

INTEGRATED CIRCUIT TRANSPORTING APPARATUS

BACKGROUND OF THE INVENTION1. FIELD OF THE INVENTION

5 The present invention relates to an integrated circuit (IC) transporting and handling or processing apparatus (commonly called IC handler) used, for example, in an IC testing apparatus (commonly called IC tester) for testing ICs.

2. DESCRIPTION OF THE RELATED ART

10 Fig. 1 shows a diagrammatical arrangement of a prior IC handler called "horizontal transporting system". A plurality of tray groups 2 are disposed along one side, namely, the lower side 1A in the drawing, of a frame 1 which serves as a base. Each tray in the tray groups 2 is loaded with ICs. Each of the tray groups 2A-2E consists of a stack of multiple trays loaded up in vertical direction. The leftmost tray group 2A in the drawing is positioned at a loader section. ICs undergoing a test hereafter (ICs to be tested) have been loaded on each tray in the tray group 2A at the loader section.

20 A carrier arm 3 picks up two ICs at a time, in this example, out of the uppermost tray of the tray group 2A which is a stack of trays and transports them onto a turntable 4 called "soak stage". On the turntable 4, in order to define the positions for receiving ICs, are formed

positioning recessed portions 5 arranged along two concentric circular lines at intervals of a constant angle as shown in Fig. 2.

Each recessed portion 5 is of substantially square shape in plan and the four sides thereof are surrounded by upwardly inclined walls (surfaces). Every time the turntable 4 rotates by one pitch, two ICs are fallen into two respective recessed portions 5 one being arranged in the inner circular line and the other in the outer circular line.

A reference numeral 6 denotes a contact arm for transferring ICs conveyed by the turntable 4 to a testing section 7. The contact arm 6 is adapted to pick up two ICs by suction at a time out of the respective positioning recessed portions 5 on the turntable 4 and transports these ICs to the testing section 7. The contact arm 6 has three arms and performs the operation of sequentially transferring the ICs to the testing section 7 and the operation of sequentially transferring the tested ICs to a transfer arm 8 located at an exit side by rotation of the three arms.

Further, the IC handler is constructed such that the turntable 4, the contact arm 6, and the testing section 7 are placed in a constant temperature or thermostatic room (chamber) 9, and ICs to be tested are maintained at a predetermined temperature within this thermostatic chamber 9 and undergo a test therein.

ICs taken out from the thermostatic chamber 9 by the

transfer arm 8 located at the exit side of the thermostatic chamber are sorted on the basis of the test results and stored in corresponding one of three tray groups 2C, 2D and 2E in this example located at an unloader section. For
5 example, non-conforming or bad ICs (ICs having a defect or failure) are stored in a tray of the rightmost tray group 2E, conforming or good ICs (ICs having no defect or failure) are stored in a tray of the tray group 2D positioned at the left side of the tray group 2E, and ICs which are needed to
10 undergo a retest are stored in a tray of the tray group 2C positioned at the left side of the tray group 2D. This sorting of ICs is performed by a carrier arm 11.

Further, the tray group 2B located at the second left side position is an empty tray group located at a buffer
15 section for accommodating trays emptied of ICs in the loader section. When the uppermost tray of any one stack of the tray groups 2C, 2D and 2E in the unloader section is filled with ICs, a tray of this empty tray group 2B is conveyed onto the tray stack of the corresponding tray group and is
20 utilized to store ICs therein.

In the aforementioned IC handler, the subject apparatus or structure to which the present invention is applied is an IC transporting apparatus comprising the contact arm 6 for carrying ICs from the turntable 4 to the testing section 7
25 and an IC transporting apparatus comprising the carrier arm 11 and the transfer arm 8 for conveying ICs from the testing section 7 to the carrier arm 11.

Fig. 3 shows a structure of a contact chuck portion for picking up ICs out of positioning recessed portions 5 formed on a prior art turntable 4. A reference numeral 12 denotes the entire structure of the contact chuck. The contact chuck 12 comprises a supporting plate 13, guide pins 14 implanted on this supporting plate 13, suction means 15 for picking up ICs by suction, and a lead pusher (a tool for pressing or pushing lead terminals of an IC) 16 surrounding this suction means 15.

The suction means 15 comprises a sucker 15A mounted on the lower or forward end portion of the suction means 15 and a sucking path 15B for aspirating air through the sucker 15A. The lead pusher 16 is arranged such that the suction means 15 is positioned in the center of the lead pusher 16 and is surrounded by the lead pusher 16. This lead pusher 16 is adapted to perform operation of defining an IC to a predetermined position so that the suction means 15 can pick up by suction an IC being accurately located on the predetermined position when the suction means 15 picks up the IC.

