

**Method and device for displacing electronic components ordered in a rectangular structure**

The present invention relates to a method for placing on a flat carrier electronic  
5 components ordered in a matrix structure, comprising the steps of picking up a number  
of components ordered in the matrix structure and placing the components on the flat  
carrier.

The invention also relates to a device for placing on a flat carrier components ordered in  
10 a matrix structure, wherein the device comprises a delivery table on which the  
components are placed in a matrix structure, positioning means for positioning a flat  
carrier on which the products must be placed and at least one transport element for  
picking up from the delivery table and placing a number of components ordered in a  
matrix structure.

15 Such a method usually, though not exclusively, finds application in the production of  
semiconductors. During their production semiconductors undergo different processes  
which take place in different processing stations. The semiconductors must be  
transported between these processing stations. Standardized flat carriers are usually  
20 used for this purpose within a production location. However, the processing stations  
usually deliver the batches of electronic components in a rectangular structure, but not  
in the correct numbers, with the correct pitch or in the correct orientation.

The flat carriers on which the components are placed are usually formed by flat plates,  
25 wherein these plates can then slide into displaceable cassettes.

The flat carriers can however also be formed by conveyor belts which transport the  
electronic components from the one processing station to the following processing  
station. The conveyor belts fulfil a carrying function during the transport. Such  
30 conveyor belts will generally be at a standstill during placing of the electronic  
components, and so the term 'carrier' appears justified. Such conveyor belts must  
therefore be deemed as falling within the term 'flat carrier'.

The object of the invention is to provide means with which numbers, pitch or orientation of groups of electronic components, and particularly, though not exclusively, semiconductor products, can be modified.

- 5 This object is achieved in that the components are placed initially on a positioning table after being picked up, and that the components placed on the positioning table are subsequently picked up again before they are placed on the flat carrier.

- 10 This object is likewise achieved in that the device further comprises a positioning table, and that the at least one transport element is adapted to transport components from the delivery table to the positioning table and to transport the components from the positioning table to a flat carrier placed on the positioning means.

- 15 The displacement of the groups of electronic components in two steps creates the possibility of modifying diverse properties, such as numbers of components, their pitch or orientation.

- 20 According to a first embodiment, at least one quality of the components is visually detected during the stay of the components on the positioning table. For this purpose visual detecting means are arranged for the purpose of detecting components present on the positioning table. This embodiment provides means for determining possible differences in the group of components, such as the absence of components in the group, or non-compliance with visually detectable quality criteria. Possibly determined differences can then be corrected in the second transporting operation.

- 25 The visual detecting means preferably comprise a camera placed above the positioning table, wherein the positioning table is perforated, and wherein illuminating means are placed on the underside of the positioning table. This is a simple but effective measure for detecting the quality of the group of electronic components.

- 30 Because more than one property of a group of components must usually be modified, it is attractive to divide these modifications between the two transport steps. A first option provides the measure that during at least one of the transporting operations of the components at least their relative position is changed.

One of the possibilities for changing a property is to change the pitch between the components. This results in the measure that during a first transporting operation the mutual distance between the components is changed in a first direction, and the measure that at least one of the transport elements is adapted to change the mutual distance  
5 between the components in a first direction.

In order to change the pitch in the other direction, the mutual distance between the components in the second direction can be changed during the second transporting operation. For this purpose at least one of the transport elements is adapted to change  
10 the mutual distance between the components in a second direction extending perpendicularly of the first direction.

For a correct placing on the carrier the group of components is preferably rotated during at least one of the transporting operations. The transport element is preferably provided  
15 for this purpose with engaging elements, the engaging elements are arranged on supports extending mutually parallel and the supports are movable in the direction of the distance between the components to be changed.

In addition to the pitch and the orientation of the group of components, the number of components per group or batch can likewise differ from the number of components that must be transported on a carrier. For this purpose the invention provides the measure that the number of components transported in the first transporting operation is different from the number of components transported during the second transporting operation. The positioning table herein acts as a buffer; the difference between the number of  
20 components transported in the first and the second transporting operation remains behind on the positioning table, and these remaining components are transported in a subsequent second transporting operation.

When the number of components removed from the positioning table in the second transporting operation is smaller than the number of components placed on the positioning table in the first transporting operation, the difference will remain behind on the positioning table. At least some of these remaining components are removed during the subsequent second transporting operation together with some of the components arranged during the intervening first transporting operation. This process is repeated  
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until sufficient components have been collected on the positioning table to carry out two successive second transporting operations without an intervening first transporting operation. It is however also possible for the number of components removed during the second transporting operation to be greater than the number of components delivered during the first transporting operation. Two first transporting operations must then be first performed before a second transporting operation can be performed.

