DESCRIPTION

COMPONENT MOUNTING APPARATUS

TECHNICAL FIELD

The present invention relates to a board transfer method and apparatus, in particular, of the return-back system that a board prior to a process, for example, component placement is transferred in onto a board positioning table such as an X-Y table by a loader unit, while another board after the component placement is also transferred out to the loader unit, for use in electronic component pick-and-place equipment in which electronic components are inserted or placed to a printed circuit board.

BACKGROUND ART

In recent years, the electronic component pick-and-place equipment is in many cases operated for batch production in terms of the flexible manufacturing system (wide-variety-of-types, low-volume production) and environmental improvement for the production of printed circuit boards. As a result, there have arisen cases, in particular, where boards are transferred in and out between a board stock rack and the electronic component

pick-and-place equipment by using one robot. In the board transfer method and apparatus of this return-back system, advantageously, the installation space can be saved, while one robot will do for both the take-in of a board prior to component placement and the take-out of a board after the component placement because the board after the component placement is returned to the position where the board prior to component placement is taken in.

Conventionally, a board transfer apparatus of the return-back system as shown in Fig. 10 comprises a pair of guide rails 2 having a drive device for guiding and transferring a board 1, a link mechanism 3 for supporting the guide rails rotatably about a fulcrum, an air cylinder 4 for driving the link mechanism 3 to rotate about the fulcrum and thereby moving the guide rails 2 up and down, and an X-Y table 5 for positioning the board.

With this arrangement, the board 1 on the X-Y table 5 after the component placement is transferred out onto the guide rails 2 that have been lowered by the air cylinder 4 and coupled with the rails of the X-Y table 5, the board 1 being then moved to the other end of the guide rails 2. Subsequently, the board 1 after the component placement is taken out by a robot or the like, and then a board prior to component placement is newly placed on the guide rails 2.

Next, the board prior to component placement is transferred onto the X-Y table 5, and the guide rails 2 are driven by the air cylinder 4 so as to be moved up, separating from the X-Y table. This is the process in which boards are exchanged and transferred.

In such a conventional board transfer apparatus, on the X-Y table 5, the board 1 after the component placement is transferred out through the guide rails 2, and thereafter a board prior to component placement is transferred in again through the guide rails 2. Therefore, much time is required for the replacement of boards, which has been an obstacle to reducing the production cycle time.

DISCLOSURE OF INVENTION

An object of the invention is to provide a board transfer apparatus of the return-back system which allows the replacement of boards from and to a board positioning table to be accomplished in short time.

In order to achieve the aforementioned object, according to a first aspect of the present invention, there is provided a board transfer method in which a board is transferred in from a loader unit into a position where a process is carried out on the board and,

after the process is carried out, the processed board is returned back to the loader unit and discharged out,

the method comprising:

after the process is carried out onto the board in the position, moving the processed board from the position onto an unloader unit, while simultaneously transferring a succeeding board prior to the process from the loader unit into the position;

thereafter relatively moving the unloader unit or the loader unit above the board that is in the position until the unloader unit is coupled with the loader unit; and

delivering to the loader unit, and thereby discharging out, the processed board that has been moved to the unloader unit.

According to a second aspect of the present invention, there is provided a board transfer method according to the first aspect, wherein a succeeding board prior to the process is positioned into the position during a period which the unloader unit or the loader unit is moved above the board in the position so as to be coupled with the loader unit, and further the processed board that has been moved to the unloader unit is delivered to the loader unit.

According to a third aspect of the present invention, there is provided a board transfer method according to the first aspect, wherein the process is to place components on the board and the processed board is a board after the components placement.

According to a fourth aspect of the present invention, there is provided a board transfer method according to the second aspect, wherein the process is to place components on the board and the processed board is a board after the components placement.

According to a fifth aspect of the present invention, there is provided a board transfer apparatus in which a board is transferred in from a loader unit into a position where a process is carried out on the board and, after the process is carried out, the processed board is returned back to the loader unit and discharged out,

the apparatus comprising:

an unloader unit for guiding and transferring a board;

a driver for moving the unloader unit or the loader unit along a direction in which the board is transferred;

a positioning table for positioning the board; and

a loader unit for transferring the board,

wherein the unloader unit is coupled with the loader unit through above the positioning table so that the board can be delivered therebetween.

According to a sixth aspect of the present invention, there is provided a board transfer apparatus according to the fifth aspect, wherein the unloader unit is equipped with a pair of first guide rails having a drive device for guiding and transferring a board, and the loader unit is equipped with a pair of second guide rails having a drive device for transferring the board, and then the first guide rails of the unloader unit are coupled with the second guide rails of the loader unit through above the positioning table sc that the board can be delivered therebetween.