That is, the forward or lower end portion of the lead pusher 16 has a tapered surface so that the lead pusher 16 can get into the positioning recessed portion 5, and the tapered end portion is inserted into the positioning recessed portion 5. By inserting the end portion of the lead pusher 16 into the positioning recessed portion 5, the sucker 15A can approach the IC and come in contact with the

IC to pick up the IC by suction. At this time, the lead terminals of the IC are forced to engage with the inner sides of the end portion of the lead pusher 16, and hence the IC is located to a position determined by the lead
5 pusher 16 and then the IC is picked up by suction.

Further, the lead pusher 16 performs operation of pushing the lead terminals of the IC against an IC socket in the state that the IC is conveyed to the testing section 7 and of maintaining the electrical contact between the IC and
10 the IC socket. Therefore, at least a portion of the lead pusher 16 which contacts with the lead terminals is formed of an insulating material. In the illustrated example shown in the drawing, a case is shown where the entire lead pusher is integrally formed of an insulating material by molding.

15 The contact chuck 12 is supported by a member 17 hanging from the contact arm 6 (not shown in Fig. 3) and is movable in the up-and-down (vertical) direction and in the rotating direction of the contact arm. A shock absorber 18 lies between the member 17 and the contact chuck 12. This
20 shock absorber 18 consists of a plate 18A mounted on the lower side of the member 17, rods 18B hanging from the plate 18A, a plate 18C hanging from the rods 18B and springs 18D each applying a predetermined pressure between the plates 18A and 18C.

25 Rods 13A stand upwardly on the supporting plate 13 which is a part of the contact chuck 12. The contact chuck 12 hangs from the member 17 through the shock absorber 18 by

causing the rods 13A to pass through the plate 18C which is a part of the shock absorber 18 and to engage the rods 13A with the plate 18C.

When the contact chuck 12 moves downwardly and
5 approaches the positioning recessed portion 5, it is necessary to align the central position or axis of the lead pusher 16 with the center or central axis of the positioning recessed portion 5. To this end, in the illustrated prior example, a pair of guide bushes 21 is provided on the
10 turntable 4 for each of the positioning recessed portions 5, and also guide pins 14 which fit in the guide bushes 21 are provided on the supporting plate 13 in such a manner that the guide pins 14 project downwardly from the supporting plate 13 whereby the center of the lead pusher 16 can align
15 with the center of the positioning recessed portion 5 by engaging guide pins 14 with the guide bushes 21.

For this positioning and aligning operation, a play or clearance is provided between each rod 13A and a through-hole through which each rod 13A passes and formed in the
20 plate 18C which is a part of the shock absorber 18 so that the positioning of the contact chuck 12 to each recessed portion 5 is made possible within the range of the play between the rod 13A and the through-hole.

In the prior art apparatus, positioning and alignment
25 of the contact chuck 12 to and with the positioning recessed portion 5 has been made possible by means of the guide bushes 21 and the guide pins 14. Since the two guide bushes

21 must be provided for each positioning recessed portion 5 formed on the surface of the turntable 4 as shown in Fig. 2, many guide bushes are required and hence the cost of such parts is high.

5 In addition, since a multiple of guide bushes 21 must be provided, even the heat capacity of only the guide bushes 21 becomes large, and thus a heating and heat absorbing or cooling apparatus of large capacity must be provided for heating and cooling the thermostatic chamber 9. Further,
10 because of a large heat capacity required, there is a shortcoming that it takes a considerable time until the temperature within the thermostatic chamber 9 reaches a target temperature and stabilizes to that temperature.

15 SUMMARY OF THE INVENTION

An object of the present invention is to provide an IC transporting apparatus which is unnecessary to provide a positioning and alignment mechanism comprising guide bushes and guide pins, can reduce the heat capacity within the
20 thermostatic chamber, and can be manufactured at low cost.

An another object of the present invention is to provide an IC transporting apparatus which can surely store the tested ICs in a tray located at the unloader section.

In the present invention, there is provided an IC
25 transporting apparatus wherein a guide surrounding the device suction means of the device chuck part has the positioning function, too. That is, the forward or lower

end (tip) portion of the guide surrounding the device suction means is formed to have a shape which can fit in a positioning recessed portion without any play or clearance therebetween, and also the guide has flat portions each of which engages with or abuts against corresponding one of the upper end surfaces of the positioning recessed portion.