In order to control this method, the presence of a component is preferably detected during the visual detection of the components and, when absence is determined, the absence is corrected during a subsequent transporting operation. This measure is not only applicable to the above described situations, in which the number of components supplied to the positioning table differs from the number of removed components, but also in situations where components are missing due to an error in the production process or when they are removed due to rejection.

For the administrative control of the process, it is recommended that the components are counted during the visual detection of the components. This function can after all be readily integrated into the check for presence on the positioning table.

There are a number of possibilities for constructing a transport element with the mobility of the engaging elements in a single direction. The inventors have found that the construction wherein at least one outer carrying element can be driven by a drive element between a retracted position and an extended position, and other carrying elements are connected by a pin and hole connection to the outer carrying element, results in an effective and relatively simple solution.

For application in the invention the position of the carrying elements need only be defined during the pick-up process and the setting-down process. This provides the option of applying a construction wherein only these requirements are met. A construction wherein in the retracted position the carrying elements are in mutual contact and in the extended position the carrying elements are each in contact with a stop meets this requirement.

The above construction requires driving of the outer carrying element or carrying elements. A particularly simple driving method results when the outer carrying element is connected by a lever to a crank or disc drivable in rotation.

- 5 An alternative to the above elucidated construction is obtained when the carriers are each coupled mechanically to edges of a disc drivable in rotation. This construction requires higher structural standards, particularly in respect of the accuracy of the edges, but has the advantage that it can be of very small construction, which is of the greatest importance particularly when the device according to the invention must be suitable for  
10 small products and the available space is small.

- The above described functionality of changing the pitch of the components by changing the pitch of the carriers relates only to a single dimension. To enable changing of the pitch in both dimensions it is attractive if at least one of the transport elements is  
15 suspended for rotation on a horizontal axis.

- In the case of devices where only a moderate flow rate of components has to be processed, it is attractive to make use of a single transport element which is adapted to transport the components to the positioning table as well as from the positioning table.  
20 The above stated function of rotation of the transport element is essential here; the transport element must after all be able to perform a pitch change alternately in both directions. It is however equally possible to make use of two transport elements, i.e. one for each of the two paths.

- 25 Irrespective of the number of elements, it is recommended that the at least one transport element is drivable in horizontal direction by a linear electric motor. The linear electric motor does after all provide the advantage of an extremely precise controllability in combination with a simple construction. Other types of drive mechanism are however not precluded.

- 30 As will be apparent from the foregoing, the transport elements must usually transport differing numbers of components. It is then attractive when at least one of the transport elements is adapted to transport a controllable number of components.

For the purpose of controlling and optimizing the whole process, the device is preferably provided with a control device, and the control device is preferably connected to the visual detecting device and to the transport element for the purpose of controlling the number of products to be transported.

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The present invention will be elucidated hereinbelow on the basis of the non-limitative exemplary embodiments shown in the following figures. Herein:

figure 1 shows a schematic perspective view of a device according to the invention;

figure 2 is a schematic perspective detail view of a transport element according to the invention;

figure 3 is a cross-sectional view of an upper part of a transport element;

figure 4 is a perspective view of a lower part of a first embodiment of a transport element;

figure 5 is a perspective view of a transport element according to a second embodiment; and

figure 6 is a perspective view of the interior of the transport element shown in figure 5.

Shown in figure 1 is a device which is designated as a whole with 1 and which is suitable for transporting to a carrier 3 electronic components 2, such as semiconductor products, which have undergone a processing. The device is provided with a delivery table 4 on which the preceding process delivers components 2 ordered in a rectangular pattern. The device further comprises a positioning table 5 and a carrier table 6 on which carriers 3 can be placed. Carrier table 6 is movable in horizontal and vertical direction to enable placing of the loaded carriers into a carrier carriage 7. Such carrier carriages 7 are usual in the manufacture of electronic components for transporting the components 2 placed on carriers 3.

The device is provided with a linear electric motor 8 which extends in lengthwise direction and on which two transport elements 9A, 9B are mounted. The linear electric motor is further provided with a guide for guiding the horizontal movement of the transport elements and supporting the transport elements. Left-hand transport element 9A is herein adapted to transport the components from delivery table 4 to positioning table 5, and the right-hand transport element is adapted to transport the components

from positioning table 5 to carrier 3. It is however possible to make use of a single transport element for both functions.

5 Arranged above positioning table 5 is a camera 10 for detecting the components present on the positioning table. A light source is arranged under positioning table 5 for illuminating the components on the underside in order to increase the contrast of the image detected by the camera and to facilitate detection of the presence of components 2.