According to a seventh aspect of the present invention, there is provided a board transfer apparatus according to the fifth aspect, wherein the process is to place components on the board and the processed board is a board after the components placement.

According to an eighth aspect of the present invention, there is provided a board transfer apparatus according to the sixth aspect, wherein the process is to place components on the board and the processed board is a board after the components placement.

According to the aspects of the invention, the board after the process such as component placement is temporarily transferred from the position to the unloader unit, and then in this state that the succeeding board is transferred in from the loader unit to the position, the unloader unit is coupled with the loader unit over the position, where the board is discharged out to the loader unit. Therefore, the replacement of boards can be accomplished smoothly without uselessness.

This board transfer method allows the succeeding board prior to the process to be positioned during the discharge process of the preceding board after the process. Thus, the production efficiency can be enhanced.

BRIEF DESCRIPTION OF DRAWINGS

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to one embodiment of the present invention;

Fig. 2 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to the embodiment of the present invention;

Fig. 3 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to the embodiment of the present invention;

Fig. 4 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to the embodiment of the present invention;

Fig. 5 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to the embodiment of the present invention;

Fig. 6 is a side view showing the arrangement and board transfer operation of the board transfer apparatus according to the embodiment of the present invention;

Figs. 7A and 7B are schematic plan views showing the arrangements and board transfer operations of the board transfer apparatus according to the embodiment corresponding to Figs. 3 and 4, respectively;

Fig. 8 is a schematic side view showing the arrangement and board transfer operation of the board transfer apparatus in Fig. 7A;

Fig. 9 is a side view showing coupling mechanisms in the embodiment; and

Fig. 10 is a side view of a conventional board transfer apparatus.

BEST MODE FOR CARRYING OUT THE INVENTION

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

Hereinbelow, the board transfer method and apparatus according to one embodiment of the present invention are described with reference to the accompanying drawings.

Figs. 1 through 6 are side views of a board transfer apparatus according to the embodiment of the present invention, showing sequential steps. Figs. 7A, 7B are schematic plan views corresponding to Figs. 3 and 4. Fig. 8 is a schematic side view showing the arrangement and board transfer operation of the board transfer apparatus in Fig. 7A.

Referring to the figures, reference numeral 12 denotes an X-Y table, as example of a board positioning table, disposed on a base 6 at a position where the electronic component placement is carried out. The X-Y table 12 holds a board 1 removably and horizontally by a holding portion 12A, and positions the board 1 on a horizontal plane, in which state components are placed. On both sides of the X-Y table 12, an unloader unit 9 and a loader unit 15 are disposed in line.

The unloader unit 9 is equipped with a pair of guide rails 7 for guiding the board 1 via parallelogrammic link mechanisms 8, the guide rails 7 having a drive device for transferring the board 1. Each of the drive device includes a motor 7e, a first pulley connected to a rotary shaft of the motor 7e, and a second pulley 7f connected to the first pulley with a belt 7d so that the belt 7d is moved in two directions by the normal and reverse rotations of the first and second pulleys 7f by driving the motor 7e to transfer the board on the belt 7d. The link mechanisms 8 are each equipped with a drive mechanism similar to the air cylinder 4 of the link mechanism 3 of Fig. 10, by which the link mechanisms 8 can be rotated about fulcrums 8a so that the guide rails 7 are moved up and down while keeping in a horizontal state.

The unloader unit 9 is movably placed on rails 11 disposed along the direction in which the board 1 is transferred. By the drive of an air cylinder 10, the unloader unit 9 can be moved back and forth along the board transfer direction together with the first guide rails 7.

Reference numeral 13 denotes a pair of second guide rails 13 for guiding a board 1 prior to component placement or a board 1 after component placement, the second guide rails 13 being equipped with a drive device for transferred the board. Each of the drive device includes a motor 13e, a first pulley connected to a rotary shaft of the motor 13e, and a second pulley 13f connected to the first pulley with a belt 13d so that the belt 13d is moved in two directions by the normal and reverse rotations of the first and second pulleys 13f by driving the motor 13e to transfer the board on the belt 13d. The second guide rails 13 are attached to the loader unit 15 via a plurality of parallelogrammic link mechanisms 14 having the same construction as the link mechanisms 8, by which the link mechanisms 14 can be rotated about the fulcrums 14a so that the second guide rails 13 are moved up and down while keeping in a horizontal state.

In this arrangement, the first guide rails 7 and the second guide rails 13 are further arranged so that they can be positionally set to any one of an "up position" and a "down position." In the down position (see Fig. 2), the first guide rails 7 and the second guide rails 13 become flush with the board 1 held by the X-Y table 12 while they come into contact with both sides of the X-Y table 12, where the X-Y table 12 is connected to the guide rails 7, 13 via unshown coupling mechanisms, so that a board can be delivered from and to each other. Although the coupling mechanisms is provided in order to ensure the connection between them, if possible, the coupling mechanisms may be omitted.