According to the arrangement of the present invention, when the device suction means of the device chuck part approaches a positioning recessed portion formed on the turntable or a positioning recessed portion formed on the transfer arm, first, the lower end portion of the guide surrounding the device suction means starts to engage with the positioning recessed portion and then the guide is guided in the positioning recessed portion by this engagement of the guide with the positioning recessed portion so that the positions of the guide and the recessed portion are aligned to each other.

Next, when the guide is further inserted into the positioning recessed portion, the flat portions formed on the guide abut against the upper end surface of the positioning recessed portion, and hence the guide is inhibited to further get into the positioning recessed portion by this engagement of the flat portions of the guide with the upper end surface of the recessed portion. As a result, it is inhibited that the guide enters into the positioning recessed portion, and hence the IC located in the recessed portion is protected to be broken or damaged by

the guide and the positioning and alignment of the guide and the recessed portion can be effected with the same accuracy as that of the prior apparatus.

5 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagrammatic plan view showing an example of an IC handler to which the present invention is applied;

Fig. 2 is a perspective view of a turntable used in a prior art IC handler for explaining the structure thereof;

10 Fig. 3 is a sectional view showing the structure of a prior art IC transporting apparatus;

Fig. 4 is a sectional view showing the structure of a first embodiment of an IC transporting apparatus according to the present invention;

15 Fig. 5 is a perspective view showing an example of a lead pusher used in the IC transporting apparatus of the present invention;

Fig. 6 is a sectional view showing the structure of a second embodiment of the IC transporting apparatus according to the present invention; and

20 Fig. 7 is a sectional view showing a tray of type for guiding IC packages and the ICs loaded on the tray.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 Now, the embodiments of the present invention will be described with reference to the accompanying drawings.

Fig. 4 shows a first embodiment of the IC transporting

apparatus according to the present invention. In Fig. 4, portions or elements corresponding to those of Fig. 3 are indicated by the same reference numerals or characters as in Fig. 3. This first embodiment shows the case in which the present invention is applied to an apparatus or structure for picking up ICs to be tested by suction out of positioning recessed portions 5 of a turntable 4 by a contact arm 6 and transferring them to the testing section 7 by the contact arm 6.

10 In this embodiment, a guiding function is given to a lead pusher 16 surrounding a suction means 15 of a device chuck part, i.e., a contact chuck 12 in this example, and so the forward or lower end portion of the lead pusher 16 is formed to have a shape which can fit in each positioning
15 recessed portion 5 without any play or clearance therebetween. That is, in the prior art apparatus, since positioning and alignment of the contact chuck 12 to and with the positioning recessed portion 5 has been made possible by means of the guide bushes 21 and the guide pins
20 14 as shown in Fig. 3 and also the distance or depth of the lead pusher 16 entering into the recessed portion 5 has been confined by means of the guide bushes 21 and the guide pins 14, the lower end portion of the lead pusher 16 has been
25 formed to have a shape which produces a play to some extent between the lead pusher 16 and the positioning recessed portion 5 when lead pusher has engaged with the recessed portion.

However, in the present invention, the lead pusher 16 is also used as a guide and the positioning and alignment of the contact chuck 12 to and with the positioning recessed portion 5 is made possible by this lead pusher 16.

5 Therefore, if there is any play in the engaged state between the lead pusher 16 and the positioning recessed portion 5 or if the lead pusher 16 loosely engages with the recessed portion, the accuracy of the positioning and the alignment is decreased.

10 For this reason, in this embodiment, the forward end portion of the lead pusher 16 has a shape formed to conform to the inclined surface of the positioning recessed portion 5 so that the forward end portion of the lead pusher 16 can engage with the positioning recessed portion 5 without any
15 play therebetween. In addition, flat portions 16A are formed on the lead pusher 16 at the position thereof spaced apart from the tip end of the lead pusher 16 by a distance corresponding to a predetermined depth which the forward end portion of the pusher 16 enters into the positioning
20 recessed portion 5. These flat portions 16A abut against the upper end surface 4A of the positioning recessed portion 5 in the engaged state.

By the abutment of the flat portions 16A against the upper end surface 4A of the positioning recessed portion 5,
25 the lead pusher 16 is inhibited to further get into the positioning recessed portion 5, and thus there is provided the IC transporting apparatus which is constructed to be

able to prevent from being caused an accident that the lead pusher 16 eats into the positioning recessed portion 5.

Further, in this embodiment, each of the positioning recessed portions has a play so that a semiconductor device
5 fallen thereinto can move in the horizontal direction to some extent when the lead pusher 16 engages with the positioning recessed portion 5.

Fig. 5 shows a structure of the lead pusher 16 used in the present invention. Since the lead pusher 16 used in the
10 present invention performs repetitive operations of engagement with and release from the positioning recessed portions 5, the lead pusher 16 is formed of a reinforced plastic material having both sliding and wear resisting (durable) features.