10 A transport element is shown in its entirety in figure 2. Transport element 9 comprises an upper part 11 which is connected by means of a support 12 to a carriage 13, which is movable by the linear electric motor 8 along the linear electric motor and the associated guide. A lower part 14 is arranged under the upper part 11 of transport element 9. In the present embodiment lower part 14 is rotatable on a vertical axis relative to upper part 11. Lower part 14 of the transport element is provided with an array of elongated 15 carrying elements 15 which are each provided with an array of engaging elements arranged on their underside and not shown in the drawings. The elongate carrying elements 15 are movable transversely of their longitudinal direction for the purpose of modifying the distance between the engaging elements in a single direction.

20 Figure 3 shows a cross-sectional view of the upper part 11 of the transport element. Upper part 11 comprises a housing 17 in which two bearings 18 are arranged. A hollow bush 19 with a central shaft 20 is mounted rotatably in bearings 18. The lower part 14 of the transport element is mounted on bush 19 for movement in vertical direction. Arranged around central shaft 20 is an annular piston 21 to which the lower part of the 25 transport element is fixed. Thus arranged above annular piston 21 is a chamber 22 which, connected to a controllable source of compressed air, controls the height of lower part 14 of the transport element. An electric motor (not shown) is arranged on the outside of housing 17 for driving central shaft 20 in rotation, and thereby the lower part of the transport element. Finally, a number of connections for compressed air are 30 arranged to enable control of a number of functions in the lower part of the transport element.

Figure 4 shows a first exemplary embodiment of a lower part 14 of a transport element. Lower part 14 comprises a frame of which only two walls 25A and 25B are shown in

the drawing, and which frame is connected to central shaft 20. A pneumatic rotation drive device 26 is arranged on the frame for driving a disc 27 in rotation. A number of curved slots 28 are arranged in disc 27. This drive device is preferably adapted to be driven pneumatically, although other types of drive are not precluded.

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Walls 25A and 25B are each adapted to guide carrying elements 15 and engaging elements 16 placed thereon. Arranged on each of the carrying elements 15 is a pin 29 which extends through one of the slots 28. As a result of this coupling between disc 27 and pins 29 together with the design of slots 28, during rotation of disc 27 the carrying elements 15 are driven between an extreme position, in which carrying elements 15 are situated far from each other, and a retracted position in which carrying elements 15 are situated close to each other. It is pointed out here that engaging elements 16 are activated by means of pneumatic energizing. The lower part of the transport element therefore also comprises a number of pneumatic connections for control of the engaging elements.

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Show in figures 5 and 6 is an embodiment of a transport element wherein carrying elements 15 are driven in alternative manner. The outer carrying elements 15A, 15B are each connected by means of a lever 31A, 31B respectively to a disc 32 which is drivable in rotation and which could otherwise also be formed by a crank. Disc 32 is here coupled for rotation to a preferably pneumatically driven motor 26 as in the previous embodiment. The outer carrying elements are moved by rotation of disc 32. Outer carrying elements 15 are each connected to a rod 33A, 33B respectively extending in the direction of movement. These rods are each coupled by a pin-hole connection to the carrying elements 15 drivable in the same direction. These remaining carrying elements 15 are hereby co-displaced during the movement of outer carrying elements 15A, 15B. Because the connection between the directly driven carrying elements 15A and 15B is a connection controlled only by friction, stops are necessary at the extreme positions in order to determine the end position of the indirectly driven carrying elements 15. It is pointed out here that the position of the indirectly driven carrying elements 15 is not precisely defined during the movement. At the end position wherein carrying elements 15 lie closest together the end position is defined in that carrying elements 15 are moved against each other.

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At the other extreme position wherein carrying elements 15 are furthest away from each other, a stop is formed by openings 35 placed in a side wall 34 of the lower part of the transport element and provided with a stepped contour. These walls with openings 35 arranged therein are shown in figure 5. The end position of each of the indirectly driven  
5 carrying elements 15 is defined here by a respective step 36 of opening 35.

The above described device is applied for the purpose of picking up electronic components coming from a processing machine, such as semiconductor products which are delivered in a determined pattern, ordering the components in a modified manner,  
10 checking the components for presence and quality and placing the components on a carrier for further transport. For this purpose the components 4 placed on delivery table 2 by the processing machine are picked up by the first transport element 9A and placed on positioning table 5. The pitch between the components can herein be changed in a first direction and the group of components can be rotated.

15 Once they have been placed on positioning table 5, the components are monitored by camera 10 for presence and optionally for quality. The components are then picked up by the second transport device 9B and placed on carrier 3. The pitch between the components can also be changed during this displacement, preferably in a direction  
20 transversely of the direction in which the pitch was initially changed. A rotation of the group of components is also possible.