In the up position (see Fig. 1 and Figs. 3 to 5), the guide rails 7 and the guide rails 13 become flush with each other at a high position. Further, both guide rails 7, 13 are identical in cross sectional shape and dimensions to each other, and placed in line as shown in Fig. 7. The guide rails 7, 13 have, at their end portions on one side on which the guide rails 7, 13 are opposed to each other, coupling mechanisms 7a, 13a for connecting the guide rails 7, 13 to each other, by which a unitary board transfer path can be formed when the guide rails 7, 13 are coupled with each other so that a board can be delivered from and to each other. Fig. 9

shows the coupling mechanisms 7a, 13a one of which has a recess and the other of which has a projection capable of detachably engaging into the recess for connecting the guide rails to each other.

Reference numerals 16, 17 and 18 denote sensors for detecting passage and arrival of the board 1. The sensors are preferably of the light reflecting type or the light transmission type, but not limited to these.

With regard to the above arrangement, its operation and board transfer method are explained below. The transfer process for the board 1 basically comprises the following six steps, where a preliminary step shown below is included at the time of start:

Preliminary step: At a start of board transfer, in the state that the second guide rails 13 of the loader unit 15 is in the down position and is connected to the X-Y table 12, a first board 1 prior to component placement is transferred from the second guide rails 13 into the X-Y table 12 and subsequently a next board 1 prior to component placement is transferred onto the second guide rails 13. Thereafter, the second guide rails 13 are lifted to the up position, where the second guide rails 13 go away from the X-Y table 12, resulting in the state of Fig. 1, in which state the component placement is performed on the first board 1 on the X-Y

table 12. In the steady-state process, since this state has resulted at the tailing stage of the final sixth step, it is sufficient to take into account the first to sixth steps explained below.

First step: Referring to Fig. 1, a board 1 prior to component placement is standing by on the second guide rails 13. There is the board 1 after component placement on the X-Y table 12. With the component placement over, when the X-Y table 12 has returned into position, the first guide rails 7 and the second guide rails 13 move down so as to be joined and connected with rails 112 of the holding part 12A of the X-Y table 12 as shown in Fig. 2. The rails 112 is equipped with a drive device for transferred the board. Each of the drive device includes a motor 112e, a first pulley connected to a rotary shaft of the motor 112e, and a second pulley 112f connected to the first pulley with a belt 112d so that the belt 112d is moved in two directions by the normal and reverse rotations of the first and second pulleys 112f by driving the motor 112e to transfer the board on the belt 112d.

Second step: Referring to Fig. 2, the board 1 after the component placement on the X-Y table 12 is transferred out to the first guide rails 7, while the board 1 prior to component placement on the second guide

rails 13 is transferred in onto the X-Y table 12 (in component placement position), simultaneously.

Third step: Referring to Fig. 2, when the board 1 after the component placement has passed through the sensor 16 and the board 1 prior to component placement has passed through the position of the sensor 18, the first guide rails 7 and the second guide rails 13 are moved up by the drive of their respective air cylinders, going away from the X-Y table 12 as shown in Fig. 3, where the X-Y table 12 starts positioning the board 1 prior to component placement, and the component placement is performed on the positioned board 1 on the X-Y table 12. The board 1 after the component placement moves up to the position of the sensor 17, coming to a stop there. A plan view corresponding to the side view of Fig. 3 is shown in Fig. 7A.

Fourth step: Referring to Fig. 4, the first guide rails 7 attached to the unloader unit 9 are driven by the air cylinder 10 so as to move leftward, as viewed in the figure, moving over above the X-Y table 12, until one end of the first guide rails 7 come into contact with one end of the second guide rails 13 of the loader unit 15. Then, the first guide rails 7 and the second guide rails 13 are joined together by the coupling mechanisms 7a, 13a. A plan view of this state is shown in Fig. 7B.

Fifth step: Referring to Fig. 5, the board 1 after the component placement on the first guide rails 7 is transferred through the connecting portion between the first and second guide rails 7, 13 onto the second guide rails 13, where the board 1 is taken out from on the second guide rails 13 by a robot or the like.

Sixth step: Referring to Fig. 5, at the stage when the board 1 after the component placement has passed through the position of the sensor 18 and has been transferred onto the second guide rails 13, the first guide rails 7 are driven by the air cylinder 10 so as to be moved in such a direction as to go away from the second guide rails 13, i.e., rightward as shown in Fig. 6, coming to a stop at a moving end. Also, onto the second guide rails 13, a succeeding board 1 prior to component placement is set up by the robot or the like and moved in the direction indicated by the arrow in the figure, i.e., toward the X-Y table 12, coming to a stop at the position of the sensor 18.