15 In Fig. 5, the lead pusher 16 is shown bottom up (upside down). Reference character 16B denotes a flange portion which is adapted to be mounted to the supporting plate 13 and reference character 16C denotes downwardly projected ridges of the forward end portion which gets into
20 the positioning recessed portion 5. The ridges 16C are provided along every sides of a regular square and the slope of the inclined surface 16D of each ridge conforms to the angle of corresponding one of the inclined surfaces of the positioning recessed portion 5. The flat portions 16A are
25 formed at the lower ends of the inclined surfaces 16D (seeing in the state of Fig. 5), respectively. A through-hole 16E through which the suction means 15 passes is formed

at the center of the regular square along each side of which the ridge 16C is disposed.

Fig. 6 shows a second embodiment of an IC transporting apparatus according to the present invention. This
5 embodiment shows the case where the present invention is applied to an apparatus or structure for picking up the tested ICs by suction out of positioning recessed portions 31 provided on the upper surface of the transfer arm 8 by a device suction means (chuck) 33 of a device chuck part 32 of
10 the carrier arm 11 and conveying the ICs to a tray located at the unloader section by the carrier arm 11.

As an example of a recent tray 40 is shown in Fig. 7, in recent years there are increased trays of a type having frame-like guide portions 43 each for guiding the mold
15 (package) 42 of a semiconductor device (an IC in this example) 41. To this end, a severe accuracy for positioning an IC in the tray 40 has been requested.

In the prior art apparatus, for example, if the transfer arm 8 stops at a position shifted by a little from
20 the normal position, the interval or space between the ICs loaded in the two positioning recessed portions formed on the upper surface of the transfer arm 8 becomes smaller or larger than the normal interval. Since the carrier arm 11 picks up by suction and holds the two ICs as they are, the
25 two ICs are transferred to the tray with the two ICs held in the state of the abnormal interval.

As a result, the prior art apparatus has a shortcoming

that the two ICs cannot be stored successfully in the tray at the normal accurate positions. Particularly, in case of the tray 40 of such mold guide type as shown in Fig. 7, there have occurred accidents that the ICs stored in the
5 tray have ridden over the guide portions 43 and have fallen from the normal storing positions.

In this embodiment, like the case of the lead pusher 16 of the first embodiment, the lower end portion of the device guide 34 surrounding the device suction means 33 mounted on
10 the end portion of the device chuck part 32 of the carrier arm 11 is formed to have a shape which engages with the positioning recessed portion 31 of the transfer arm 8 without any play therebetween.

That is, in the prior art apparatus, since positioning
15 and alignment of the device guide 34 to and with the positioning recessed portion 31 has been made possible by means of the guide bushes 21 and the guide pins 14 as seen in the prior case shown in Fig. 3, and also the distance or depth of the lower end portion of the device guide 34
20 entering into the recessed portion 31 has been confined by means of the guide bushes and the guide pins, the device guide 34 of the prior apparatus has been formed to have a shape which produces a play to some extent between the tip portion of the device guide 34 and the positioning recessed
25 portion 31 when the device guide has engaged with the recessed portion.

However, in the present invention, the positioning and

alignment of the device guide 34 to and with the positioning recessed portion 31 is made possible by this device guide 34. Therefore, if there is any play in the engaged state between the forward end portion of the device guide 34 and the positioning recessed portion 31 or if the forward end portion of the device guide 34 loosely engages with the recessed portion 31, the accuracy of the positioning and alignment is decreased.

For this reason, in this embodiment, the forward end portion of the device guide 34 is also formed to have a shape which conforms to the inclined surfaces of the positioning recessed portion 31 so that the forward end portion of the device guide 34 can engage with the positioning recessed portion 31 without any play therebetween. In addition, flat portions 34A are formed on the device guide 34 at the position thereof spaced apart from the tip end of the device guide 34 by a distance corresponding to a predetermined depth which the lower end portion of the device guide 34 enters into the positioning recessed portion 31. This flat portions 34A abut against the upper end surface 31A of the positioning recessed portion 31 in the engaged state.

By the abutment of the flat portions 34A against the upper end surface 31A of the positioning recessed portion 31, the device guide 34 is inhibited to further get into the positioning recessed portion 31, and thus there is provided the IC transporting apparatus which is constructed to be

able to prevent from being caused an accident that the device guide 34 eats into the positioning recessed portion 31, and the position where the device guide 34 picks up an IC by suction can be determined with high accuracy.

5 Further, in this second embodiment, each of the positioning recessed portions 31 also has a play so that a semiconductor device fallen thereinto can move in the horizontal direction to some extent when the device guide 34 engages with the positioning recessed portion 31.