The placing of the components on positioning table 5 provides the further option of leaving a number of components behind on the positioning table in the situation where  
25 the number of components placed on the delivery table by the processing machine is not equal to the number of components placed on the carrier.

It will be apparent that diverse variations of the constructions shown here can be applied without departing from the invention.

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**Claims**

1. Method for placing on a flat carrier electronic components ordered in a rectangular structure, comprising the following steps of:
  - 5 - picking up a number of components ordered in a matrix structure; and
  - placing the components on the flat carrier,characterized in that the components are placed initially on a positioning table after being picked up, and that the components placed on the positioning table are subsequently picked up again before they are placed on the flat carrier.
- 10 2. Method as claimed in claim 1, characterized in that at least one quality of the electronic components is visually detected during the stay of the components on the positioning table.
- 15 3. Method as claimed in claim 1 or 2, characterized in that during at least one of the transporting operations of the electronic components at least their relative position is changed.
- 20 4. Method as claimed in claim 3, characterized in that the mutual distance between the electronic components is changed in a first direction during a first transporting operation.
- 25 5. Method as claimed in claim 3 or 4, characterized in that the mutual distance between the electronic components is changed in the second direction during the second transporting operation.
6. Method as claimed in claim 3, 4 or 5, characterized in that the electronic components are rotated during at least one of the transporting operations.
- 30 7. Method as claimed in any of the foregoing claims, characterized in that the number of components transported in the first transporting operation differs from the number of components transported during the second transporting operation.

8. Method as claimed in claim 7, characterized in that the difference between the number of components transported in the first and the second transporting operation remains on the positioning table, and at least some of the remaining components are also transported in a subsequent second transporting operation.

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9. Method as claimed in claim 2, characterized in that the presence of a component is detected during the visual detection of the components and that, when absence is detected, the absence is corrected during a subsequent transporting operation.

10 10. Method as claimed in any of the claims 2-9, characterized in that the components are counted during the visual detection of the components.

11. Device for placing on a flat carrier components ordered in a rectangular structure, comprising:

- 15 - a delivery table on which the components are placed in a matrix structure;  
- positioning means for positioning a flat carrier on which the components must be placed;  
- at least one transport element for picking up from the delivery table and placing a number of components ordered in a matrix,

20 characterized in that the device further comprises a positioning table, and that the at least one transport element is adapted to transport components from the delivery table to the positioning table and to transport the components from the positioning table to a flat carrier placed on the positioning means.

25 12. Device as claimed in claim 11, characterized in that visual detecting means are arranged for the purpose of detecting components present on the positioning table.

13. Device as claimed in claim 12, characterized in that the visual detecting means comprise a camera placed above the positioning table, that the positioning table is  
30 perforated, and that the underside of the positioning table is provided with illuminating means.

14. Device as claimed in claim 11, 12 or 13, characterized in that at least one of the transport elements is adapted to change the mutual distance between the components in a first direction.
- 5 15. Device as claimed in claim 14, characterized in that at least one of the transport elements is adapted to change the mutual distance between the components in a second direction extending perpendicularly of the first direction.
- 10 16. Device as claimed in claim 14 or 15, characterized in that the transport element is provided with engaging elements, that the engaging elements are arranged on supports extending mutually parallel and that the supports are movable in the direction of the distance between the components to be changed.
- 15 17. Device as claimed in claim 16, characterized in that at least one outer carrying element can be driven by a drive element between a retracted position and an extended position, and other carrying elements are connected by a pin and hole connection to the outer carrying element.
- 20 18. Device as claimed in claim 17, characterized in that in the retracted position the carrying elements are in mutual contact, and that in the extended position the carrying elements are each in contact with a stop.
- 25 19. Device as claimed in claim 17 or 18, characterized in that the outer carrying element is connected by a lever to a crank drivable in rotation.
20. Device as claimed in claim 16, characterized in that the carrying elements are each coupled mechanically to edges of a disc drivable in rotation.
- 30 21. Device as claimed in any of the claims 11-20, characterized in that at least one of the transport elements is suspended for rotation on a horizontal axis.
22. Device as claimed in any of the claims 11-21, characterized in that the device comprises only a single transport element which is adapted to transport the products to the positioning table as well as from the positioning table.

23. Device as claimed in any of the foregoing claims, characterized in that the at least one transport element is drivable in horizontal direction by a linear electric motor.

24. Device as claimed in any of the claims 11-23, characterized in that at least one  
5 of the transport elements is adapted to transport a controllable number of components.

25. Device as claimed in claim 24, characterized in that the device comprises a control device, and that the control device is connected to the visual detecting device and to the transport element for the purpose of controlling the number of components to  
10 be transported.