As shown above, the board transfer operation is iterated with the first to six steps taken as one cycle, while the take-in and the take-out of boards are performed in parallel with the component placement onto the boards.

In the above description, the component placement has been done in the third step. However, it is also possible to perform the component placement in the first step.

As described above, according to the board transfer method and apparatus of the embodiments of the present invention, the replacement of a board after component placement and another board prior to component placement from and to the X-Y table 12 are performed at a time. When the board 6 after component placement that has one been moved to the unloader unit 9 is transferred to the loader unit 15, the first guide rails 7 are joined with the second guide rails 13 over above the X-Y table 12 on which the next board is placed. Thus, an efficient board transfer is enabled in the return-back system production.

In addition, the present invention may be modified and changed in various ways without being limited to the above embodiments.

For example, although the positioning of a board and the component placement have been performed in the same step in the above description, the positioning of a succeeding board prior to component placement can be done simultaneously, for example, during the discharge process of the preceding board after component placement.

In such a case, the time required for board replacement can be shortened to an extent of the board positioning time.

Although the component placement is carried out on the board 1 in the component placement position in the embodiment, the present invention is not limited to such a component placement but can be applied to another process such as an inspection of the component, soldering of the component in a position where such another process is carried out.

According to the present invention, it is enabled to transfer out the preceding board after component placement with a succeeding board present on the X-Y table. This allows a very efficient board transfer to be attained in the return-back system production. Also, one operating robot will do for this system, so that the facility cost can be saved to a relatively low.

Although the unloader unit is moved above the board in the embodiment, the present invention is not limited to this arrangement. That is, for example, instead of the unloader unit, the loader unit can be moved above the board that is in the position until the unloader unit is coupled with the loader unit. Also, although the unloader unit and the loader unit are moved

upward and downward with respect to the board in the embodiment, the present invention is not limited to this arrangement. That is, for example, the board can be moved upward and downward by upward and downward movements of the positioning table with respect to the loader unit and the unloader unit so as to perform the same operations.

The entire disclosure of Japanese Patent Application No. 8-54956 filed on March 12, 1996, including specification, claims, drawings, and summary are incorporated herein by reference in its entirety.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

CLAIMS

1. A board transfer method in which a board (1) is transferred in from a loader unit (15) into a position where a process is carried out on the board and, after the process is carried out, the processed board is returned back to the loader unit and discharged out,

the method comprising:

after the process is carried out onto the board in the position, moving the processed board from the position onto an unloader unit (9), while simultaneously transferring a succeeding board (1) prior to the process from the loader unit into the position;

thereafter relatively moving the unloader unit or the loader unit above the board that is in the position until the unloader unit is coupled with the loader unit; and

delivering to the loader unit, and thereby discharging out, the processed board that has been moved to the unloader unit.

2. A board transfer method according to Claim 1, wherein a succeeding board (1) prior to the process is positioned into the position during a period which the unloader unit or the loader unit is moved above the board in the position so as to be coupled with the loader unit,

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and further the processed board that has been moved to the unloader unit is delivered to the loader unit.

3. A board transfer method according to Claim 1, wherein the process is to place components on the board and the processed board is a board after the components placement.

4. A board transfer method according to Claim 2, wherein the process is to place components on the board and the processed board is a board after the components placement.

5. A board transfer apparatus in which a board (1) is transferred in from a loader unit (15) into a position where a process is carried out on the board and, after the process is carried out, the processed board is returned back to the loader unit and discharged out,

the apparatus comprising:

an unloader unit (9) for guiding and transferring a board;

a driver (10) for moving the unloader unit or the loader unit along a direction in which the board is transferred;

a positioning table (12) for positioning the board; and

a loader unit (15) for transferring the board,

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wherein the unloader unit is coupled with the loader unit through above the positioning table so that the board can be delivered therebetween.

6. A board transfer apparatus according to Claim 5, wherein the unloader unit (9) is equipped with a pair of first guide rails (7) having a drive device (7d,7e,7f) for guiding and transferring a board (1), and the loader unit is equipped with a pair of second guide rails (13) having a drive device (13d,13e,13f) for transferring the board, and then the first guide rails of the unloader unit are coupled with the second guide rails of the loader unit through above the positioning table so that the board can be delivered therebetween.

7. The board transfer apparatus according to Claim 5, wherein the process is to place components on the board and the processed board is a board after the components placement.

8. The board transfer apparatus according to Claim 6, wherein the process is to place components on the board and the processed board is a board after the components placement.