-seating picker 261 grips a semiconductor device D or releases a semiconductor device D. To this end, the position of the semiconductor device D has to be prevented from changing when the semiconductor device D is handed over between the re-seating picker 261 and the test chuck 210.
25 Therefore, the height of the test chuck 210 has to be determined considerably precisely.

[293] When the lifting height of the test chuck 210 is even slightly insufficient, the position of the semiconductor device D may change.

[294] In contrast, when the test chuck 210 is lifted even
5 slightly excessively, excessive pressure is applied to the semiconductor device D, which may cause damage to the semiconductor device D. Accordingly, even when the test chuck 210 is lifted slightly excessively as in the present modified example, the buffer 263 is compressed and the re-
10 seating picker 261 is lifted slightly, thereby reducing the pressure applied to the semiconductor device D that the re-seating picker 261 has to grip or is gripping. Therefore, the handover of the semiconductor device D may be performed without a change in position between the re-seating picker
15 261 and the test chuck 210, and damage to the semiconductor device D may be minimized.

[295] **2. Application of Elevator**

[296] FIG. 32 is a second modified example of the re-seating mechanism 260.

20 [297] The re-seating mechanism 260 of FIG. 32 may include a re-seating picker 261, a camera 262, and an elevator 264.

[298] The elevator 261 may lift/lower the re-seating picker 261.

[299] The test chuck 210 is lifted only to a height where
25 the semiconductor device D loaded on the test chuck 210 is positioned at the focal length of the camera 262.

[300] According to the present modified example, during the process of re-seating the semiconductor device D, when the test chuck 210 is lifted and thus the semiconductor device D is positioned at the focal length of the camera 262, the semiconductor device D is photographed by the camera 262.

[301] Therefore, the position of the semiconductor device D at the temporary position Pt may be determined more precisely.

[302] **3. Application of Rotator**

10 [303] FIG. 33 is a third modified example of the re-seating mechanism 260.

[304] The re-seating mechanism 260 of FIG. 33 may include a re-seating picker 261, a camera 262, and a rotator 265.

15 [305] The rotator 265 may rotate the re-seating picker 261 by using the vertical line PL as the axis of rotation.

[306] According to the present modified example, the misalignment of the semiconductor device D may be corrected by rotating the re-seating picker 261 with the rotator 265 instead of rotating the test chuck 210 during the process of re-seating the semiconductor device D.

[307] **4. Others**

[308] The above buffer 263, elevator 264, and rotor 265 may be selectively combined and applied to the re-seating mechanism 260.

25 [309] **<Additional Notes>**

[310] **1. Regarding Second Cooling Channel**

[311] As shown in the example of FIG. 34, second cooling channels CR2 in a test chuck 210 may be formed as a pair of second cooling channels.

5 [312] As shown in FIG. 35, the first channel CR2-1 of the pair of second cooling channels CR2 is formed such that an introduced cooling fluid is first circulated from the edge portion of the test chuck 210, is moved to the central portion, and is then discharged. That is, the cooling fluid introduced into the first channel CR2-1 has a flow that
10 starts to cool the edge portion and then moves toward the central portion.

[313] As shown in FIG. 36, the second channel CR2-2 of the pair of second cooling channels CR2 is formed such that an introduced cooling fluid is first moved to the central
15 portion of the test chuck 210, is moved toward the edge portion while being circulated from the central portion, and is then discharged. That is, the cooling fluid introduced into the second channel CR2-2 has a flow that starts to cool the central portion and then moves toward the edge portion.