10 The device guide 34 having similar shape and structure to the lead pusher 16 shown in Fig. 5 and used in the first embodiment can be used. The device suction means 33 consists of a sucker 33A for picking up an IC by suction and a sucking path 33B. The sucker 33A is fixed to the
15 lower end of a cylindrical slidable member 35 which is adapted to be able to slide in the vertical direction in the drawing within the device guide 34. The positioning recessed portion 31 is formed on an unit member 37 slidably mounted on a base member 36 which is fixed to the transfer
20 arm 8.

 In other words, the unit member 37 has, in this example, two positioning recessed portions previously formed thereon and is called "recessed portion unit". This recessed portion unit 37 is mounted to the base member 36 so
25 as to be slidable in the horizontal direction in the drawing to some extent so that an IC fallen into the recessed portion 31 can be movable to some extent in the horizontal

direction due to the sliding of the recessed portion unit 37. Therefore, even if the transfer arm 8 stops at a position shifted by a little from the normal position and the interval between the ICs held by the transfer arm 8 becomes shorter than the normal interval, the carrier arm 11 picks up and holds the two ICs by suction in the state that the interval between the two ICs is normal because the recessed portion unit 37 slides relative to the base member 36 due to that the two device guides 34 (only one of them is shown in Fig. 6) enter into and fit in the corresponding positioning recessed portions 31 (only one of them is shown in Fig. 6).

As a result, the two ICs are transferred to the tray in the state of the normal interval by the carrier arm 11, and the two ICs are stored successfully in the tray at the normal accurate positions.

Since the IC handler to which the present invention is applied is constructed such that two ICs are transported and tested at a time, two positioning recessed portions 31 are formed on the recessed portion unit 37. However, it is needless to say that the number of positioning recessed portions 31 formed on the recessed portion unit 37 is changed depending on the kind of the IC handler.

Further, it goes without saying that the present invention can also be applied to other portions of the IC transporting apparatus having similar semiconductor device positioning recessed portions and device suction parts.

As is apparent from the foregoing, the IC transporting apparatus according to the present invention is so constructed that a guide surrounding device suction means of a device chuck part such as the lead pusher 16 or the device
5 guide 34 is engaged with a positioning recessed portion thereby to align the position of the chuck part with the position of the positioning recessed portion, and therefore the IC transporting apparatus can always pick up a semiconductor device by suction at the accurate position.
10 Consequently, even in case of transporting a plurality of semiconductor devices, there occurs no positional discrepancy therebetween.

In addition, since there is no need for providing any guiding and engaging means such as the guide bushes around
15 each positioning recessed portion, the number of parts can be reduced and thus the cost can be reduced. Further, since the heat capacity within the thermostatic chamber can be reduced, the time required to stabilize the temperature in the chamber to a predetermined target temperature can be
20 shortened. Furthermore, there is an advantage that the capacity or power of the heating and heat sinking (cooling) apparatus for controlling the temperature in the chamber can also be reduced.



WHAT IS CLAIMED IS:

1. An IC transporting apparatus comprising:

a positioning recessed portion having upwardly inclined surfaces, said positioning recessed portion having a play so that a semiconductor device fallen into said positioning recessed portion can move in the horizontal direction;

a device chuck part having device suction means for picking up by suction a semiconductor device fallen into said positioning recessed portion; and

a guide surrounding said device suction means and for guiding said device suction means such that it can pick up by suction a semiconductor device at the predetermined suction position, said guide having downwardly projected ridged portions at the lower end thereof;

wherein each of the downwardly projected ridged portions of said guide has a shape formed to conform to corresponding one of the upwardly inclined surfaces of said positioning recessed portion, and said guide has flat portions provided at the base portion of said downwardly projected ridged portions of said guide, said flat portions abutting against an upper end surface of said positioning recessed portion when the downwardly projected ridged portions of said guide engage with the upwardly inclined surfaces of said positioning recessed portion without any play therebetween.



2. The IC transporting apparatus according to claim 1 wherein said positioning recessed portion is formed on a turntable for carrying a device to be tested to a testing section, and said guide for guiding the device suction means is a lead pusher for pressing lead terminals of a semiconductor device against a socket to electrically contact the lead terminals with the socket on testing.

3. The IC transporting apparatus according to claim 1 wherein said positioning recessed portion is formed on a transfer arm for transferring a tested semiconductor device, and said guide for guiding the device suction means is a device guide surrounding device suction means of a carrier arm, said carrier arm being adapted to load the semiconductor device transferred by said transfer arm on a predetermined tray.