20 [314] According to the present embodiment, the inlet 1i of the first channel CR2-1 and the outlet 1o of the first channel CR2-1 have different heights, and the inlet 2i of the second channel CR2-2 and the outlet 2o of the second channel CR2-2 have different heights. Furthermore, the
25 inlet 1i of the first channel CR2-1 and the outlet 2o of the second channel CR2-2 have the same height, and the inlet 2i of the second channel CR2-2 and the outlet 1o of the first

channel CR2-1 have the same height. Moreover, the first and second channels CR2-1 and CR2-2 are formed such that their height increases from the edge portion toward the central portion. The reason for this is to ensure that the test
5 chuck 210 can be cooled uniformly from its edge portion to its central portion by taking into consideration the chill lost from the cooling fluid in a connection section 2j formed in the shape of a straight line extending from the inlet 2i of the second channel CR2-2 to the central portion.
10 That is, according to the example of FIGS. 34 to 36, the overall surface area of the test chuck 210 may be cooled uniformly by the cooling fluid.

[315] This type of cooling structure may also be applied to the relay plate 310.

15 [316] **2. Automatic Replacement of Pickers**

[317] The pickers 161a and 161b may be implemented to automatically change their specifications.

[318] For example, a handler TH is provided with a table equipped with pickers 161a and 161b of various
20 specifications.

[319] The table has a remover for removing the pickers 161a and 161b.

[320] An implementation may be made such that the first picker robot 160, the second picker robot 250, and the re-seating picker 260 move as needed to remove currently
25 mounted pickers 161a and 161b and load them into empty positions of the table. Furthermore, the first picker robot

160, the second picker robot 250, and the re-seating picker 260 mount new pickers 161a and 161b of different specifications placed on the table.

[321] As described above, the pickers 161a and 161b may be
5 implemented to automatically change their specifications.

[322] **3. Shape of Heaters**

[323] The first and second heaters 311 and 211 may be provided in a linear shape. However, to improve thermal uniformity, it is preferable that they be provided in a
10 plate shape, as shown in the example of FIG. 37.

[324] Due to the second cooling channel CR2 and the plate-shaped second heater 211, it may be possible to perform real-time temperature control while maintaining a uniform temperature distribution across the overall surface area of
15 the test chuck 210.

[325] **4. Regarding Manipulator**

[326] In the handler TH according to FIG. 30, the manipulator 400 is placed behind the relay device 300. Accordingly, the relay device 300 is placed between the test
20 area TD and the manipulator 400. In this arrangement, it is difficult to adopt the structure of the manipulator 400 such as that of FIG. 2.

[327] Accordingly, as shown in FIG. 38, a manipulator 400 is implemented to include a main body 410, a support 420, a
25 rotation device 430, a forward/rearward movement device 440, and an elevation device 450.

[328] The main body 410 firmly fixes the position of the manipulator 400, and supports all the components.

[329] The support 420 supports a tester TESTER. The tester TESTER may be detachably mounted on the support 420.

5 [330] The rotation device 430 rotates the tester TESTER 180 degrees to turn the tester TESTER upside down, as shown in FIG. 39.

[331] In the state in which the terminal side of the tester TESTER has been made to face upward by the rotation device
10 430, it becomes convenient to repair the tester TESTER.

[332] The forward/rearward movement device 440 moves the tester TESTER forward and rearward, as shown in FIG. 40.

[333] The position of the tester TESTER may be located in the test area TD or removed from the test area TD by the
15 forward/rearward movement device 440.

[334] The elevation device 450 lifts/lowers the tester TESTER, as shown in FIG. 41.

[335] When the tester TESTER is lowered by the elevation device 450, the tester TESTER enters the state of being
20 mounted and the tester TESTER and the probe board 220 are electrically connected to each other.

[336] When the tester TESTER is lifted by the elevation device 450, the tester TESTER enters the state of being separated, and the contact between the tester TESTER and the
25 probe board 200 is released.

[337] The manipulator 400 according to FIG. 38 may also be sufficiently applied to the handler TH of FIG. 1.

[338] **5. Independent Manufacturing**

[339] The handler TH according to the present invention may be assembled at a test house of a user after the feeding and recovery device 100, the connection device 200, the relay device 300, and the manipulator 400 have been individually manufactured independently.

[340] Accordingly, the feeding and recovery device 100, the connection device 200, the relay device 300, and the manipulator 400 may individually be manufactured in modified forms independently.

[341] **6. Replacement of Probe Board**

[342] The probe board 220 may be replaced in the state in which the coupling of the tester TESTER has been released, as shown in FIG. 2.

[343] The probe board 220 may be replaced manually by an operator, but it may also be implemented to be replaced automatically.

[344] For automatic replacement, the controller 500 is required to have a communication means capable of communicating with a management server.

[345] When a manager requests the controller 500 to replace the existing probe board 220 with a probe board 220 of specific specifications via an input means after the tester TESTER has been separated from the handler TH, the controller 500 transmits the replacement command of the manager to the management server via the communication means.

[346] The management server operates an automated logistics robot, such as an Overhead Hoist Transport (OHT) or Automated Guided Vehicle (AGV), in accordance with the replacement command to perform the automatic replacement of the probe board 220.

[347] The OHT or AGV separates and collects the existing probe board 220, and mounts a new probe board 220 onto the handler TH.

[348] This method of replacing the probe board 220 may be applied to the replacement of the relay plate 310 in the same manner.

[349] **7. Regarding Relay Plate**

[350] 1) The first cooling channels CR1 of the relay plate 310 may be formed as a pair of cooling channels, as referenced from FIG. 42.

[351] In the first channel CR1-1 of the first cooling channels CR1, a cooling fluid is introduced from the left and then discharged to the right.

[352] In the second channel CR1-2 of the second cooling channels CR2, a cooling fluid is introduced from the right and then discharged to the left.

[353] Both the first channel CR-1 and the second channel CR1-2 are each formed to have a zigzag shape, and do not overlap each other.

[354] The direction of movement of the cooling fluid in the first channel CR1-1 and the direction of movement of the

cooling fluid in the second channel CR1-2 are opposite to each other.

[355] Furthermore, when the first heater 311 is provided in a plate shape along with the first cooling channel CR1 of FIG. 42, the relay plate 210 may have a temperature distribution as uniform as possible over its overall surface area, and real-time temperature control may be enabled.

[356] The arrangement structure of the first cooling channels CR1, such as that of FIG. 42, may also be applied to the arrangement structure of the second cooling channels CR2.

[357] 2) The relay plate 310 may be divided into a heating area HZ and a cooling area CZ, as shown in FIG. 43.

[358] The heating area HZ is the area where loaded semiconductor devices D are heated.

[359] The cooling area CZ is the area where loaded semiconductor devices D are cooled.

[360] The heating area HZ may be operated by the heating of the first heater 311, and the cooling area CZ may be operated in such a manner that air is injected onto a resistance coil, heat reaches the bottom surface of a thermoelectric device located above, and the top surface of the thermoelectric device is cooled.

[361] When the relay plate 310 is operated in the manner of being divided into the heating zone HZ and the cooling zone CZ as shown in FIG. 43, it is possible not only to preheat or precool semiconductor devices D before testing but also

to rapidly return tested semiconductor devices D to room temperature.

[362] **8. Change of Direction of Semiconductor Device**

[363] The direction of the terminals T of semiconductor devices D placed on a customer tray may not match the direction of the terminals of the micro-sockets 222. Accordingly, a switch may be additionally provided in the feeding and recovery device 100.

[364] The switch may rotate semiconductor devices D by rotating them by using the vertical line as the axis of rotation. The amount of rotation of the semiconductor devices D by the switch may be 90 degrees, 180 degrees, or 270 degrees.

[365] When the operation of the switch is required, the first picker robot 160 first feeds semiconductor devices D, gripped from a customer tray, to the switch. Then, the switch rotates the semiconductor devices D to align the direction of the terminals T of the semiconductor devices D with the direction of the terminals of the micro-sockets 222. Thereafter, the first picker robot 160 recovers the semiconductor devices D from the switch, and loads them onto the relay plate 310.

[366] **9. Operating Structure of Stackers**

[367] The feeding and recovery device 100 is provided with various types of stackers, such as the feeding stacker 120, the recovery stacker 140, and the empty stacker 150.

[368] Furthermore, the various types of stackers may include a multi-stacker that can be utilized for various roles.

[369] The stackers each have a set plate and a set base, and may each accommodate a customer tray.

5 [370] The stackers may each have an inlet for receiving a customer tray in its front. In this case, there may be provided a door configured to be able to be opened and closed from the front and a cognitive sensor configured to be able to detect the approach of a surrounding structure.

10 When the approach of a surrounding structure is detected by the cognitive sensor, the door is opened, and, thus, a customer tray is fed from an OHT or AGV.

[371] To more appropriately receive customer trays coming from the OHT or AGV, the stackers may each be discharged in
15 the form of one or more steps outside the handler TH. In this case, the stackers may each have a support protrusion configured to support the transmitter of the OHT or AGV, and the stackers may be moved rearward.

[372] Furthermore, the stackers are implemented to be able
20 to be lifted/lowered when needed to prevent interference with the transfer 150.

[373] **10. Regarding Applicability**

[374] The handler TH according to the present invention may be widely applied to semiconductor devices capable of
25 supporting mass production of a small variety, semiconductor devices capable of supporting small-quantity production of a

large variety, semiconductor devices in a die state, and semiconductor devices in an HBM state.

[375] Moreover, the handler TH according to the present invention may be applied to various electronic components
5 other than semiconductor devices.

[376] 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 feeding and recovery device configured to feed
electronic components requiring testing or recover tested
electronic components;

10 a connection device configured to electrically connect
the electronic components requiring testing, fed from the
feeding and recovery device, to a tester to enable testing
of the electronic components and transfer the tested
electronic components to the feeding and recovery device;

a relay device configured to relay electronic
components between the feeding and recovery device and the
connection device; and

15 a controller configured to control operations of the
feeding and recovery device, the connection device, and the
relay device;

wherein the connection device comprises:

20 a test chuck provided with suction holes for
vacuum-sucking seated electronic components, and
configured to move between a unloading area and a test
area;

25 a probe board configured to electrically
connect electronic components, seated on the test
chuck in the test area, to a tester;

a horizontal mover configured to move the test

chuck in a horizontal direction to selectively position the test chuck in the unloading and test areas;

5 a vertical mover configured to move the test chuck in a vertical direction to bring the electronic components, seated on the test chuck in the test area, into contact with the probe board or release contact of the electronic components with the probe board;

10 a picker robot configured to move the electronic components requiring testing from a relay plate in the relay device to temporary positions on the test chuck in the unloading area, or move tested electronic components from the test chuck in the unloading area to the relay plate;

15 a re-seating mechanism configured to readjust the electronic components, loaded into the temporary positions on the test chuck, to regular positions; and

a rotary mover configured to rotate the test chuck;

20 wherein the re-seating mechanism comprises:

a re-seating picker configured to grip or release an electronic component; and

25 a camera placed to be spaced apart from the re-seating picker, and configured to photograph a semiconductor device placed at a temporary position of the test chuck by the picker robot; and

wherein, when the camera photographs the semiconductor

device loaded into the temporary position on the test chuck,
the controller analyzes an image captured by the camera to
calculate a horizontal position and degree of misalignment
of the semiconductor device, and controls operations of the
5 re-seating picker, the horizontal mover, the vertical mover,
and the rotary mover to load the semiconductor device at a
regular position on the test chuck.

[Claim 2] The handler of claim 1, wherein the re-
seating mechanism further comprises an elevator configured to
10 lift or lower the re-seating picker.

[Claim 3] The handler of claim 1, wherein the re-
seating mechanism further comprises a rotator configured to
rotate the re-seating picker.